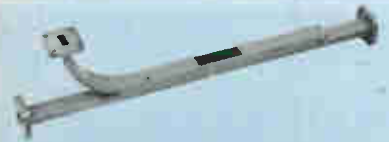
May 27, 1960

electronics

SPECIAL REPORT *Japanese transistor plant symbolizes a nation's booming electronics industry. For a first-hand report on research, development, design, production and marketing* *turn to p 53*

A McGraw-Hill Publication 75 Cents

TESTED *waveguide and coaxial equipment*



hp 752 Multi-Hole Coupler

Precision directional couplers, 3 models, coupling factors 3, 10 and 20 db. Coupling accuracy ± 0.4 db or 0.7 db. Directivity better than 40 db full range, SWR less than 1.05. S through R bands, 2.6 to 40.0 KMC. $100.00 to $375.00.

hp 764D-767D Dual Directional Couplers

High directivity dual coaxial couplers make reflectometer measurements practical in vhf and uhf coax systems. Flat response, high power capacity, low insertion loss. Four models, covering 216 to 4,000 MC collectively. 764D/765D $160.00. 766D/767D $150.00.

870A Slide Screw Tuners

For flattening waveguide systems, matching, etc. Probe position, penetration adjusts to set up reflection canceling existing reflection. Precision lead screw or micrometer varies probe insertion; vernier adjusts probe position. Corrects SWRs of 20 with accuracy of 1.02 SWR. For S, G, J, H, X, M, P, K, R bands. 2.6 to 40.0 KMC. $125.00 to $300.00.

hp 372 Precision Attenuators

Rugged, broadband fixed attenuators retaining precise calibration regardless of humidity, temperature or time. Invariant attenuation assured by permanent, "multi-hole coupler" joining of two waveguides. 10 and 20 db models for S, G, J, H, X and P bands, 2.6 to 18.0 KMC. $100.00 to $375.00.

hp 375A Variable Flap Attenuators

Simple, convenient for adjusting waveguide power or isolating source and load. Max. SWR less than 1.15 full range; attenuation variable 0 to 20 db, dissipates average powers up to 0.5 or 1 watt. S through R bands, 2.6 to 40.0 KMC. $90.00 to $180.00.

WR75 Components—10 to 15 KMC

An increasing number of precision waveguide instruments shown here are available in the M-band, recently allocated for private microwave communications.

See your hp catalog for general description, call your hp rep for prices, details.

hp 476A, 477B Detector Mounts

hp 476A Universal Bolometer Mount, for rf power measurement 10 to 1,000 MC; no tuning, SWR less than 1.25. $85.00. hp 477B Coaxial Thermistor Mount (shown) for rf power measurement 10 MC to 10 KMC; no tuning, SWR less than 1.5, $75.00.

hp 485 Detector Mounts

Three basic series offered: S485A for S band (no tuning, 1.35 SWR, 821 element); 485B, for G, J, H, X bands (tunable, uses 1N23, 1N21, 821 element, 1.25 SWR using barretter); 485D for S, G, J bands (factory-installed 821 barretter). $75.00 to $170.00.

hp 487B Thermistor Mounts

Each covers full range of its waveguide. No tuning, SWR 1.5 or 2.0 max. Max. power 10 mw. Rugged construction, negative temperature coefficient thermistors virtually eliminate burnout. G through R bands. 3.95 to 40.0 KMC. $75.00 to $225.00.

hp 810/815B Slotted Sections

hp 810B Slotted Sections hp 810B, for 809B carriage, flanged, waveguide section with accurately machined slot. Slot tapered at ends to minimize reflection. Available in 6 waveguide bands (including M-band), 3.95 through 18.0 KMC. $90.00 to $110.00.

hp S810A. Complete slotted section assembly including probe carriage. In 2.6 to 3.95 KMC (S-band) size only. $450.00.

hp 815B Slotted Sections For mounting in 814B carriage. Available in K and R bands, 18.0 to 40.0 KMC. Accurately machined; easy interchange, precise positioning. $265.

hp 806B Coaxial Slotted Section 3 to 12 KMC, mounts in 809B, has Type N connectors. $200.00.

hp 805A/B Slotted Lines

Utmost mechanical rigidity, less leakage, greater accuracy, SWR 1.02 or 1.04. Range 500 MC to 4 KMC, reads in cm and mm to 0.1 mm. hp 805A, for 50 ohm Type N, hp 805B, for 46.3 ohm RG 44/U. hp 805A/B, $450.00.

hp 415B Standing Wave Indicator

For all waveguide and coaxial slotted sections. Gives readings in SWR or db. Single frequency operation; 315 to 2,020 cps. Low noise level, 0.1 μv (full scale) sensitivity, 60 db calib. attenuator. $200.00 (cabinet), $205.00 (rack mount).

hp 416A Ratio Meter

Displays ratio between two signals, irrespective of common amplitude variations. Ideal with directional couplers and swept frequency sources for swept frequency measurement of VSWR, reflection coefficient, gain, insertion loss and other microwave parameters. Calibrated in VSWR, % reflection, db. Oscilloscope, recorder output. $475.00 (cabinet) $460.00 (rack mount)

HEWLETT-PACKARD COMPANY

1032A Page Mill Road — Palo Alto, California, U.S.A.
Cable "HEWPACK" — DAvenport 6-7000
Field representatives in all principal areas
HEWLETT-PACKARD S.A., Rue du Vieux Billard No. 1, Geneva, Switzerland
Cable "HEWPACKSA" — Tel. No. (022) 26. 43. 36

6271

presenting 182 high quality

hp FULL-RANGE TESTED microwave measuring instruments

Your hp representative offers two very important advantages

- **the world's most complete (and rapidly expanding) microwave line**
- **complete assurance that the equipment will perform precisely as specified**

hp makes sure you get what you pay for by rigid quality control plus 100% electrical testing using hp developed methods including reflectometer and swept frequency techniques. hp *knows* when a parameter is out of spec; never gambles your money and time that 3 or 4 sample measurements taken across an instrument's range truly indicate its full-range performance.

See your hp rep now for FULL-RANGE TESTED microwave equipment . . . *get what you pay for.*

FREE TEST METHOD DESCRIPTION

Interested in swept frequency testing? Ask your rep, or write direct for "Applications of hp 416A Ratio Meter," describing reflectometer systems and hp swept frequency measuring techniques.

NEW hp NOISE MEASURING EQUIPMENT

hp 344A Noise Figure Meter

Quickly, accurately measures noise figure of operating radar sets. Automatic operation; simple front panel calibration. Militarized, transistorized, reliable in extreme environments, minimum size and weight. Continuous noise figure presentation on most radar receivers. Extremely high sensitivity permits decoupling noise source up to 20 db from main transmitter line to minimize system degradation. Provision for automatic alarm, remote noise figure monitoring, modulating. Meter scale/excess noise options; 30 MC input frequency, 1 MC bandwidth, 75 ohms input impedance. Approx. $1,600.00 (depending on options and modifications selected).

hp 340B/342A Noise Figure Meters

General-purpose instruments making possible, in minutes, receiver and component alignment jobs that once took hours. Simplifies accurate alignment; encourages better maintenance; better performance.

hp 340B automatically measures, continuously displays IF or receiver noise figure at 30 or 60 MC; other freq. on order. $715.00 (cabinet) $700.00 (rack).

hp 342A, similar, operates on 30, 60, 70, 105, 200 MC. 30 MC and 4 other frequencies between 38 and 200 MC on order. $815.00 (cabinet) $800.00 (rack). (Note: Models 340B and 342A available only in the U.S.A. and Canada)

hp 343A vhf Noise Source, temperature limited diode broadband source, 10 to 600 MC, 5.2 db excess noise, $100.00.

hp 345B IF Noise Source, 30 or 60 MC (others to order); 4 impedances, 5.2 db excess noise. $75.00.

hp 347A Waveguide Noise Source, Argon gas discharge tubes in waveguide section; for bands S, G, J, H, X, P, 2.6 to 18.0 KMC, 15.2 db excess noise. $190.00 to $250.00.

Basic test, power and impedance measuring equipment →

World's largest line of FULL-RANGE

BASIC TEST EQUIPMENT

-hp- 382A Precision Attenuators

Popular -hp- 382A series precision attenuators now include in "K" and "R" bands, 18.0 to 40.0 KMC. "K", "R" band attenuators are of new, space-saving design (see photo). Direct reading, one-control setting, high power handling capacity. Attenuation 0 to 50 db full range, independent of frequency. Phase shift constant with attenuation. G, J, H, X, M, P, K, R bands, $275.00 to $500.00.

-hp- 421A, 420A/B Crystal Detectors

-hp- 421A (shown), silicon crystal detector of rf signals in waveguide systems. High sensitivity, for H, X, M, P bands, 7.05—18 KMC. -hp- 421A, $75.00 to $105.00. -hp- 420A, similar but for Type N coax lines, 10 MC to 12.5 KMC. $50.00 each. Also -hp- 420B, same in matched pairs, $150.00 pair.

-hp- 532 Waveguide Frequency Meters

New design for H, M, P, K, R bands. Wide band, direct reading, no interpolation or charts. Has a high Q resonant cavity tuned by choke plunger; no sliding contacts. Transmits almost full power at resonance; resonance indicated by 1.5 db dip in output. Similar model for X-band. $150.00 to $275.00.

-hp- 914 Moving Loads

Waveguide section containing sliding, tapered, low-reflection load. Plunger controls load position, travels ½ wavelength at lowest frequency to reverse phase of residual load reflection. Models for S, G, J, H, X, M, P, K, R bands, 2.6 to 40.0 KMC. $55.00 to $250.00.

-hp- P932A/934A Harmonic Mixers

Mixer for wide band beat detecting, beat frequency mixer for stabilizing a signal source. -hp- P932A 12.4 to 18.0 KMC; -hp- 934A (coaxial) covers 1 to 12.4 KMC. Both models: max. input power 100 mw. -hp- P932A, $250.00 -hp- 934A, $150.00.

POWER MEASURING EQUIPMENT

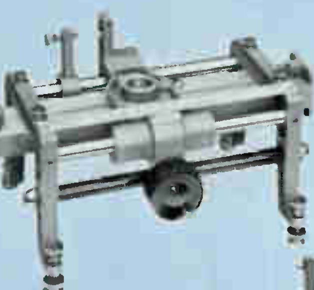
-hp- 434A Calorimetric Power Meter

Connect and read powers 10 mw to 10 watts, dc to 12.4 KMC. No barretter, thermistor needed, no external terminations or plumbing. Measures CW or pulsed power. Two simple controls. Dc input impedance 50 ohms approx.; input SWR less than 1.7 full range, less than 1.3 to 5 KMC. Accuracy within 5% full scale. $1,400.00 (cabinet) $1,385.00 (rack mount).

-hp- 430C Microwave Power Meter

No computations! Provides instantaneous, automatic power readings *direct* in dbm or mw at all frequencies for which there are suitable bolometer mounts. For CW measurements, uses either 1/100 amp fuse or Sperry 821 barretter. Also measures CW or pulsed power with negative coefficient thermistor. Provides up to 16 ma bias current. Operates with -hp- 476, 477, 485, 487 mounts. Range 0.02 to 10 mw. $250.00 (cabinet) $255.00 (rack mount).

IMPEDANCE MEASURING EQUIPMENT



-hp- 809B and 810B

Quick, easy waveguide interchange

-hp- 814B, 815B, 446B

-hp- 809B/814B Universal Probe Carriages

Models 809B and 814B are precision built mechanical assemblies operating, respectively, with -hp- 810B and 815B series slotted sections.

Combination of the 809B carriage and 810 slotted sections covers 2.6 to 18.0 KMC. Combination of 814B carriage and 815B series sections covers 18.0 to 40.0 KMC.

On either carriage, waveguides can be interchanged in seconds. Only one probe (for each carriage) covers full frequency range. Manufacture is of highest quality, assures positive mechanical positioning of interchangeable waveguides and precise installation of mating -hp- probes. -hp- 809B has vernier scale reading to 0.1 mm, is equipped for dial gauge mounting. -hp- 814B has dial read directly to 0.1 mm, interpolated to 0.01 mm. -hp- 809B, $160.00, -hp- 814B, $200.00.

-hp- 444A/446B Untuned Probes

-hp- 444A (shown) is modified crystal (1N76 or 1N26) plus small antenna in convenient housing. Probe penetration easily variable; locks in position. No tuning; sensitivity superior to elaborate single, double tuned probes. Range 3.0 to 18 KMC; fits ¾" bore. *New -hp- 446B* for -hp- 814 Probe Carriage, similar but covers K and R bands, 18.0 to 40.0 KMC. -hp- 444A, $40.00. -hp- 446B, $145.00. -hp- also offers model 440A, for barretter or crystal, Type N coaxial, $85.00.

May 27, 1960

electronics

A McGraw-Hill Publication *75 Cents*

editor MacDONALD

BUSINESS

ENGINEERING

DEPARTMENTS

extremely FAST RECOVERY LOW CAPACITANCE SILICON DIFFUSION COMPUTER DIODES

1N925 • 1N926 • 1N927 • 1N928

5 Mμsec RECOVERY! 4 μμf CAPACITANCE Max. @Zero volts! 500 mW DISSIPATION! DIFFUSED JUNCTION Ruggedness!

Electrical Specifications

TYPE NO.	MIN. SAT. VOLTAGE @ 100 μa @ (volts)	MIN. FWD. CUR. 1.0 volt (mA)	MAXIMUM REVERSE CURRENT (μa)		REVERSE RECOVERY CHARACTERISTICS			MAX CAP. @ ZERO VOLTS (μμf)
			25° C	100° C	REVERSE RESIST. (Ohms)	MAX. RECOV. TIME* (μs)	TYPICAL RECOV. TIME** (Mμs)	
1N925	40	5	1.0 (10v)	20 (10v)	20K	0.15	5.0	4.0
1N926	40	5	0.1 (10v)	10 (10v)	20K	0.15	5.0	4.0
1N927	65	10	0.1 (10v) 5.0 (50v)	10 (10v) 25 (50v)	20K	0.15	5.0	4.0
1N928	120	10	0.1 (10v) 5.0 (50v)	10 (10v) 25 (50v)	20K	0.15	5.0	4.0

*Switching from 5mA to − 10 volts (R_L = 1K, C_T − 10μμf)
**Switching from 5mA to − 10 volts (R_{loop} = 100 ohms, C_L = 8μμf including diode capacitance)

These new Very Fast Recovery, Very Low Capacitance types are added to the broadest line of silicon diffused computer diodes in the industry . . . a *complete* line that also features these high performance PSI originations:

1N643	1N662	1N663
(Mil-E-1/1171)	(Mil-E-1/1139)	(Mil-E-1/1140)

1N789 thru 1N804 High Conductance versions of previously available types.

All types are immediately available in production quantities. Phone, wire or write one of these PSI sales offices for detailed information, prices and delivery schedules.

SALES OFFICES

NEW YORK—2079 Wantagh Ave., Wantagh, L. I., SUnset 1-7470 TWX: WANTAGH NY 2320

BOSTON — 471 Washington Street, Wellesley 81 • CEdar 5-0171

PHILADELPHIA — 320 Huntington Pike, Rockledge • PIlgrim 2-8089 TWX: ROCKLEDGE PA 1064

BALTIMORE — 1811 North Rolling Road, Windsor Building • WIndsor 4-3622

MADEIRA BEACH, FLA.—P.O. Box 8215 • WAverly 1-9735

OTTAWA—227 Lauier Ave., West • CE 2-8504

CHICAGO—6957 W. North Avenue, Oak Park, Illinois • VIllage 8-0750 TWX: OPK 1547

DALLAS—954 Magellan Circle • P.O. Box 6067 • RIverside 7-1258

DETROIT—1204 No. Woodward, Royal Oak • LIncoln 8-4722

LOS ANGELES—8271 Melrose Ave. OLive 3-7850

PALO ALTO — 701 Welch Road, Suite 305 • DAvenport 1-2240

PSI Authorized Distributors from coast-to-coast can supply up to 999 units at factory prices.

PSI ®

Pacific Semiconductors, Inc.

A Subsidiary of Thompson Ramo Wooldridge, Inc.
10451 West Jefferson Boulevard, Culver City, California

CIRCLE 3 ON READER SERVICE CARD

electronics

May 27, 1960 Vol. 33, No. 22

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

Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York, 36, N. Y. Longacre 4-3000. Publication Office: 99-129 North Broadway, Albany 1, N. Y. See panel below for directions regarding subscriptions or change of address.

OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

Subscriptions are solicited only from persons engaged in theory, research, design, production, management and use of electronic equipment. POSITION and COMPANY CONNECTION must be indicated on subscription orders. Subscription rates for individuals within the field of the Publication: United States and United States Possessions, $6.00 one year; $9.00 two years; $12.00 three years. Canada, $10.00 one year. All other countries $20.00 one year. Single Copies, United States, United States Possessions and Canada 75¢; Buyers' Guide $3.00; Single Copies all other countries $1.50; Buyers' Guide $10.00.

Our primary aim is to provide subscribers with a useful, valuable publication. Your comments and suggestions for improvement are encouraged and will be most welcome. The publisher, upon written request from any subscriber to our New York Office, agrees to refund the part of the subscription price applying to copies not yet mailed.

Second class postage paid at Albany, N. Y. Printed in U.S.A.

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

ELECTRONICS is indexed regularly in The Engineering Index and annually in a December issue.

Subscriptions: Send subscription correspondence and change of address to Fulfillment Manager, Electronics, 330 West 42nd Street, New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address, and including postal zone number, if any. If possible, enclose an address label from a recent issue of the magazine. Since copies are addressed one to two issues in advance, please allow one month for change of address to become effective.

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

Audited Paid Circulation

CROSSTALK

CAPE CANAVERAL. From a mile or two away, it looks like a Texas oil field. Only it isn't. The structures jutting into the skyline aren't for bringing in oil. They are there to send out missiles and satellites. Cape Canaveral, Fla., is a busy and important and highly-classified area. Recently a select group of industrial publication editors, newspapermen and television reporters were permitted to tour a ground command guidance center at the Cape. Senior Associate Editor Charest was present. He saw a solid-state computer with a reliability record of 99.89 percent. He saw a new radar with a range of "thousands of miles." And he got the impression Cape Canaveral, in coming years, will be expanding—meaning more business for our industry. His on-the-scene story is on p 43.

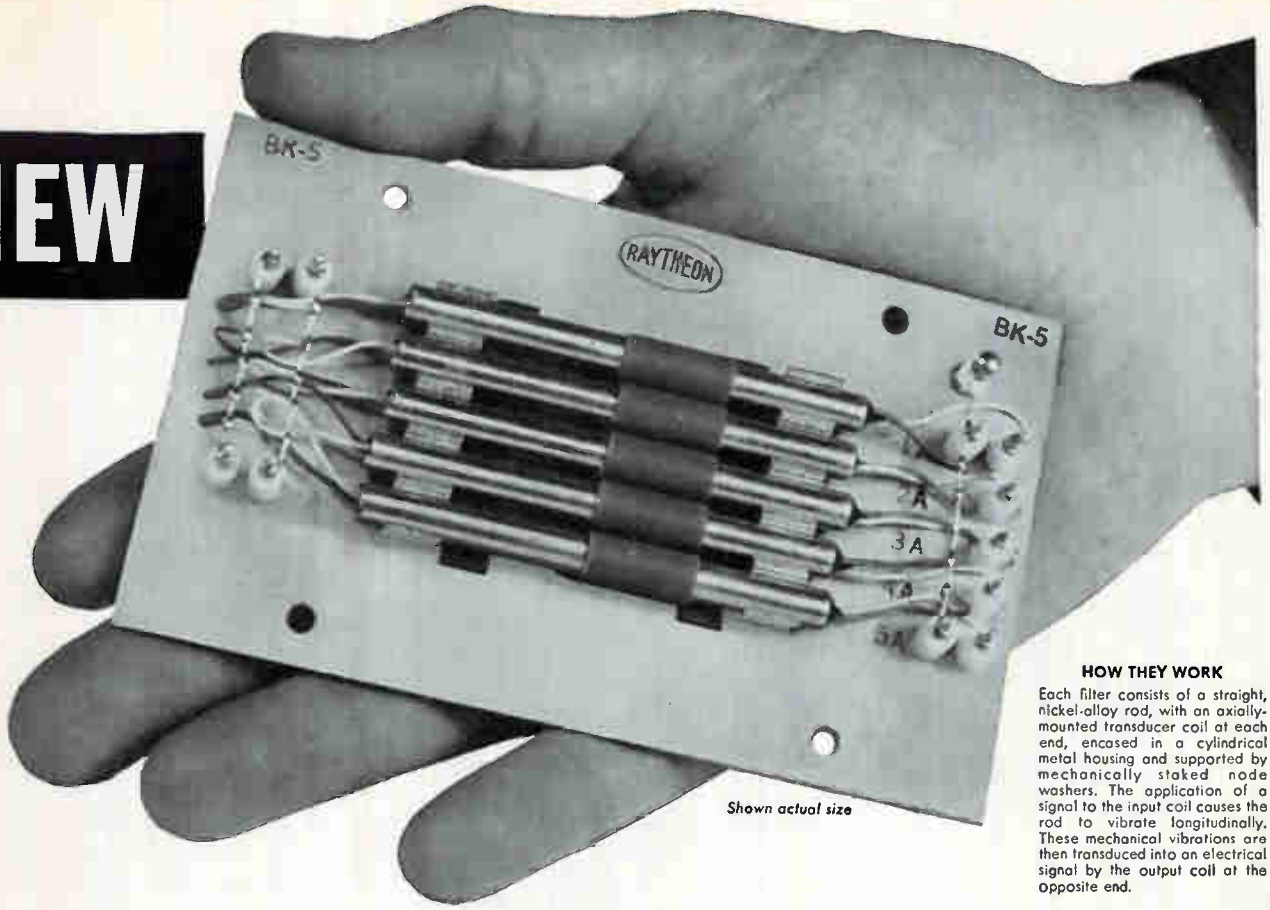
DATA LINKS. Communication between computers is being examined from many viewpoints as the importance of data processing becomes more clearly evident to more classes of users. With the growth of computer centers, ways to allow remote data-gathering stations to send in their findings are also being sought. Among the latest methods is a system that allows computers to "speak" to each other by phone. Developed by American Telephone and Telegraph Co., the concept is proving itself workable in conjunction with IBM equipment. Other manufacturers are also showing interest and indicating plans to form networks for data processing. To learn of some present installations and what lies ahead for them, see Associate Editor Emma's article on p 38.

Coming In Our June 3 Issue

PARAMETRON CIRCUITS. Basic building blocks of many Japanese digital computers are parametrons, which consist of parametrically excited circuits with nonlinear magnetic cores and capacitors as switching elements. The recent large-scale electronic computer, the NEAC-1103, built by the Nippon Electric Company, is based on the parametron. In our June 3 issue, Kyozo Nagamori, Chief of the 4th Laboratory of the Nippon Electric Co. Research Laboratories, gives a full-length treatment of parametron circuits for digital computers. He describes many types of practical logic circuits—AND, OR, NOT, serial and parallel type registers, half and full adders, counter circuits, code converter circuits, etc. This comprehensive six-page article will be a useful addition to the computer-man's library.

NOISE STUDIES. In the mathematical theory of noise, the statistical distribution of axis-crossing intervals of random processes is presently an unsolved problem. For this reason, scientists are designing equipment to measure such intervals. A. J. Rainal, on the Research Staff of the Johns Hopkins University Radiation Laboratory, describes the design of a digital system that automatically measures axis-crossing intervals. Accurate measurement of these intervals will not only provide useful data for the noise theorist, but could conceivably lead to the design of an extremely weak signal detector based on an axis-crossing interval principle.

NEW



Shown actual size

HOW THEY WORK

Each filter consists of a straight, nickel-alloy rod, with an axially-mounted transducer coil at each end, encased in a cylindrical metal housing and supported by mechanically staked node washers. The application of a signal to the input coil causes the rod to vibrate longitudinally. These mechanical vibrations are then transduced into an electrical signal by the output coil at the opposite end.

RAYTHEON MAGNETOSTRICTION

BANDPASS FILTER ARRAYS

cost less...weigh less...take less space...more rugged

Wherever you have an application involving multiple narrow-band filter channels, you'll find Raytheon Magnetostriction Filters will meet your most exacting requirements. They are ideal for *Shock Vibration and Test Equipment, Spectrum Analyzers, Underwater Sound Analysis Equipment, Telemetering Equipment, Oscillators and Wireless Paging Systems.*

Features of the Raytheon Magnetostriction Bandpass Filter Arrays include:

Unlimited combinations can be arrayed at accurately spaced frequency intervals — At 50 kc., center frequency can be adjusted within 0.3 cps.

More economical for arrays in 45 kc to 300 kc range — Priced from $16 to $39 per filter, depending on quantity and type.

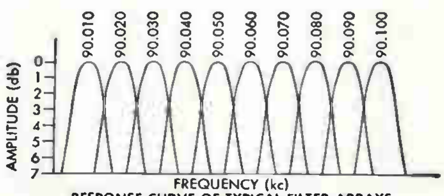
Arrays are smaller and lighter — A bank of ten filters can be mounted on a 3″ x 5″ panel — total assembly weighs only ten ounces.

Higher Q and higher frequencies than toroidal coils — Q from 2000 to 15,000. Resonant frequencies from 45 to 300 kc.

Wide dynamic range — 40 to 55 db.

Stable over wide temperature extremes — Over range from −60°C to +80°C, maximum resonant frequency variation is only 8 ppm/°C.

Ideal impedances for transistor circuits — Single filter input and output standard from 15 to 2000 ohms.



RESPONSE CURVE OF TYPICAL FILTER ARRAYS

Sample orders for Raytheon Magnetostriction Filters are available with no minimum quantity restrictions. For data sheets write Dept. 2527.

RAYTHEON COMPANY **Industrial Components Division**

51 CHAPEL STREET, NEWTON 58, MASSACHUSETTS

Sales Offices: Boston • New York • Chicago • Los Angeles • Baltimore • Cleveland • Dallas • Orlando

Government Sales: Boston • Dayton • Washington

COMMENT

Ions and Health

Reference your article "Ions Affect Health, Behavior" (p 45, Feb. 26). . . Since reading the article, I have noticed that a falling barometer does affect the behavior and tensions in our home. I wonder if positive ions might have some effect on a slight rheumatic condition which both my wife and I have. This also seems to coincide with a falling barometer.

WILLIAM H. HULL
PARKERSBURG, W. Va.

. . . (Our) small but serious-minded group . . . read with great interest the article dealing with the effects upon the human organism of negatively ionized air. We have laboratory facilities available and are currently interested in doing experimental work in connection with ionization and measurement of ionization of air and its various gaseous components, and determination of characteristics of both positively and negatively ionized gases. . . .

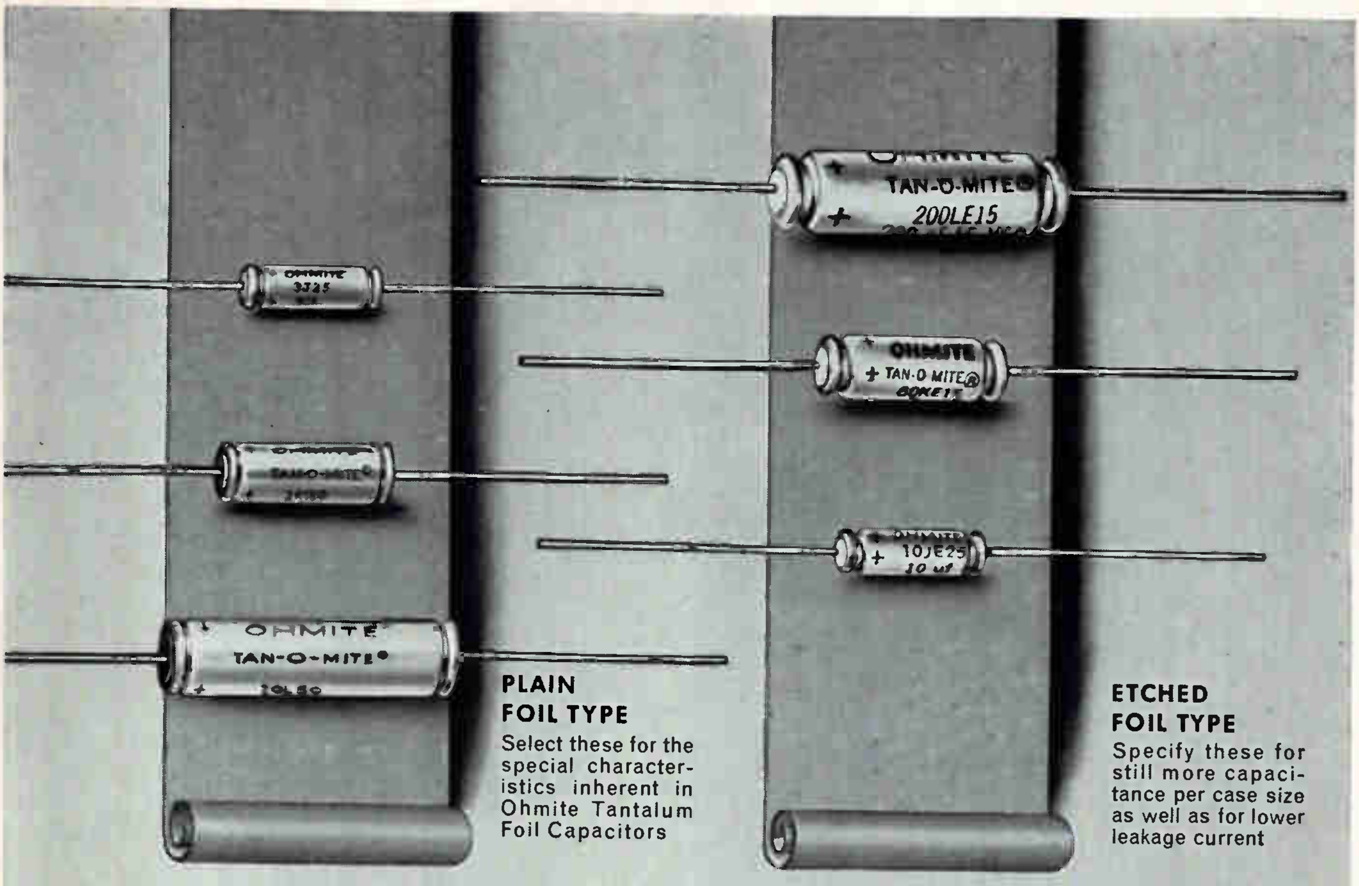
ALTON R. ANDERSON
WOODBURY, CONN.

Readers Anderson and Hull both asked for references and sources, which we were pleased to send on. Other research groups have also written in to get more information on this subject. A surprisingly large body of references already exists in this field, dating to 1899. It makes us feel good to have brought to light a subject of wide interest that research groups are avid to pursue—and which, into the bargain, may be of positive benefit to mankind.

Gremlins

I sincerely appreciate the speed with which you handled my recent article in ELECTRONICS ("Preamplifier Designed for Minimum Power Consumption," p 106, Apr. 29). There are a few points which I feel should be called to your attention.

The first is one of a somewhat



OHMITE TAN-O-MITE®

TANTALUM FOIL CAPACITORS . . .
BOTH PLAIN AND ETCHED FROM STOCK

- **113 Stock Values**
- **Polar and Non-Polar Types**
- **Meets MIL-C-3965B: Insulated and Uninsulated Case Styles; All Vibration Grades**
- **Extra High Capacitance in Small Case Size**
- **Great Stability in Use or Storage**
- **Long Life—in Operation and Storage**
- **Operates in Wide Temperature Extremes**
- **Very Low Leakage Current and Power Factor**

Write for Bulletin 152F

OHMITE

OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois
RHEOSTATS • RESISTORS • TAP SWITCHES
RELAYS • R.F. CHOKES • TANTALUM CAPACITORS
VARIABLE TRANSFORMERS • GERMANIUM DIODES

CONDENSED SPECIFICATIONS—Series TF

Construction Tantalum foil in metal cases sealed against atmospheric conditions. Plastic insulating sleeves optional.

Range Plain foil units, 0.25 to 140 mfds; etched foil units, 0.5 to 200 mfds. Working voltages range up to 150 VDC depending on capacitance.

Tolerances (120 cps, +25°C) Plain foil, ±20%. Etched foil as follows:

less than 50 volts	−15% +75%
50-99 volts	−15% +50%
100-150 volts	−15% +30%

At extremes of operating temperature, the capacitance change meets MIL-C-3965B requirements.

Temperature Range Operation in ambients from −55°C to +85°C.

Power Factor (120 cps, +25°C) Plain foil, 10-15% depending on voltage rating; etched foil, 15-20% depending on voltage rating.

Maximum DC Leakage Current Plain foil, 0.017 microamps/volt-mfd at 25°C; 0.10 at 85°C. Etched foil, 0.01 at 25°C and 0.06 at 85°C.

CIRCLE 7 ON READER SERVICE CARD

minor nature and concerns the way in which the word *nanoamperes* is written. It is my feeling that the term is one word, the same as microamperes, and should not be separated. In the published article we have *nano amperes*.

In Fig. 1, several resistors, capacitors and transistors lack label with regard to part number. Since those parts discussed do have proper notation, no technical difficulty is encountered.

Figure 2 has an error in the caption; reference should be to R_{13} and not R_{18} as printed.

Figure 3 is printed upside down and thus loses its significance. Unless the reader realizes the error, he can become quite confused.

As a general comment with regard to ELECTRONICS, some better method of separating text from advertising material would be most helpful. Several of us here at Hughes have just had our back issues of ELECTRONICS bound (my issues date back to 1953), and the binder had one miserable time . . .

CARL DAVID TODD
HUGHES PRODUCTS
NEWPORT BEACH, CALIF.

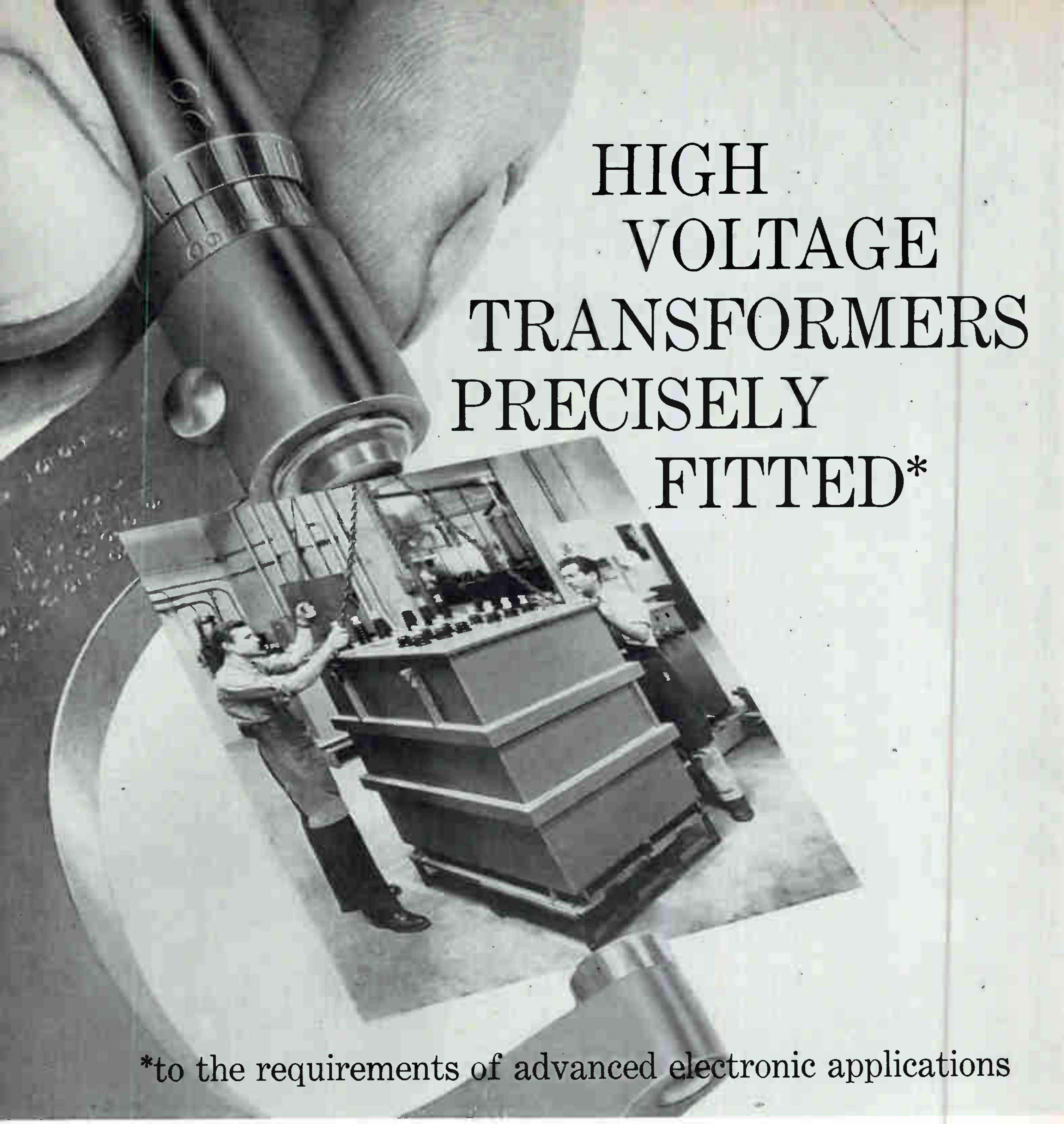
Our main feature section has always been kept free of advertising, and we plan to keep it that way. Many engineers save and bind only the feature section.

More Gremlins

The article titled "Crossed-Field Microwave Tubes" (p 75, Apr. 29; a section of the special report on electron tubes) was scrambled by the printer. Each page is correct in itself, but the sequence of pages is wrong. The article reads correctly if the pages are read in the following order: 75, 78, 79, 76, 77.

WILLIAM C. BROWN
RAYTHEON COMPANY
WALTHAM, MASS.

We regret the gremlins, and the necessity it imposed on our readers to go through the magazine like a study in Brownian movement.



gners of high power transmitters, amplifiers, particle accelerators and other advanced electronic equipment often encounter a lem in finding the **right resource** to meet their exacting specifications for high voltage transformers. The reason: most giant firms have the flexibility to fully accommodate the customer on custom engineered units; while many smaller companies simply don't the technical depth and production capability. **Electro** has all of these qualifications: unique **experience** in custom designing voltage transformers for advanced electronic applications; the **production capability** to build them; and the **flexibility** to do the quickly and economically. Electro units are now being used by electronic systems and equipment manufacturers across the n—in ground radar, scatter communications, missile support equipment, sonic vibration testing equipment, accelerators. If requirement for a high voltage transformer is a little more sophisticated, a bit more demanding and exacting than the average ıen get the complete Electro story.

ELECTRO

high reliability transformers

ECTRO ENGINEERING WORKS / 401 PREDA STREET, SAN LEANDRO, CALIFORNIA

New Plan for Specifying Component Parts

UPSHOT of more than 8,000 man-hours of effort by Defense Department's 50-man Ad Hoc Study Group on Electronic Parts Specifications Management for Reliability may be a central organization to administer a program for control over design and procurement of military components.

The industry group says the key to ensuring high-grade components is specifying parts by failure rate or mean life, and numbering them to coordinate each component with its application and military standard sheet.

A similar quality-control system introduced two years ago in England created a special-quality class of components, boosted procurement costs 3 to 25 times. Overall result in U.S. procurement is expected to be net saving, since more reliable equipment performance should result.

A 250-page report on activities of the study group, now being prepared by the Pentagon, will be released in a few weeks.

Use Strobe Techniques For Picosec Scope

USE OF stroboscope principle for nanosecond and picosecond oscilloscopes was described earlier this month by engineers of Bell Telephone Laboratories. Developmental model of a sampling oscilloscope with 5,500-Mc bandwidth and rise times in the fractional-nanosecond range has been built at the labs.

Fast rise times and high sensitivity are usually compromised in broadband amplifier oscilloscopes; the stroboscope principle makes this unnecessary. Rise time for a stroboscopic scope is a function of bandwidth of sampling circuits, and sensitivity depends on the amplifier gain in low-frequency portions of the instrument.

In the developmental Bell device, a gallium-arsenide crystal is used as a gate, controlled by pulses from a high-speed pulse generator. The gate passes short samples of the signal, which are integrated into a presentation on a low-frequency display tube. If the strobe is synchronized to the input signal, the same portion of the signal will be continuously observed; slightly out-of-sync conditions permit scanning of the input signal. Bell's instrument has been used in studies of pulses of 1-Gc repetition frequency.

Overall sensitivity is 2 mw/cm. Rise times of 200 and 100 picoseconds have been satisfactorily displayed. Strobe pulses are generated by clipping a compound signal formed by a 10-Mc pedestal and a 320-Mc sine wave produced harmonically from the basic 10-Mc strobe.

Infrared Detectors May Change Design

THREE NEW infrared and visual detectors under development at Philco labs may change some design concepts in advanced military and industrial equipment.

Detector for long infrared wavelengths (about 14 microns) consists of a germanium crystal doped with zinc and antimony. The crystal operates in a gas cryostat at 35 K. The device is a photoconductor; it has no *p-n* junction.

An indium-arsenide detector for 4-micron energy has a one-microsecond time constant. The device is photovoltaic, having a *p-n* junction with a gaseous-diffused *p* layer.

A gallium-arsenide detector operates in the optical range (0.4 to 0.9 microns). Its sensitivity is said to be at least as good as that of a 7102 multiplier phototube.

Audio Analgesic Might Aid Dentists

DENTAL ANESTHETIC device that uses stereo sound has been placed in production by Medasonics, a subsidiary of Microsonics Inc., Hingham, Mass. First model has been delivered to Novasonics of Boston, developers of the device.

Controlled volume of stereo music reaches patient through a headset, desensitizes oral areas under treatment. The device can be used for both fillings and extractions. Dental journals report instruments of this type are 85-percent effective in Boston trials on 600 to 700 patients.

Researchers Studying New Energy Sources

RESEARCHERS at Westinghouse are experimenting with the conversion of solar energy by photoelectric emission. I. Limansky and A. S. Jensen demonstrated an experimental photogenerator last week at the 14th Annual Power Sources Conference in Atlantic City, N. J.

The device, developed under sponsorship of the USASRDL Power Sources Division and ARPA, uses an antimony-cesium photocathode to deliver 125 microwatts at 0.01-percent efficiency. However, researchers hope that by using a low work-function anode in the dark and a 2-mil spacing they can eventually achieve power outputs of 10 watts/lb at 2-3 percent efficiency. They speculated on the possibility of fabricating the device in the form of a spherical balloon.

The conference, attended by approximately 1,200 people, also heard several papers describing work on solar cells and regenerative fuel cell systems, including solar conversion systems. Sunstrand Machine Tool Co. is studying the photodissociation of nitrosyl chloride and Lockheed Aircraft is experimenting with an organic dye.

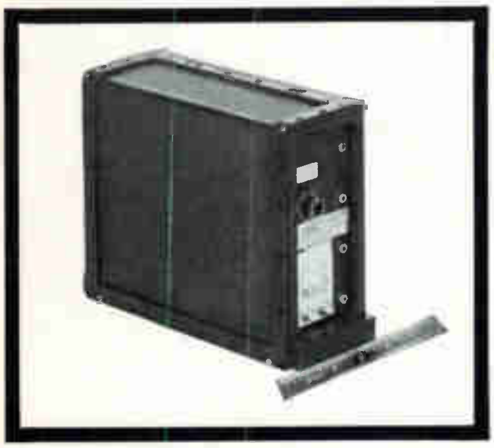
Report Progress in Cryotron Research

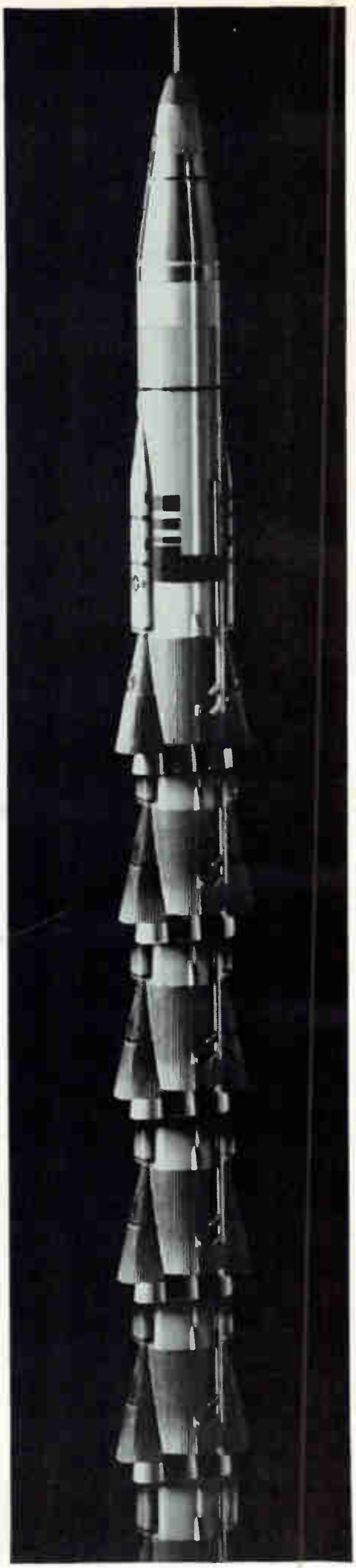
SUPERCONDUCTIVITY symposium held last week in Washington disclosed that basic work in the field is still concentrating on the cryotron, and that the major problem remains one of fabrication.

Three-day session was sponsored by Office of Naval Research's information systems branch. ONR's M. C. Yovits, who directed the symposium, remarked that switching speeds of 100 and 10 nanoseconds—or less—are feasible with the cryotron.

3M COMPANY CHEMICALS **THE RAW MATERIALS OF PROGRESS**

FC-75 SHOCK-PROOFS "HI-FI SET" FOR ATLAS MISSILE





The Atlas climbs toward outer space! Inside, a delicate instrument—an inertia compensated telemetering device, shown left—is at work. Manufactured by the Speidel Corporation of Providence, Rhode Island, this sealed unit contains a continuously operating magnetic tape recorder that is capable of reporting, via telemetry as required, pre-selected conditions that a missile might encounter, i.e.: temperatures, strains, stresses, vibrations, air pressures.

The problem: find a protective "cushion" that will isolate the telemetering device from the missile's violent motion and even a fall to earth, yet permit it to operate accurately and with great sensitivity.

The answer: 3M Brand Fluorochemical Inert Liquid FC-75. Why? FC-75 protects the tape and all associated moving parts of the tape transport from vibrations, shocks, acceleration. And, at the same time, FC-75 remains stable over the entire temperature span of the missile's effective range. It has a pour point of less than minus 100°F., will not break down even at 750°F.

Furthermore, FC-75 undergoes no chemical or electrical changes. It is completely compatible with various materials such as metals, plastics, elastomers, even above the maximum practical temperatures permissible with other dielectric coolants. Therefore, it will not attack the recording tape or any other part of the telemetering mechanism.

FC-75 is ideally suited for many uses in the field of missiles and rocketry because it is nonexplosive, nonflammable, nontoxic, odorless and noncorrosive. It is one of 300 specialty chemicals from 3M serving industry and country. For complete performance characteristics, write today, specifying area of interest to: 3M Chemical Division, Dept. KAX-50, St. Paul 6, Minnesota.

CHEMICAL DIVISION

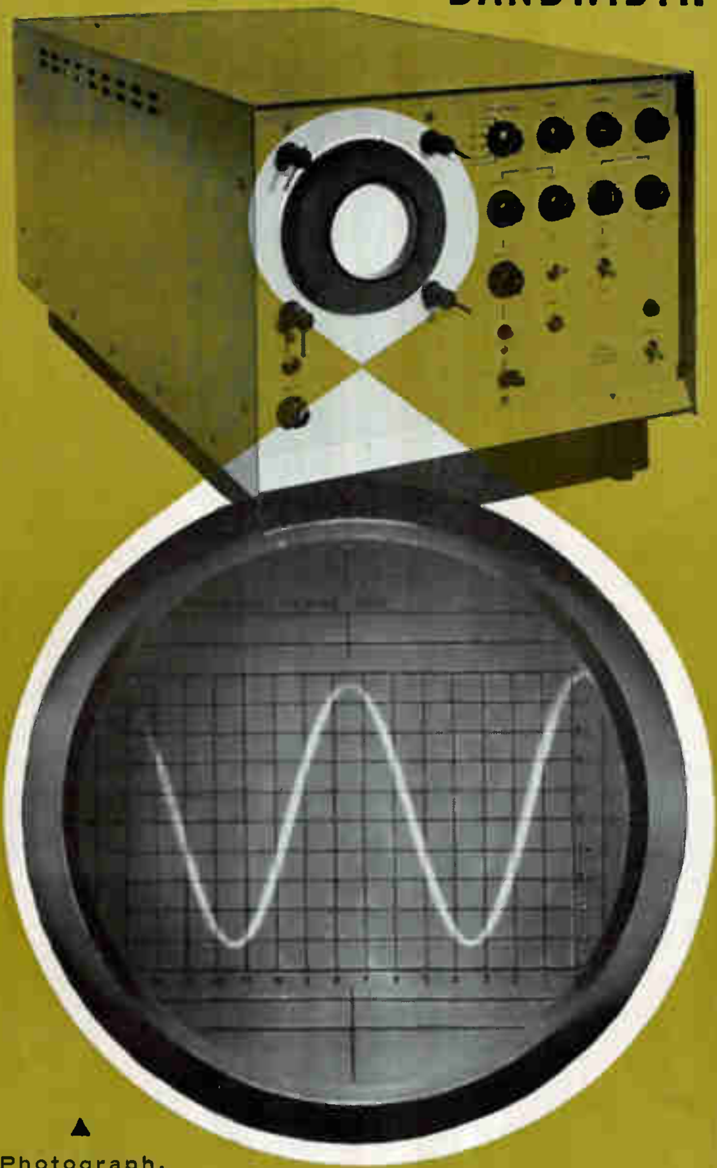
MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

DC TO **2000 Mc** BANDWIDTH

0.2 Mu sec RISE TIME

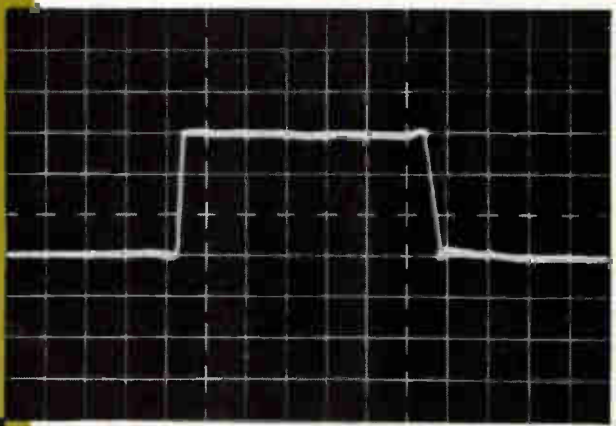


Photograph, actual size, of high frequency sine wave display.

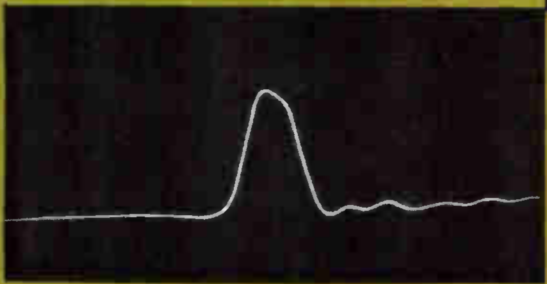
milli-mike® TRAVELING WAVE OSCILLOSCOPE SETS NEW PERFORMANCE STANDARDS

Unquestionably the most advanced traveling wave oscilloscope available, EG&G's new milli-mike is the only scope capable of many types of basic research. Its phenomenal performance gives it *both* single transient and repetitive signal capability. Yet its simplicity and ease of operation make it a highly versatile production-evaluation instrument.

For precise photographic recording, EG&G's Model 850 integrated camera system is recommended. For less accurate requirements, however, any standard camera can be used to record pulse displays through an illuminated reticle attachment which completely eliminates parallax. Single transient displays can be recorded directly from the screen. .0015″ spot size ensures maximum resolution. This, in combination with the fact that signals as low as 5.5 mv will deflect the beam a full trace width, gives you an idea of this instrument's extreme sensitivity.



▲ Pulse display on illuminated reticle photographed with ordinary camera.



◀ Photograph of one milli-microsecond single transient display.

For full details, write for Data Sheet 7070.

Edgerton, Germeshausen & Grier, Inc.
162 BROOKLINE AVENUE, BOSTON 15, MASSACHUSETTS

WASHINGTON OUTLOOK

STILL ANOTHER AGENCY has been added to the Pentagon's decision-making machinery which affects the awarding of electronic research, development and production contracts.

The new organization is the Defense Communications Agency set up to operate a single long-haul military telecommunications system. The unified network will consist of 79 major relay stations scattered around the world. The system represents plant investments of $2 billion, handles 63 million messages annually, involves 6.3 million channel miles of leased wires and 489,000 high quality long-range voice channels.

Once again, the Defense Dept.'s explanation for creating a new agency centers on simplification. The Pentagon says that by unifying the three services' communications systems, it will cut operating costs, eliminate duplication of research and development efforts, and standardize installation and maintenance.

The benefits of centralized control over communications operations are clearcut. But there's a question over the role of the new agency in procurement and R&D. Here, DCA will have a coordinating and consulting function. On this score, decisions on contract awards and other hardware matters may be stretched out as the new agency's views are imposed upon those of the individual services and other agencies in the office of the Secy. of Defense.

For instance, DCA will consolidate and analyze communications facilities requirements; translate approved requirements into system plans for detailed engineering and system engineering into program guidance, including the assignment of priorities; review and coordinate R&D projects related to the unified long-haul system.

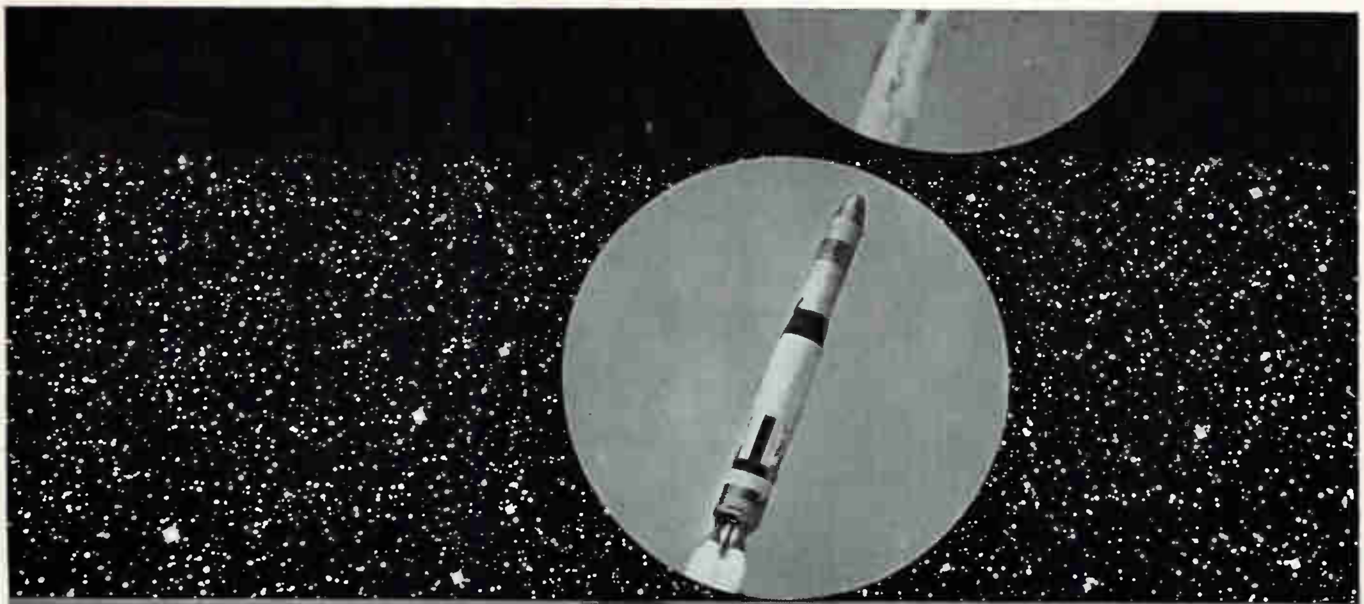
Excluded from the new agency's operations are: tactical communications which are self-contained within tactical organizations; self-contained information gathering, transmitting and processing facilities which are normally local in operation and use; weapons system requirements which cannot be met through DCA facilities; and land, ship or airborne terminal facilities or broadcast, ship-to-shore, ship-to-ship and ground-air-ground systems.

COMMERCE DEPT. meets this week with a committee of electronics industry representatives to discuss spurring exports of U. S. goods.

Major feature of the Administration program: short-term insurance to exporters against political risks, such as losses due to a change in government or monetary devaluation. Exporters complain that such measures, while of some value in exporting to unstable or underdeveloped nations, do little to open the big markets in nations with advanced economies. Some exporters would prefer direct protective action.

While the Commerce Dept. plans to step up its publicity efforts, many in Congress and elsewhere are skeptical over results. They want to extend the program to stimulate exports by providing insurance to exporters against all commercial losses—nonpayment of debt by a foreign customer, for instance. The White House, so far, is cool to this scheme.

A $39-MILLION authorization for building educational tv stations has been killed by the House Rules Committee after passing the Senate. The bill lost on a 5-5 vote with Republican opposition. Democrats had touted it as a way of saving school costs by stimulating tv teaching. Republicans attacked it as unnecessary spending.



Building Strength Upon Strength… the USAF Ballistic Missile Program

The strength and prestige of this nation depends upon many things . . . important among these are the successes of the Air Force Ballistic Missile Program and related advanced space projects.

In turn, these programs depend upon the continuing flow of new ideas and inventions. All of these are part of a common pool of knowledge and know-how which are drawn upon for today's capability and tomorrow's advances.

In building strength upon strength in the race for space technology leadership, the knowledge and experience gained from Atlas, Thor, and Titan ballistic missile systems developement is being applied to advance Minuteman. For these programs, under the management of the Air Force Ballistic Missile Division, Space Technology Laboratories has had the direct responsibility for over-all systems engineering and technical direction. As these ballistic missile and related space programs go forward, STL continues to contribute technical leadership and scientific direction.

STL

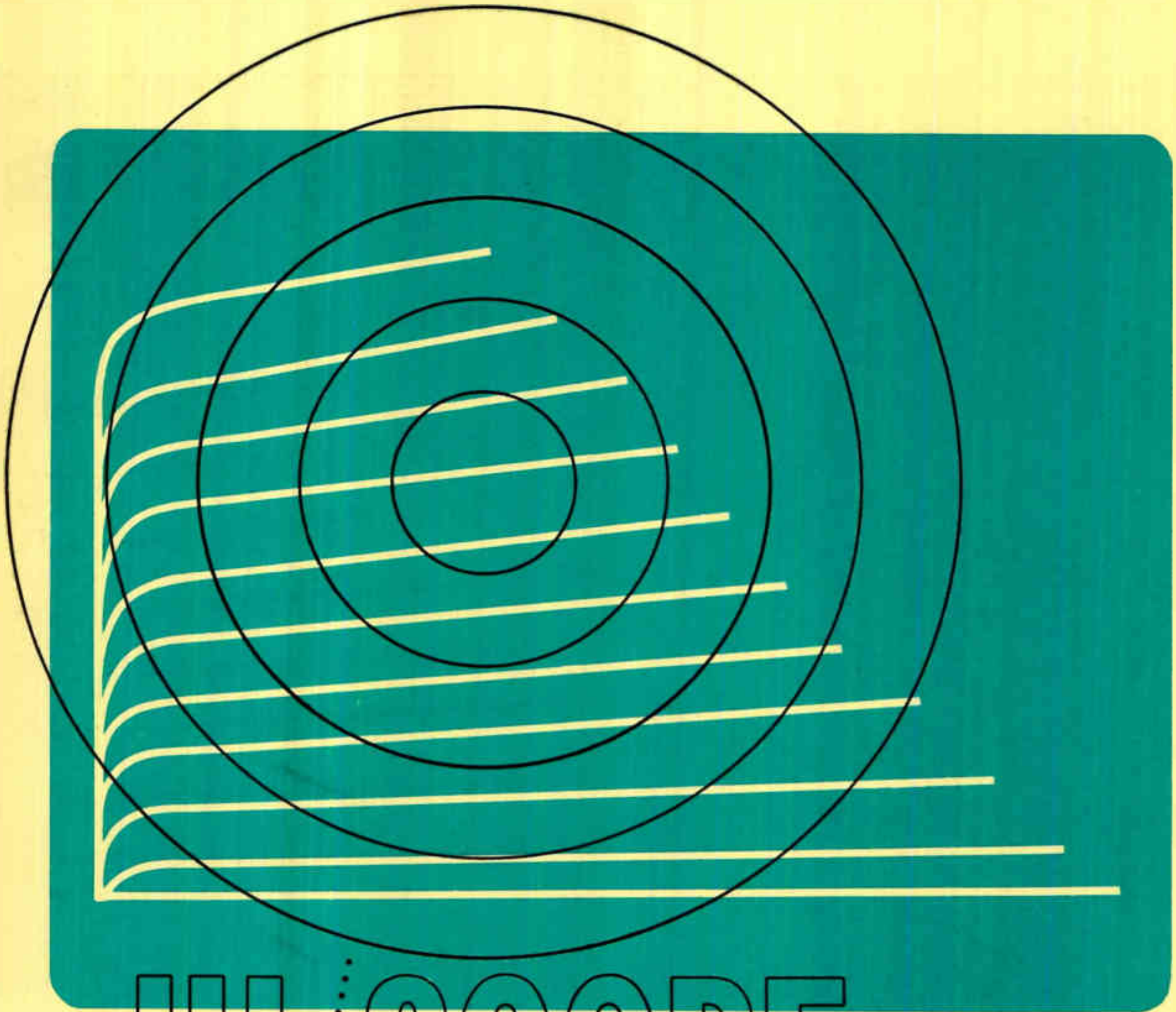
In this capacity STL offers unusual opportunities for creative work in the science and technology of space systems. To those scientists and engineers with capabilities in propulsion, electronics, thermodynamics, aerodynamics, structures, astrophysics, computer technology and other related fields and disciplines, STL now offers immediate opportunities. Please address your inquiries and/or resumes to:

SPACE TECHNOLOGY LABORATORIES, INC.

P. O. Box 95004, Los Angeles 45, California

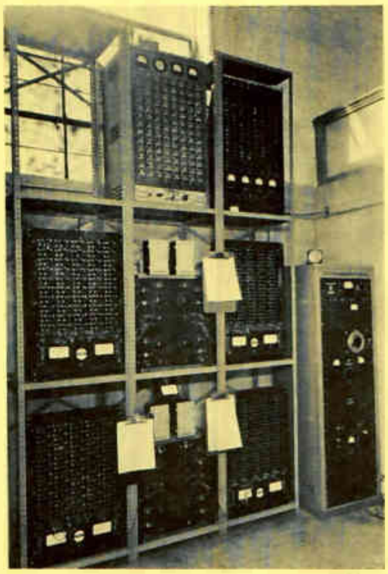
Los Angeles • Santa Maria • Cape Canaveral • Washington, D. C.
Manchester, England • Singapore • Hawaii

CIRCLE 17 ON READER SERVICE CARD→



HI/SCOPE

General Transistor's Program of Service Especially Helpful in Designing For Military Use



General Transistor offers you a program of assistance that is truly unique in scope. This service, which we call HI/SCOPE, reflects the flexibility of our company. It can be personalized to anyone's requirements, and is especially helpful in designing for the military.

Here are some of the ways we are currently helping GT customers ... ways in which we'd like to help you.

100% Lot Preconditioning

Let's assume you have equipment which must undergo severe environmental conditions ... be subjected to high mechanical shock and vibration. To be certain that all the transistors you intend to use will withstand this type of exposure, we will set up a preconditioning program that will test out every single unit before we ship to you.

GENERAL TRANSISTOR CORP.

91-27 138th Place / Jamaica 35, New York

Special Electrical Parameter Testing

Certain transistor applications are so unusual that they cannot be completely described by standard parameters. If you are in such a position, we will design a test fixture to closely approximate actual circuit performance. This procedure will provide assurance that 100% of the transistors delivered to you will perform satisfactorily.

Special Selection on Standard Catalog Types

In many instances you may find that a standard catalog transistor is about 90% acceptable, but still needs improvement in a few parameters. In such a case, please ask us about the possibility of getting these improvements. We can tell you what increase in specifications is feasible, and produce the units to this spec. Thus, you get the desired parameters without having to redesign or wait for a custom-built semiconductor.

Special Reliability Testing Programs

Must your completed systems meet a high reliability requirement? If so, you may wish special procedures to be established with regard to your reliability programs. This is another GT service. When necessary, we will build such transistors on a specially designed production line, check them exhaustively to hold tight parameter tolerances, and subject large lots to specific and unique life tests. In many cases, we have established a program so that we ship those units which have high survival probability in your application. These things we have done, and will do again, at your request. Sound helpful?

Qualification Approvals

Let's consider the case where you want to design a certain transistor into a system for the government, yet a government specification does not exist for the transistor. You must be ready to substantiate your use of the non-standard part. Here's what GT can do to help your case. We will run a qualification approval procedure in the same format we would for a military type. Then we'll provide you with this necessary data. This will greatly accelerate your approval for use of this transistor type.

High and Low Temperature Testing

Standard transistor parameters are generally controlled at room temperature. Yet many systems must function at other ambients. If you have a problem specifying electrical parameters at room temperature in a manner that will be valid at high or low temperatures, we are ready to assist. General Transistor is prepared to run any measurements you dictate, at any specified ambient. We can do this on complete production lots if you feel it essential.

Special Coatings or Encapsulations

In your manufacturing process, do you expose transistors to any kinds of solvents or potting materials? If so, just let us know. By using special highly resistant coatings, we'll make sure that the transistor case and markings are not vulnerable to solvent attacks.

Cost Economies Through Parameter Modifications

Yield has a strong influence on transistor cost. To give you the best economies and at the same time give you the most desirable quality, we offer this working arrangement. At your request, General Transistor will suggest slight modifications of your specifications which will allow us to ship the major portion of a production run. We will make the necessary measurements and indicate what the various parameters should be and what proportions of the run will fall into preselected types. If you then design your system to use this production mix, you will benefit from some genuine economies.

Samples with Parameter Measurements

Assume you want to check out the margins in a design. You require upper and lower limit samples of a certain transistor type. We'll be happy to supply you with sufficient samples to cover the spread in one or two significant parameters. Thus, you can experimentally determine the performance of your circuit.

Circuit Design

If you are starting on a new program, you may want some information on what performance you can expect from state-of-the-art circuits. We will provide you with such typical circuits at your request, together with data on the performance of our transistor types within these circuits.

Special Production Runs

Assume that your transistor application is so unusual that units are not available from standard production. What can be done? We will analyze your requirements and decide whether it would be feasible to make a special production run of transistors to meet your needs.

These services are typical of GT HI/SCOPE.
Write or call for specifics
relating to your own projects.

GENERAL TRANSISTOR CORP.

91-27 138th Place / Jamaica 35, New York

1055/360/85

Thanks to you . . .
CTI SETS A NEW STANDARD FOR WIRING-HARNESS TESTERS

After carefully reviewing customer requests received during the past few years, CTI has designed an automatic tester incorporating every feature desired by the manufacturer or user of wiring harnesses and cables. Compact, inexpensive, and simple to operate, the new Model 165 Cable Tester can handle the most complex wiring test problems. Test capacity can be increased indefinitely by adding small switch-unit modules to the basic equipment.

Only the CTI Cable Tester offers all these features:

- Completely automatic
- Simple operation, go/no-go readout
- Simultaneous continuity, leakage, and hi-pot measurements on each test
- Leakage measured from the circuit under test to all others
- Self-testing and fail-safe — validity of tests is assured
- Wide choice of test parameters from calibrated, front-panel controls
- Simple programming without complex patchboards
- Branch circuits can be programmed without sacrificing additional test points
- Precision bridges assure accuracy and stability of measurements
- Provides control of relays in the circuit under test
- Accessory printer lists rejects
- Manufactured by a company that has pioneered automatic testing

SPECIFICATIONS

Continuity test currents: Off, 0.1, 0.5, 1.0, and 2.0 amps d-c
Continuity accept limits: 0.1, 0.5, 1.0, 5.0, and 10.0 ohms (maximum test current on the 1-, 5-, and 10-ohm ranges is 1.0 amp.)
Hi-pot voltages: Off, 28, 100, 500, 1000, and 1500 volts d-c (hi-pot current limited to approximately 1 ma)
Leakage-resistance limits: 1, 5, 10, 100, and 500 megohms
Hi-pot dwell time: continuously variable from 0.2 secs to 100 secs
Test rate (maximum): 5 circuits per second (0.2 seconds dwell time)
Test capacity: 200 tests plus 200 for each complete, additional Switching Unit used. Switching Unit panel may be supplied with 50-test switch modules as needed.

Each of the above test parameters can be selected independently of the others. All values are set with front-panel selector switches.

Engineers: Career opportunities are currently available at CTI

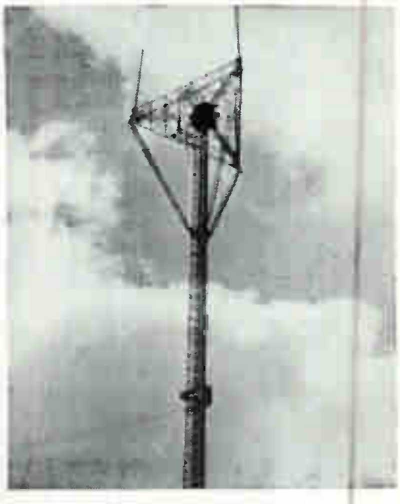
CALIFORNIA TECHNICAL INDUSTRIES
DIVISION OF TEXTRON INC.
BELMONT 8, CALIFORNIA
Foremost in Automatic Testing

ANTENNA TOWERS & STRUCTURES

Dresser-Ideco Designs, Fabricates, Erects A Wide Variety of Large Land-Based Antenna Structures

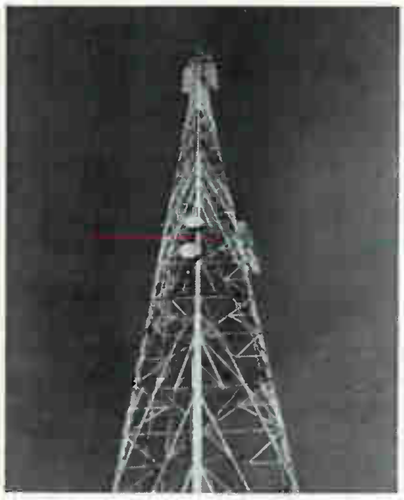
Whatever the antenna tower or structural problem, Dresser-Ideco can handle the job. A large technical service staff, more than a quarter-million square feet of well-equipped production area, extensive research and development facilities, and many years experience designing and erecting steel and aluminum structures qualify Dresser-Ideco as a major contractor for any type of antenna tower . . . from 100 to 2000 feet. Below are some of the many types of Dresser-Ideco towers serving the nation's communications and military electronics facilities.

A.



B.

C.



A. Multiple antenna tower. This big 729' tower in Baltimore supports three television antennas on a 105' wide platform at the top.

B. Antenna test range tower for height finding radar.

C. Microwave antenna tower typical of those used in systems built for the Ohio Turnpike and the Illinois Toll Road.

D. Surveillance radar towers on the DEW line. Designed for hurricane force winds and heavy ice and snow loads. These are some of more than 1,000 radar towers built by Dresser-Ideco for the nation's early warning systems.

D.

Dresser-Ideco offers a complete tower and structural service—design, application, field installation. Call or write for consultation on your structural problems at no obligation. Send for booklet "Facilities For Defense Production". Dresser-Ideco Company, A Division of Dresser Industries, Inc., 875 Michigan Avenue, Columbus 15, Ohio. Branch: 8909 So. Vermont Avenue, Los Angeles 44, Calif.

DRESSER-IDECO COMPANY

DRESSER IDECO®

DRESSER INDUSTRIES INC.

ELECTRONIC • INDUSTRIAL
OIL • GAS • CHEMICAL

Three-way Split for 3-M Stock

STOCKHOLDERS of **Minnesota Mining & Manufacturing Co.** have approved a 3-for-1 split of common stock, according to company officials. Also approved is the amendment of the company's incorporation certificate to increase authorized common stock from 25 to 75 million shares. Also approved is an increase in quarterly dividends to 45 cents per share payable on June 12. First-quarter sales for 3-M this year were $128,669,218, compared with $115,172,320 a year ago.

Indiana General Corp., Valparaiso, Ind., has approved a 2-for-1 stock split to be issued June 10. Also announced is the declaration of a 30-cent dividend payable on the same date. The company, which specializes in magnetic materials, permanent magnets and ferrites, reports first-quarter sales and earnings this year were 15 percent above those of last year.

Collins Radio reports formation of a French subsidiary company to promote sales and service. The new entity, **S.A.R.L.**, is located in Paris. The U.S. company has formed similar firms in Australia and Germany.

Century Geophysical, Tulsa, Okla., announces purchase of **Smalley Radio, Ltd.**, Calgary, Alberta, Canada. Century, which engages in geological exploration and manufacture of electronic instruments for that field, will use Smalley facilities for the conduct of its Canadian business.

Avien, Inc., Woodside, L. I., reports purchase of **Colvin Labs.**, East Orange, N. J., and **Pressure Elements, Inc.**, also in East Orange. Combined sales of both N. J. companies last year were $620,000.

Common stock of **Emerson Electric Manufacturing Co.** will be exchanged for the assets of **Day-Brite Lighting Co.**, if stockholders of the St. Louis, Mo., firms approve at their June 8 meeting. For each share of Day-Brite held, shareowners will receive 0.43 shares of Emerson. A total of 316,119 Emerson shares will be exchanged for 735,160 shares of Day-Brite.

Lerco Electronics, Burbank, Calif., reports acquisition of **Automation Development Co.** of Los Angeles through an exchange of stock. A-D is producing logic systems for electronic systems and stepper motors. Both firms manufacture equipment for controlling automation production.

ACF Industries, Inc., reports acquisition of a block of 214,000 shares of **Republic Aviation.** This block represents approximately 15 percent of the 1,437,148 Republic shares outstanding. W. T. Taylor, ACF board chairman, says the purchase will allow his company to increase the stability of its defense business and strengthen its position in electronic research and production.

25 MOST ACTIVE STOCKS

WEEK ENDING MAY 13

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Ampex	1,943	37¾	33⅛	37⅝
Int'l Tel & Tel	1,533	43⅝	41⅝	43½
Gen Inst	1,407	35¼	30⅛	33
Burroughs	1,182	37⅜	33⅜	36¾
Sperry Rand	1,048	23¾	21⅜	23½
Lockheed	1,045	21¼	18⅝	20½
RCA	897	75¾	72½	75¾
Int'l Resistance	859	26⅜	22½	25⅝
Reeves Sndcrft	783	9½	7	9⅛
Raytheon	622	40⅞	37	40⅞
Siegler Corp	586	40¼	36¾	40¼
Varian Assoc	576	52⅝	48⅛	52½
Lear Inc	564	17¼	14⅛	16¾
Barnes Engnr'g	511	41⅜	31¾	39½
Gen Electric	470	90⅜	88¼	89⅛
Clevite	462	62½	57	62
Avco Corp	448	12½	11¾	12¼
DuMont Labs	426	9¼	8⅛	8¾
Temco Aircraft	416	14¾	12⅝	13⅞
Philco Corp	416	32⅝	29¾	32⅜
Westinghouse	412	55¼	52½	54¾
Magnavox	408	47½	44	47⅜
Microwave Assoc	398	33⅞	27¾	33⅞
Litton Ind	394	78⅞	71⅜	77¼
Texas Inst	384	227¾	213¾	226¼

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.

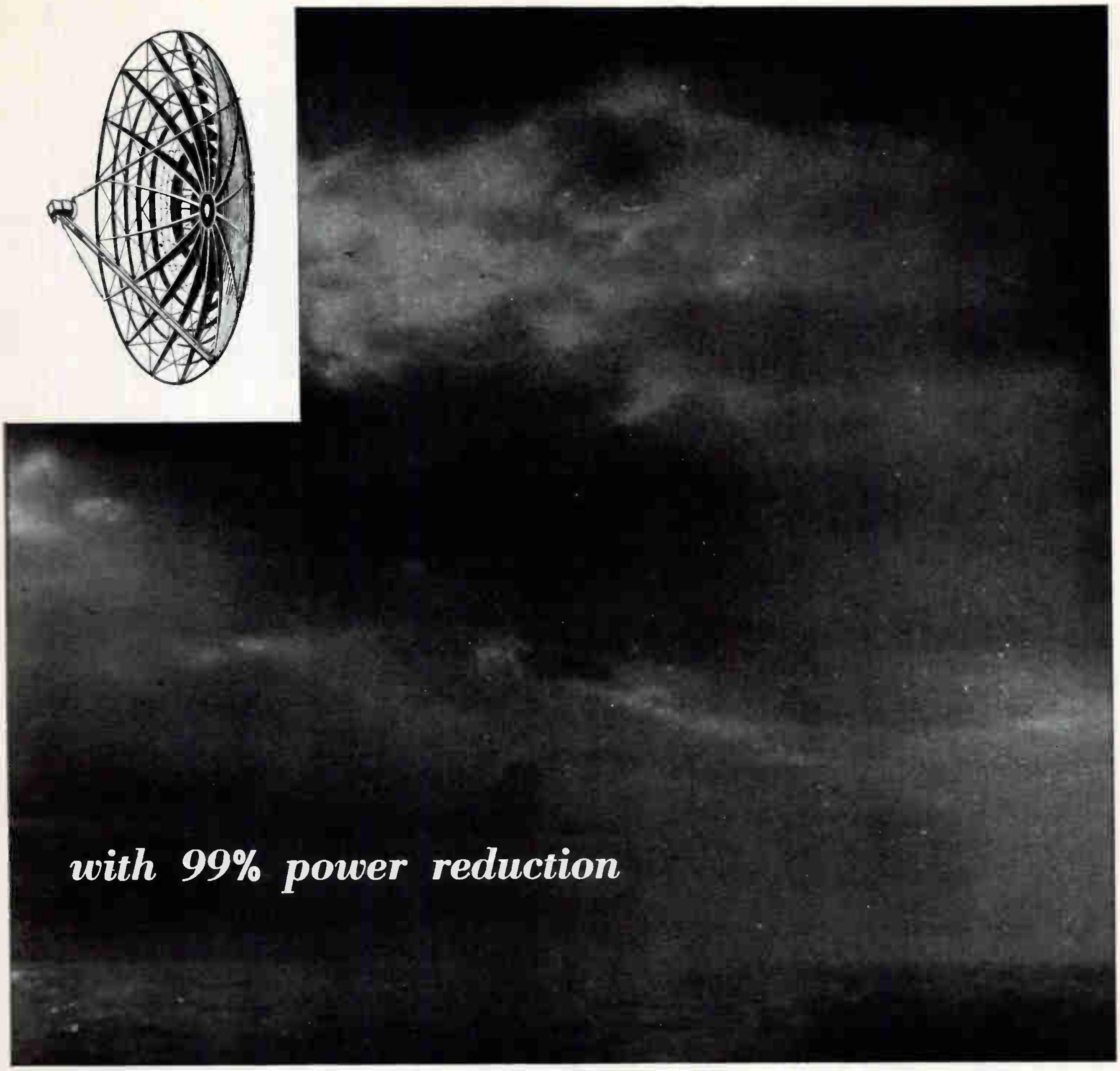
CIRCLE 23 ON READER SERVICE CARD

Here is an important new advance in microwave communications—NEC's High Sensitivity Reception system. By combining high sensitivity reception, parametric amplifier, low feeder loss design, and the high antenna gain possible at 2000 mc, this system improves S/N ratio by more than 20 db.

This permits hops at 1/100 of the power required for conventional links. For example, a 400 W OH-2000 using a 33-ft. dish is capable of a 300-mile hop at 99.0% reliability with quadruple diversity and reliability of 99.9% at 260 miles. Other systems would require a 40 KW transmitter for the same hop.

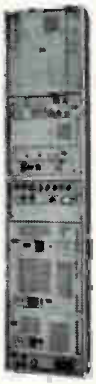
The OH-2000 is drastically reducing installation and maintenance costs of over-the-horizon links in capacities up to 60 voice channels. A descriptive brochure is available on request.

Components / Systems NEC



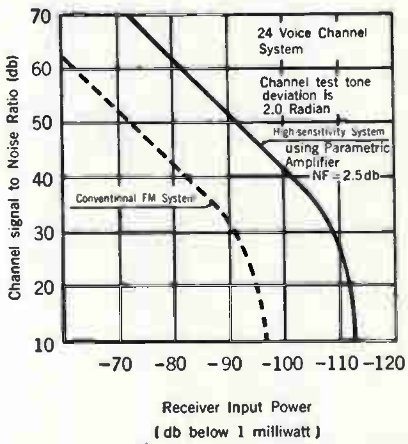
OH-2000 in military communications

First major OH-2000 installation will be a 17-station system for the United States Air Force linking radar sites on the three main islands of Japan. The system contains no active repeaters. Longest hop is 145 miles at 100 W output. Guaranteed reliability is a character error of no more than 1:10,000 for 99.9% of a year's hours.



OH-2000

The compact 100 W transmitter uses economical planar tubes in the final stage. A quadruple diversity station requires a radio room of only 100 Sq. ft. NEC can also supply completely transistorized carrier equipment.



Nippon Electric Company Limited Tokyo, Japan

Affiliated with International Telephone and Telegraph Corporation

Tv Sales: 60-70% Higher in '70

RETAIL SALES of tv sets will rise to a record high of nine to 10 million units by 1970, Frank Mansfield predicted at a recent American Statistical Association conference on forecasting. Mansfield is director of market research for Sylvania and chairman of the EIA marketing data committee.

Last year 5.7 million tv sets were sold, 12 percent more than in 1958. Record to date is the 7.4 million sets sold in 1955.

Mansfield's prediction is based on rapidly increasing replacement sales, trend to multiple-set homes and rising number of households.

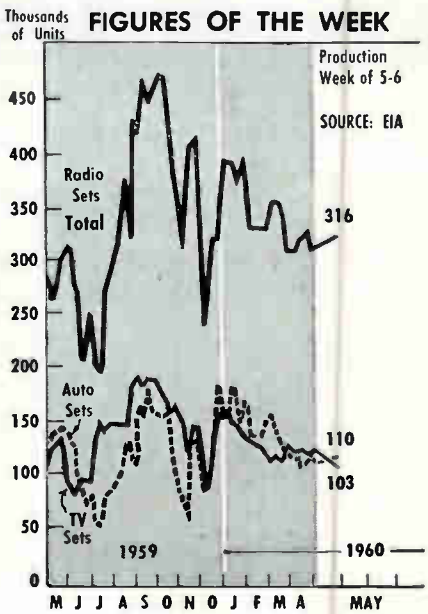
By the end of this decade, replacement sales are expected to more than double, as average age and number of sets in use rise. Trend to multiple-set homes will raise average number of tv sets per home from 1.12 in 1959 to about 1.5 in 1970. The approximately 10 million new households in the next ten years will mean many new initial set sales.

The 1970 sales estimate above includes both black and white and color sets. What proportion will be color is impossible to predict, says Mansfield. We do not even have reliable statistics on color set sales or color sets now in use, he says.

In the past, color set growth has been slowed by high prices, high maintenance costs and limited programming, he said. Prices are about three times the black and white prices and maintenance costs are in the order of nine to one. Three to four hours of color programming cannot be compared with 18 hours of black and white, as far as viewers are concerned, he says.

As long as these differences prevail, color sets will have a limited market, he indicated. Of course a technical revolution or a basic change in consumer psychology could alter sales prospects considerably.

Bureau of Census issues two preliminary industry reports from its 1958 Census of Manufactures which are of particular value to electronics industry marketers: Electrical Measuring Instruments and Electron Tubes (includes semiconductors). Reports show shipments in 1954 and 1958 and list the number of employees and establishments.



HITACHI ELECTRONICS

In Electronics are combined the exquisite precision of the research laboratory and the mass production of industry; the latest discoveries of the scientist and the ever-increasing applications of the technician. Should Electronics be defined as a science, an industry, an industrial science? Whatever it may be called, our 3 research laboratories, 26 modern plants and 40,000 skilled employees will continue to ensure that Hitachi will always be the leader in Japan's electronics progress.

Hitachi, Ltd.
Tokyo Japan
Cable Address: "HITACHY" TOKYO

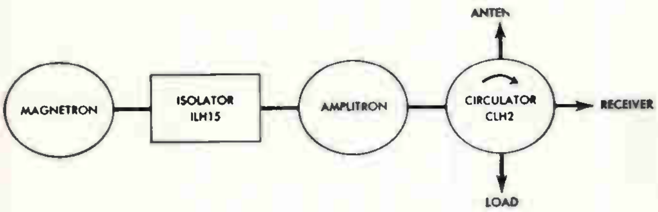
▲ Hitachi Digital Computer, Type HITAC-301

Hitachi Numerically Controlled Milling Machine ►

▲ Hitachi Electron Microscope with a Direct Magnification of 250,000 Times

CIRCLE 27 ON READER SERVICE CARD

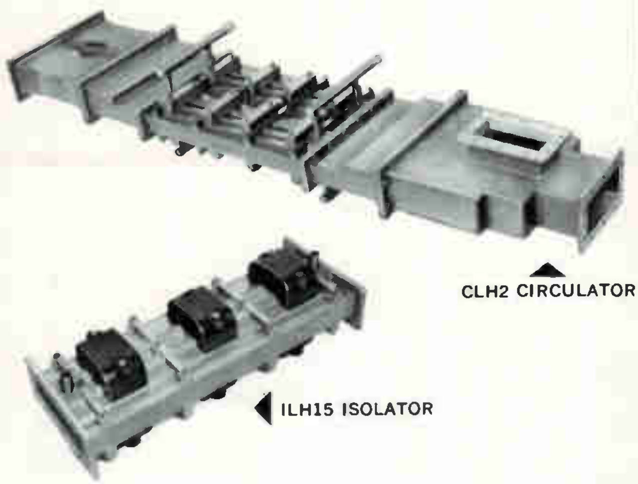
FERRITE DEVICES FOR HIGH-POWER RADAR



RAYTHEON ISOLATORS AND CIRCULATORS IN IMPROVED L-BAND "FLIGHT TRACKER" SYSTEM THAT BOOSTS OUTPUT TO MORE THAN 5 MEGAWATTS

With an output of more than 5 megawatts at 1,280 to 1,350 mc., the improved FAA "Flight Tracker" radar system has *ten times* the power of its predecessor. In the microwave generator and amplifier circuits, Raytheon isolators and circulators help achieve this power level by providing the required broadband match between magnetron and Amplitron®...and between Amplitron and antenna. The isolator also aids in maintaining frequency stability during the 5 megawatt pulse peaks by acting as a buffer between magnetron and Amplitron.

The L-band ILH15 isolator and CLH2 circulator in the "Flight Tracker" are part of Raytheon's line of L-band devices with ratings from 1.5 to 10 kilowatts average and peak power capabilities as high as 6.5 megawatts.



TYPICAL SPECIFICATIONS

	ILH15 ISOLATOR	CLH2 CIRCULATOR
Frequency range (mc)	1250-1350	1280-1350
Power, average	2.5 KW	5 KW
Power, peak	2 MW	6.5 MW
Isolation, min.	22db	26db
Isolation, max.	24db	32db
Insertion loss, min.	.7db	.65db
Insertion loss, max.	.9db	.8db
VSWR, min.	1.28	1.04
VSWR, max.	1.30	1.12
Weight, lbs.	60	140
Length, in.	22	69 1/16
Flanges	1/2 ht. L-band	mates with UG418/U
Waveguide (liq. cooled)	1/2 ht. L-band	WR 650

On Massachusetts' Route 128 in the Waltham Industrial Park, Raytheon has recently opened the most modern facility devoted exclusively to microwave ferrite device and materials development, testing and production. To learn more about the work now underway at these new facilities, or for information on your particular microwave ferrite problem, **please write to the address below.**

RAYTHEON COMPANY
SPECIAL MICROWAVE DEVICE OPERATIONS
WALTHAM INDUSTRIAL PARK
WALTHAM 54, MASSACHUSETTS

RAYTHEON *Excellence in Electronics*

Recent Economic Growth — The Numbers Game

If it truly portrayed recent rates of economic growth in the United States, the report on employment, growth and price levels recently issued by the staff of the Joint (Congressional) Economic Committee would point up scarcely less than a national disaster. Among other things, it would document impressively Premier Khrushchev's crack that "the capitalist steed the United States is riding . . . is worn out."

One of the major findings of the Joint Committee's staff (in the Eckstein Report, named for its staff director Otto Eckstein) is that between 1953 and 1959 the average rate of growth of physical output in the United States was only 2.4 per cent per year. This is scarcely more than half the average annual rate of growth of 4.6 per cent the staff found to have prevailed between 1947 and 1953.

Happily, however, the report does not reflect the basic economic realities. Its finding on relative rates of economic growth for the two periods is a statistical *tour de force* which, by the selection of certain figures and certain dates, distorts the record of America's long-term economic growth.

Playing The Numbers Game

By the selection of appropriate starting and terminal periods it is possible to document almost any rate of economic growth that is desired. The table at the bottom of this page shows you how this can be done. It will also show you how the Eckstein staff worked out its shocking contrast in growth rates. The table is built like a schedule of airplane fares between different cities. The postwar years 1946 through 1959 are put down on two axes. One runs down the left hand column, the other runs across the top of the table. Put your finger on the point where the two axes intersect and you have the average rate of growth for the period covered.

ANNUAL AVERAGE GROWTH RATES OF THE U.S. ECONOMY, 1946-1959*

(Percent increases, starting year to terminal year, of GNP in 1954 dollars).

Starting Year	Terminal Year 1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
1946	X	–0.1	–1.9	–1.2	3.0	3.9	3.8	3.9	3.2	3.7	3.6	3.4	2.9	3.2
1947	X	X	3.8	1.8	4.1	4.9	4.6	4.6	3.7	4.2	4.0	3.8	3.2	3.5
1948	X	X	X	–0.1	4.2	5.3	4.8	4.7	3.6	4.3	4.0	3.8	3.1	3.4
1949	X	X	X	X	8.7	8.1	6.5	6.0	4.4	5.0	4.6	4.2	3.5	3.8
1950	X	X	X	X	X	7.4	5.4	5.1	3.4	4.3	3.9	3.6	2.9	3.3
1951	X	X	X	X	X	X	3.4	3.9	2.0	3.5	3.2	3.0	2.2	2.8
1952	X	X	X	X	X	X	X	4.4	1.3	3.6	3.2	2.9	2.0	2.6
1953	X	X	X	X	X	X	X	X	–1.6	3.2	2.8	2.6	1.6	2.4
1954	X	X	X	X	X	X	X	X	X	8.1	5.1	4.0	2.4	3.2
1955	X	X	X	X	X	X	X	X	X	X	2.1	2.0	0.5	2.0
1956	X	X	X	X	X	X	X	X	X	X	X	1.8	–0.2	2.0
1957	X	X	X	X	X	X	X	X	X	X	X	X	–2.3	2.0
1958	X	X	X	X	X	X	X	X	X	X	X	X	X	7.0
1959														

*Compound rates of growth

Following this procedure, you can find growth rates ranging all the way from —2.3 per cent, between 1957 and 1958, to +8.7 per cent, between 1949 and 1950, along with almost any other rate you would choose for various years and sequences of several years over the postwar period.

For example, if you want to demonstrate that the postwar growth rate through 1953 was less than 4% per year, you take off from 1946, include a drop of 0.1 per cent between 1946 and 1947, and come up with a growth rate for the 1946-1953 period of 3.9 per cent. But if you want to show it was quite high, you take off a year later, from 1947 (which drops out that dismal —0.1 per cent for 1947) and come up with a fine growth rate of 4.6 per cent for the 1947-1953 years.

Statistical Hocus-Pocus

That's what the Eckstein staff did. It took off at one end from a year when there was just about no growth, went to the Korean War boom year of 1953 at the other end, and got that average growth rate of 4.6 per cent. Then it took off from the Korean War boom year of 1953 and ran to the year 1959, when business was recovering from a recession and suffered through a steel strike of 116 days, to come up with its 2.4 per cent growth rate for the second postwar period. As the table indicates, by taking off a year later (1954) the average growth rate would have become 3.2 per cent, and if the take off had been 1949 it would have been 3.8 per cent.

There are those who, in nontechnical terms, would characterize this as statistical hocus-pocus. There are also those who would see in it an element of political hocus-pocus, too. This is because the years 1947-53, when the Eckstein staff found there had been the healthy 4.6 per cent growth rate, were roughly years when we had a Democratic president, while the anemic growth rate of 2.4 per cent it calculated for the subsequent years was for years of a Republican presidency.

Actually it can be shown that the civilian part of our economy has had more rapid growth during the Republican administration than it had during the Democratic years. If military expenditures are subtracted from the national ouput, the resulting growth rate for 1953 to 1959 is slightly higher than for 1947 to 1953.

However, we do not question the *bona fides* of the Eckstein staff. **But we do assert that it has produced a statistical picture of the postwar growth of the American economy which is dangerously misleading both at home and abroad.**

Abroad, the report appears to give official documentation to the propaganda line that the Soviet economy is running rings around the U.S. economy in growth, and that it is Communism a country should choose if it really wants to develop rapidly. Building on a much smaller economic base than the U.S.A., the Soviet Union — as well as almost every less advanced nation in the world — is bound to show a larger percentage increase in output than the U.S.A. But the Eckstein staff calculation gives the Communists ammunition they don't deserve.

Are We Facing A Crisis?

The contrast drawn by the Joint Committee staff in postwar U.S. growth rates suggests that we are facing scarcely less than a crisis through paralysis of our economic growth which calls for drastic remedies. But this, as the full 1947 to 1959 growth record set forth in the table makes clear, is very definitely not the case. Our over-all postwar rate of growth, as measured by the gross national product in physical terms, has been 3.5 per cent per year, a rate nearly double the long-term growth rate of 2 per cent per year between 1909 and 1939. In the continuing fluctuations in the rate of growth which more or less inevitably characterize a relatively free economy, we have had some downs in recent years. **But our economy is now on the upbeat again. And at the end of this year, the U.S. economic growth rate for the postwar period can be expected to be 3.7 per cent per year.**

It is extremely important for the United States to continue to maintain this rate of economic growth or even to surpass it. Upon this effort depends our capacity to meet our defense requirements without dangerous strain, to provide an adequate margin for foreign aid, to improve our own productive facilities, and to continue to raise our own standard of living.

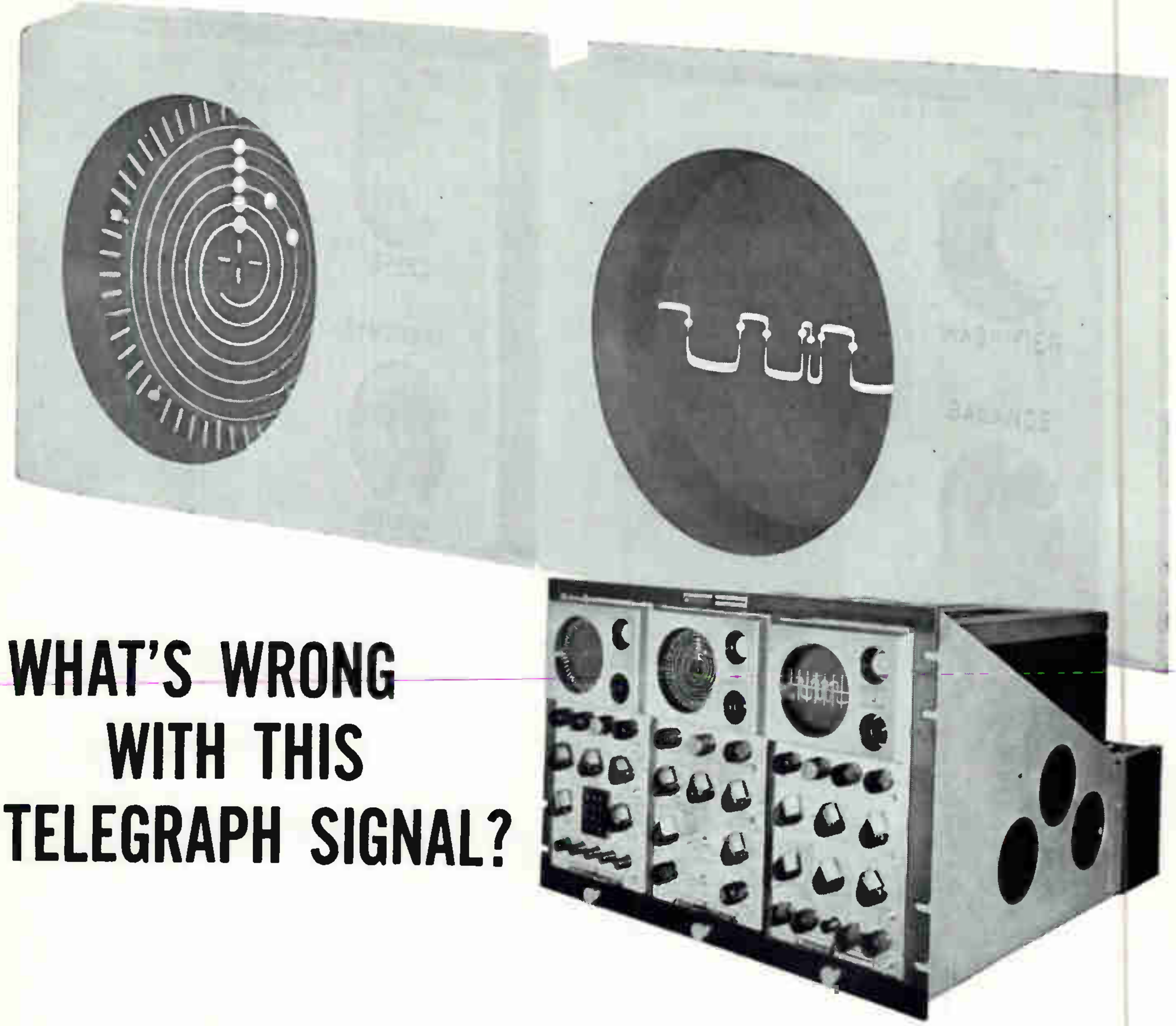
How not only to maintain but possibly improve upon our postwar pace of economic growth will be the subject of strenuous debate in the months ahead. However, the debate will have a much better chance of being constructive if the postwar growth record is seen in proper perspective. To this end one of the first things to do is to junk panic rousing statistical portrayals such as that in the Eckstein report.

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

Donald C McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.



WHAT'S WRONG WITH THIS TELEGRAPH SIGNAL?

...and how do you find out without interrupting traffic?

The answer to the second question is Radiation's TDMS—Telegraph Distortion Measurement System—a compact, self-contained unit for on-line testing, analysis and monitoring of telegraph and data transmission links.

The TDMS detects, measures and analyzes signal distortion on a continuous basis, alerts even a non-technical operator that a circuit is deteriorating. Thus pinpointed, the malfunction (a badly-tuned receiver in a radio link, for example) can often be corrected with little or no circuit downtime.

For detailed information on the TDMS, write for Bulletin RAD EL-5 to Radiation Inc., Melbourne, Fla.

WHAT'S WRONG WITH THE SIGNAL SHOWN ABOVE? Character (letter R) shows a split 4th element, a result of poorly adjusted transmitting equipment. Spiral trace display on Telescan CRT (at left) indicates the presence, and analyzes the nature of characteristic distortion.

THE ELECTRONICS FIELD ALSO RELIES ON RADIATION FOR...

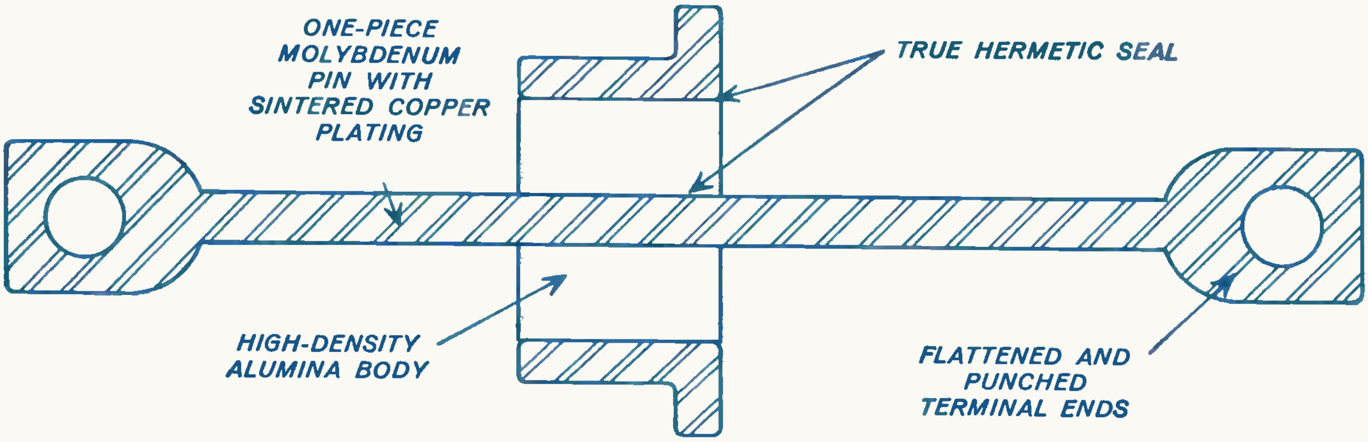
RADIPLEX—50-channel low-level multiplexer with broad data processing applications. Features rugged solid-state circuitry, almost unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.

RADICORDER—Multistylus recorder provides high-speed instantaneous readout for wide range of data acquisition or processing systems. Eliminates necessity of electronically translating complete data, thereby reduces computer work loads.

TELEMETRY TRANSMITTER—Model 3115 is a ruggedized 215-260 MC unit with extremely linear FM output under the most severe environmental conditions. With its record of outstanding performance in many missile programs, Model 3115 is specified by leading missile manufacturers.

RADIATION
INCORPORATED

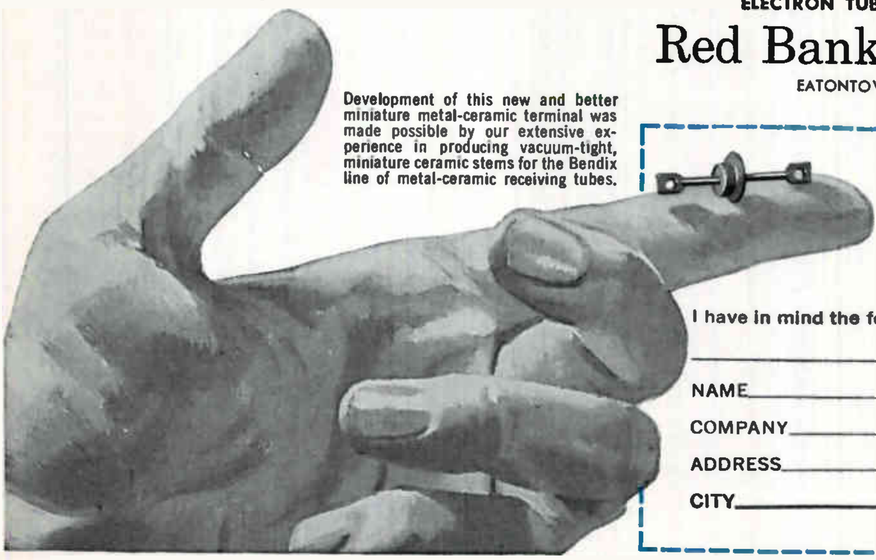
NEW BENDIX CERAMETERM[T.M.] (CERAMIC-METAL TERMINAL) is offered as a superior solution to glass terminal problems confronting manufacturers of military electronics gear, transformers, condenser banks, relays, transistors and similar equipment.



Now in production—this new and better terminal with 8 big advantages: **1** Developed especially for super-reliability on high-performance applications involving shock and high temperatures. **2** Vacuum-tight seal. **3** Will withstand brazing temperatures at 1500°F. **4** Tested to 11,000 psi shear stress without failure. **5** Ideal for encapsulated devices. **6** For both replacement and original equipment use. Extreme resistance to cracking under mechanical or thermal stresses. **8** Variety of configurations. Send for full details.

ELECTRON TUBE PRODUCTS
Red Bank Division
EATONTOWN, N. J.

Bendix AVIATION CORPORATION



Development of this new and better miniature metal-ceramic terminal was made possible by our extensive experience in producing vacuum-tight, miniature ceramic stems for the Bendix line of metal-ceramic receiving tubes.

Electron Tubes Dept. C5-27
Bendix Aviation Corporation
Eatontown, New Jersey

Gentlemen: Please send me complete details on your new Bendix CERAMETERM.

I have in mind the following applications__________

NAME__________ TITLE__________

COMPANY__________

ADDRESS__________

CITY__________ ZONE____ STATE__________

Official Lid Comes Off Ferreting

U. S. acknowledgement of recon operations drops the cloak from a big and growing area of our industry

RECENT DOWNING of an American U-2 reconnaissance plane near Sverdlovsk, Russia, brings out into the open once again the continued importance of ferreting in the cold war.

Though publicity is the last thing either side wants, reconnaissance is a steady occupation for the Free World as well as the Communist. The U-2's unfortunate flight was scheduled "so close to the Summit Conference" probably because it was a routine reconnaissance mission.

U. S. Loses 20 Planes

Since April 8, 1950, the Communists have attacked 81 U. S. planes. We've lost a total of 20. The Navy has met with 12 incidents, involving 15 planes, since April, 1950. Eight of the 15 were shot down or disappeared.

The Air Force has had 18 incidents since June, 1951, involving a total of 65 planes. Reports show nine were shot down or disappeared and two more landed in Czechoslovakia. (For detailed listing see ELECTRONICS, p 22, July 10, 1959).

How many successful flights we've made will probably never be revealed.

The Defense Department is constantly seeking new gear for data acquisition, recording, processing and analysis. Detection equipment not only includes photographic cameras, but infrared sensors, radar (when the reconnaissance pilot feels he can risk transmission of signals), and receivers for acquisition of hostile electromagnetic radiation.

Equipment seen in Moscow in the wreckage the Soviets claim to be the U-2 is conventional gear: a Magnavox radio set with 20 channels, AN/ARN-6 radio direction-finder, Lear automatic pilot, GE controller to regulate fuel flow, altimeter and rolls of magnetic tape.

Besides photographic equipment, a single-manned plane like the U-2 would conceivably carry broadband radio receivers for collecting radar and communications signals. Airborne videotape recorders would be of value in this work. Ampex has delivered prototypes of such equipment to the Air Force and will be in production by next spring. Receivers and tape recorders might be left on during an entire flight.

Several Receivers

Tapes are later analyzed in laboratories using sound spectrographs and other analytical equipment for frequency, pulse repetition frequency (prf) and pulse width.

Reconnaissance planes carrying more crew members often carry several panoramic intercept receivers for scanning the radar portions of the spectrum.

One positive outcome of the U-2 incident is a heightened respect for the effectiveness of the Strategic Air Command.

If a relatively slow aircraft can get half way across the Soviet Union (and Representative Clarence Cannon says we have been sending planes into the Soviet Union this far for four years), our faster SAC bombers could conceivably accomplish the job they are prepared to do.

Maximum speed of the U-2 is about Mach 0.75 (under certain atmospheric conditions 480 mph at 60,000 ft.). The B-47 flies at 600 mph at altitudes above 40,000 ft.; the B-52 at 650 mph, above 50,000 ft.; the B-58 at 1,300 mph, above 50,000 ft.; the B-70 (still in R&D) 2,000 mph at 70,000 ft.

Whether the U-2 went down entirely due to Soviet defense efforts has not been cleared up. Lockheed, who developed the planes in 1954 and now operates them for the National Aeronautics and Space Administration, claims that the U-2 flies beyond the reach of Soviet rockets or missile-armed interceptor aircraft. Mechanical failure may have forced the craft down into rocket range. Lockheed is also certain the neat pile of debris shown in the first Soviet photograph has

Zeus Transmitter Readied for Army

Special facility at Sperry's Great Neck, L. I., plant tests radar transmitter for antimissile system designed by Bell Telephone Labs no relation to the U-2 plane. The second photograph seems more plausible to the company.

What would we do if we sighted a Soviet recon plane over the U. S.?

The North American Air Defense Command says our procedure is the following: A plane picked up and not identifiable by SAGE is investigated at close range by an Air Defense Command interceptor. Once it is identified by the pilot, information is radioed back to the nearest Fighter Control Center and from there to the Pentagon for instructions. If the intruder is unarmed, the interceptor pilot tries radio communication with the plane, then visual communication. If the plane makes no hostile move, it will not be shot down.

NORAD states that to date they have no knowledge of Russian aircraft flying over the U. S. The only suspicious detection NORAD has picked up was a number of contrails sighted over Alaska on April 17, 1952.

Red China Tops U. S. In Global Broadcasts

RED-CHINA has climbed past the United States in its volume of international radio broadcasts, according to Henry Loomis, who heads up Voice of America.

Loomis said that Radio Peiping is now putting forth 674 program hours per week in international broadcasts, nearly one-third more than the 512 hours recorded at the start of this year.

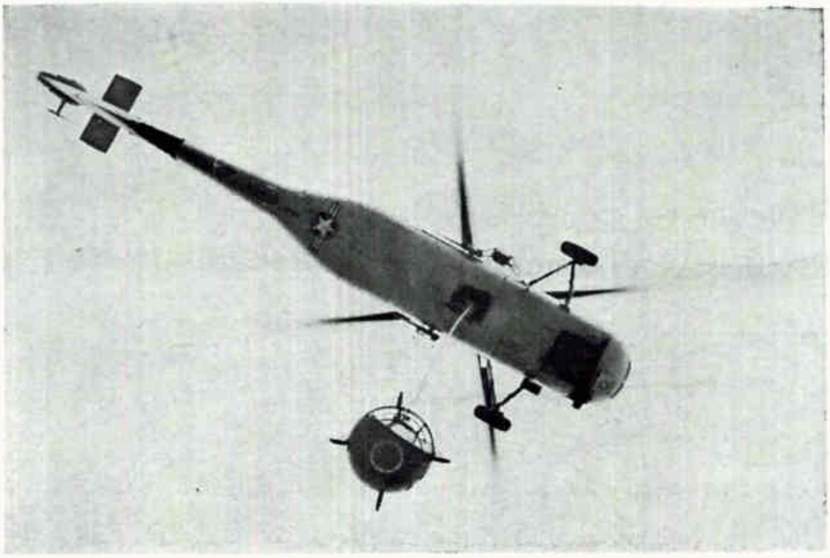
This places the U. S., with its 500 hours weekly, in fourth place behind China, the United Arab Republic's 625 hours and Soviet Russia's 975 hours.

Problems of Numbers Cited in Systems

NEED TO DESIGN components as single structures to reduce cost and improve performance was stressed recently at the Electronic Components Conference in Washington, D. C.

Bell Lab's Henry Stone predicted that solid blocks avoiding physical interconnections between components will be the rule rather than the exception in the future.

Hovering 'Copter Hunts Submarines



C-w doppler radar ground velocity system, made by Ryan Electronics, enables Sikorsky 'copter to hover inches above sea, lower ball and conduct sonar dunking operations

New Computer Draws Only 100 W

SAN FRANCISCO—This year's Western Joint Computer Conference, held here recently in the Jack Tar Hotel, presented a dual image to the more than 2,000 engineers and business leaders who attended. They were treated to a display of hardware which occupied 91 booths, and which ranged from subminiature components to complex systems. The sessions emphasized trends, theory and use rather than hardware.

On the hardware side, there were indications of the growth of the systems concept. Packard-Bell introduced its new PB 250 digital computer, a solid-state device described as a standardized system component rather than an autonomous unit. Company said the device is adaptable to broad range of scientific, industrial and military problems.

The big news about the computer was its price, $30,000 basic, and its power consumption, 100 watts. Some of its proposed uses include closed-loop industrial processes, navigation, and data processing.

Only 38 papers were presented, little more than half the number of 1959. Those selected went through a triple screening process.

Conference chairman Robert M. Bennett, of IBM Research Lab, San Jose, told ELECTRONICS that half the papers originally proposed were knocked out. "We wanted a discussion-type conference, not a sounding board for existing devices," said Bennett. "Where we felt we needed a paper on a subject, we went out and looked for it."

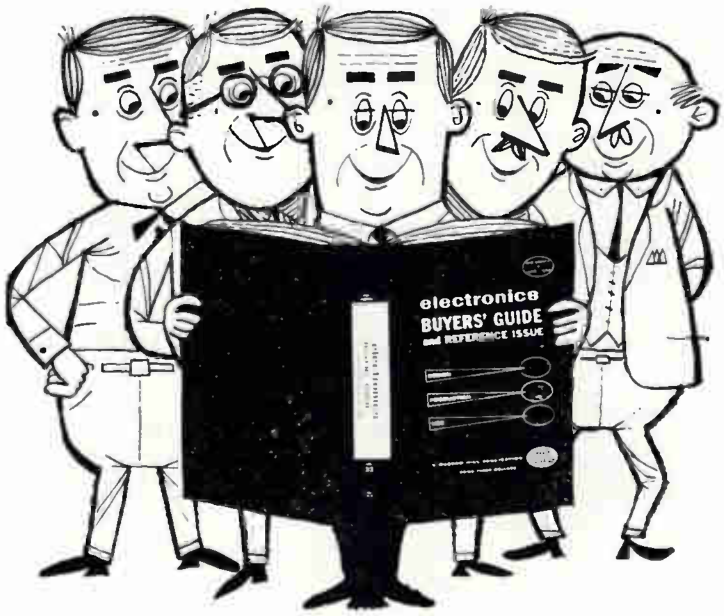
A recurring theme was a deemphasis of the computer elements and a rise in importance of the over-all system. Walter F. Bauer of Thompson-Ramo-Wooldridge predicted that in coming years electronics firms will spend less time developing circuits and components and more time in figuring out computer systems in which already available hardware can be put to optimum use.

Another T-R-W man, Charles Kellogg, described as an example the fact-compiler concept, one of whose main advances would be an input geared to unambiguous "restricted English".

Another piece of hardware, which arrived too late to be shown at the conference itself, was the Advanced Instrument Corp.'s Perfograph. This is based on a portable recorder, which works on 12-v batteries, designed to operate unattended in remote areas.

Advinco has a contract with Bonneville Power Administration to supply seven instruments to measure wind speed, wind direction, air temperature, barometric pressure, humidity, precipitation and r-f noise from power lines.

NEED PRODUCT INFO? LOOK IN THE NEW

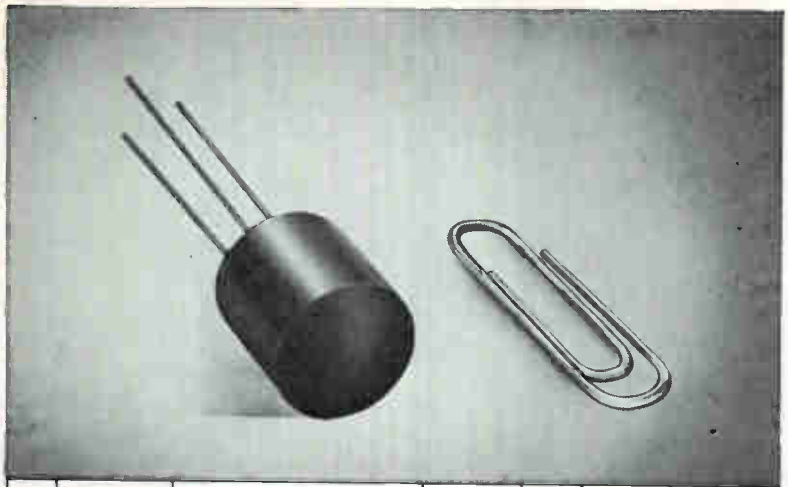


electronics BUYERS' GUIDE

You'll find detailed facts about the products of almost 700 different advertisers — that's 42% more than you'll find in any other electronics directory.

There's also 64 pages of reference data about markets, materials and design — vital information for all working in electronics. Also local sales offices of manufacturers . . . the names, addresses and phone numbers of representatives . . . complete lists of manufacturers . . . registered trade names . . . and also, of course, the most complete listing of all electronic and related products. Tells what you want to know . . . *when you're ready to buy.*

A McGraw-Hill Publication • 330 West 42nd Street, New York 36, New York



TT No.	Mil Type	Application	Pri. Imp.	D.C. Ma.* in Pri.	Sec. Imp.	Nom. Pri. Res.	MW Level @ 1 KC
001	TF5RX13YY	Interstage	20,000 30,000	.5 .5	800 1200	850	50
002	TF5RX17YY	Output	500 600	3 3	50 60	60	100
003	TF5RX13YY	Output	1,000 1,200	3 3	50 60	115	100
004	TF5RX17YY	Output	600	3	3.2	60	100
005	TF5RX13YY	Output	1,200	2	3.2	115	100
006	TF5RX13YY	Output	10,000	1	3.2	790	100
007	TF5RX16YY	Input	200,000	0	1000	8500	25
008	TF5RX20YY	Reactor 3.5 HYs. @ 2 Ma. DC, 1 Hy. @ 5 Ma. DC					
009	TF5RX13YY	Output or driver	10,000 12,000	1 1	500CT 600CT	800	100
010	TF5RX13YY	Driver	10,000 12,000	1 1	1200CT 1500CT	800	100
011	TF5RX13YY	Driver	10,000 12,000	1 1	2000CT 2500CT	800	100
012	TF5RX17YY	Single or PP Output	150CT 200CT	10 10	12 16	11	500
013	TF5RX17YY	Single or PP Output	300CT 400CT	7 7	12 16	20	500
014	TF5RX17YY	Single or PP Output	600CT 800CT	5 5	12 16	43	500
015	TF5RX17YY	Single or PP Output	800CT 1,070CT	4 4	12 16	51	500
016	TF5RX13YY	Single or PP Output	1,000CT 1,330CT	3.5 3.5	12 16	71	500
017	TF5RX13YY	Single or PP Output	1,500CT 2,000CT	3 3	12 16	108	500
018	TF5RX13YY	Single or PP Output	7,500CT 10,000CT	1 1	12 16	505	500
019	TF5RX17YY	Output to Line	300CT	7	600	19	500
020	TF5RX17YY	Output or Line to Line	500CT	5.5	600	31	500
021	TF5RX17YY	Output to Line	900CT	4	600	53	500
022	TF5RX13YY	Output to Line	1,500CT	3	600	86	500
023	TF5RX13YY	Interstage	20,000CT 30,000CT	.5 .5	800CT 1200CT	850	100
024	TF5RX16YY	Input	200,000CT	0	1000CT	8500	25
025	TF5RX13YY	Interstage	10,000CT 12,000CT	1 1	1500CT 1800CT	800	100
026	TF5RX20YY	Reactor 6 Hys. @ 2 Ma. DC, 1.5 Hys. @ 5 Ma. DC				2100	
027	TF5RX20YY	Reactor 1.25 Hys. @ 2 Ma. DC, .5 Hy. @ 11 Ma. DC				100	
028	TF5RX20YY	Reactor .3 Hy. @ 4 Ma. DC, .15 Hy. @ 20 Ma. DC				25	
029	TF5RX17YY	Single or PP Output	120CT 150CT	10 10	3.2 4	10	500
030	TF5RX17YY	Single or PP Output	320CT 400CT	7 7	3.2 4	20	500
031	TF5RX17YY	Single or PP Output	640CT 800CT	5 5	3.2 4	43	500
032	TF5RX17YY	Single or PP Output	800CT 1,000CT	4 4	3.2 4	51	500
033	TF5RX13YY	Single or PP Output	1,060CT 1,330CT	3.5 3.5	3.2 4	71	500
034	TF5RX13YY	Single or PP Output	1,600CT 2,000CT	3 3	3.2 4	109	500
035	TF5RX13YY	Single or PP Output	2,000CT 10,000CT	1 1	3.2 4	505	500
036	TF5RX13YY	Isolation or Interstage	10,000CT	1	10,000CT	950	500

*DCMA shown is for single ended usage (under 5% distortion — 100MW — 1KC) . . . for push pull, DCMA can be any balanced value taken by .5W transistors (under 5% distortion — 500MW — 1KC)

Hermetic Seal transformer co.

MAGNETIC IRON-CORE COMPONENTS
ENVIRONMENTAL TESTING
POWER SUPPLIES—SERVO AMPLIFIERS

DRESSER INDUSTRIES INC.
ELECTRONIC
OIL • GAS
CHEMICAL
INDUSTRIAL

TEXAS COMPONENTS DIVISION
555 N. Fifth St. P. O. Box 978
Garland, Texas
Dallas phone BRoadway 6-5141

PACIFIC COMPONENTS DIVISION
18151 Napa St. P. O. Box 161
Northridge, California
Phone DIckens 5-2250

ORDER THESE LOW-COST GUARANTEED PERFORMANCE

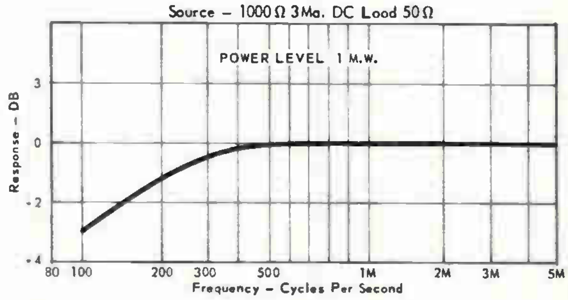
MINIATURIZED TRANSISTOR TRANSFORMERS

from Hermetic Seal

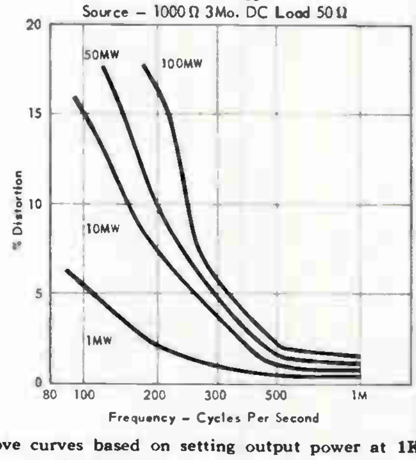
Designed for transistor circuits operating in the audio range of frequencies, these miniaturized HERMETIC SEAL Transistor Transformers are widely and reliably used for audio amplifiers, servc amplifiers and signalling equipment. ½-inch diameter and height, with four standard lead terminations spaced on 0.10 grid for mounting on circuit boards without using bulky clamps. Built to meet MIL-T-27A, Class R, grade 5 requirements, units may be used reversed, input to secondary. PRICES ON REQUEST.

TYPICAL PERFORMANCE CURVES

TT – 003
Source – 1000 Ω 3 Ma. DC Load 50 Ω



TT – 003
Source – 1000 Ω 3 Ma. DC Load 50 Ω



Above curves based on setting output power at 1KC and maintaining same input level over frequency range.

QUOTATIONS WITHOUT OBLIGATION ON YOUR SPECIAL PRODUCTION REQUIREMENTS

Data Links Use Common Carrier

Increased emphasis on information transmission by common carrier is coming up as the next major development in computer usage

THE NEW LOOK in data processing will emphasize communications between computers. This is indicated by a number of recent developments.

Computermen have joined forces with communications specialists and are now able to transmit data from one location to another simply by dialing a telephone number. Beyond the dialing, human intervention is usually not needed. New systems allow the computers to exchange data between themselves.

Contributing to the successful operation of such networks is AT&T's Data-Phone gear which converts d-c pulses into tones for transmission by phone lines. The equipment, using a recorded carrier subset and a digital subset, has been available for about a year and a half.

Last week, an 18-month test of an IBM system was pronounced successful by Firestone Tire & Rubber Co. officials in Akron, O. As part of the shakedown, the new Tele-processing system was used to gather payroll information on Firestone employees in 50 states. The network tied in a 5,100 mile chain of company locations. Using the IBM equipment along with the AT&T gear, punch-card information was relayed directly by standard telephone lines from each remote site. In using the new equipment, it is not necessary to change the card information to tape form nor to have leased lines available. The network is being used presently to handle retail accounting data as well.

Also by IBM is a system demonstrated last month in Canoga Park, Calif., by Rocketdyne, a division of North American Aviation.

Engine Data

The network there is being used to maintain status reports on each of the company's rocket engine programs. Information on scheduling, inventory production line performance and accounting information is reported from test sites in California, Texas and Missouri by leased wires to the rocket company's home base. Two large-scale computers there process the data. The division's network is in turn connected by microwave to a battery of four more computers at North American's Los Angeles division 30 miles away. The communications system, developed in cooperation with the Pacific Telephone and Telegraph Co., allows the six computers to "talk" to each other at the rate of 75,000 words per minute.

The aircraft firm's spokesmen estimate that the new system has helped reduce the cost of Thor and Atlas engines by about $27 million. Along with communications savings, the company expects to save about $50,000 a month.

Another new concept in communications, Avco's Comex can transmit a 3,000-word message over a telephone line in three minutes. The same message by conventional teletypewriter would take from 30 to 50 minutes. Introduced last month, the new system has already been installed at sites by Westinghouse and by the Department of Defense.

Westinghouse is using a combination of Comex, teletype and AT&T's data sub-set to link manufacturing, depot and sales operations at three appliance plants in Columbus and Mansfield, Ohio and Springfield, Mass. New Westinghouse facilities in Ogden, Utah will be tied into the Columbus plants in the near future.

The new system operates from magnetic tape input in this way: An operator punches out business information on a teletypewriter tape. The tape is fed through a transmitter which stores the information on magnetic tape. At regularly scheduled intervals each day, direct telephone communication is made between points in the network. The information on the tape is converted in the common-carrier subset and sent over the telephone.

Comparable equipment at the other end receives the tones, and converts them into electrical impulses on high-speed tape. The tape is then played at slow speed (100 words per minute) into the teletypewriter tape punching device.

Information received by microwave at North American's Los Angeles computer room is recorded on IBM units for processing, playback

The teletypewriter tape is then fed into a teletypewriter which prints the data.

A few weeks ago Department of Defense officials termed a high-speed system designed by Collins Radio significant. According to Army officers, the rapid system performs a 13-hour communications job in 60 minutes. The time-saver is a high-speed magnetic tape transmission system operating over standard voice-type telephone circuits. The prototype equipment is now in operation linking Army Signal Supply Agency in Philadelphia with the Lexington, Ky. depot 500 miles away.

Among older installations based on the network system of data transmission is General Electric's IBM center in Schenectady, N. Y., using leased lines to tie in 150 remote locations, and Sylvania's Rem-Rand center in Camillus, N. Y., linking 52 plants by leased wire.

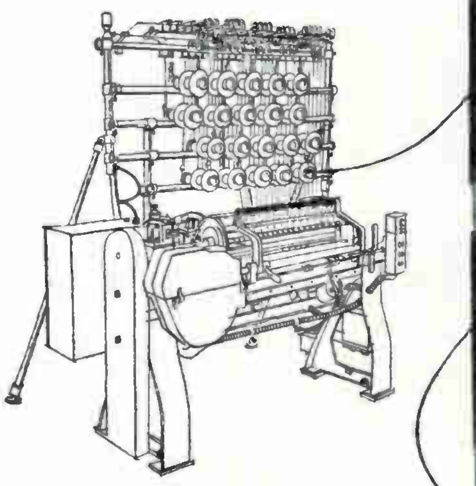
Solid-State Dimmer Controls 12,000 W

CHICAGO—A 1½-pound solid-state light dimmer which promises to cut industrial power bills 30 percent was demonstrated here by International Research Associates. The unit controls up to 12,000 watts.

Applications include airport runway lighting, factory lighting, municipal street lighting, television studio light control, theater light dimming and automatic machine control.

In operation, the device is connected between the power main and the load lights. A single control is preset proportional to a desired light level. A photocell picks up light from all sources in the area; when ambient light decreases to the preset level, lamps connected to the device come on gradually, maintaining the desired light level within two foot-candles.

Only static components are used: two silicon controlled rectifiers, phase-shifting transformer, variable resistor, photocell and other parts. Everything except the photocell is contained within a four-inch-square package. The photocell can be separated from the package by 10,000 feet without affecting circuit operation.



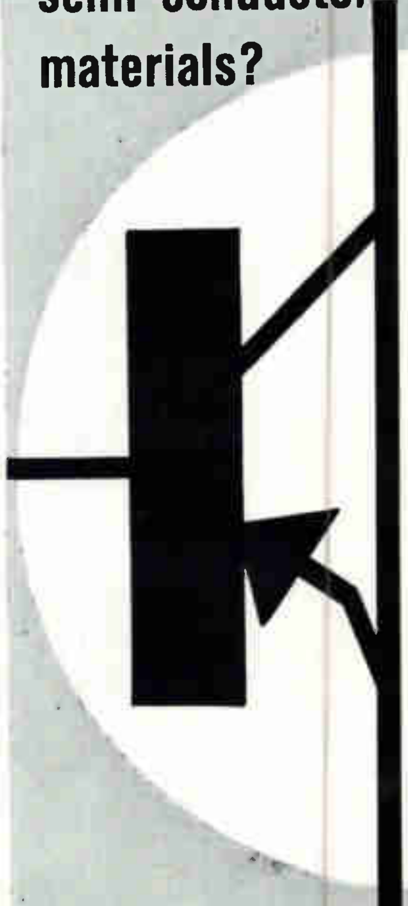
Investigate the super-precise fully automatic Leesona No. 107 Coil Winder for Paper Insulated Coils · Speeds up to 2500 rpm · Short Paper (1⅜″ insert) Attachment · Paper Miss Detector · Space Wind Attachment for High Voltage Coils · One operator for two or more machines! Leesona Corporation, P.O. Box 1605, Providence 1, Rhode Island.

(formerly Universal Winding Company)

LEESONA

23B.0.1

do you know what's expected from semi-conductor materials?



There were more than a dozen articles on semiconductor materials in **electronics** in recent months. Each was specially edited to give you all key facts, ideas or trends—and there's more coming! Accurate **electronics'** reporting tells you what's happening now . . . what's *expected* in materials and components. Don't miss dozens of articles on basic subjects edited to keep you informed, help make your research, development, sales and marketing plans pay off. It pays to subscribe to **electronics** (or renew). Fill in box on Reader Service Card now. Easy to use. Postage free.

FIND WHAT YOU NEED IN electronics

LAPPING COMPOUND FOR SILICON AND GERMANIUM SEMICONDUCTORS

(Also for lapping other semiconductor materials)

GARNET ABRASIVE POWDERS

Produced from highest quality Semi-Precious Gem Garnet Crystals

Will Achieve
Best quality surfaces
at
Lowest lapping costs

The application of Garnet Abrasive Powders for lapping semiconductor materials was discovered about a year ago and is now widely acclaimed by members of the semiconductor industry. It is true:—A low cost—high quality—proven abrasive—in plentiful supply—to do a superior lapping job—at maximum economy.

Garnet Abrasive Powders which are produced under closest control for high precision work are also in extensive use for grinding precision optical lenses.

For further data and prices write to:

BARTON MINES CORPORATION

NORTH CREEK, NEW YORK

(Producers of world's largest selling line of technical abrasive powders.)

CIRCLE 41 ON READER SERVICE CARD

10-inch high-quality Storatrons are available. Choice of electrostatically or magnetically deflected writing guns. The popularity of these tubes has been proved—a result of their overall quality of display plus excellent resolution and brightness.

Electrostatic tubes feature two identical writing guns—mounted along with a view gun on a single, sturdy, centrally located mount for ease of control and operation.

Magnetic tubes feature a viewing gun axially located for uniformity of display and a writing gun placed for use with standard yokes. Both guns have standard miniature bases. These Storatrons are just two examples from the largest line of immediately available quality direct view storage tubes (2¾" to 21")—DU MONT STORATRONS.

Send for complete specifications including circuit information.

ELECTRONIC TUBE SALES

DU MONT®

precision electronics is our business

*T.M.

ELECTRONIC TUBES/INDUSTRIAL TV/MILITARY ELECTRONICS/MOBILE COMMUNICATIONS/SCIENTIFIC INSTRUMENTS/AUTOMOTIVE TEST EQUIPMENT

Allen B. Du Mont

ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J., U. S. A.

INTERNATIONAL DIVISION • 515 MADISON AVENUE, NEW YORK 22, N Y • CABLES ALBEEDU, NEW YORK

Guiding Satellites Into Orbit

New long-range radar, computer with high reliability are key units in ground controlled guidance system being used at Cape Canaveral

By ROLAND J. CHAREST,
Senior Associate Editor

CAPE CANAVERAL, FLA.—The secrecy door was opened a wee bit here recently to show:

(1) A solid-state computer which has achieved a reliability record of 99.89 percent.

(2) A new radar with a range of "thousands of miles".

(3) Indications that Cape Canaveral facilities are expanding, not standing pat, and may someday be occupying part of the mainland.

The computer and radar are parts of the ground controlled guidance system being used to launch the National Aeronautics and Space Administration's Echo passive communications satellites and the Tiros weather satellites.

Bell Telephone Laboratories has responsibility for the guidance system, which is produced by Western Electric at its North Carolina facilities. The three-stage Delta launch vehicle is built by Douglas. The computer was designed, developed and produced by Remington Rand Univac.

Details on the long-range radar are classified—except that its range is "thousands of miles."

Three Sections

The complete guidance system consists of three sections: radar, interface (where analog information is automatically converted to digital data), and computer.

The guidance beacon, carried in the rocket's second stage, consists of a receiver, transmitter and decoder. Operational details are classified.

The rocket has two antennas, one protruding from each side. Before and during flight, the radar stays "locked on" whichever antenna is in direct line.

Signals continuously go back and forth between the rocket and control center during flight. Any adjustments are calculated by the computer and transmitted to the rocket until the satellite goes in orbit.

The Athena computer used has attained a reliability of 600 hours mean time to failure. Its 100,000 components include 35,000 resistors, 23,000 diodes and 10,000 transistors.

It dissipates only 800 watts. The computer's soldered joints—120,000 of them—are goldplated. The joints, in tests, are subjected to abrupt temperature changes of 100 degrees.

The computer has 1,185 sealed modules. "We have not had one operational failure in two years," says Lawrence W. Reid, head of RRU's field training. "The few failures we had were caught during the maintenance phase."

Circuit details and the computer's operating speed remain classified. A 7,000-word program is used for an Echo launching.

Echo, a 100-ft plastic balloon as big as a 10-story building, inflates to full size before entering into orbit 1,000 miles above the earth.

It weighs about 150 lb and is packaged in a small container before launching. At the proper altitude, water previously injected vaporizes and inflates the sphere.

Population Soars

Cape Canaveral itself shows signs of one day being too small to handle all its activities. Cocoa Beach, about five miles away, had a population of 125 in 1950. Today the total is 5,000—and expanding.

Already, local observers say, most of the Cape's area is used up. One indication: Saturn, this nation's super-thrust missile, may be launched from a pad only a short distance from a fence at one limit of the Cape.

Residents here say it won't be long before Cape Canaveral facilities expand inland—pointing to more space operations and more electronics business.

Hearing Aids: 1937 Meets 1960

Compared to old 4½ lb hearing aid (left) is today's Telex unit whose hidden transmitter broadcasts to earpiece amplifier with no direct connections

Reprints Available of ELECTRONICS IN JAPAN and other Past Special Reports or Feature Articles

Key No.	Title	Date Published
R-1	Electronics Handbook	June Mid-month, 1959
R-2	Instruments for Design and Production	Sept. 11, 1959
R-3	Materials for Environmental Extremes	Dec. 4, 1959
R-4	1959 electronics Article Index, 10¢ ea.	Dec. 25, 1959
R-5	Electronic Markets Special Report	Jan. 1, 1960
R-6	Designing High-Power Transistor Oscillators, 50¢ ea.	Jan. 8, 1960
R-7	Electronics Research and Development Around the World	Feb. 12, 1960
R-8	Graphical Extensions of Transform Techniques, 50¢ ea.	Apr. 1, 1960
R-9	What's New in Electron Tubes, 50¢ ea.	Apr. 29, 1960
R-10	Electronics in Japan	May 27, 1960

Price: Reprints on items above are 1-10 copies, 75¢ each; 11-24 copies, 60¢ each; 25 copies or more, 50¢ each unless otherwise noted.

Fill in, clip out and mail to:
Reprint Service Dept., electronics, 330 W. 42nd St., New York 36, N.Y.

electronics REPRINT ORDER FORM

For Reprints of ELECTRONICS IN JAPAN (May 27, 1960) fill in below:

Send me________Reprints of Key No. R-10 (1-10 @ 75¢ ea., 11-24 @ 60¢ ea., 25 or more @ 50¢ ea.)

For Reprints of past SPECIAL REPORTS or FEATURE ARTICLES fill in below:

Send me________Reprints of Key No.________@________¢ each.

*For Reprints of other editorial articles in this issue, fill in below:

Send me________reprints of article entitled____
____on page(s)________. (Minimum order 100 copies)

*For Reprints of other editorial articles in past issues, fill in below:

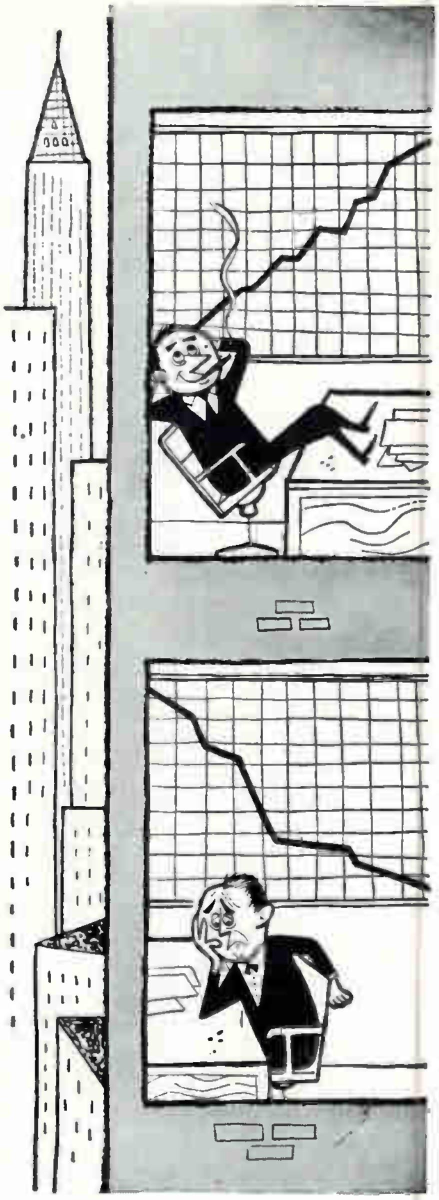
Send me________reprints of article entitled____
________________________on page(s)________of issue dated________________. (Minimum order 100 copies)

Check one box *First advise me of costs ☐ Mail immediately and bill me later. ☐

Name____

Number and Street____

City, Zone No., State____



WHO'S MAKING OUT BEST?

A quick, 3-minute Financial Round-up that names electronics companies that have achieved substantial financial gains. Tells where they are and what they make.

Fast visual summary of active stocks each week in the electronics industry. New public issues. Stock price averages.

This highly readable score card helps keep you informed on what counts most on the financial front. This is just one more reason why you should subscribe to **electronics** (or renew your subscription). Fill in box on Reader Service Card. Easy to use. Postage free.

FIND WHAT YOU NEED IN...

electronics

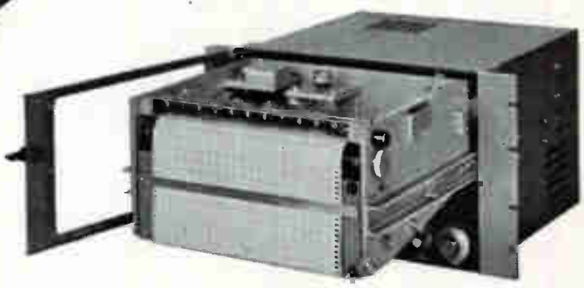
AUTOGRAF • AUTOGRAF • AUTOGRAF

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

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

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

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



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

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

SEE YOUR MOSELEY REPRESENTATIVE OR WRITE DIRECT FOR DETAILS

NEW! TYPE F-2 LONG-STRIP CURVE FOLLOWER

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

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

AUTOGRAF *recorders*

F. L. MOSELEY CO.
Dept. A-5 409 N. Fair Oaks Ave., Pasadena, California
MUrray 1-0208 TWX PASA CAL 7687
Field representatives in all principal areas

Fair Promises New Equipment

Next year's World Trade Fair exhibitors to put more stress on science, technology

THE RECENTLY concluded fourth annual World Trade Fair held in New York leaves a number of interesting promises for the year to come.

Fair officials told ELECTRONICS that next year's participants will lay greater stress on scientific and technological exhibits than ever before. There will probably be more stress in this area than in consumer goods.

"A number of European exhibitors are realizing for the first time that they have equipment competitive with American gear, and in some cases they have items which have not yet been introduced in this country," was one comment.

Another spokesman said this realization was particularly true of the European electronics manufacturer. Talks with exhibitors indicated that many of them are not familiar with ways to present their products to potential users or to make their past accomplishments known.

This year's fair showed a great deal of Japanese electronic equipment. Among gear exhibited was a transistorized four-channel rural carrier terminal for telephone use, shown by Nippon Electric. By the same company was an exhibit of tubes and crystal diodes including rectifier, thyratron, cathode ray and a number of other types. Voltage regulator tubes, traveling wave tubes and magnetrons were also shown as part of a display which included a line of foil type solid tantalum hole capacitors.

In addition to components, a line of voltage regulators attracted the attention of technically minded fair-goers. Made by Teikoku Dempa, Tokyo, the line included three models having outputs of 300 va, 500 va and 1 Kva. All three use vacuum tubes.

An operating electron microscope by Hitachi Ltd., Tokyo, proved interesting to the passerby, who was able to seat himself before it and see for himself.

In the consumer field, Japanese manufacturers demonstrated that they have moved one step closer to the saleable portable tv set. Shown was a battery-powered portable tv using 24 transistors. Made by Hayakawa of Tokyo, the item has an 8-in. picture tube and uses a specially designed 12-volt wet cell. The set can operate for about 2$\frac{1}{2}$ hours, according to the manufacturers, who add that the cells can be recharged 100 times. When plugged in to house current, the batteries recharge themselves. The same manufacturer displayed a 21-in. color set which was described as selling in the $800-$900 range in Japan. Prices for U. S. consumers on this receiver and the portable are not yet given by Hayakawa.

Among electronic equipment shown by French manufacturers was a line of frequency-time period counters by Rochar Electronique, Montrouge. As part of the display was literature on more than a dozen different items of test equipment including gear for nuclear physics measurements.

In other booths, manufacturers from several European countries displayed a variety of portable and console radios, stereo equipment and record players.

Microcircuits Lead Components Conference

WASHINGTON, D. C.—The big problem of smallness was discussed at length at the Electronic Components Conference here recently.

S. W. Herwald of Westinghouse said the nub of his company's approach to smallness is not miniaturization, but simplification of complex circuits. Instead of arranging components to perform functions in a cascaded manner, a steering of charges by shaping fields is looked upon as the basic tool of molecular electronics.

J. J. Bohrer of International Resistance Company presented a paper on the preparation and evaluation of thin-film circuit functions.

The paper presented data on what the design engineer needs to know about thin films to design elements for resistance and capacitance functions.

The Sylvania microminiature module was the subject of a paper by G. J. Selvin. Selvin pointed out that advances in circuit fabrication or temperature increases to 500 C will not obsolete this module.

Other sessions dealt with advances in components and materials. The use of gallium phosphide, four-layer *pnpn* alloyed devices, the physics of thin resistive films, ferromagnetics and ferroelectric ceramics, investigation of columbium, and ruggedized traveling wave tubes were the subjects of other talks.

East German Automatic Answering Service

RECENTLY SHOWN AT the Leipzig Fair in East Germany was an Hungarian telephone-answering tape recorder whose playback mechanism can only be triggered by the subscriber when he utters a sound at a predetermined, yet secret point on the prerecorded tape. The secret triggering for the playback is made possible by a short slot cut in the prerecorded tape loop. The tape loop instructs any caller to speak his message. But when the subscriber makes a sound at the right spot on the tape, a special pickup head actuates the rewind mechanism for the main tape reels. Recorded messages are automatically played back for the subscriber to hear. The circuit is so arranged that a constant tone will not actuate the playback. Furthermore, two wrong guesses at the trigger signal will block the system even if on the third try the spoken signal is timed correctly.

When you need replacement tubes for industrial control equipment...

...you'll get fast service from your local RAYTHEON distributor.

and at factory prices

RAYTHEON

RAYTHEON COMPANY

DISTRIBUTOR PRODUCTS DIVISION • WESTWOOD, MASS.

RECEIVING AND INDUSTRIAL TUBES • SEMICONDUCTOR PRODUCTS
MECHANICAL COMPONENTS • RAYTHEON/MACHLETT POWER TUBES
VOLTAGE REGULATORS • MICROWAVE TUBES • CAPTIVE HARDWARE

CIRCLE 48 ON READER SERVICE CARD

Raytheon Distributors Serving Key Markets Include

Alabama
Birmingham
Forbes Distributing Company
AL 1-4104
MG Electrical Equipment Company
FAirfax 2-0449
Mobile
Forbes Electronic Distributors, Inc.
HE 2-7661

Arizona
Phoenix
Radio Specialties & Appl. Corp.
AL 8-6121
Tucson
Standard Radio Parts, Inc.
MA 3-4326

California
Burbank
Valley Electronic Supply Co.
VIctoria 9-3944
Glendale
R. V. Weatherford Co.
VIctoria 9-2471
Hollywood
Hollywood Radio Supply, Inc.
HO 4-8321
Inglewood
Newark Electric Company
ORchard 7-1127
Los Angeles
Federated Purchaser
BRadshaw 2-8771
Graybar Electric Company
ANgelus 3-7282
Kierulff Electronics, Inc.
RIchmond 8-2444
Oakland
Brill Electronics
TE 2-6100
Elmar Electronics
TEmplar 4-3311
Palo Alto
Zack Electronics
DA 6-5432
San Diego
Radio Parts Company
BE 9-9361
San Francisco
Fortune Electronics
UN 1-2434
Santa Monica
Santa Monica Radio Parts Corp.
EXbrook 3-8231

Colorado
Denver
Ward Terry Company
AMherst 6-3181

Connecticut
East Haven
J. V. Electronics
HObart 9-1310

District of Columbia
Electronic Industrial Sales, Inc.
HUdson 3-5200
Kenyon Electronic Supply Company
DEcatur 2-5800

Florida
Miami
East Coast Radio & Television Co.
FRanklin 1-4636
West Palm Beach
Goddard Distributors, Inc.
TEmple 3-5701

Illinois
Chicago
Allied Radio Corporation
HAymarket 1-6800
Newark Electric Company
STate 2-2944

Indiana
Indianapolis
Graham Electronic Supply Inc.
MElrose 4-8486

Maryland
Baltimore
Wholesale Radio Parts Co., Inc.
MUlberry 5-2134

Massachusetts
Boston
Cramer Electronics, Inc.
COpley 7-4700
DeMambro Radio Supply Co., Inc.
AL 4-9000
Lafayette Radio Corp. of Mass.
HUbbard 2-7850
Cambridge
Electrical Supply Corporation
UNiversity 4-6300

Michigan
Ann Arbor
Wedemeyer Electronic Supply Co.
NOrmandy 2-4457
Detroit
Ferguson Electronic Supply Co.
WOodward 1-2262

Minnesota
Minneapolis
Electronic Expeditors, Inc.
FEderal 8-7597
Mississippi
Jackson
Ellington Radio, Inc.
FL 3-2769
Missouri
Kansas City
Burstein-Applebee Company
BAltimore 1-1155
New Jersey
Camden
General Radio Supply Co.
WA 2-7037
New Mexico
Alamogordo
Radio Specialties Company, Inc.
HEmlock 7-0307
Albuquerque
Radio Specialties Company, Inc.
AM 8-3901
New York
Buffalo
Genesee Radio & Parts Co., Inc.
DElaware 9661
Mineola, Long Island
Arrow Electronics, Inc.
Pioneer 6-8686
New York City
H. L. Dalis, Inc.
EMpire 1-1100
Milo Electronics Corporation
BEekman 3-2980
Sun Radio & Electronics Co., Inc.
ORegon 5-8600
Terminal Electronics, Inc.
CHelsea 3-5200
Ohio
Cincinnati
United Radio Inc.
CHerry 1-6530
Cleveland
Main Line Cleveland, Inc.
EXpress 1-1800
Pioneer Electronic Supply Co.
SUperior 1-9411
Columbus
Buckeye Electronic Distributors, Inc.
CA 8-3265
Dayton
Srepco, Inc.
BAldwin 4-3871
Oklahoma
Tulsa
S & S Radio Supply
LU 2-7173
Oregon
Portland
Lou Johnson Company, Inc.
CApital 2-9551
Pennsylvania
Pittsburgh
Marks Parts Company
ELectric 1-1314
Philadelphia
Almo Radio Company
WAlnut 2-5918
Radio Electric Service Co.
WAlnut 5-5840
Reading
The George D. Barbey Co., Inc.
FR 6-7451
Tennessee
Knoxville
Bondurant Brothers Company
3-9144
Texas
Dallas
Graybar Electric Company
RIverside 2-6451
Houston
Busacker Electronic Equipment Co.
JAckson 9-4626
Harrison Equipment Company
CApitol 4-9131
Utah
Salt Lake City
Standard Supply Company
EL 5-2971
Virginia
Norfolk
Priest Electronics
MA 7-4534
Washington
Seattle
Western Electronic Supply Company
AT 4-0200
West Virginia
Bluefield
Meyers Electronics, Inc.
DAvenport 5-9151
Wisconsin
Milwaukee
Electronic Expeditors, Inc.
WOodruff 4-8820

MEETINGS AHEAD

May 31-June 2: Frequency Control Symposium, USA Signal Research & Devel. Lab., Shelbourne Hotel, Atlantic City, N. J.

June 1-3: Radar Symposium, Willow Run Laboratories, Univ. of Michigan, Ann Arbor, Mich.

June 10-26: British Exhibition, Electrical and Electronic Equipment, Coliseum, N. Y. C.

June 12-15: American Nuclear Society, Annual, Palmer House, Chicago.

June 14-16: Railroad Communications, Assoc. of Amer. Railroads, Communications Section, Sheraton-Cadillac Hotel, Detroit.

June 20-21: Broadcast and Tv Receivers, Chicago Spring Conf., IRE, Graemere Hotel, Chicago.

June 20-24: American Institute of Electrical Engineers, Summer General, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 22-24: Standards & Electronic Measurements, NBS, AIEE, IRE, NBS Laboratories, Boulder, Colo.

June 23-24: Solid-State Electronics Workshop, IRE, ASEE, Purdue Univ., Lafayette, Ind.

June 26-29: New England Electronic Conf., ERA, the Salsams, Dixville Notch, N. H.

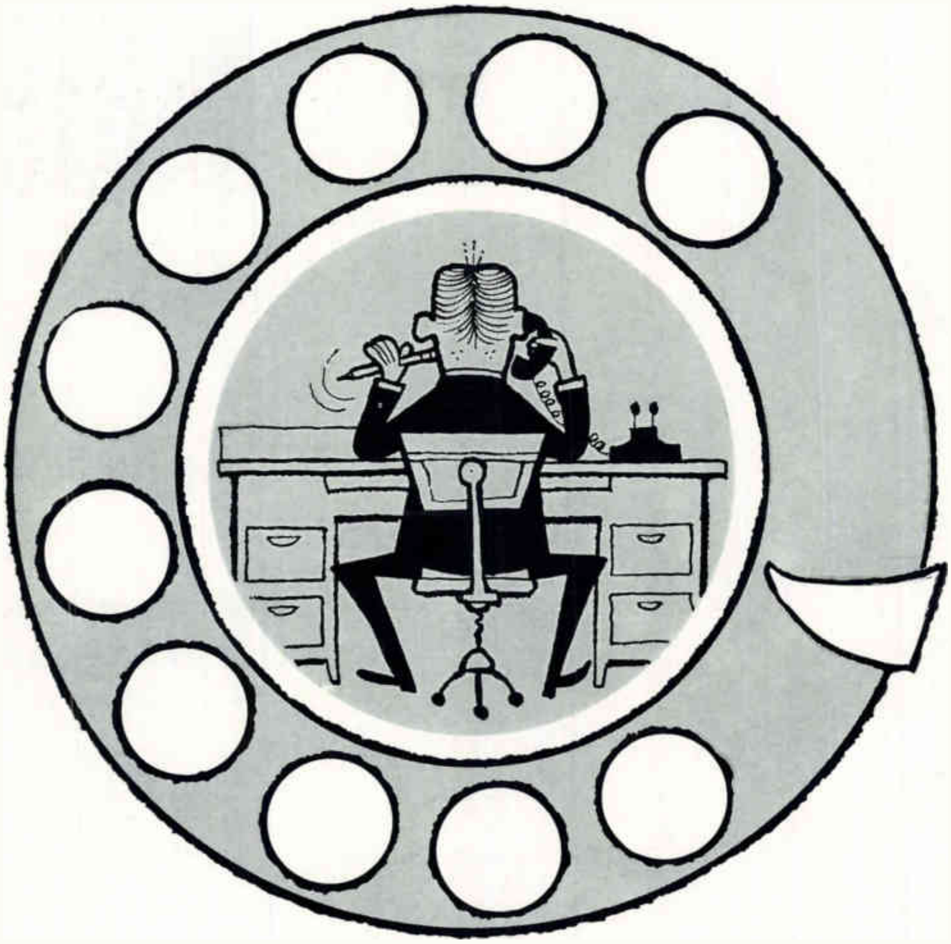
June 26-July 1: Materials Sciences, ASTM, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 27-29: Military Electronics, National Convention, PGME of IRE, Sheraton-Park Hotel, Washington, D. C.

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

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

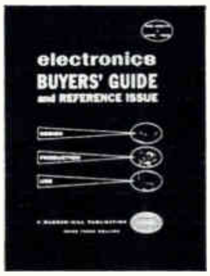
Who's the local rep?
What's his number?



LOOK IN THE NEW

electronics BUYERS' GUIDE

You'll find the local representative . . . his name, telephone number . . . his address. You'll find such detailed information about more than 25,000 local sales offices of more than 4,000 major manufacturers.



There's also a wealth of reference data about markets, materials, components and applications that make buying easier. Catalog information on nearly 700 different advertised products (that's about 42% more than you'll find anywhere else). Also complete lists of manufacturers . . . registered trade names . . . and also, of course, the most complete listing of electronic and related products. Tells what you want to know . . . *when you're ready to buy.*

ABC ABP A McGraw-Hill Publication • 330 West 42nd Street, New York 36, New York

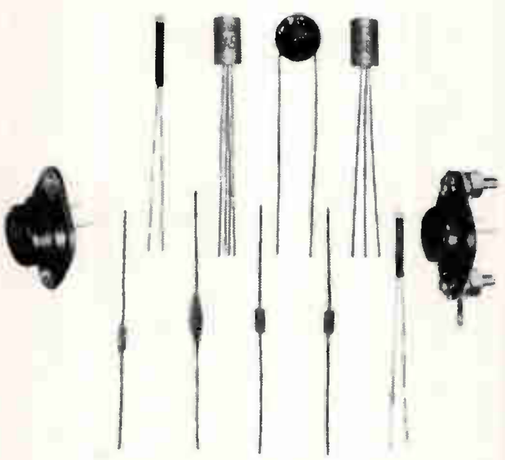
Toshiba

Toshiba leads the field in Japan's big semiconductor industry. This plant produces 4 million units monthly.

These agents supply high-reliability Toshiba electronic products

Transistors

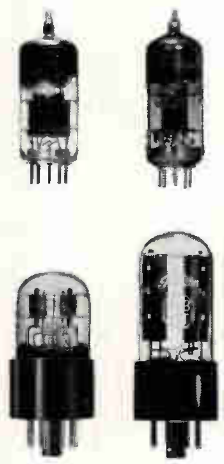
Toshiba transistors can be classified among those of leading international suppliers in low failure rate, long life, and high power efficiency.



Agent: **Cornell-Dubilier Electric Corp.**
333 Hamilton Blvd., South Plainfield, N.J.
PLainfield 6-9000

Receiving Tubes

These are direct replacement types with high performance and long life.



Agent: **A & A Trading Corp.**
1140 Broadway, New York 1, N. Y.
MUrray Hill 4-2758/9

Transistor Radios

The size of these popular radios is among the smallest achieved and at no sacrifice in performance.

Agent: **Transistor World Corp.**
52 Broadway, New York 4, N. Y.
BOwling Green 9-5460

TOKYO SHIBAURA ELECTRIC CO., LTD. Tokyo, Japan

CIRCLE 51 ON READER SERVICE CARD

How to determine high-frequency characteristics of precision film resistors

Specify with confidence from this complete line of time-proved TI resistors

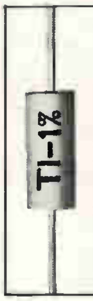
MOLDED†

TI type number	wattage rating watts	MIL desig-nation	standard resistance ranges	max. recom-mended voltage volts
CDM⅛	⅛	RN60B	10 Ohm-1 Meg	350
CDM¼	¼	RN65B	10 Ohm-1 Meg	500
CDM½	½	RN70B	10 Ohm-5 Meg	750
CDM 1	1	RN75B	10 Ohm-10 Meg	1000
CDM 2	2	RN80B	50 Ohm-50 Meg	2000

MIL-LINE †

TI type number	wattage rating watts	MIL desig-nation	standard resistance ranges	max. recom-mended voltage volts
CD⅛R	⅛	—	10 Ohm-1 Meg	350
CD¼R	¼	RN10X	10 Ohm-1 Meg	500
CD½PR	½	RN15X	10 Ohm-3 Meg	650
CD½MR	½	RN20X	10 Ohm-5 Meg	750
CD½SR	½	—	50 Ohm-10 Meg	850
CD1R	1	RN25X	10 Ohm-10 Meg	1000
CD2R	2	RN30X	50 Ohm-50 Meg	2000

HERMETICALLY SEALED LINE †



TI type number	wattage rating watts	MIL desig-nation	standard resistance ranges	max. recom-mended voltage volts
CDH⅛M	⅛	—	10 Ohm-500K	250
CDH⅛	⅛	RN60B	10 Ohm-1 Meg	350
CDH¼	¼	RN65B	10 Ohm-1 Meg	500
CDH½P	½	—	10 Ohm-3 Meg	650
CDH½A	½	RN65B	10 Ohm-3 Meg	650
CDH½M	½	RN70B	10 Ohm-5 Meg	750
CDH½S	½	—	50 Ohm-10 Meg	850
CDH 1	1	RN75B	10 Ohm-10 Meg	1000
CDH 2	2	RN80B	50 Ohm-50 Meg	2000

†All values available in 1% tolerance; nominal lead length 1.5 in.

sensistor* SILICON RESISTORS

Standard available resistances @ 25° C:
68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820, 1000, 1200, 1500, 1800 ohms.‡

Type No.	Wattage Rating	Body Dimensions		Average Temperature Coefficient	Resistance Tolerance
	W	Length	Diameter	%/°C	%
TM ¼	¼	0.585"	0.200"	+0.7	±10
TM ⅛	⅛	0.406"	0.140"	+0.7	±10
TC⅛	⅛	TO—5	Transistor	+0.7	±10

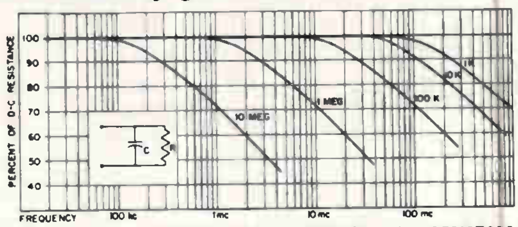
* TRADEMARK OF TEXAS INSTRUMENTS INCORPORATED
‡ Other resistance values and tolerances available on special order

For a more detailed discussion of this subject, contact your nearest TI sales office for a copy of "High-Frequency Characteristics of Precision Film Resistors."

In high frequency applications, precision film resistors are superior to composition or wirewound resistors; skin effect of the thin film is negligible.

OHMIC VALUE vs FREQUENCY

Precision film resistors of a given physical size have the same distributed capacitances regardless of their ohmic value. As the frequency increases, the shunting effect of the distributed capacitance causes the effective parallel resistance to decrease. The reactance of the stray capacitance becomes a relatively good shunt when it approximates the ohmic value of the resistor. The smaller the ohmic value of a precision film resistor (for a given physical size), the higher its usable frequency range.



HIGH FREQUENCY RESISTANCE OF PRECISION FILM RESISTORS

INDUCTANCE CONSIDERATIONS

The inductance caused by helixing the higher value resistors is negligible throughout the "useful" range of frequencies at which the resistance is greater than 60% of its d-c value.

When resistors under 500 ohms are measured using high frequency meters, the reactive component of the equivalent parallel circuit appears inductive because of lead and binding post inductance. However, the resistor itself is capacitive.

TI TYPE	SIZE (WATT RATING)				
	⅛	¼	½	1	2
MIL-LINE (CD)	0.2	0.1	0.25	0.5	0.6
MOLDED (CDM)	0.3	0.25	0.45	0.7	0.7
HERMETICALLY SEALED (CDH)	0.3	0.25	0.45	0.75	0.8

CAPACITANCE IN μμf OF TI PRECISION FILM RESISTORS

CAPACITANCE CONSIDERATIONS

The average measured capacitance of Texas Instruments Precision Film Resistors is determined primarily by the end cap-to-cap capacitance which is proportional to the dielectric constant of the core and encapsulating material.

MOUNTING

Precision film resistors of 200 ohms or less perform satisfactorily at 5000 mc and higher if placed in a well-designed coaxial mount. A coaxial mount constructed from a standard UG-18B/U Type N plug can be used effectively. In conventional terminals, correct mounting of the body of the resistor off the circuit chassis and the use of short leads will minimize the stray capacitance and lead inductance.

Specify TI precision resistors!

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

Electronics in JAPAN

BY FRANK LEARY
Associate Editor

一企業の成功はそれにたずさわる人々に依存致します。

例へば、電子機械は人よりも知的にも、物理的にも非常に六カ敷い仕事を、より良く、早く、且つ正確に致します。

しかし最初にこれらの機械を夢見たのは人間であり、人
それらを考案して造ったのです。人の造る機械が如何
なものでも、その主人となるのはやはり人であります。す
が成功、不成功、或は使用上の善悪を決定します。武器
これを平和のために用ゆることが出来るのは、人にまたねば
りません。人は劔を鍬に変え、槍を鎌に変えることが出来るからです。

偉大な日本の電子工業にたずさわる男性、女性の方々に本誌は深甚な感謝の意を表します。

この報告は皆様方の事業に関するものでありまして皆様方の御協力なしには書き上げることは出来ませんでした。

御親切と御協力のすべてに対して、私共は適切な謝辞もありません。私共の最高の謝辞も余りにも見すぼらしいものにしか過ぎません。

电 Electronics in JAPAN Part 1

JAPAN

Background of the Electronics Industry

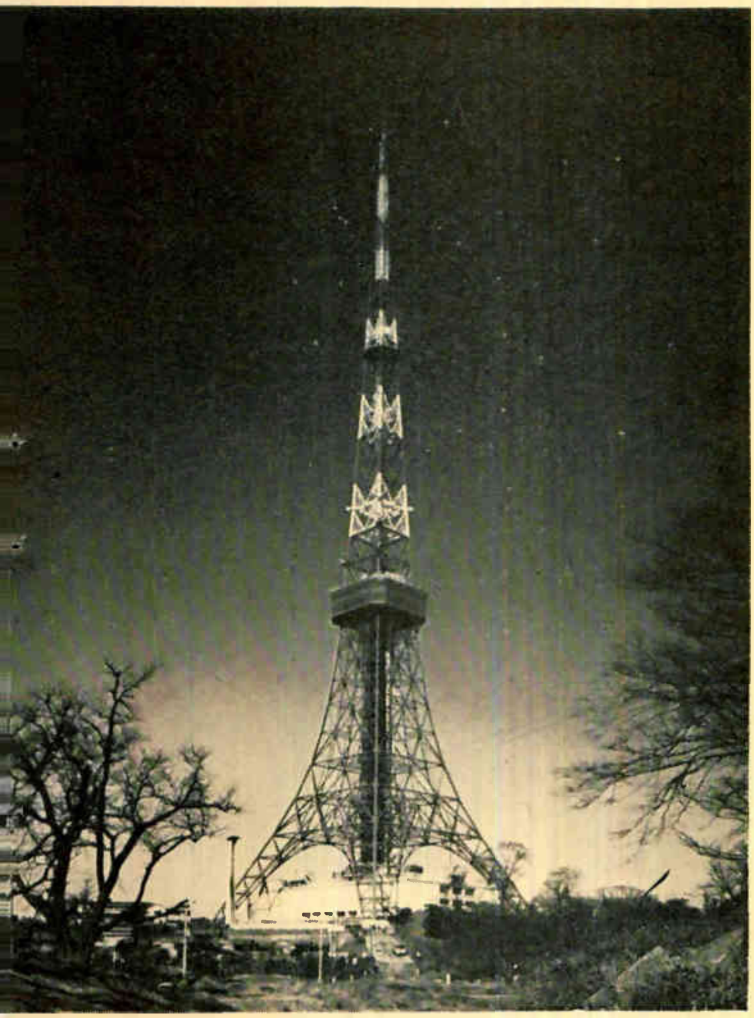
THIS YEAR, Japan and the U. S. celebrate the hundredth anniversary of the treaty of amity and trade between the two nations. This year is also a pivotal one for Japan's electronics industry, for a series of commercial and scientific developments have set a new wind of change blowing in almost every quarter of the industry.

Japan has gone through many transformations in its long history. Some were self-consciously superimposed by a ruler or ruling clique, some erupted from below. The changes taking place today in Japan's industry are both.

It was the singleminded intent of the regent Shotoku to civilize his country which in the 7th century gave Japan its government structure, its philosophical base, its Chinese writing (still called *Kanji* or "Han words") and ultimately its religion. It was pressure from the Osaka merchants and unemployed samurai which by 1850 had paved the way for opening Japan to contact with the Western world after 350 years of somnolence under the repressive rule of the Tokugawa shoguns.

In 1853, and again in 1854, Commodore Matthew C. Perry appeared with his gunboats off Japan with the demand that he be permitted to establish a trading post. The second time he refused to leave Suruga Bay without the agreement. The shogun allowed him to set up a post in Yokohama, and thus brought down the

Electronics manufacture relies heavily on the patience and industry of young girls between school and marriage



Japan's paradox is dramatically illustrated by the Tokyo Tower, a flagrant copy of the Eiffel Tower (but 12 meters higher), which dominates the Tokyo skyline and is transmission point for half the city's tv stations. Japan has reached a point where copying is no longer enough; yet many firms still copy

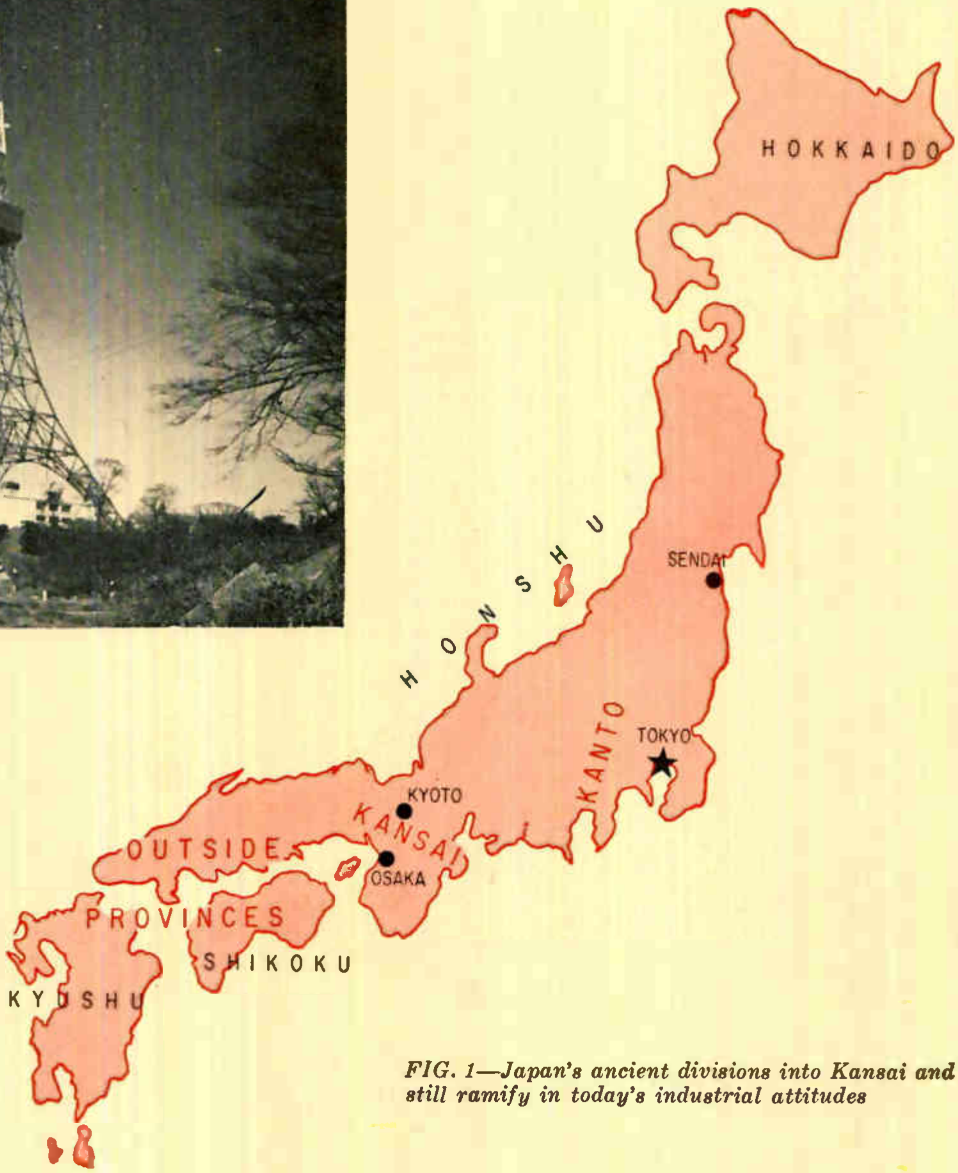


FIG. 1—Japan's ancient divisions into Kansai and Kanto still ramify in today's industrial attitudes

already tottering shogunate about his ears.

The restoration of power to the young Emperor Meiji in 1858 began the history of modern Japan. Within a few decades, the Japanese effectively remodeled their government, their social structure and the face of their economy, creating an impressive and competitive industrial base to withstand the colonializing forces of Europe.

The Meiji Restoration also created many of the conditions that still operate in business and industry in this paradoxical island nation. First, the planners for the young emperor—an unusually brilliant group of well-versed but hitherto unemployed samurai—realized that Japan had to catch up in a hurry. To that end they created and force-fed industries, banks and commercial organizations. This not only fostered strong ties between business and government, but created the tradition of government control over and protection of business that is dying so hard just now in Japan.

ZAIBATSU—By the time World War I was over, the business structure was marked by a dozen monolithic trusts, called *zaibatsu* (literally "money cliques"). These were giant family-owned aggregations of trading companies, shipping firms, light and heavy manufacturing industries and subsidiary supply services, governed from a central bank which was usually joined with an insurance company. Four were true giants: Mitsui, Mitsubishi, Sumitomo and Yasuda. (Of these, three have regrown since the war. Yasuda remains an important bank but has been effectively dispersed as a manufacturing entity. The Dai Ichi bank has grown to importance as a bank which controls industry, and Hitachi Ltd., without direct banking connections, has grown as a giant industrial entity.)

The zaibatsu and the government worked hand in hand to fulfil the plans of the Meiji Restoration, and by the 1920s economic prosperity and a high degree of political liberalism had begun to grow. When the depression struck Japan in the 1930s, the *gunbatsu* (military cliques) claimed the zaibatsu had failed. The chairman of Mitsui's board was murdered in 1932 by "young officers," and the zaibatsu retreated.

In 1931 the brilliant Takahashi became Finance Minister and attempted to reinflate the country's economy. He pursued his policy successfully until the February 1936 revolt of the officers corps, when he was brutally assassinated and the gunbatsu took over. The consequences were first the long war against China and then Pearl Harbor.

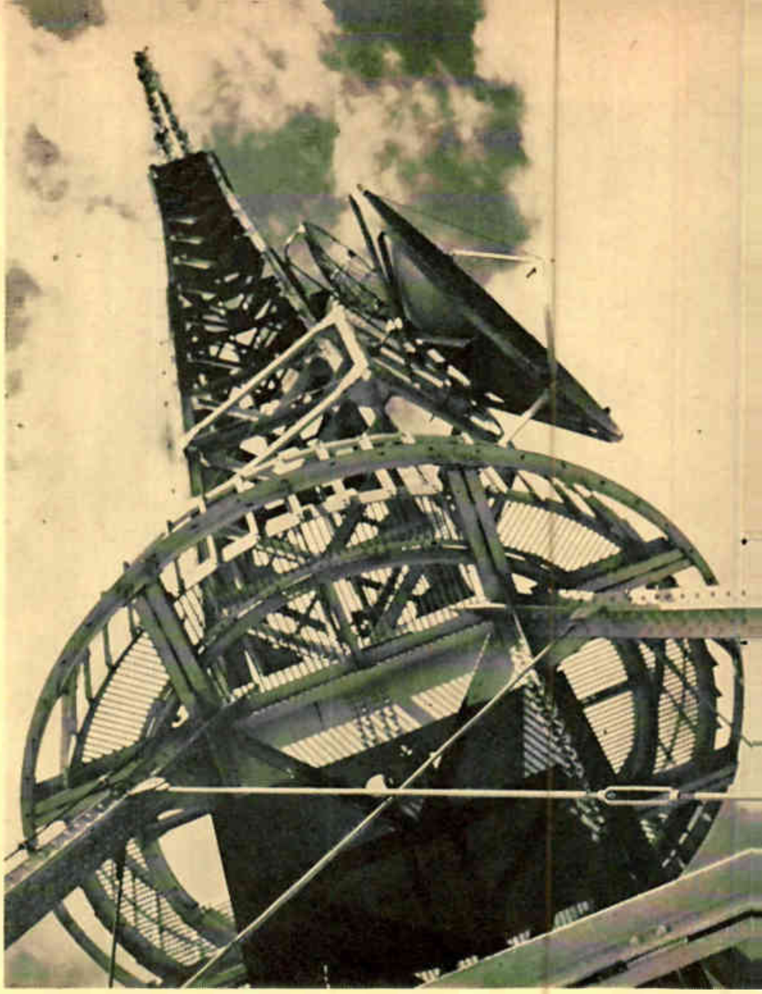
At the height of World War II, the power of Japan stretched to India and almost a billion people were under her dominion. By autumn of 1945, she was exhausted at home and defeated abroad, and for the first time in her long history became an occupied nation.

The occupation attempted to dissolve the zaibatsu, encourage trade unions and decentralize the authority of government. Industry was forced to lie stagnant; U. S. aid financed essential imports. The supply of goods dwindled, and, with aid injections coming in for rehabilitation, inflation flamed. In 1949 an abrupt about-face was instituted and industry was encouraged to struggle to its feet. It had just began its comback when the Korean War threw millions in offshore contracts its way and a firm regrowth resulted.

Since Korea, industry has gone through two successive capital-expansion booms and subsequent retrenchments. The latest retrenchment coincided almost exactly with the 1958 recession in the U. S., and caused the most recent government attempts to keep the yen stable at a favorable rate in the world market by artificial controls on currency and the import trade.

In 1952, Japan regained her national independence and took off on a spectacular economic and industrial rise. And the zaibatsu, which the occupation had tried to disperse ("deconcentrate" was the unfelicitous word employed by the MacArthur planners) began growing back together. This reorganization did not come about through wilful perverseness, nor through a plot to concentrate wealth in a few hands. It is an accidental result of another important phenomenon of the Japanese economy—the serious and vitiating shortage of capital.

RESOURCES—Excepting for water power and a few minerals, Japan is a resource-poor nation. Its volcanic mountains contain few rich mineral deposits, and what



This Hitachi transmission gear is used for relaying news from Osaka to Tokyo newspaper office

minerals are there are locked into compounds difficult to smelt out. Only about 15 percent of the land is arable. Historically, even the majority of farmers have had to eke out their livelihoods with nonagrarian activities. Many were parttime fishermen; after the opening of world markets, increasing numbers turned to small handicraft enterprises.

In the last years of the Tokugawa shogunate—between the time Perry's classic gunboat diplomacy opened the gates of trade and the time the young Mutsuhito became Emperor Meiji and made Tokyo his capital—some shrewd European traders milked Japan of most of its liquid capital. One of the techniques was brutally simple. The shogun maintained a monopoly of silver, and had established a very profitable silver-gold trading ratio of 5 to 1, while silver was valued at only 16 to 1 on the world market. The traders imported Mexican silver dollars, traded them weight for weight for Japanese silver coins, exchanged these on the Yokohama market for gold at 5 to 1, and exchanged the gold in Shanghai for silver at world-market prices. Before the shogunate could act, most of Japan's gold had been drained out.

On top of this, Japan has lived through 75 years of forced industrial growth, more than 10 years of war involving the devastation of much of her industrial base, and five years of occupation policy calculated to inhibit regrowth of that base. The inevitable result is a serious capital shortage. Government fiscal policies designed to stabilize the yen have inadvertently made this shortage even more serious by discouraging foreign capital investment.

Japanese industry—and the electronics industry is no exception—is fantastically undercapitalized. The mean ratio of owned capital to authorized capital for all Japanese industry stands at around 30 percent. And the authorized equity-capital figures tell only part of the story, since equity financing is not the capital foundation of most Japanese industry.

A company like Tokyo Shibaura Electric, producing 100-billion yen worth of goods in a year, considers it news that last year its directors raised the capital authorization to 25 billion yen. Mitsubishi Electric has 256-million shares of stock outstanding, valued at 12.8-billion yen; the breakdown of its shareholders shows Westinghouse International, with 10.125 million shares, (3.96 percent) to be the largest shareholder. Neither of these perfectly true statements discloses the fact that Toshiba's financial foundation is in the Mitsui Bank and Mitsubishi's is in the Mitsubishi Bank.

Bank ownership of industry, of course, does not come about through equity capital investment, but through loans. It consequently does not show up in capital statements, and such is the nature of business practice in Japan that it may not show up anywhere at all. But the silver cables that bind industry to a double handful of banks and insurance companies crisscross the land.

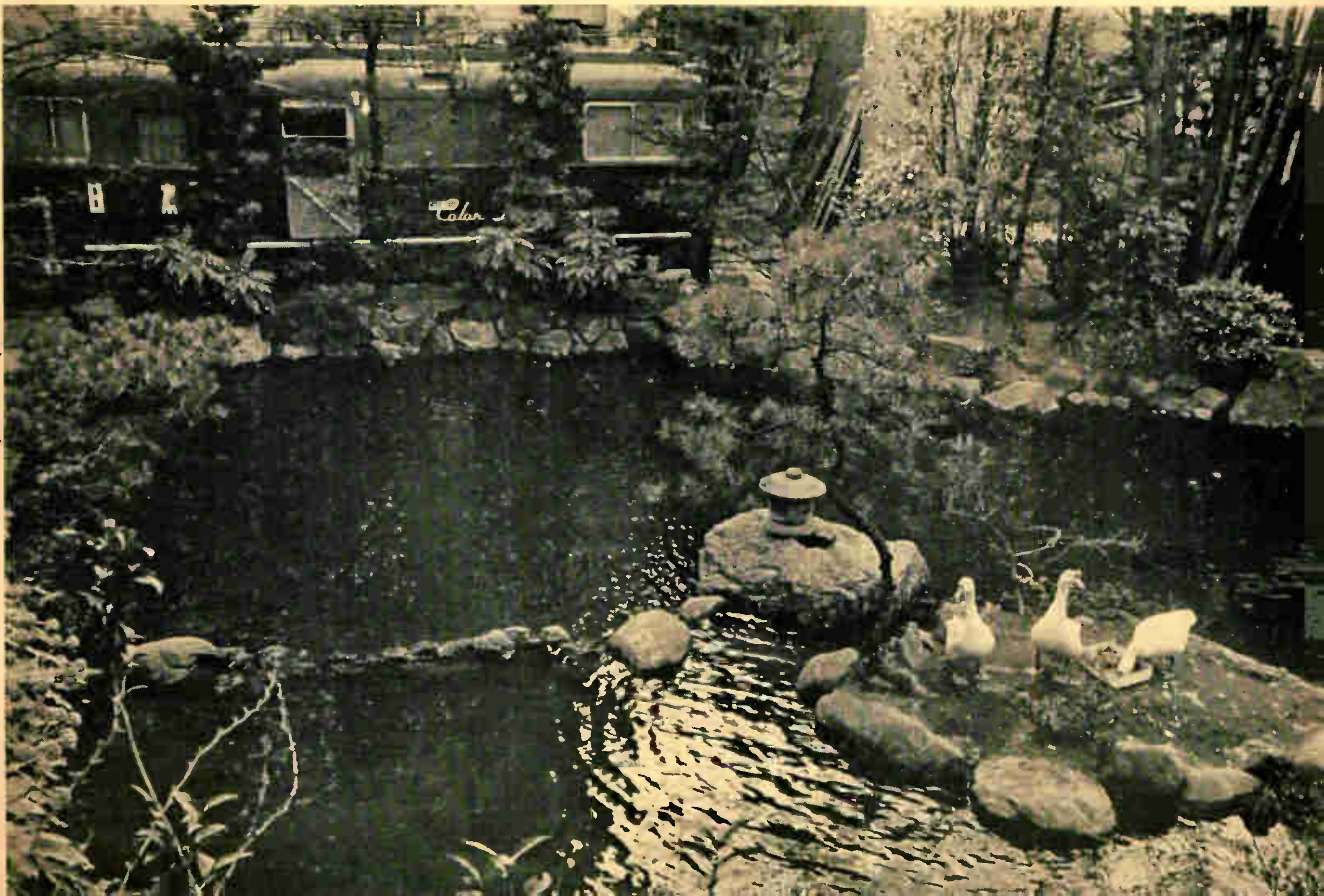
BANKERS' WEB—The weaving of these cables starts at the inception of a new enterprise. If a man wishes to go into business, exploiting, say, a new invention, he may—in the U. S. or in Europe—begin by taking out a bank loan, or by floating a stock issue, or he may finance his enterprise out of his own, his family's or his friends' savings. In Japan he has no such option. The amount of capital available in the stock market is small; most small investors seek the security of government-sponsored Postal Savings. The market itself fluctuates furiously; it is a buyers' market when it is not a roulette game for a handful of speculators. Consequently the companies listed on the exchange know they must declare fat dividends in order to compete. So to a small and unproved enterprise, the market is closed as a source of capital.

He may tap his own, his family's and his friends' savings. But the probability is small that there will be enough capital there to enable him to put a foundation under any but the most modest enterprise.

If he goes to a bank, he will usually be denied a loan unless he produces a letter of intent from a prospective customer. This puts him at the mercy of his customers right from the start, and mortgages his profits to the bank for a loan. Unless he is very cagey indeed, he may find the customer—frequently a trading company which itself may have close affiliations with a bank—working with the bank to control his enterprise.

If he escapes this trap, another faces him. With profits mortgaged to paying off his loan, he cannot accumulate

The old and the new: almost hidden by the shrubbery of a classical Japanese garden, a color-tv remote truck idles behind Nippon Television studios. NTv is vigorous commercial competitor for state-owned network



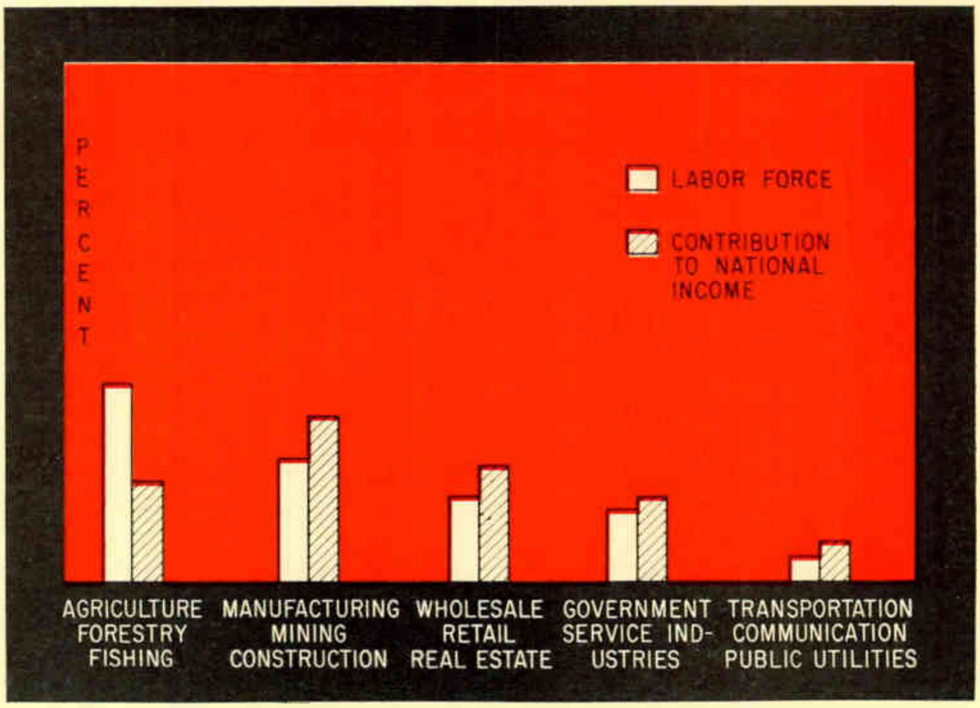


FIG. 2—A fourth of Japan's labor force, engaged in mining, manufacturing and construction, generates a third of the national income

reserves for expansion. If he wishes to make capital improvements, he must borrow again. And if he makes any mistake that delays repayment, he will find the bank moving in to direct his enterprise.

If he eventually seeks to escape from debt financing by selling equity in his enterprise, he finds himself faced with the necessity of mortgaging still more of his profits to declare dividends—10 percent is considered a fair dividend, and blue-chip stocks pay 20 percent.

Bankers have an additionally repressive effect on a technological industry such as electronics. The bankers' dislike of speculative endeavor discourages research and engineering. This inhibition works in two ways; firstly, the ultraconservative attitude which obtains in most bank-controlled companies inhibits the engineer and damps out his creative enthusiasm; secondly, the same attitude encourages the company to concentrate on proved techniques and devices rather than on developing new ones.

Hand of bureaucracy rests heavily on Japan's industry. Ministries of International Trade & Industry and ost & Communications, and Science & Technology Agency are only part of Tokyo's bureaucratic complex

This partly accounts for the large number of technical-assistance agreements in force between big U. S. companies and Japanese firms. Most Japanese companies have one or more links with Western technology—RCA and Western Electric, for instance, license almost everybody. But in some cases the ties become almost identity.

Giant Hitachi, for example, is very closely linked with RCA in much of its electronic activity. Toshiba for many years was almost identified with General Electric, still has strong ties. Shimadzu and Mitsubishi are both linked to Westinghouse in the X-ray and instrument fields. Little Origin Electric now has a loose tie to Raytheon (see ELECTRONICS, p 32, April 8). Matsushita has a direct link to N. V. Philips, and Nippon Electric is not only a Sumitomo company but an ITT affiliate.

Most ties are of the loose contractual nature of the three agreements approved in March by the Finance Ministry, in which basic licenses were granted by Western Electric to New Dengen Industries, Origin Electric and Toho Sanken for a fee amounting to 2 percent of sales of licensed products.

One result of the close ties between big Japanese electronics manufacturers and Western technology is that the best research in Japan is not always done by the giants in the industry. These companies have big, gleaming laboratories and hordes of research men, but comparatively speaking they are doing journeyman engineering. The best and most imaginative research work in

Japan is either in the big government laboratories—including the half-dozen or so big government-supported universities—or in the middle-sized companies which do business just outside the reach of the big banks.

MANPOWER—One of Japan's most valuable resources is her manpower. The island nation, with an area about the size of California, has a population density second among industrialized countries only to Belgium. The people are industrious and thrifty, with a long tradition of discipline, industry and frugality.

Japan's population at the beginning of the Meiji Restoration was about 26 million; in 1938 it was 71-million; it is now over 93 million, growing fairly slowly (1 percent annually, with birthrate and deathrate both below those in the U. S.). It will pass 100 million by 1970. About 45 million people are considered as being in the labor force, with 7 million more to be added during the next decade.

Only about 40 percent of the work force receives a regular salary; of the remainder, many of whom work on farms or in small family enterprises, nearly half receive no money wages at all. The segment of Japan's work force employed in industrial activities, as Fig. 2 illustrates, account for a disproportionately large share of the nation's income.

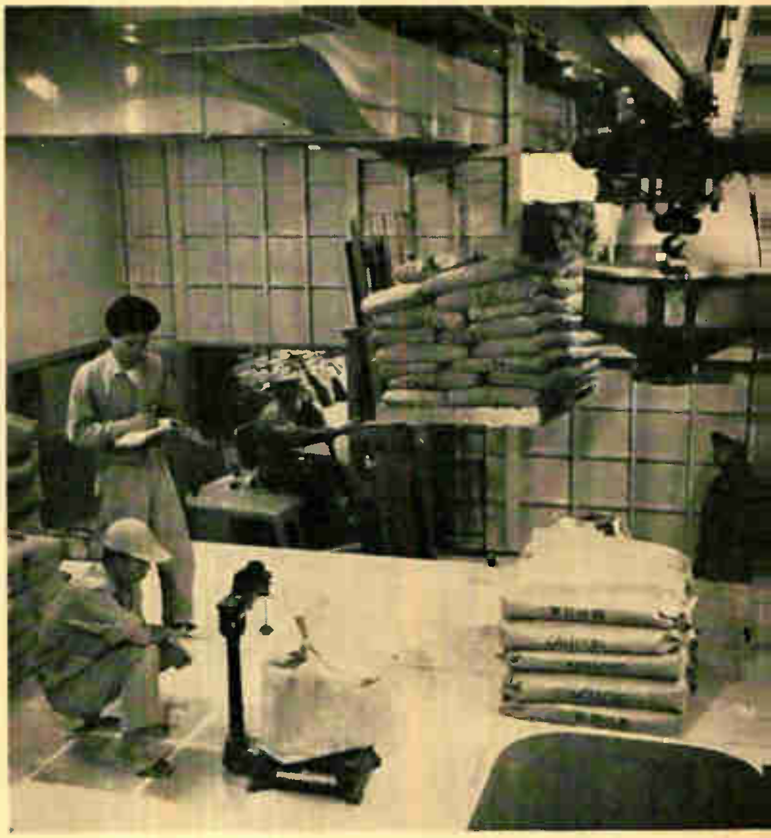
As of yearend 1959, the electronics industry in Japan hired 158,343 employees, paid them a monthly total of $7,440,700 (including the 15-percent bonus that is practically an industry standard), for an average monthly wage of $47. This sum is high by the standards of most other Japanese industry, and does not represent the end of industry's payments for labor. There must also be included (see ELECTRONICS, p 36, Apr. 1) medical benefits, including hospitals in some cases; extra allowances for children and indigent parents; pensions; allowances for transportation and housing; cost of employer-provided restaurant facilities and stores; athletic and cultural facilities.

All of these can boost labor costs by as much as 150 percent. In the case of some firms, paternalistic practice hides actual per-employee average payments of $110 monthly in all these benefit categories.

Japanese companies have a niche for every worker. Once hired, an employee gives a kind of loyalty that can only be called filial, and is in return cared for in a manner that can only be called paternalistic. Men rarely quit, are rarely fired. One executive comments: "In a 12- or 20-man company, perhaps an inefficient worker can reasonably be discharged. But when you have 2,000 or 20,000 employees, one man's inefficiency will not affect your profits. If he is inefficient, it's his employer's fault for assigning him improperly; we shift them around until they find a niche."

This kind of paternalism is much more pronounced in the older and bigger companies than in newcomers to the field, but even the most progressive managers can't make too much headway against tradition. The winds of change are blowing, however, and one by one, progressive firms are trying to lop off services to employees and substitute real wages instead.

Manufacturing executives further estimate that it costs over 1.5 million yen ($4,200) to create one new job. To absorb 800,000 new workers a year will require capital investment of $3.4 billion a year. In order to generate this kind of capital, Japan's industry—and electronics is leading industrial growth in Japan—will have to both increase exports and encourage more domestic and foreign investment.

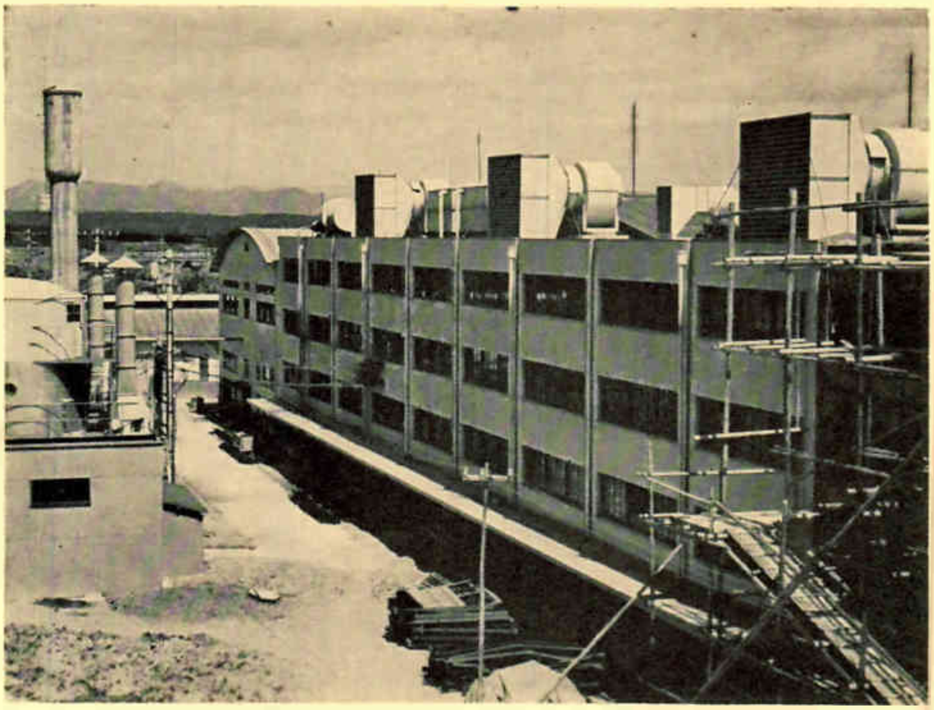


One great advantage of electronics to capital-shy Japan is that not all raw materials need be imported. Many basic raw materials for component manufacture are available in Japan's soil

TV SPARKS GROWTHS—The dramatic resurgence of Japan's industry since 1950 has been sparked by electronics. A white paper published last month by Ministry of International Trade & Industry admitted that the electronics technology had powered the boom in capital goods. And television is almost singlehandedly credited with pushing up sales in the consumer fields.

In one of the deliberate moves characteristic of Japanese government for 1,300 years, and especially since the Meiji Restoration, the government decided in 1952 to plant and grow a television network. It set up the Japan Broadcasting Company in the tv business. This company is a public corporation in Japan's usage of the term; that is, a corporation financed either by the government outright or partly by the government and partly by the Postal Savings of which the government is the custodian. It also permitted private competition; but, as in Britain, licensing fees for consumer sets accrue to the public corporation.

A number of bold entrepreneurs set out to compete. One of these—Matsutaro Shoriki, publisher of the Tokyo *Yomiuri* newspaper—bought 300 tv sets and put them



All over Japan, electronics' phenomenal success has sparked expansion. In Kyoto, Murata is putting up a new technology lab

up in public places all over Tokyo. They immediately became so popular that traffic in downtown Tokyo's already impossibly congested streets ground to a halt.

This simple promotion technique—and Shoriki is planning to employ it again for color tv—started people buying television. A couple of more progressive companies like Matsushita Electric made purchases easier by extending financing plans for consumer goods for the first time in Japan's commercial history.

The advertising of goods over these commercial stations sparked consumer buying and provided the foundation for the industrial resurgence. Consumer purchases have been among the brightest sectors of the Japanese economy, even continuing at a fairly strong clip during the 1958 recession.

In 1958, tv sets and other electronic consumer goods comprised 49 percent of the sales total for all household electrical appliances (refrigerators were next at 28 percent and electric lights third at 10 percent). In 1959, with sales of household electrical appliances reaching a postwar high, tv and other consumer electronics jumped to 59 percent; refrigerators and other motor-attached devices dropped to 23 percent and electric lights to 8 percent.

PATTERNS OF INDUSTRY—Electronics in Japan is dominated by a double handful of companies. Old-line firms like Hitachi, Fuji Electric, Toshiba and Mitsubishi Electric fall into a fairly conservative industrial pattern. Another pattern is being set by aggressive newcomers, both big ones like Matsushita and middlesized ones like Sony, Sanyo and Yaou.

Toshiba (Tokyo Shibaura Electric Co.) is Japan's largest producer of exclusively electrical and electronic equipment; its neck-and-neck competitor, Hitachi Ltd., is larger but diversified into other fields. Toshiba's history and business practice are representative of the older firms in the field.

Shibaura Engineering Works grew out of a small manufacturing enterprise founded in 1875 to make telegraph equipment, and by 1939 was Japan's largest privately owned machinery company. The Tokyo Electric Co. was the outgrowth of a small company founded in 1890 to make bamboo-filament electric light bulbs (Edison's original light bulbs used filaments made of bamboo grown in Japan).

When the two firms merged in 1939, they were both progressive companies, each in its own way a giant. Shibaura had tied up 70 percent of Japan's electrical-machinery market prior to 1919. Tokyo Electric made wire-filament bulbs in 1910, developed the two-coil filament in 1936, before it was introduced in the U. S., and was the first company to frost its bulbs.

During World War II, Toshiba's reputation for efficient management led the militarists to put many military contracts under its wing, and it supplied much of the electrical equipment used by the Japanese armed forces. Also during the war, about 20 percent of its productive capacity was destroyed. During the occupation, its ties with the militarists and with the Mitsui zaibatsu led the occupation to attempt to deconcentrate it.

General Electric, which had owned a quarter of Shibaura and half of Tokyo Electric, owned about a quarter of the merged company when the war broke out. GE's management methods were in large measure responsible for the reputation acquired by Toshiba before the war. But the deconcentration of Toshiba, and a shifting of the nature of GE's relationships with all its overseas affiliates, have placed the two companies in a less exclusive relationship than heretofore.

The result is that while Toshiba appears on the surface to operate like GE, beneath the surface it bears no resemblance. It is structurally divided—as GE is—into divisions according to kinds of product. It makes heavy and light electrical equipment and electronic gear. It has excellent relations with public utilities throughout the country, and its consumer products enjoy a valuable reputation.

But without the direct guidance of GE, which had steered the two companies before 1939 and the merged company until the war, Toshiba missed several important bets after the war. Matsushita, a rank upstart in the Osaka area, has beat the older firm out in its own bailiwick of consumer goods, and another upstart company, Sanyo, is threatening it from third place. In the bleak postwar years, Toshiba forgot that selling is an important part of the appliance business; it rested on its laurels. It has also tended to overlook the importance of research and engineering in the electrical and electronic fields, relying more on imported research.

Indeed, Toshiba was in such a bad way in 1949 that Taisho Ishizaka, an officer of the Dai Ichi Insurance Company (one of Toshiba's creditors), was called in to pull the company together. Measured against the tradition of loyalty so deeply ingrained in Japanese business practice, this was bitter medicine indeed.

Ishizaka has today withdrawn from intracompany affairs and concentrates on policy. He is also president of the Keidanren, Japan's equivalent to the National Association of Manufacturers, and is probably the single most influential industrialist in Japan. He is politically and economically progressive, fighting against government control over business and in favor of foreign investment for Japan's industry. But within his own company there are still peculiar paradoxes.

Two plants of the Toshiba group exist almost side by side in Kawasaki, halfway from Tokyo to Yokohama. In one, a manager of the prewar school, almost professionally despondent and pessimistic, merely allows the production of communications equipment to take place. In the other, one of the most dynamic engineering and management groups works constantly and enthusiastically to perfect transistor manufacture.

The first plant, unfortunately, is more representative of conservative big business in Japan than the second. But in the second plant one can sense the winds of change that are clearing out the cobwebs even in the giants of Japan's industry. Here engineers have been set free to develop new techniques for performing the drudgery of transistor assembly. Some of the production jigs used, for example, to deposit indium dots on the pellets, and to insert the pellets in the base tabs—24 at a time—are models of imaginative engineering. They are undramatic things, perhaps, but they represent a kind of engineering imagination that may ultimately mean more than all Toshiba's giant power equipment, of which the company is inordinately proud.

EMPHASIS ON MARKETING—Matsushita Electrical Industries, which has boosted itself into first place in many of the consumer electrical areas, has grown to prominence almost entirely since the war. Its basis is in the consumer field, and its tradename, National, is today a household word in Japan.

Its president, Konosuke Matsushita, started in business in 1918 with capital of about $25, making lamp sockets and plugs. By the time the war came, his firm was producing electric irons, batteries, motors, and a few radios. During the war it made electrical equipment for the war effort, and because of its size was not subjected to deconcentration when the war ended.

In 1950, the company issued some debentures and a lot of stock, taking on outside capital for the first time. With the capital, the firm took off on an expansion program. In 1952 it tied up with Philips of Eindhoven and formed Matsushita Electronics, with Philips holding 30 percent interest. Armed with the Netherlands company's technical knowledge, and with modern merchandising methods, Matsushita began taking over increasingly larger shares of the market in almost all electrical appliances.

The company's organization is less topheavy with management than older firms, is set up more like a tactical operation than a firm. Matsushita delegates a surprisingly large part of functional responsibility, relies unashamedly on inside and outside help in making his decisions. The 15 manufacturing divisions of the company are each headed by a man responsible for all phases of its operation; each has its own working capital, keeps its own books. Profits are not pulled from one division into another; each has to stay in the black on its own.

Three coordinators for the company oversee sales, research and manufacturing techniques. These, with the heads of the three subsidiaries (including Japan Victor) and three staff men, make up Matsushita's board—a sort

Conservative Mitsubishi is just moving into its new Itami transistor plant—and its employees are moving into the new company quarters in the foreground of war council free to move quickly when necessary.

Matsushita is a successful industrialist, a self-made man in a country where birth distinctions still count, and the highest-paid industrialist in the country. He believes strongly in merchandising his products, but has a healthy respect for the power of engineering in making those products merchandisable. Besides the Philips ties, he maintains research observers in the U. S., has tie-ins with RCA, Western Electric and Arcair. He also has a sincere social consciousness that leads him to believe that his company can succeed only so long as it renders a valuable service to the community.

His aggressive merchandising techniques have almost forced a marketing revolution in the electrical merchandising field. His canny handling of finance, plus his reputation as a shrewd businessman, have permitted him to expand his company and still stay out of the hands of the several banks who were his creditors. Many of the younger and smaller Japanese electronics firms now coming up are consciously trying to emulate his firm.

DIVISIONS—One phenomenon, understanding of which may help to reduce the paradox of Japan's electronics industry, is the geographical separation of the country, which is rooted in history and ramifies in today's commercial and scientific attitudes. During the isolation of the Tokugawa shoguns, the country was roughly divided in three: the *Kanto*, or east provinces, centered around the administrative capital at Edo (now Tokyo) where the shogun lived; the *Kansai*, or west provinces, centered around the imperial capital at Kyoto and the commercial nexus of Osaka; and the outside provinces—most of southern Honshu, plus Shikoku and Kyushu—where lived the princes who were in a more or less constant state of opposition to the shogunate (see Fig. 1).

With the addition of northern Honshu and the island of Hokkaido—still relatively sparsely settled and not heavily industrialized—these divisions still remain. The Kansai merchants of Osaka remain hostile to the Tokyo industrialists, for instance. This division can be most clearly seen in the argument still raging over trade liberalization. The Kanto industrialists and trade unions are fighting a delaying action; the Kansai merchants, who realize that free trade is the country's only hope for a healthy economy, want to "take the plunge" right away.

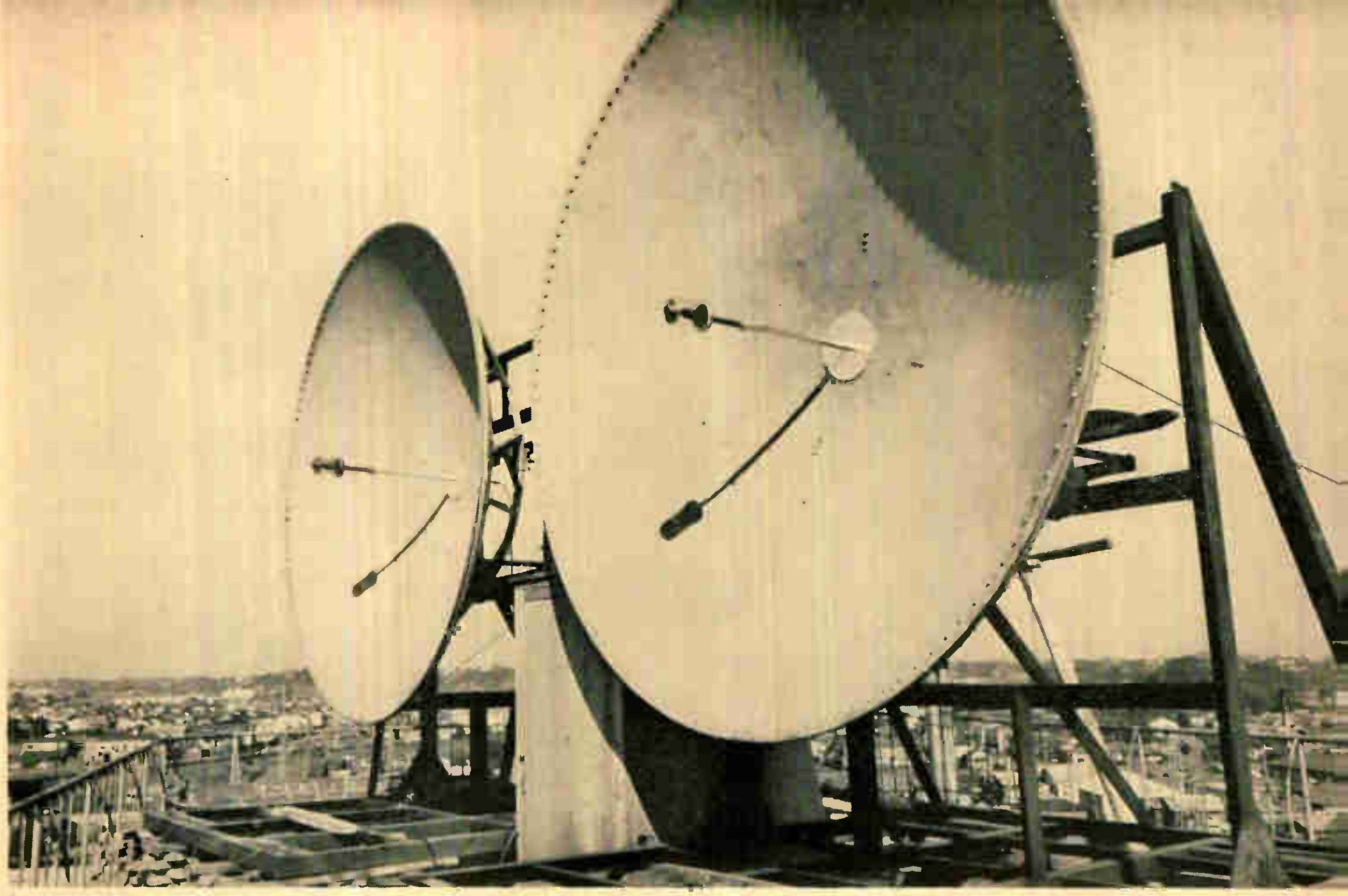
In matters of industrial policy, the outside provinces are generally at one with the Kansai. But the power of the *kanbatsu* (bureaucracy; literally "government clique") is strong, and most bureaucrats have strong emotional and philosophical ties with Kanto industry.

It is gradually becoming clear, however, that the stifling air of the Kanto inhibits the growth of electronics. Even Mitsubishi—of all zaibatsu the most clearly identified with the Kanto—is expanding its electronics activities in the Osaka region, with a new transistor plant just now completed in Itami, near Osaka.

The most progressive and aggressive among Japanese electronics firms are found in the Kansai, and the growth of the electronics complex around Osaka, Kobe and Kyoto has produced a labor shortage, an unusual phenomenon in this underemployed country and a tribute to the drawing power of electronics.

This condition is worsened by the fact that young Japanese—especially those not college trained—who wish to abandon conservative traditions have historically sought their fortunes in Tokyo. Thus Tokyo city is jammed with unemployed or underemployed young people, while as close as Kawasaki (halfway to Yokohama, and also a manufacturing center for electronic products) there is a shortage of technically adept people.

Young people seek out electronics for employment because of clean working conditions, good pay by Japan's standards, progressive management. Here Sony president Ibuka checks a transistor assembly area



Communications systems were the nucleus, are still the heart of Japan's electronics. This over-horizon system at 2,000 Mc was developed by NEC, will be used by U. S. forces in Korea

Electronics in JAPAN 電 Part 2

PRODUCTS and PRACTICES

Status of the Electronics Industry

SIXTY YEARS AGO, Japanese engineers successfully made wireless contact across 37 miles of water and brought the electronics technology to Japan. Five years later, test communications were opened between Nagasaki and Formosa.

During the succeeding thirty years, the technology moved sometimes ahead of developments in the rest of the world, sometimes behind. In 1912, for example, scientists at the Communications Ministry's electricity laboratory developed the first wireless telephone. Many of the experiments in communications techniques—including the development of carrier telephony—preceded similar work in Europe and America, while vacuum-tube work and the radio technology followed after developments in the U. S. Television work in Japan dates from 1927; a working system was publicly demonstrated in 1939.

When the control of government passed into the hands of the military cliques in 1936, much research work was suspended. Even in the military electronic areas—radar, for instance—the search for the immediately practicable blocked off advanced research, and for ten years electronics stagnated in Japan.

When in 1948 the Supreme Commander, Allied Powers authorized uhf f-m communications, research breathed again and electronics began to grow. In 1949, half a dozen big manufacturers began to produce electron microscopes, and three years later work in the digital

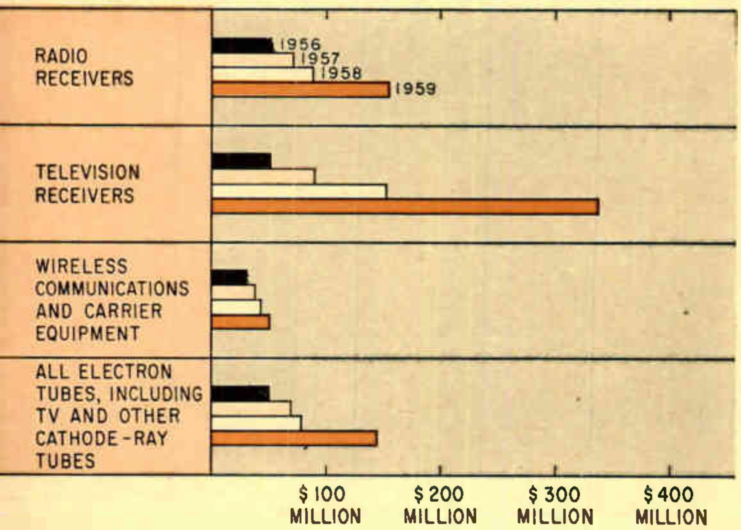


FIG. 3—Components, consumer goods and communications are the bread-and-butter base of Japan's electronics

computer field was begun at several laboratories.

But electronics as a strong force in Japan's industrial community dates from the opening in 1952 of the nation's first microwave tv relay from Tokyo through Nagoya to Osaka. With the beginning of television broadcasting on February 1, 1953, electronics began to grow like a young giant and at the same time to spark the consumer boom which has powered most of Japan's economic growth since the end of the Korean fighting.

The industry has an unusual makeup by Western standards. It is, firstly, oriented almost exclusively to consumer goods and communications. Radio and television production account for about 40 percent of the industry's sales, communications equipment and parts for another 25 percent. The rest is broadcast gear, sonar and loran, industrial electronics and a tiny category of defense electronics.

With its communications-consumer base, the industry has grown phenomenally, as Tables I and II illustrate. Sales trebled between 1956 and 1959, with much of this growth recorded in 1959; a 40-to-50-percent increase overall is projected for 1960.

The industry owes its growth rate to several sources. One is the small size of the base from which it is growing: total industry sales for 1959 are not much greater than General Electric's sales for the same year. But statistical tricks aside, the strength and extent of growth owes to:

- The necessity for completely reoutfitting the nation's industry following the war, coinciding with the introduction of electronic controls; and the need to update the nation's communications system;
- The way television caught on with the public; there is now a set in one out of five homes;
- The development of solid-state components and printed wiring, which permitted the building of small, inexpensive products;
- The protection of the industry from outside competition by government control and direction of research and production, and barriers against imports.

Industry spokesmen like to say that Japan has bypassed the missile age. It would perhaps be more accurate to say that she has ignored it, because of its militaristic connections and her forced abjuring of things military. But it is true that those areas which are coming up fast in electronics in Japan are industrial and medical fields, while development of military-type gear is dormant.

Industry opinion feels that growth of industrial and commercial fields, plus medical applications, is essential to industry health. With the tv market at 20-percent saturation, most industrialists feel that maximum penetration has been reached; a couple of big producers are already cutting back production plans against this possibility. This would put both consumer and communications electronics in the replacement category (exports aside) and require the industry to look around for other sources of income.

This opinion is not universally shared. Many of the more progressive firms feel that a higher degree of market penetration is possible with intelligent merchandising and are going ahead with expansion programs. Broadcast executives, some manufacturers, and the government all look with some hope for the introduction of color tv to spark a buying spree, even at the enormous (by Japanese standards) price of color sets. And transistorization of tv—now an accomplished fact in Japan—may help haul the price down within reach of the average Japanese consumer.

It is probable, then, that—military purchases excepted—Japan's electronics industry will progress along the same lines as U. S. and European industry, with consumer goods and communications, plus components, providing a base from which industrial and commercial systems, plus medical electronics, can be developed and marketed.

COMPONENTS—Tube production is on the increase, both in volume and variety. Production in 1958 was 50

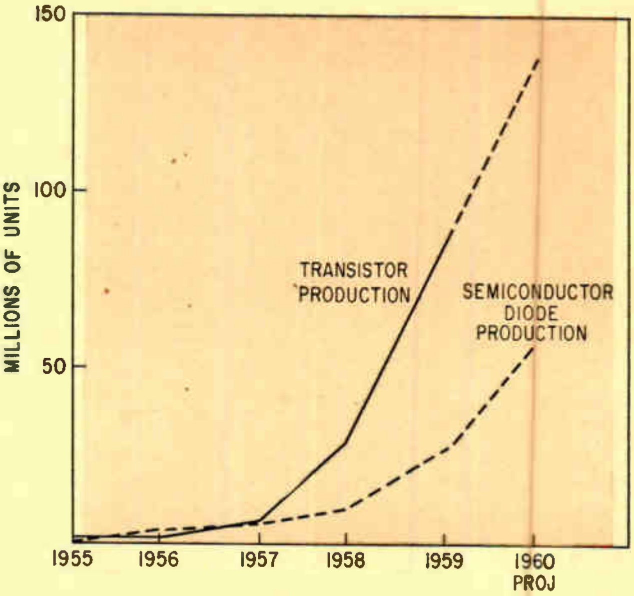
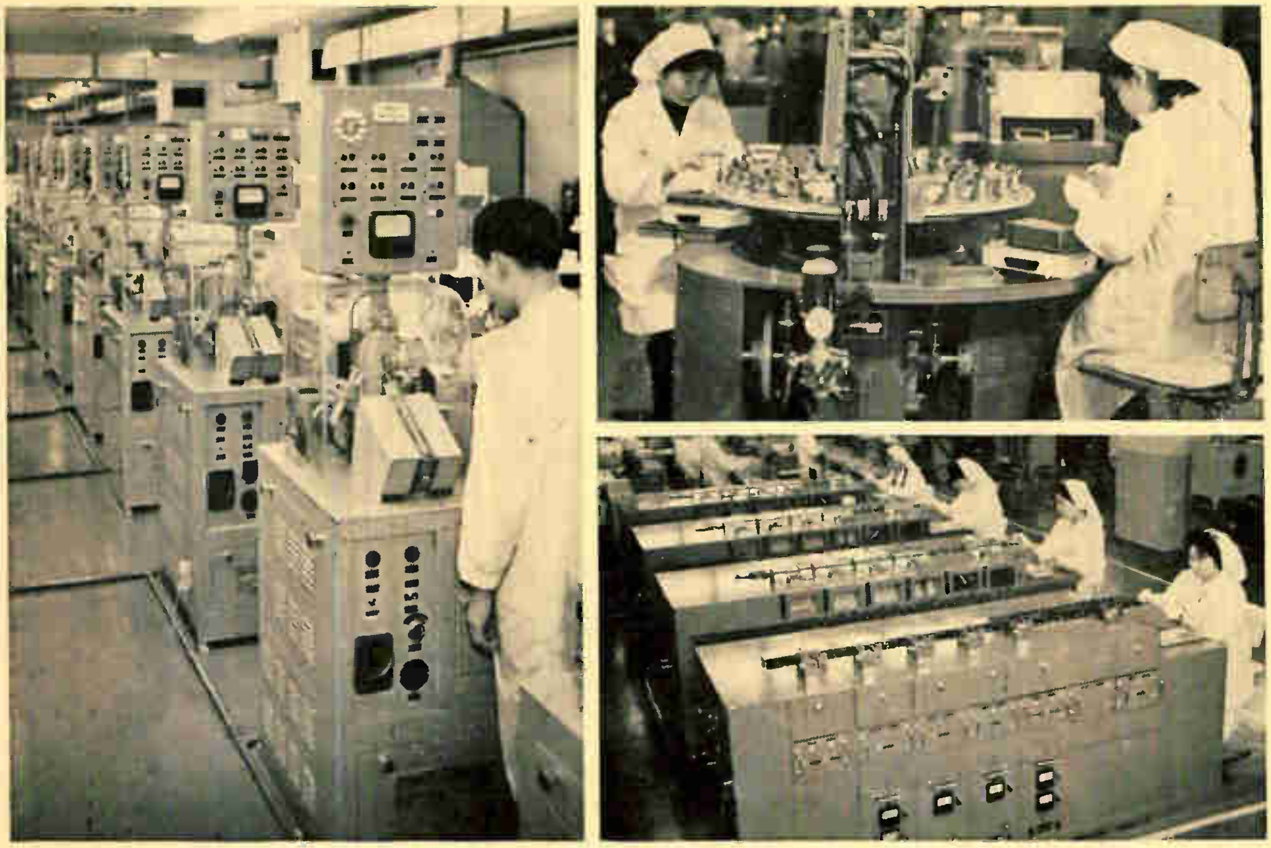


FIG. 4—Semiconductor production, which more than doubled last year, is still going strong. Almost all transistors produced are of the entertainment type



Transistor assembly uses up-to-date techniques. At Toshiba plant, sorter developed by Tokyo Seizakusho (l.) counts and sorts pellets; automatic sealing (top r.) and test (bottom r.) equipment is coming into widespread use

percent over 1954 in value, and last year the sales figure almost doubled 1958's. Receiving tube types and cathode-ray tubes for tv use top the production list, but the production of tubes with high figures of merit is on the upswing. Principal producers are Toshiba, Matsushita, Hitachi, Nippon Electric and Kobe Kogyo; the last two manufacturers specialize in the high figure-of-merit types.

The whole family of uhf and microwave tubes is also produced; traveling-wave, klystron, magnetron and disk-sealed tubes. Most klystrons are of the reflex type, but some big direct power klystrons are manufactured.

Almost all big television manufacturers make their own cathode-ray tubes (mostly 90-deg deflection types). Production of image orthicons and vidicon-type tubes is of relatively recent date.

Transistors are the brightest field in Japanese electronics; a half dozen manufacturers—the tube producers mentioned above, plus Sony and Sanyo—may now be producing more transistors of the entertainment type than any other nation in the world. Rapid development in circuit design in the last year sees transistors being used in Japan in communications equipment, computers and industrial controls as well as consumer goods. Indeed, transistorization has somewhat the same faddist appeal in Japan that it has in the U. S.

Average monthly production of transistors (see Fig. 4) runs almost three times production of diodes. All types are produced, including power types with $P_{C max}$ up to 30 w, and high-frequency types with alpha cutoff at 100 Mc. High-frequency tetrode types with cutoff in the 100-300-Mc region, and diffusion types with cutoff up to 500 Mc are being produced on an experimental basis, as are silicon transistors.

Japan produces the full spectrum of passive components. Many small manufacturers are active in this field, including most of the tiny family- or cottage-type enterprises that still remain in the electronics industry. These firms receive advice and guidance, materials, and even financing from their customers—who are frequently among the respected big companies in the industry, but may also be fly-by-night domestic or foreign traders. They produce largely on a job-shop basis, and their activities are not recorded by either government or the industry associations; as a consequence, documenting domestic component production is almost impossible. For 1958 and 1959, however, the figures in Table III are recorded.

Solar batteries of silicon are being produced by Nippon Electric among others; NEC's are being used as power source in several unattended repeater stations in utility communications links.

Of all materials being produced in Japan, ferrites are showing the most marked increase. Ferrites were first developed by two Japanese scientists in 1933, and are now being used in the manufacture of antennas for transistor radios, for flat speakers, and in the widely-used parametron phase-locked oscillators and other computer components. Barium ferrites are becoming more popu-

TABLE I—Growth of Electronics Industry in Japan

	1958		1959		1960 (projected)	
	1,000 units	$1,000	1,000 units	$1,000	1,000 units	$1,000
ALL INDUSTRY		$494,516		$914,533		$1,229,200
Radio receivers	4,897	87,783	10,025	157,884	13,000	201,600
Television receivers	1,205	156,640	2,875	339,108	3,600	406,000
Audio systems		27,182		41,496		75,600
Radio-tv broadcast equipment		11,796		13,627		9,500
Fixed-station communications		12,625		11,628		12,900
Mobile communications		10,772		12,961		15,700
Navigation and other applied wireless equipment		7,168		11,542		14,000
Electrical measuring instruments		14,073		19,116		24,920
Computers		1,190		1,823		2,380
Receiving tubes	58,401	36,820	117,832	71,011	168,000	105,800
Cathode-ray tubes	1,472	33,396	3,242	60,799	4,800	88,800
Transistors	26,736	21,524	86,500	44,836	130,000	62,700
Capacitors	305,789	16,848	722,678	32,161	1,572,000	44,800
Resistors	276,696	8,084	555,122	15,470	832,000	23,000
Transformers	11,042	8,266	23,212	15,019	34,000	22,400
Speakers	4,171	6,840	9,899	11,544	15,000	16,800

Source: MITI

lar because of excellent magnetic properties and relatively low price.

Most germanium is now imported by Japan's semiconductor manufacturers, but recently the Tokyo Gas Co. has developed a method of extracting and refining germanium residue found in the waste from dry distillation of coal. Mitsubishi Metals has also produced high-quality germanium from the waste of zinc refining. Both methods may produce germanium in usable quantities this year.

COMMUNICATIONS—The field of communications was the nucleus and still is the heart of Japan's electronics industry. Eighty percent of the demand for cable communications comes from government monopoly Nippon Telephone & Telegraph, with its 7,000-plus exchanges, 4 million sets and 2 million miles of toll lines (see Fig. 5). Demand for radio communications is more widespread, coming from NTT for domestic service and Kokusai Denshin Denwa for overseas service; from the Ministry of Transportation and its Japan National Railways; from other government offices, including Police, Defense, Maritime Safety and Meteorological Agencies; from newspapers, traffic services, public utilities and industry. Production of a wide variety of equipment types is steadily on the increase.

Conventional wire-communications facilities and equipment are produced largely by NEC, Fuji Communications Apparatus, Hitachi, Oki Electric, Toshiba and Iwasaki Communications.

Line concentrators are used in areas where subscribers who make comparatively little use of phones live in large numbers. The equipment is made by NEC and Fuji Communications, who also make 24-channel a-m carrier telegraph equipment with level-compensating circuitry. Teleprinter and telegraph-relay gear is made by Oki, and facsimile recording equipment is made by NEC, Toshiba and Tokyo Koku Keiki. Telex equipment, parametron ARQ (automatic request) equipment to accommodate atmospheric fading, echoes and other error sources in wireless communications, and multichannel time-division telegraph equipment are manufactured by Mitsubishi

TABLE II—Factory Sales of Electronic Products

(Sales in thousands of dollars)	1956	1957	1958	1959
Consumer Electronics, including tape recorders	$105,243	$159,650	$252,137	$511,630
Communications and communications-measuring equipment	31,867	50,761	53,400	67,048
Industrial and commercial electronics, including computers	27,787	45,016	47,373	62,448
Navigation gear and other applied wireless, including sonar	6,168	9,288	7,746	12,647
Radio and tv broadcast equipment	2,962	3,520	11,780	13,448
Medical X-ray equipment	5,295	6,376	6,801	4,760
All tubes, including tv picture tubes	52,648	71,148	78,142	143,637
All semiconductors	2,192	10,786	24,664	53,316
Other components and parts	38,088	50,571	58,776	103,452

Source: Japan Electronic Industries Development Association

Table III — Value of Component Production, 1958-1959

(Production in thousands of dollars)	1958	1959
Receiving tubes	$36,819	$71,012
Tv picture tubes	32,925	59,882
Other tubes	8,399	12,743
All semiconductors of which Transistors	24,664 (21,524)	53,316 (44,835)
Capacitors	16,848	32,204
Transformers	8,266	15,019
Resistors	8,084	15,470
Coils	1,316	2,392*
Crystal products excluding semiconductors	896	1,628*

(*—Estimated) Source: JEIDA

Electric and NEC principally.

Printed circuitry and transistors are now used in short-haul carrier equipment and channel-translating bays of 60 circuits per bay, developed by NEC, Oki and Fuji Communications.

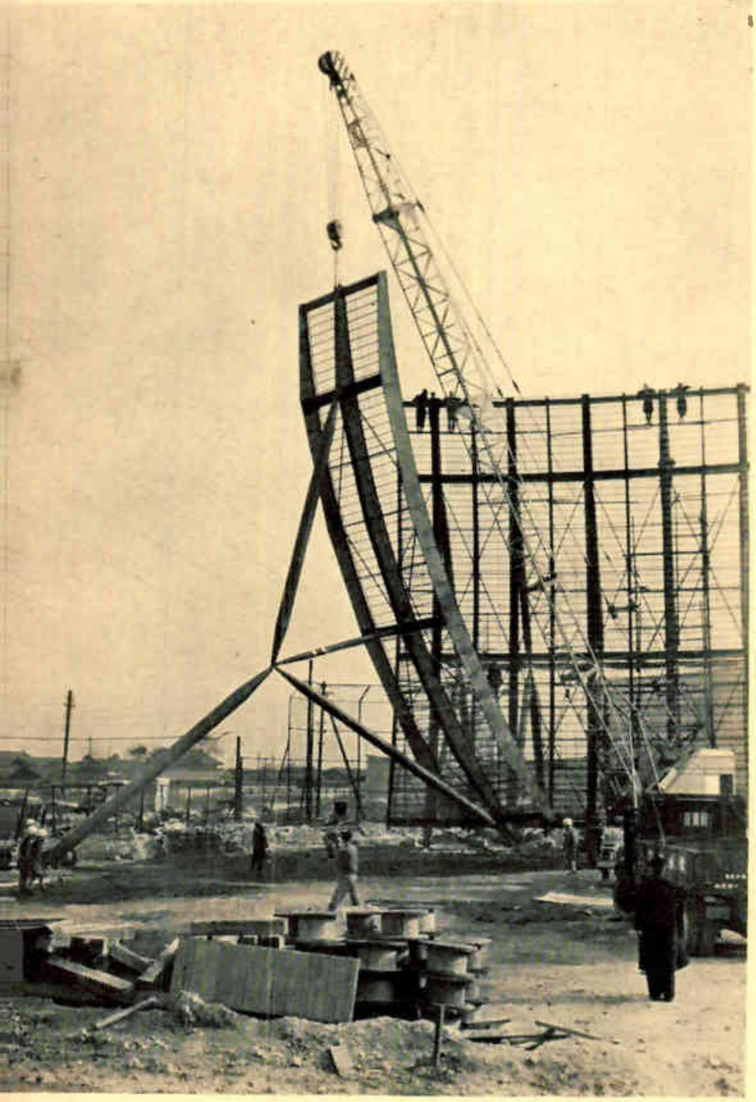
A surprisingly large part of Japan's domestic communications travels over microwave link—owing both to the destruction of her communications system during the war and also to the mountainous terrain. A 4,000-Mc system has been adopted for trunk public communications, although 60- and 120-channel 2,000-Mc equipment is still in use in some branch lines. In the trunk system, transmitters and receivers use travelling-wave tubes duplexed to serve as both amplifier and oscillator, eliminating afc circuits. This two- and three-way use of the twt, coupled with periodic permanent-magnet focusing, has permitted the development of small and economical transmitting and receiving equipment.

The 4,000-Mc band provides seven radio-tv channels or 3,260 telephone channels. To augment these facilities and permit increasing the number of circuits, a 6,000-Mc system was adopted two years ago. The newer system, developed by NEC, can carry 960 radio channels or one color-tv channel. Crystal-controlled 400-Mc phase-modulation systems of 12-channel capacity are also produced by Fuji Communications.

Japan National Railways (a state-owned system) has built up a 7,000-Mc microwave net to handle traffic-control communications. Toshiba and NEC make the equipment. The 11,000-Mc band is used for medium-haul multichannel communications and for studio-remote tv links. Television links in the 11,000-Mc band are being developed to work with the 6,000-Mc system.

Over-the-horizon systems in both uhf (tropospheric) and vhf (ionospheric) are under investigation. A tropo link is now under test between southern Kyushu and Okinawa. Another link, on 48.17 Mc, will soon be installed to connect Kyushu with a station on Formosa. U. S. Army is putting in a scatter link from Kyushu to Pusan in Korea to back up the Mukden cable that now crosses the Korean straits.

Pulse-position and pulse-time modulation telemetry



Giant Mitsubishi-built reflector operates from Kagoshima on Kyushu to the island of Oshima

Automatic test equipment for ceramic capacitors at Murata Mfg. Co. measures Q factor, capacitance, resistivity, dielectric strength, at rate of 1,200 units per hour

systems are widely used for communication by utilities over circuits of less than 12 channels. Equipment is manufactured by NEC, Toshiba, Japan Radio, Fuji Communications and others.

Simple radio equipment of one to three channels is being manufactured for mobile purposes. For example, a 60-Mc unit with transistorized receiver is made by Kokusai Electric. Matsushita and others make vhf-range radiophone systems for use in automobiles, with 5-watt output and range up to 12 miles. Radios of the walkie-talkie type are also made by several manufacturers.

Remote supervisory-control systems are used to monitor unattended microwave relay stations and, where necessary, control machinery.

Industrial tv systems are employed at hydroelectric plants to watch water level and, in some factories, to watch critical work sites. In a few cases where monitor stations are several miles from receivers, microwave links are used to transmit the picture.

Navigation and fishery communications have been important in Japan for many years, since fishing is a major industry there. Vhf equipment is used for coastal and in-port services. Shortwave is generally used by the fishing fleets for radio communications. Because of spectrum congestion, single-sideband systems are being adopted. Both Oki and Kobe Kogyo have developed low-priced ssb fishery radio equipment.

Many kinds of communications-measurement equipment have been developed, including oscillators, level meters and attenuators. Frequency meters covering the spectrum from audio to microwave are produced by Yokogawa Electric, Japan Radio and Anritsu Electric. Other precision equipment includes transmission quantity measurement gear of Anritsu; admittance measuring equipment of Yokogawa; direct-viewing amplitude and delay equipment for monitoring microwave transmitters and receivers, made by Anritsu and Japan Radio; frequency counters by Oki; Japan Radio's direct-viewing equipment for measuring the differential characteristics of modulators and demodulators; and Anritsu's direct-viewing circuit delay gear.

The transmission quantity measuring equipment measures amplitude and phase characteristics of communications transmitters over the power range from 60 db loss to 60 db gain. Equipment in the 500 Kc-150 Mc band is also used to measure the characteristics of coaxial cable repeaters. Admittance-measuring equipment is used to measure crosstalk, divides the measurement into real and spurious components. Results are recorded on paper or can be observed on a crt.

BROADCASTING—Prior to World War II, broadcasting in Japan was monopolized by NHK (Nihon Hoso Kyokai, the state-owned Japan Broadcasting Corp.). The field was opened to commercial enterprise in September, 1951. Demand for transmitters and home receivers both rose with the introduction of commercial broadcasting; at the same time orders began arriving for export. Broadcast transmission gear still forms only a small part of electronics sales in Japan, however.

There are over 300 a-m broadcasting stations, including a dozen high-power stations, reaching 85 percent of the nation's households. F-m is 2½ years old in Japan and only just catching on. There are only half a dozen stations; the production of small and inexpensive receivers, now beginning, is expected to boost f-m up fast. In tv broadcasting, 50 stations beam to 67 percent of the nation's populated area, but are received by only 20 percent of the households. Several of the big-city stations broadcast color programs for an hour or so every day. A batch of new radio and tv stations are due to be opened this year.

Most radio transmitters are in the 100w to 10Kw range, with a few in the 100Kw category. Production totals some 50 sets a year. The big sets are final-stage plate-modulation systems of the forced-air-cooled type. Much current development work is aimed at reducing the size and weight of transmitter equipment. Redundancy in design sees four tubes used in both modulator and modulation amplifier, so that the transmitter can stay on the air while an out-of-order tube is cut out of the circuit and replaced.

Properties of broadcast gear are held to NHK standards: efficiency runs as high as 50 percent, frequency response is flat ±1db from 50 to 10,000 cps, signal-to-noise ratio is above 67 db at 80-percent modulation, and distortion is held below 1 percent between 80 and 80,000 cps at 80 percent modulation. Both NEC and Toshiba are active in manufacture of big transmitters.

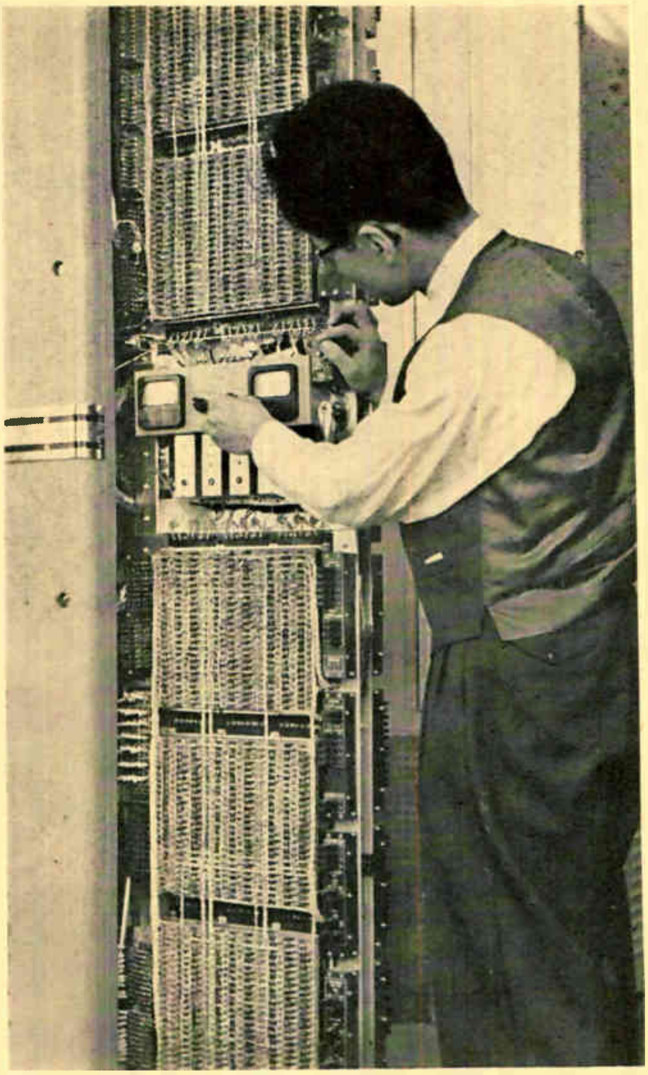
Ten-watt transmitters are made by NEC and Toshiba, and also by Kobe Kogyo, Kokusai Electric, Oki, Shiba Electric and Hitachi. Transistorized 10-w a-c/d-c transmitters—transistorized except for the output tubes—are made by Matsushita.

Many medium and small transmitters are unattended, operated remotely from studios. At one NHK station, for instance, a common reserve transmitter is held in readiness to service either of NHK's "programs" or services. Timing relays start and stop the two working transmitters; disorders are detected by a circuit that compares signal input with air-monitored transmitter output. The reserve unit is automatically cut in if one of the service transmitters goes bad, with its carrier automatically converted to the transmitter frequency of the crippled service. This system is being adopted throughout the NHK network.

Television broadcasting in Japan, now only 7 years old, follows the same standards as in the U. S.: a-m video (negative) with vestigial sideband, f-m audio, 525 lines per frame, 30 frames per second, 2:1 interlace, 4.25-Mc video bandwidth. Only vhf channels are used. Nonsynchronized systems for both transmitter and receiver were required, since Japanese power sources can be either 50 or 60 cps.

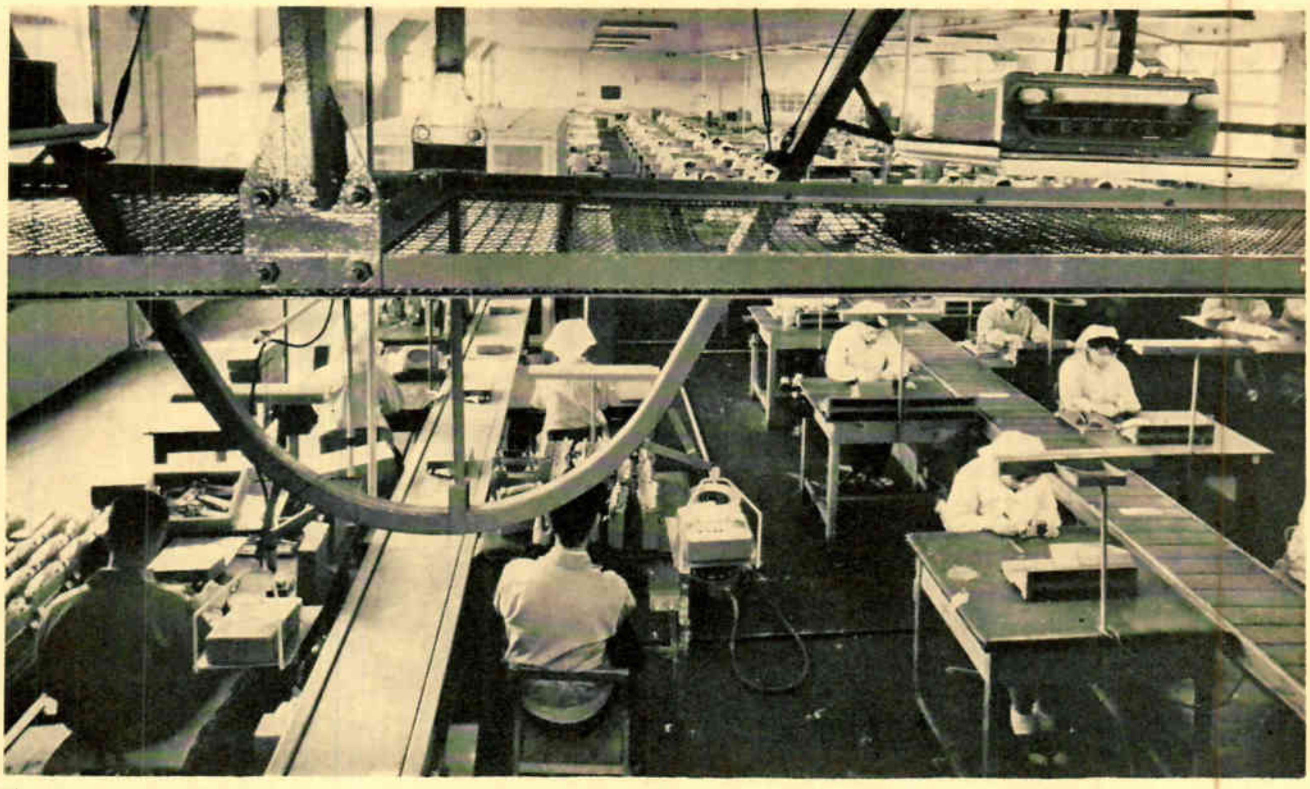
Transmitters range in output power from 1 to 10 Kw. Last-stage modulation is standard for the smaller types; another power stage after the modulator is added for the higher-power types, with d-c heating of the tube and pedestal-level negative feedback employed to overcome post-modulation amplifier difficulties. Frequency response, linearity, permissible waveform distortion and so forth conform to U. S. Electronic Industries Association standards. Hum is held below 60 db in the video signal. Serrasoid and reactance types of audio modulation are both in production.

Transmitters of both forced-air-cooled and water-



Parametron ARQ (automatic request) equipment was developed at labs of quasi-government monopoly Kokusai Denshin Denwa

Hand-carried and pack-carried radio equipment is produced by several manufacturers; these units are by Toyo Communications

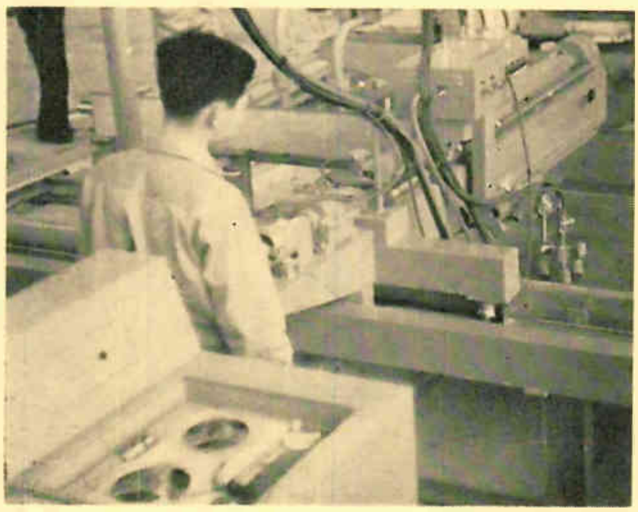


Many Japanese manufacturers produce unrelated product lines. Here instrumentmaker Kobe Kogyo has set up production line for transistor radios and other consumer electronics

cooled types are marketed by NEC, Toshiba, Shiba Electric, Kobe Kogyo, Hitachi and Kokusai Electric. Production averages around 50 sets a year.

Low-power repeater stations are frequently required to hoist signals over the country's many mountains. Automatic unattended stations of both vhf (translater) and uhf (booster) types, 5 to 25 watts in output, are being produced.

Studio equipment is mostly produced domestically. Image-orthicon and vidicon cameras and flying-spot scanners are made by Toshiba, NEC and Shiba Electric. Camera production runs about 150 sets a year.



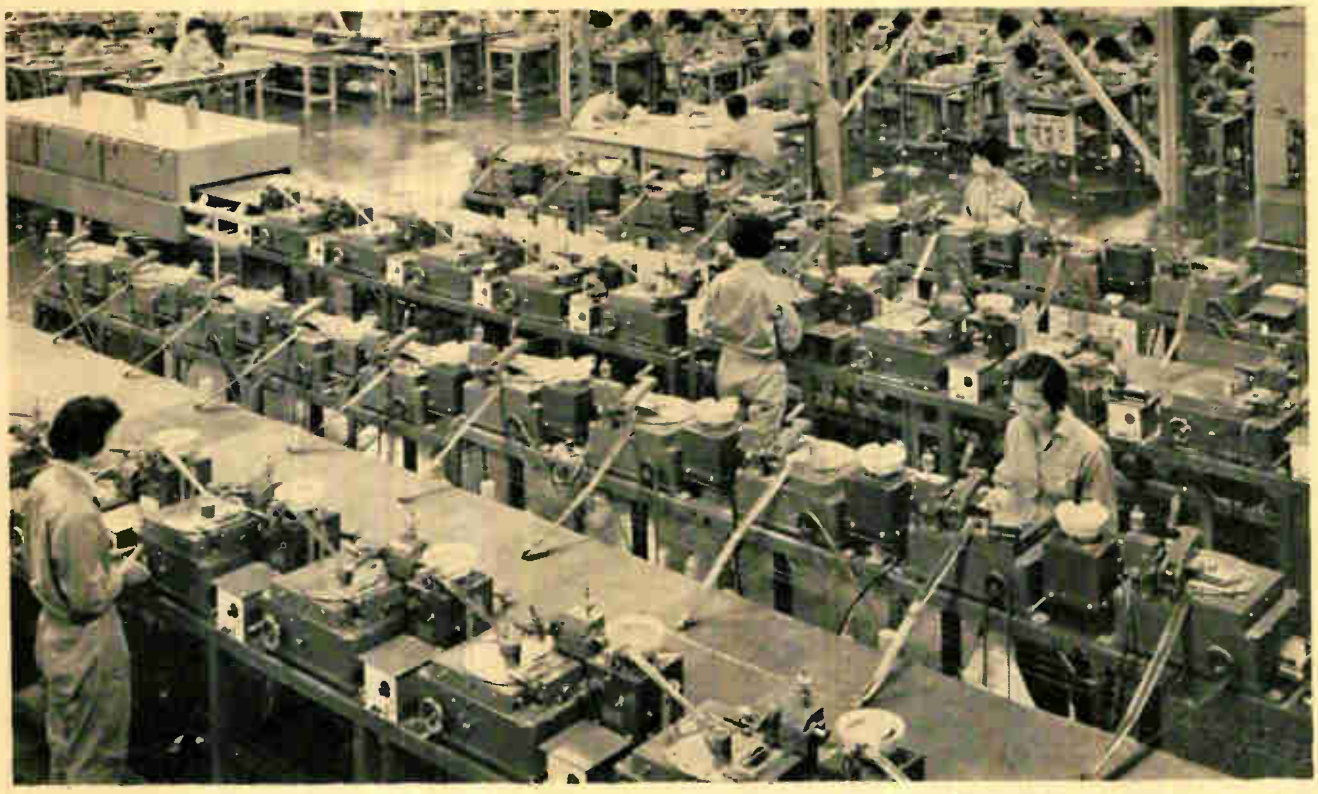
Tape-controlled milling machine uses Toshiba entertainment-type tape recorder

Videotape recording systems have been developed by both Toshiba and Victor Co. of Japan. Toshiba's will go on sale this summer. Both systems put the signal for one scan line in one 26-in. strip at an acute angle longitudinally (about 4 deg). Toshiba's system uses one recording head on an 8-in. drum rotating at 3,600 rpm; the tape passes around the entire circumference of this drum on its way from feed reel to takeup. Tape speed is 8 in. per second. Japan Victor's unit has two recording heads 180-deg apart on a drum twice the diameter rotating at half the speed and with the tape making contact over only half the drum circumference. Video synch signals and audio track are along the outer edges of the 4-in. tape. Toshiba's system puts a monitor head 180 deg away from the recording head.

Yaou Electric is leading the way in developing transistorized and miniaturized studio equipment, is working on flying-spot equipment for color transmission. Cameras and master-control consoles for NHK are produced by this firm.

RCA and GE color cameras are being used in the few stations now broadcasting color. NEC, Toshiba and Shiba Electric have developed color cameras, NEC's selling for half the RCA price. The NEC and Shiba cameras use three image orthicons, split light with a prism instead of trichroic mirrors; the result is a reduction of ghost effects.

CONSUMER PRODUCTS—Most radio sets now in production are 5-tube or 6-transistor superhets. A large number of home and portable radios are also made to receive shortwave, while the relatively small proportion of a-m/f-m receivers is growing.



Automatic machines to print silver paste on ceramic wafer surfaces speed capacitor production. Ten machines can be operated by one girl. Machinery to increase efficiency is necessary despite Japan's lower labor costs

Of the 5 million radio receivers produced in 1958, more than half were transistorized portables and the major part of the remainder were 5-tube table models. Only 43,000 a-m/f-m sets and 133,000 radio-phonograph combinations were produced, along with 36,000 auto radios. Among portables, over 300,000 tube types were produced.

The percentages shift somewhat for 1959. Twice as many receivers were produced last year, of which about 8 million were transistorized. Production of auto radios rose to about 50,000, while radio-phono combinations recorded a small rise. Electron-tube portables disappeared completely, and the number of tube-equipped home radios was cut almost in half. A-m/f-m sets recorded a rise as f-m broadcasting became more widespread; most of these are 15-transistor sets.

Transistorized portable record-players and magnetic recorders are now being produced by many smaller manufacturers. Some 500,000 tape recorders are now in use in Japan, most of them sold during the last two years; they are being used for entertainment and for office use. A recent show had about a dozen midget models on display. Magnetic-tape systems were designated by the government in 1955 as an area to be pushed: tape production jumped from 13,000 7-in. reels in 1955 to 205,000 reels in 1956, last year hit 880,000, is expected to top 1.5 million this year.

The awkardness of operating a motor-driven device on batteries has been partially overcome by development of efficient motors and by use of extremely lightweight motorboard construction. Wow and flutter figures are held below 1 percent. The novelty of these devices is exciting great interest, and many of the trading com-

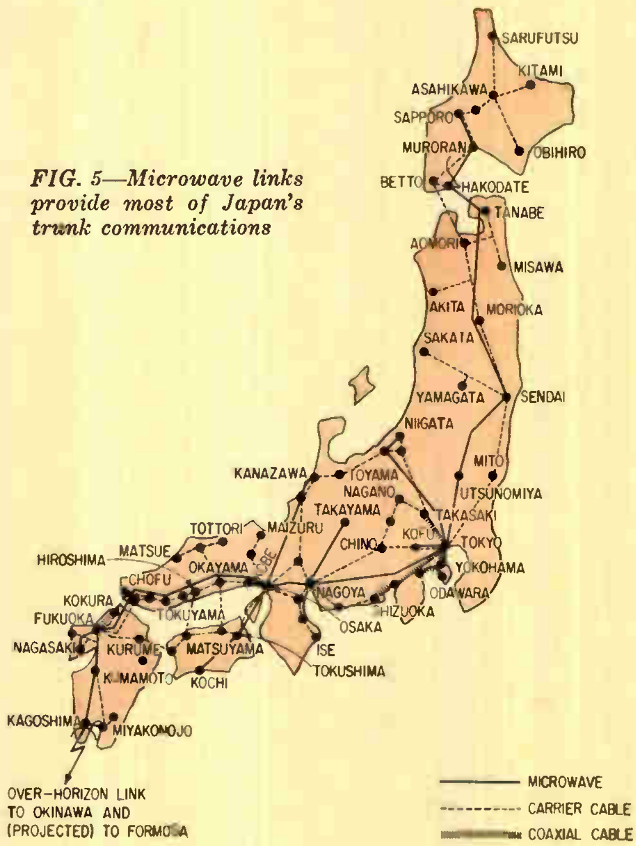
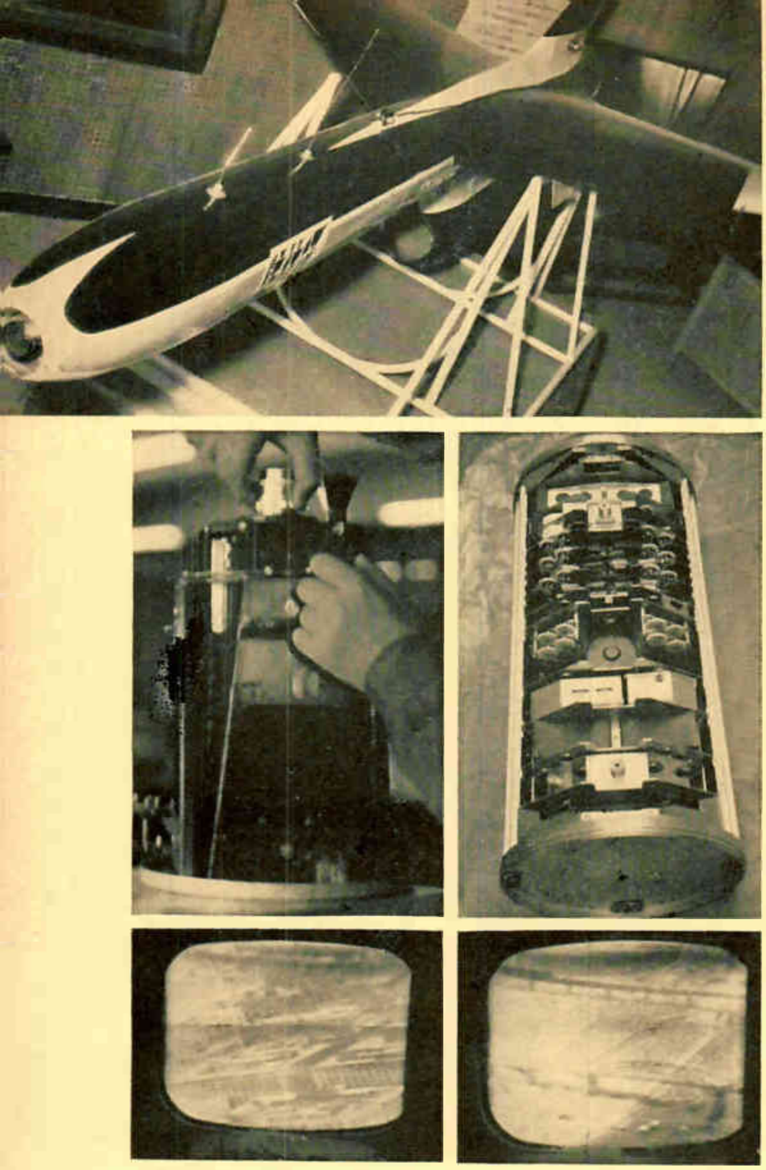


FIG. 5—Microwave links provide most of Japan's trunk communications



J-3 airbreathing reconnaissance drone developed by Yaou for Defense Agency. Top: airframe; center left, tv camera; center right, miniaturized transmitter gear; bottom, pictures of Tokyo's downtown Maranouchi district and Tamagawa bridge taken by drone's tv camera

panies are marketing the portable recorders under their house trademarks; but the success of the enterprise has yet to be proved.

High-fidelity has caught on in Japan, as has stereo. At the moment, production is small due to the relatively high cost by Japanese standards: an average system runs around 70,000 yen (almost $200), which may represent two months' salary for a middle-class citizen. Japan imports much of its stereo and hi-fi gear from European firms and overseas affiliates of American firms. A few smaller firms are producing speakers and other components, but most of these do little more than copy popular imports.

Portable transistorized tv sets, using mesa transistors with 600-Mc cutoff in the r-f stage, are already being marketed by Sony Corp. Five hundred were offered for sale in March. The sets use an 8-in., 90-deg picture tube, 23 transistors and 14 diodes, consume 11 watts, weigh 13 lb with battery. Other big manufacturers are rushing transistorized models into production. The portables will bring down average set prices, which have already dropped 25 percent in the last three years under competitive selling pressure. Latest market prices stand at about 45,000 yen ($126) for a 14-in. set, 72,000 yen ($200) for a 17-in. set, and 113,000 yen (about $316) for a 21-in. set. Most sets installed in Japan are 14-in. sets. Transistorized portables will sell for less than $100.

Tv-receiver market is currently shared by Matsushita (18.3 percent), Toshiba (16.8 percent), Hayakawa (13.9 percent), Sanyo (10.4 percent), Hitachi (9.5 percent), Yaou (9.2 percent), Mitsubishi (8.0 percent), Columbia Japan (4.5 percent) and Japan Victor (3.9 percent). Sony's new portable may enable it to shoulder aside many of these established setmakers and compete directly with the top two or three for the rest of the market.

Other engineering advances which setmakers hope will spark consumer interest are remote switching, tuning and volume control; automatic brightness control to accommodate varying ambients; and automatic tuning and picture controls, recently introduced by several manufacturers.

Increase in color programming (already undertaken) and mass-production of color sets (now planned) may beat down the high price of color and make it acceptable to the Japanese domestic market; current prices are in excess of 360,000 yen ($1,000). Eight hundred color sets were turned out—using RCA color tubes—between April and September last year; 2,500 more were produced between Oct. 1, 1959 and April 1 just past.

Toshiba is working on producing a 17-in. color receiver, and Matsushita has already made its own color tubes using 70-deg deflection. Mitsubishi successfully made a square 17-in. color tube early this year; the tube is similar to a 70-deg monochrome tube with a larger neck to accommodate the three guns.

INDUSTRIAL TO MEDICAL—Japan's work in loran, radar, beacons, direction-finding and so forth is not so far

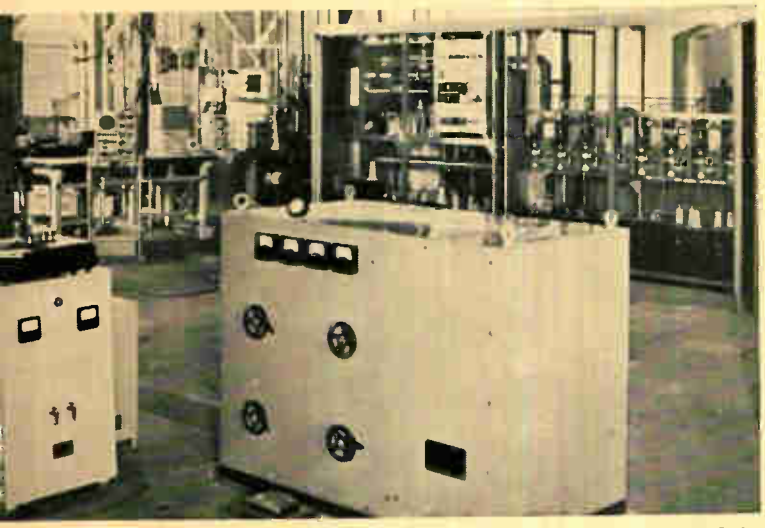
Numerical controls for Hitachi milling machine include transistorized special-purpose computer HIDAM. Machine costs 14 million yen—about $39,200 advanced as her work in other areas. Principal contributions have been in the field of marine radar, where solid-state components have permitted the building of small and relatively inexpensive shipboard installations. NEC, Kobe Kogyo, Japan Radio, Koden Electronics, Tokyo Precision Instrument, Oki Electric, Kokusai Electric and Yaou are all active in this general area.

Airborne radar, still in its infancy in Japan, is being developed by NEC, Kobe Kogyo and Mitsubishi, while Toshiba is developing the precision approach radar needed for GCA (ground-controlled approach).

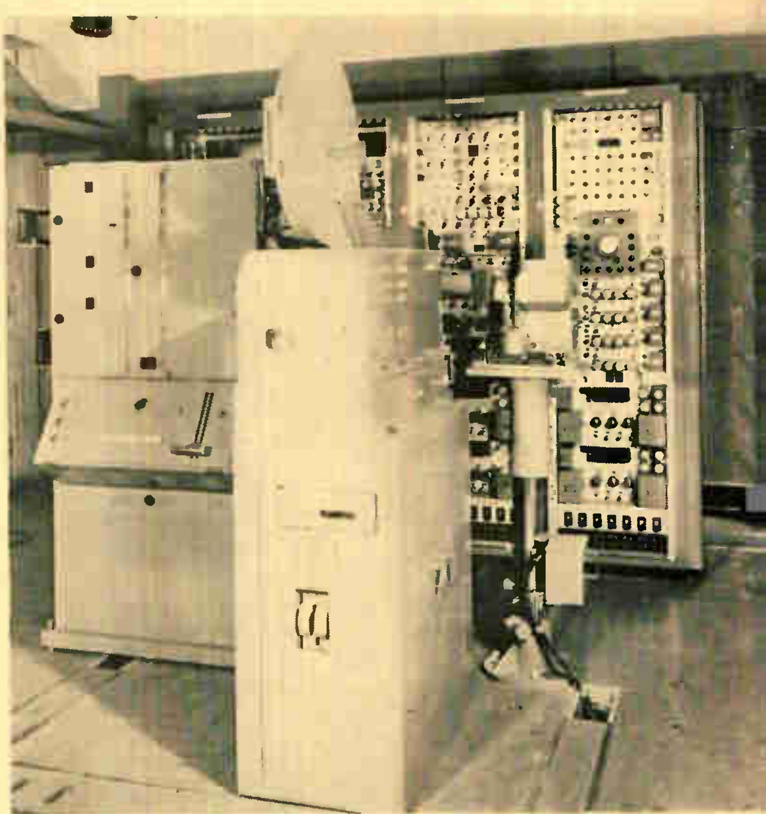
Computer electronics leans heavily on Eiichi Goto's parametron (manufactured commercially by Tokyo Electro Chemical Co., one of the country's major producers of precision magnetic components and subassemblies). Led by Tokyo and Tohoku Universities and the Postal Ministry's telecommunications lab, NEC, Hitachi, Fuji Communications and Oki have all produced commercial models of parametron computers. All these systems—although some are marketed as "scientific and commercial"—are essentially scientific systems. Only Oki's is a decimal computer, and none has commercially adaptable input-output facilities. Several systems have drum memories, but none is a large-volume store. The digital-recording technology is one of the glaring deficiencies in Japan's electronics.

The inattention to input-output requirements arises in part from the cumbersome symbologies in which the Japanese language must be written: neither of the kana syllabaries, nor the Kanji (Chinese writing), can be easily adapted to digital processing. It also results from the lack of commercial pressure: recordkeeping in Japan is still largely a matter of pen and soroban (abacus), and the machine-handling of commercial documents is a concept at least several years away in Japanese business practice.

The techniques for handling data by computer are to some extent spilling over into the automatic-control field, which—like the computer field—is growing almost



Linear accelerator with klystron pulse-modulator at left, klystron test gear at right in rear. Such heavy capital gear is pushed by industry, government



Studio broadcast equipment made for NHK by Yaou. Film chain is miniaturized; some of master-control equipment is transistorized

without commercial pressure because of government "suggestion." Through the same instrumentality, large manufacturers in the fertilizer, textile, chemical, cement and iron-steel industries are adopting automatic controls. Public utilities like giant Tokyo Gas and Tokyo Electric Power use calorific controls, load dispatchers, and so forth to great advantage; other industries do not profit by their investment so quickly.

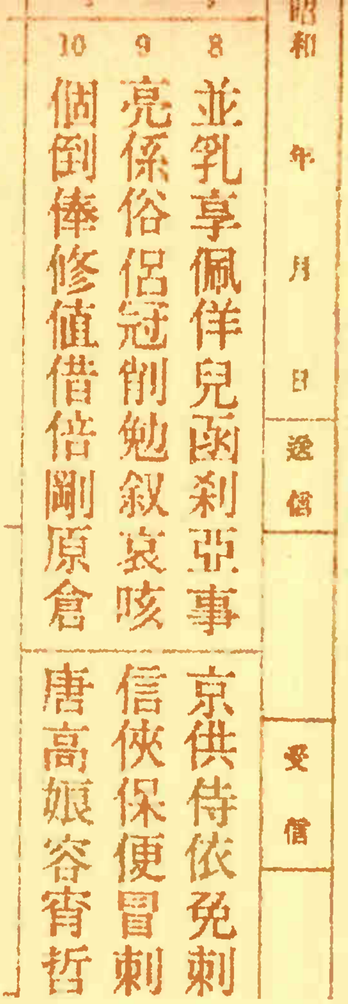
Four billion yen worth ($11.2 million) of industrial measuring instruments were produced in 1958, of which a third were for measuring thermal parameters. About 60 percent of the instruments were electronic. The sales figure and electronics percentage both increased during 1959.

Toshiba, Hitachi, Kobo Kogyo, Fuji Electric, Yokogawa, Hokushin and Tokyo Precision Instrument are prominent among instrumentmakers. Products include a radiation thermometer using lead-sulfide photocell; an electromagnetic flowmeter; radioisotope instruments; piezoelectric and magnetostrictive devices; ultrasonic thickness gauges.

Ultrasonics is also used in shoal-detectors for the fishing fleets; defect-finders for metal, glass and plastic production checks; boring and cutting tools; ultrasonic soldering; deburring and cleaning tools.

Ultrasound techniques employed in the U. S. for "mapping" lesions of the eye have been used recently in Japan for equivalent purposes and also for measuring the length of the eye axis (depth of the eyeball). Techniques were developed at Tokyo's Komagome Hospital.

Medical electronics is a popular field of endeavor in



Facsimile is popular for business communications in Japan due to complexity of language symbology. This is sample of Toshiba's fax

Japan; in a way, this popularity explains the wide variety of instruments, and the number of producers, in this relatively small-income area.

Toshiba, Shimadzu and Hitachi are among manufacturers of X-ray equipment. Hitachi and Japan Electronic Optical are prominent in electron microscopes. Toshiba has developed color itv systems for use in surgical amphitheatres; one is in use in Tokyo University's medical department. Ultraviolet microscopes for observation of living cells have been produced by Shimadzu.

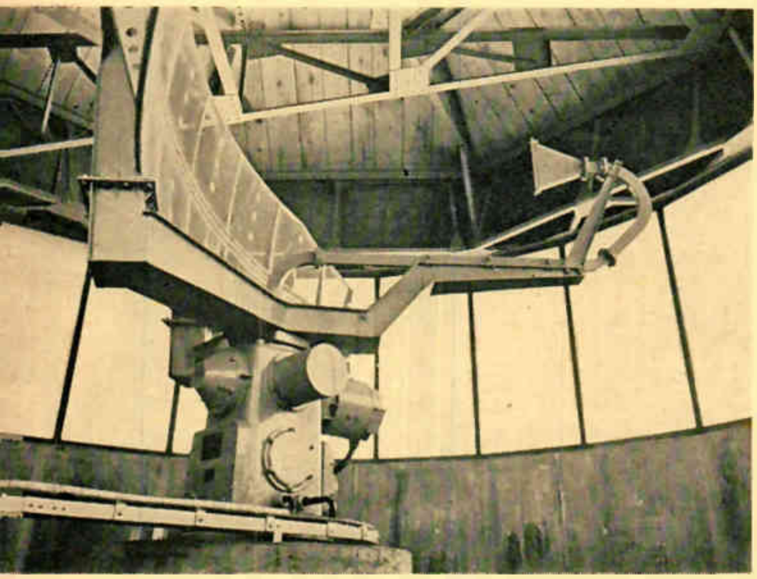
DEFENSE—Japanese defense forces were recreated in 1950 as a National Police Reserve, later expanded and renamed the Self-Defense Agency. The force numbers about 200,000 men, separated into ground, sea and air forces. The U. S. underwrites part of the cost of the Agency forces to the tune of about $150 million annually; allocations in the national Japanese budget were 100 billion yen ($280 million) in 1956, growing slowly to 145 billion yen ($406 million) this year.

Of this, 1.5 billion yen ($4.2 million) in 1957, 1.9 billion yen ($5.32 million) in 1958 and 2.1 billion yen ($5.9 million) in 1959 supported the SDA's research establishment, with more than 500 million yen ($1.4 million) going toward research in communications, radar, sonar and other underwater detection systems, and missile electronics. An undisclosed amount is dedicated to countermeasures—mostly copies of available U. S. devices. Between 700 million and 1.3 billion yen ($1.96 million to $3.64 million) is contained in allocations to the individual forces to pay for prototype-stage development.

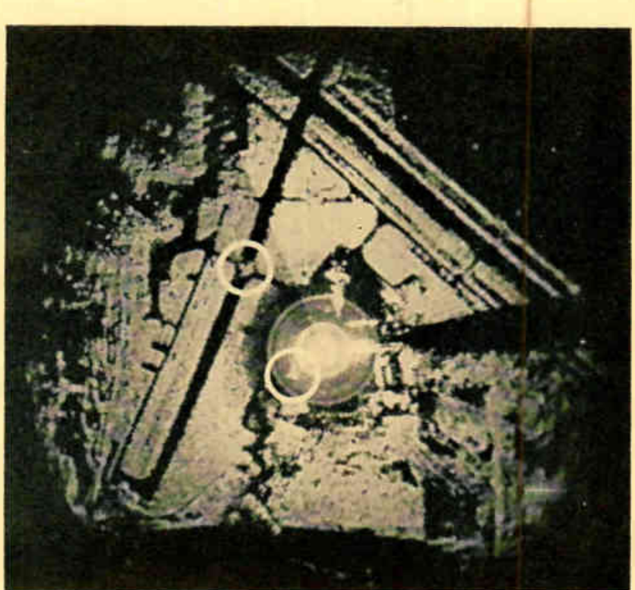
Missile research is limited to a surface-to-air missile with active beam guidance; an air-to-air heatseeker like Sidewinder, and the wire-guided antitank missile TATM-2. The air-to-air and surface-to-air missiles are still in the basic research stage; Toshiba is working on controls for the heatseeker.

An airbreathing reconnaissance drone with tv camera and controls developed by Yaou Electric has been successfully flight-tested and delivered to the SDA.

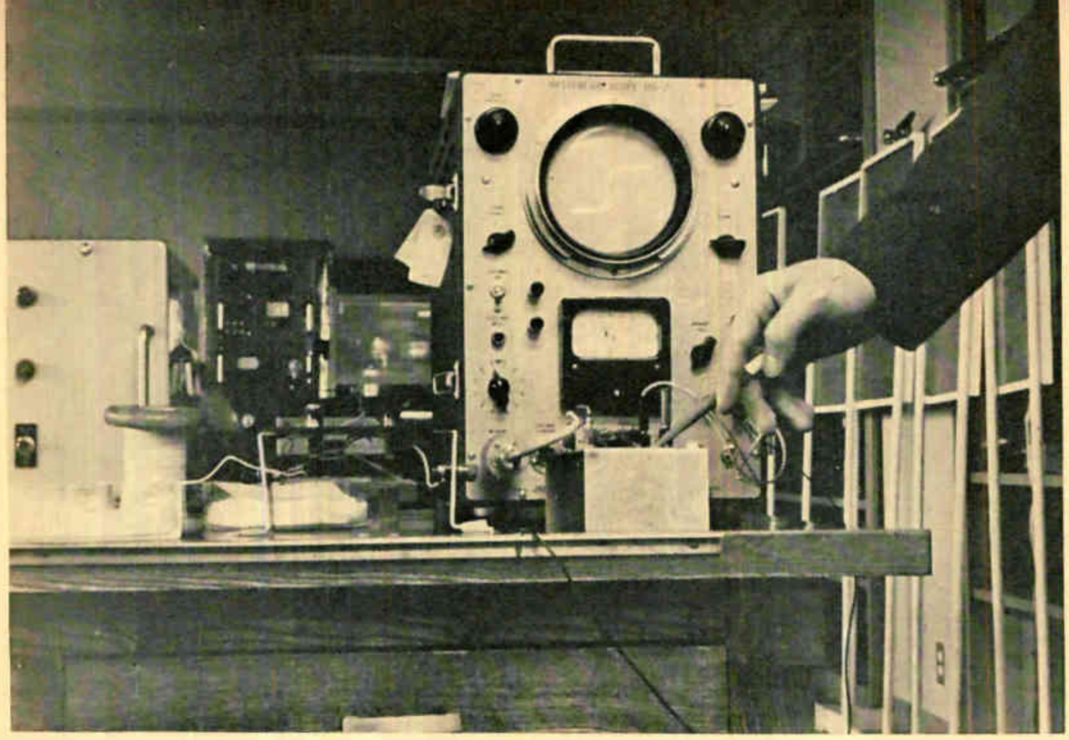
Procurement of defense electronic equipment—mostly communications, radar, and underwater detection—amounts to less than the yen equivalent of $10 million annually.



AN/GPS—1 type radar made by Mitsubishi and installed at the Self-Defense Agency's outpost at Wakkenai, northernmost point on island of Hokkaido



Airport surface detection radar developed by Mitsubishi discloses DC-4 sitting on runway, another craft close in to terminal



At KDD's research laboratory, new thinfilm components undergo B-H test

Electronics in JAPAN 電 Part 3

RESEARCH and ENGINEERING

Frontiers of the Electronics Technology

ALL OF JAPAN'S large and middlesized electronics companies, and most of the small ones, have relatively large engineering staffs (10 to 16 percent of total complement is not unusual as the percentage of engineering graduates employed). Despite this promising statistic, the advanced research in electronics, and most of the imaginative engineering, is being done by a dozen and a half laboratories. More than half of these are directly or indirectly under government control.

There are deplorably few instances where profits from a bread-and-butter product line are plowed back into researching a less profitable but promising field. Yaou Electric, Kobe Kogyo, Matsushita, Tokyo Electro Chemical, Murata—these are among the exceptions.

GOVERNMENT—The Postal Ministry operates a Radio Research Laboratory, concerned primarily with regulation of radio usage and spectrum allocation, but also to a small extent concerned with propagation studies. The same Ministry governs the domestic communications utility Nippon Telephone & Telegraph, whose Electrical Communications Laboratory does much advance work in telecommunications, information theory and computer-allied subjects such as switching and controls.

Post also controls Kokusai Denshin Denwa (the name means International Telephone & Telegraph, but this public corporation—financed partly by the government and partly by Postal Savings—is no kin to ITT). KDD maintains one of the finest and most advanced engineering facilities in Japan, concerned with propagation, computer-allied techniques of switching and automatic error correction, video transmission, facsimile, and such studies.

NHK network maintains a technical research lab with

Tokyo University houses a lot of the nation's scientific intellect. At left, Todai's main gate; at right, departments of physics (foreground) and electrical engineering. Lab facilities are weakest attribute

interest in acoustics and broadcasting techniques. It was this lab, for instance, which suggested the three-orthicon color cameras with prism optics ultimately engineered by NEC and Shiba.

All these laboratories cooperate on such projects as over-the-horizon studies for joint communications-tv use.

Ministry of International Trade and Industry (MITI) maintains an Electrotechnical Laboratory which has official control over standards for electrical and electronic devices. The first extension of this function has ETL keeping an eye on quantity and quality of exported goods. Like the U. S. National Bureau of Standards (whose functions it duplicates), the lab has expanded into independent research and engineering work.

It has also grown into another function which bears directly on the state of industry research. MITI watches over all industry to keep it balanced, and tries to encourage development in those areas where import figures run high. ETL performs this function in the electronics areas. It was ETL and the Electronic Industries Development Association which put the pressure on industry to develop magnetic recorders, instruments and production controls, and computers—areas in which imports are conspicuously high despite currency controls.

These two organizations have also pushed industry into exhaustive investigation of photoelectric thin films,

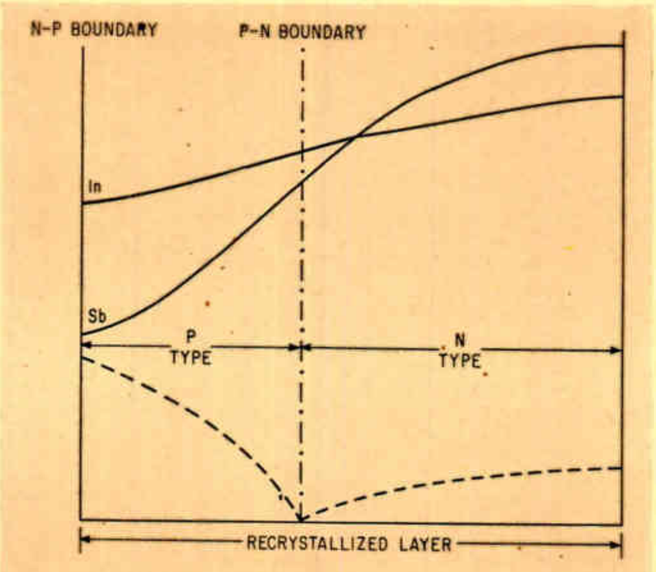


Fig. 6—Impurities distribution in recrystallized germanium as measured by Hitachi

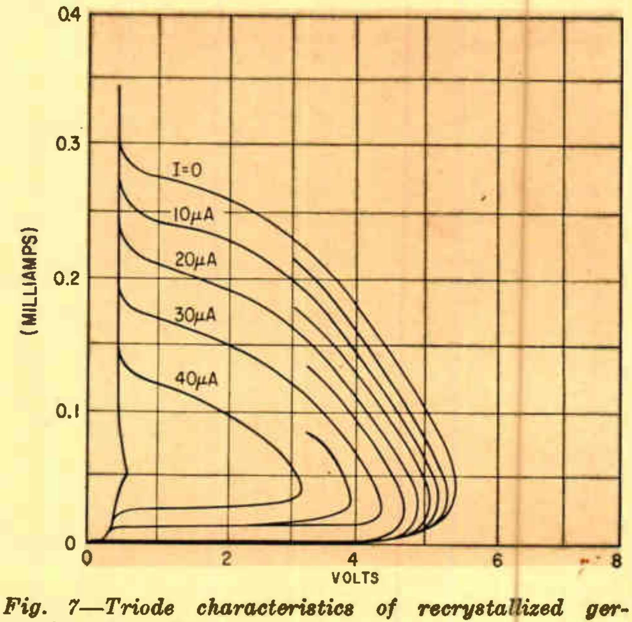


Fig. 7—Triode characteristics of recrystallized germanium elements

thermoelectricity and Peltier cooling, again without any discernible need but with promising results.

Augumenting the government labs are the physics and electrical engineering labs of the half-dozen big government-supported universities—Tokyo, Kyoto, Osaka, Nagoya, Sendai, Hokkaido and Kyushu. Right behind these are a couple of private universities—Doshisha and Keio particularly.

INDUSTRY—Working closely with the universities and government labs are some of the more advanced industrial labs: Tokyo Electro Chemical in ferrites, Shimadzu and Kobe Kogyo in instruments, Murata in piezoelectric and magnetostrictive devices, Yaou in broadcast techniques, NEC in communications, Sony in television receivers. The common characteristic of all these companies is that they are not the giants of industry—excepting NEC, which is the smallest of the four big Japanese firms that produced more than $40-million worth of equipment last year (the others were Matsushita, Hitachi and Toshiba).

Proportionately, the giants lease more of their engineering than they perform. Hitachi is affiliated with RCA, Western Electric and Philips; Toshiba is tied in with International General Electric, RCA, EMI, Western Electric, Raytheon, Hoffman and Philips; Mitsubishi has ties to Westinghouse, RCA, Western Electric, Collins, Servomechanisms, Philips and Corning; the Fuji companies are tied to four German companies, Siemens, Voith, Escher Wyss and Siemens & Halske.

These companies hire the cream of engineering graduates from major universities, and unfortunately put most of them to work processing leased engineering. In doing so, they wind up at a competitive disadvantage. It is a regrettable truth that technical assistance contracts always put the lessee behind the lessor by at least publication time plus contract-negotiation time. Additionally, a technical assistance agreement does not always convey the background—even essential background—of the invention; as a result Japan's engineering occasionally borrows the surface and outward appearance of an innovation and misses the heart and substance.

This 12,000-Mc link built by NEC is used for remote control of a lighthouse in Hokkaido

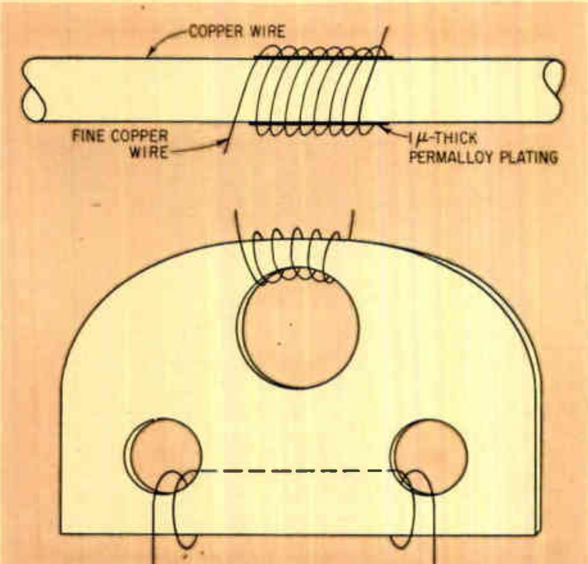


Fig. 8—At bottom, multiple-aperture parametron currently in use. At top, fabrication principle for new parametron device being developed by Goto; magnified

As an example: a major manufacturer disclosed to ELECTRONICS that when his firm first began making a particular type of complex electron tube on leased plans and specifications, only one in 100 worked. The contract had failed to convey the necessary background in the theory of the device, and rote mechanics were not sufficient to make for ample production controls.

The buyers of research results waste much motion in empiric purification or modification of their purchase. Companies with the courage to embark on their own research programs break their own ground and establish their own technological foundations.

GOVERNMENT RESEARCH—NTT's Communications Laboratory—which recently produced some new approaches to data-handling (see ELECTRONICS, p 36, Apr. 15), performs research across the communications spectrum. Electronic telephone switchboards have been

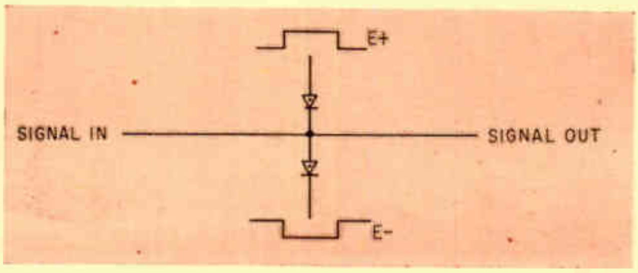


Fig. 9—Tunnel diodes (Esaki diodes) are connected as twins for digital work

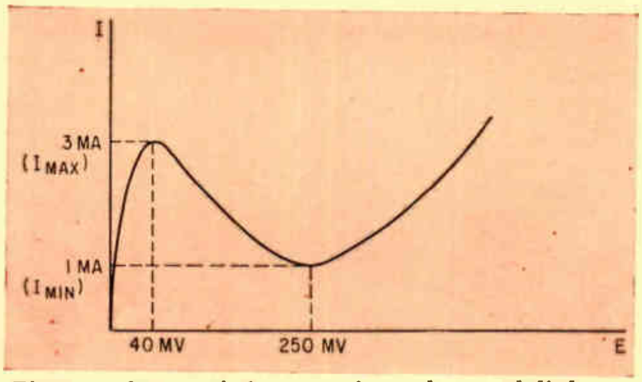


Fig. 10—Characteristic curve of sample tunnel diode

developed, with further engineering from NEC. One is now installed in the Mitsukoshi Department Store in Tokyo. Speech paths are provided by conventional crossbar switches, but controls are solid-state circuits. D-c diode logic and transistor amplifiers are used.

Transistorization of carrier equipment and repeaters was also undertaken at NTT's lab and engineered by NEC.

Materials research projects include semiconductor studies, research in high-polymer plastics for insulating materials, and ferroelectric studies. The latter projects are investigating the use of barium titanate and aluminum-sulphate hexahydrate guanidine as memory circuit elements.

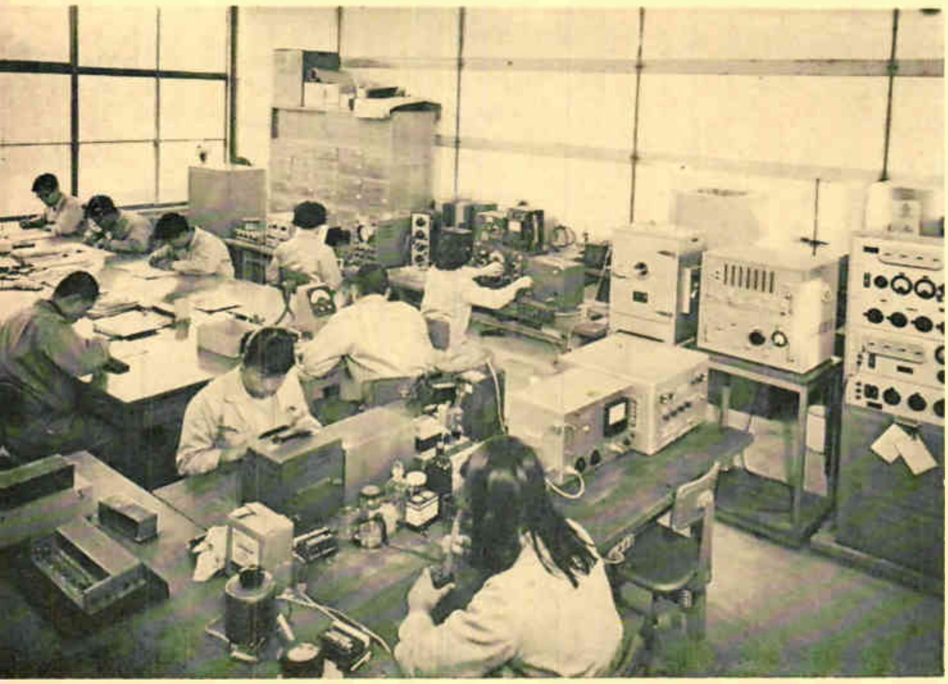
In millimeter-wave studies, the lab produced a 50-Gc amplifier tube, is pursuing waveguide experiments and developing solid-state amplifiers for the millimeter waveband.

MITI's Electrotechnical Laboratory, aside from its work in standards, has developed a number of interesting industrial instruments. Analog and digital computers are one main interest; analog systems of 0.1-percent accuracy, and transistorized digital systems with 200-Kc clock are among its developments. A high-speed magnetic drum rotating at 18,000 rpm was developed in the lab; its iron-oxide coating limits information density to about 50 bits per inch, resulting in only 24,000 bits of storage on the 8-in. drum.

Process simulators, process controls and atomic clocks have been developed as industry models. Electronic reading systems to scan kana characters and convert them into 6-place code are under study. A Japanese-English translator developed by the lab is now in trial use at the government university in Kyushu.

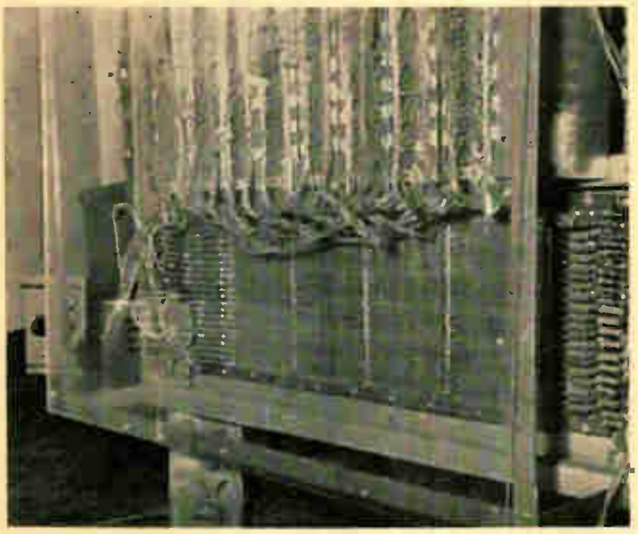
MATERIAL RESEARCH—Physical and electrical characteristics of various ferroelectric and other ceramics have been under investigation at Kyoto University and Murata since 1955. A pyrometer using barium-calcium titanate elements was among the developments.

Experiments in the temperature dependence of the resistivity of semiconducting barium titanate have been one of the chief interests of these researchers. When doped with 0.3 mol-percent of bismuth, cerium, lanthanum, niobium and certain other additives an anomalous positive jump was observed in the resistivity-vs-temperature curve in the neighborhood of the crystal transition point.

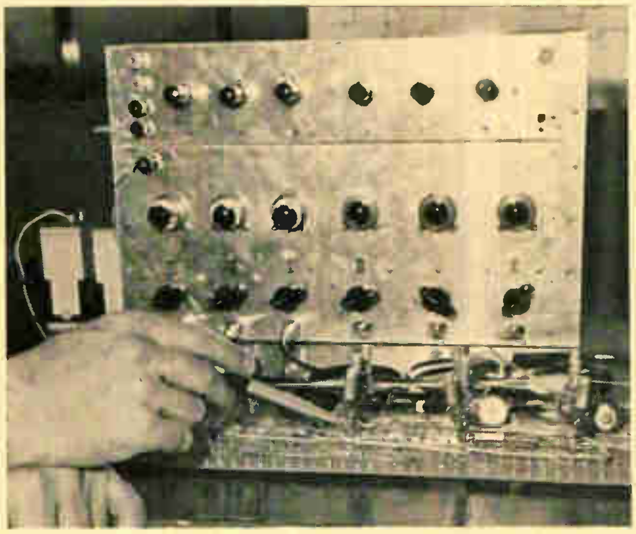


Recrystallized n-p-n layer formed when alloy containing both p and n impurities is fused to n-type germanium (base layer in the picture)

Investigations in piezoelectric phenomena are conducted in this Murata lab



Matrix at the bottom of this computer bay does not use diagonal "Z" readout wire familiar in core memories. This is 2-wire system using frequency discrimination



Tunnel-diode data-processing circuitry under stability test in laboratories of KDD. Pencil points to the Esaki diode in circuit shown in Fig. 15

Results of experiments with dielectric constant of barium titanate indicate that interfacial polarization causes high dielectric constant at low frequencies (1 Kc and below). Pursuing this work further, the Kyoto researchers discarded the traditional method of shifting the Curie point of $BaTiO_3$—adding strontium titanate, magnesium stannate or lead stannate—and found that additives of stannates of manganese, iron, cobalt or nickel completely eliminated the shift in dielectric constant at the Curie point. The result was a ceramic material with a flat dielectric-constant temperature characteristic and a high dielectric constant.

Cause of this change was ultimately deduced as being a change in the tetragonal crystalline structure of $BaTiO_3$ as the stannates were added, until the axial ratio approached one and the effective crystalline structure be-

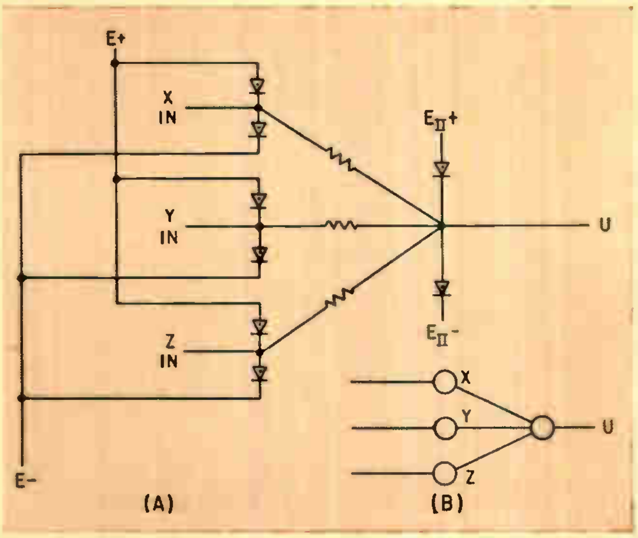
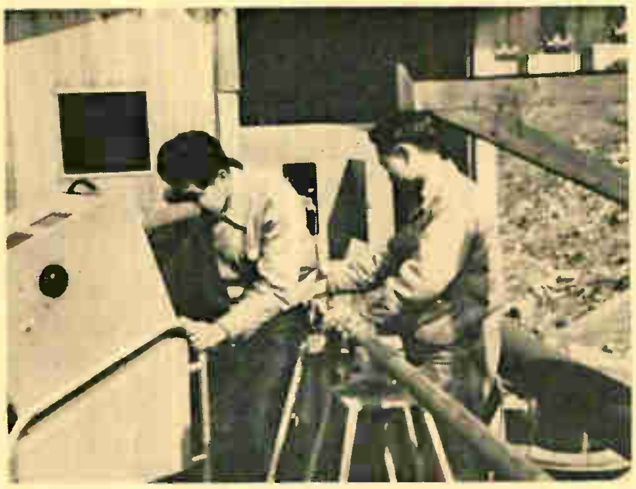


Fig. 11—Majority-decision circuit using tunnel diodes; circuit (A) and block (B) diagrams



Above: test facility at Sumitomo labs where X- and O-type waveguides are checked out; below: closeup of 35-gigacycle coupling under test

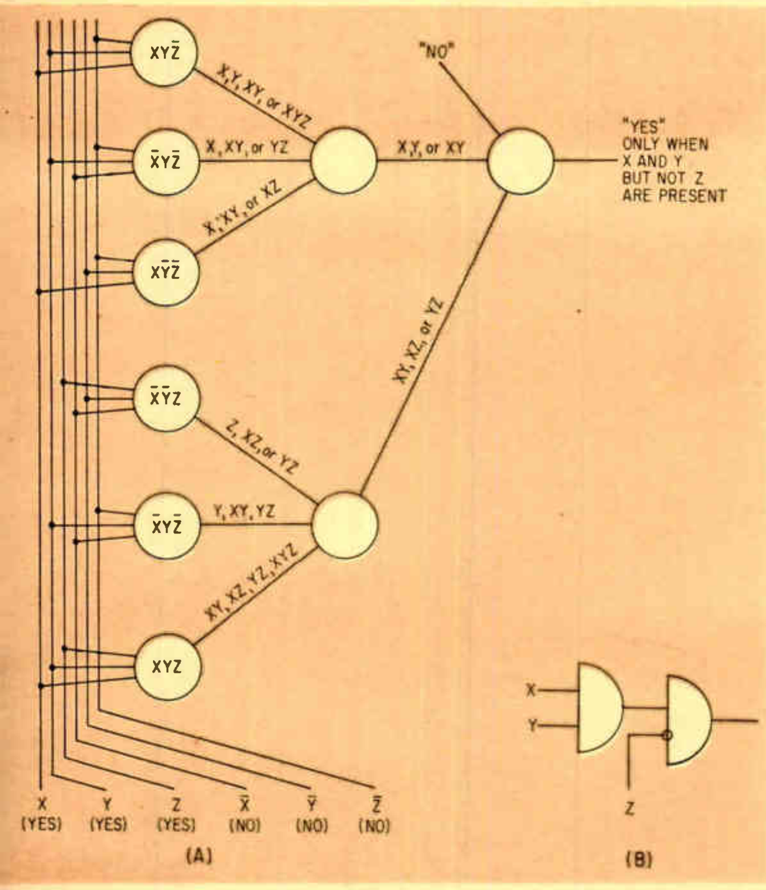


*Fig. 12—*NOT *circuit using tunnel diodes. First group make assorted decisions; second group pass "yes" signal if (top) X, Y, or both are present and (bottom) if X-and-Y, X-and-Z, or Y-and-Z are present. "No" signal at third stage overrules all other possibilities but X-and-Y*

came cubic (cubic crystals exhibit flat temperature characteristics).

Further work disclosed that hydrated stannates tended to decompose under heat into oxides, and that oxides, or compounds that reduce to oxides when fired, such as carbonates, would do the job as well. To prevent formation of large coarse crystals in the sintering process, small amounts of previously fired compounds of tin, titanium or zirconium are added, and the mixture is fired at 1,200 to 1,400 C.

Other recent work by the same group investigated piezoresistivity of silicon and germanium, and piezoelectric effects in the rectifying contact of selenium and germanium junctions.

Results of the basic materials investigations led to the use of barium titanate as an electrostrictive vibrator for transmission of underwater sound and other high-power ultrasonic uses; as a high-dielectric material in capacitors and dielectric amplifiers; as a transducing material for pressure gauges and accelerometers, and a driver or pickup device for tuning forks or vibrating reeds. In the later case, one advantage is that the driver can be attached directly to the vibrator.

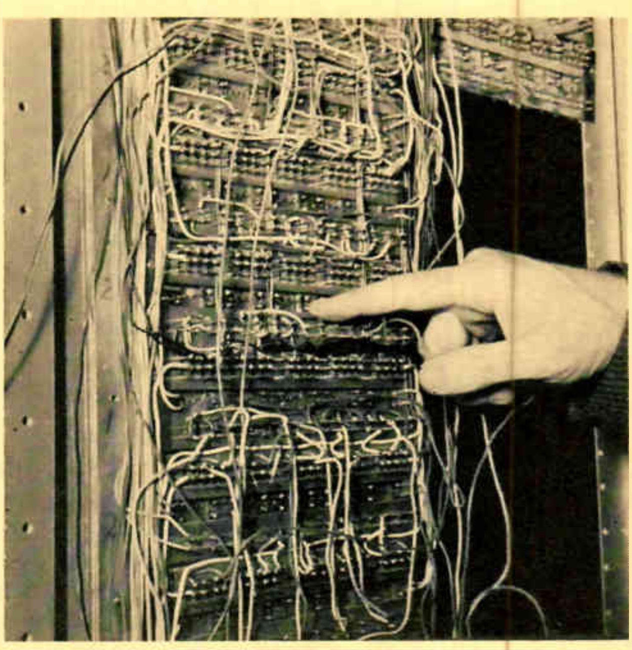
COMPONENTRY—Work in thin ferromagnetic films has been undertaken by KDD's laboratories. Nickel-iron alloy (permalloy) is deposited on wires and on glass. In the latter case it is deposited to 0.6-micron thickness, lifted off to form tape. A vacuum-deposition furnace is used, depositing 0.32 to 2.0 microns in 1 to 6 minutes at 1,300 C. Pressure during deposit is 2×10^{-5} mm Hg.

Novel fabrication techniques for semiconductors have been developed at Hitachi's central research laboratory. A double-layer alloyed *p-n-p-n* switching device using germanium is made by fusing an alloy containing both negative and positive donor impurities (antimony and indium) on one surface of *n*-type germanium; when cooled at proper speed, the effective distribution coefficients (see Fig. 6) vary sufficiently that a *p-n* junction will result within the recrystallized layer, and a *p-n-p-n* device can be made merely by alloying indium on the opposite side.

If the effective amount of active impurities in the inner *p*-layer is made large with respect to the outer *n*-layer, the injection ratio of electrons across the *p-n* junction from *n* to *p* is fairly small, increasing in almost a linear relation to current. Triode characteristics of the material are shown in Fig. 7. Characteristics of the device are quite stable, and do not vary widely even in open air; breakdown and sustaining voltages are small (2 to 10 v for breakdown and 0.4 v for sustaining), and turnoff time is of the order of 100 nanoseconds. The production process is quite simple.

Molten diffused silicon transistors have been made at Hitachi by a process similar to post-alloy diffusion. An *n*-type silicon single crystal is dipped into molten silicon doped with arsenic and gallium. After a small portion of the crystal tip has melted back, the crystal is held steady for some tens of seconds at a temperature at which neither melting nor growing can occur. A direct molten diffusion takes place, forming a thin *p*-type base layer.

Rapid pulling up of the crystal forms a second *n*-type region. The impurities thus diffuse through the fresh sur-



New parametron computer circuitry undergoes test in a government lab face of the solid, from a reservoir in which impurity concentrations are constant. The solid surface constitutes an isothermal plane, and anisotropic and lattice defects have small effect on impurity diffusion. Thin but sharp and uniform *p*-type base layers can be produced by this technique, making fabrication of high-frequency transistors with uniform characteristics a fairly simple production process.

Silicon transistors with cutoffs in the 400-Mc region have been made by this process, with collector and emitter currents of 20 ma and rated collector dissipation values of 100 mw. Rated junction temperature range is −65 to +175 C and maximum collector voltage is 10 v.

NEC has developed foil-type tantalum electrolytic "hole" capacitors capable of operating in temperatures down to −200 C and up to +200 C. The component is made of anodic-oxidized tantalum with the plate materials vacuum-deposited on the oxidized surface. Capacitance tolerance is −15 percent +50 percent, and maximum power factor tolerance is 5 percent, but lifetimes of 2,000 hours at rated voltage and maximum rated temperature make the device useful in difficult environments.

Neferrite, a manganese-zinc ferrite developed by the company, possesses coercivity of 4,000 gauss and high Curie temperature, with permeability relatively flat at 2,000 ±200 to temperatures above 200 C. Miniaturization of wave filters for carrier systems, and improvement of the frequency response of wideband (12-Mc) matching transformers were among the first applications of the highly stable ferrite.

At Todai (Tokyo Daigakko: Tokyo University), Goto is continuing his work in parametrons, producing a miniature unit adaptable to higher-frequency work than present units. Current parametron circuitry is limited by hysteretic characteristics of the wound cores to information rates in the tens of kilocycles; new circuitry will be able to operate in the megacycle range. New unit (see Fig. 8) consists of a copper wire plated with 1-micron thickness of permalloy, then wound with finer copper wire.

This installation in Japan's mountains checked out NEC's 2000-Mc o/h system to be sure it could work in Korea's mountainous country

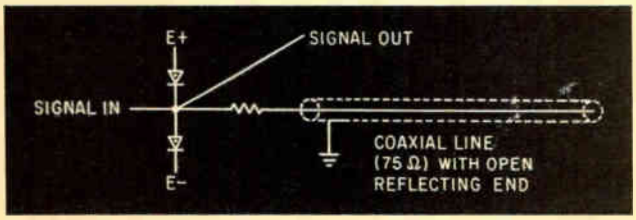


Fig. 13—Regenerating delay-line storage using tunnel diodes. Delay is just long enough that reflected signal is regenerated by recurring power pulses (E)

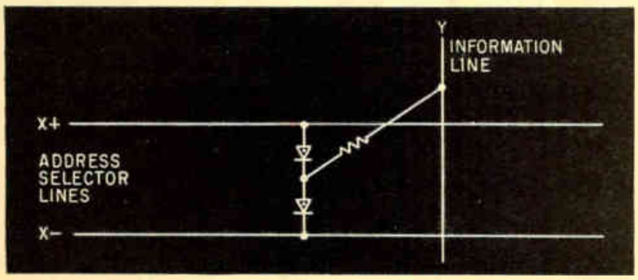


Fig. 14—Bit storage in tunnel-diode matrix. Nondestructive readout shifts voltage on one address-selector line, senses variations in current on Y line

Goto feels that the device can be produced in a continuous production process: the bare base wire to be plated with permalloy, then overplated with copper and the copper etched away to leave a winding.

The same Ni-Fe plated copper wire is also suggested by Goto as a two-frequency memory device fabricated without cores. The wire would be woven into a mesh; information signals at frequency f would come in one axis, and indexing signals at frequency $f/2$ on the other axis. Twisting of the magnetic field at the selected intersections would record bits of information. Reading would be accomplished by pulsing the index lines with signals at $f/2$; the second harmonic of f would then be read into the information lines because of the harmonic distortion introduced by the twist in the fields at the intersections where information was stored.

Such a memory system presumes parametrons or other phase-locked oscillator circuitry, since it requires frequency discrimination in the output stages.

TUNNEL DIODES—Other work at Todai—to be carried into development stages at Hitachi—is researching tunnel-diode circuitry for digital use. The essentially bi-

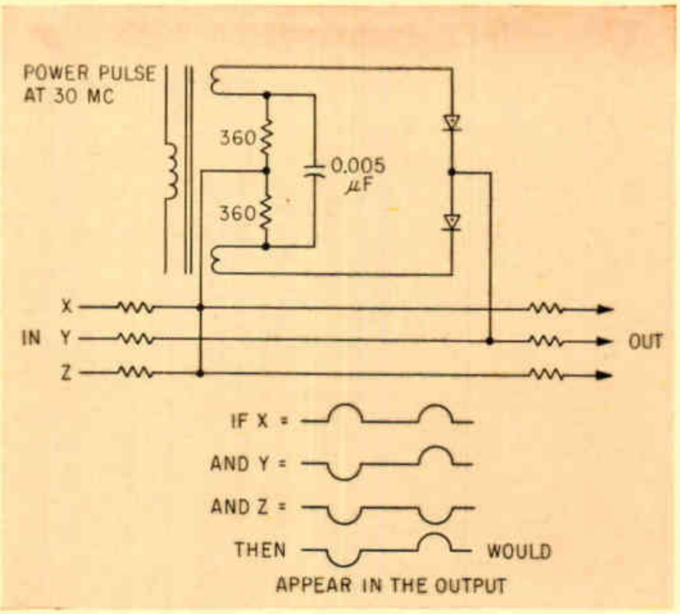


Fig. 15—Basic tunnel-diode twin circuit as developed at KDD. Resistors smooth out variations in diode parameters

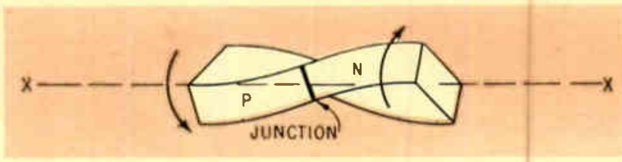


Fig. 16—Deformation of shape of semiconductor material at p-n junction in direction shown produces negative-resistance phenomenon

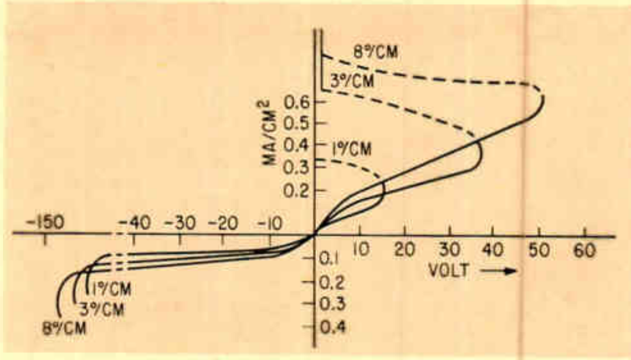


Fig. 17—Characteristics of plastic-deformation diode as a function of twist angle as measured at Kobe Kogyo

lateral characteristics of the tunnel diode require special methods to make it usable in amplifying or switching digital signals. Working on proposals of Goto, three Todai labs have developed a variety of digital circuits, including working models with clock frequencies in the 30-Mc range.

For digital use, tunnel diodes of similar characteristics are connected as series twins, shown in Fig. 9, with input and output connection at the junction between them and symmetrical exciting voltages of equal amplitude and opposite polarity applied to the outer terminals. When the exciting voltages are small, the operating points of the two diodes lie on the first positive-resistance side of the characteristic curve of the tunnel diode (see Fig. 10), and the potential at the midpoint is near zero. Very large exciting voltages shift the operating points to the second positive-resistance slope and the midpoint is again zero.

A median voltage value for the exciting voltages puts the operating points of both diodes in the twin circuit on the negative-resistance slope, where three conditions can obtain: zero potential at the midpoint, which is unstable because both diodes are in the negative-resistance region; and two stable points representing two possible midpoint potentials of equal magnitude and opposite polarity. These two stable points are used to represent binary information.

When the exciting voltages shift from a small value to an operating value, the zero potential at the midpoint of the twin will become unstable; in a perfectly matched pair, either stable potential is equally possible. In such a circumstance, a small signal applied at the midpoint will be enough to control the choice between states. This can be regarded as amplification of a small input, or as digital control. The amplified output continues only so long as the pulsed exciting voltages, and decays on an *R-C* curve when the pulse cuts off.

Resistors are used to couple between midpoints of these basic circuits to build up circuit complexes for performing computer logic. Majority operations can be performed by the circuit in Fig. 11A; Fig. 11B is the block diagram of the same circuit. In this circuit, the algebraic sum of the outputs of the three twins *X*, *Y* and *Z* serves as the effective input to *U*. The exciting voltages applied to *U* rise slightly later than those applied to the *X*, *Y*, and *Z* twins, so that the information flow will be unidirectional.

As with parametron circuits, AND and OR circuits are regarded as special cases of majority decision circuits, with one of the inputs replaced by a constant input of unit intensity and the correct polarity: + for OR and − for AND. Conventional inhibiting functions or NOT circuitry require either the addition of transistor or tube circuits to invert the sense of the signal, or the interconnecting of cascades of twins in logical arrangements that can decide among available doubled sets of signals: one set being the signal in its proper sense and the other its complement. Although this increases the complexity of circuitry—the circuit complex in the block diagram Fig. 12A performs the same job as the simple block in Fig. 12B—it has, according to Goto, the advantage of being able to detect single significant errors with the addition of comparison detectors among the circuits.

Two kinds of memory device have been tested using tunnel diodes. One is a serial delay-line store, the other a nondestructive-readout matrix.

The delay line, shown in Fig. 13, uses a coaxial line with an open reflecting end connected to the midpoint of the twin. The state of the twin is thus controlled by the reflected signal. A 16-bit store at 30 Mc has been successfully operated; this type of serial delay-line would be useful for high-speed internal storage.

Basic bit-storage in the matrix array is shown in Fig. 14. D-c holding voltages of sufficient amplitude to move the tunnel-diode operating point beyond the negative-resistance area onto the second positive-resistance slope are applied to the outer contacts of the twin circuit. To

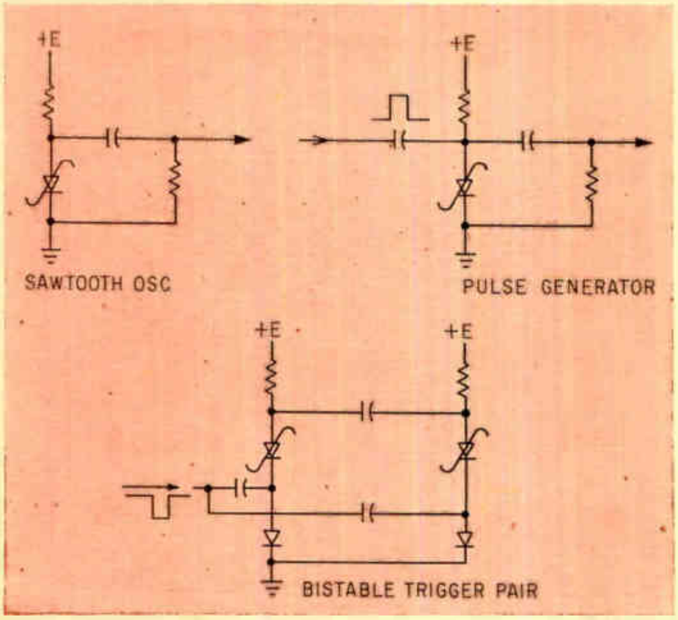


Fig. 18—Three examples of circuits using deformed diode

write, information signals are applied to the Y lines, and the holding voltages are shifted to select the register. The twins shift to one of the two stable states and are held there with the reapplication of the holding potential. For nondestructive readout, one of the selector voltages is shifted and the polarity of current variation on the Y lines is sensed by the readout circuitry. So far, tests at Todai have been made only on single units due to inadequate supply of tunnel diodes.

Silicon tunnel diodes used in tests at the University had I_{max} of 3 ma, capacitance of 400 pf; minimum value of absolute magnitude of negative resistance was 100 ohm, resulting in an operating time constant (minimum resistance value times capacitance) of 4 x 10^{-8} sec. Germanium units with the same I_{max} but negative resistance values as low as 10 ohm and capacitance of 40 pf had an operating time constant of 4 x 10^{-10} sec. With 2,000-ohm coupling resistors, the labs operated a silicon-diode binary-counter circuit at a 10-Mc clock frequency. In a germanium-diode configuration using 500-ohm coupling resistors, it was operated at 30 Mc. This frequency limit was imposed by inadequate lab equipment; the researchers are confident that it could have operated at 100 Mc.

Researches indicate that the balance between the two diodes used in a tunnel twin is vital to the circuit gain and stability. Most critical factor is I_{max}; binary-counter circuitry developed at Todai used tunnel diodes with I_{max} matched within 3-percent tolerance.

Meanwhile, the research lab at KDD and several private industrial groups, including Kobe Kogyo and Sony, are pursuing development of tunnel-diode circuits. At Sony Corp., a 10-to-30-Mc binary counter has been under stability test for several months. KDD's interest in stable circuitry has led it to develop a basic configuration using transformer coupling for the power pulse, as shown in Fig. 15, and with an R-C balancing circuit to equalize the variations in the diodes.

Kobe Kogyo has developed another negative-resistance device whose operation results from crystal defects introduced by deformation of the shape of the p-n junction. The plastic-deformation diode is simple to fabricate, and the company's engineers figure it will ease the problem of producing high-power switching circuits to operate

Keio University, among the wealthiest of Japan's private universities, has bright new economics building, also healthy approach to computer development.

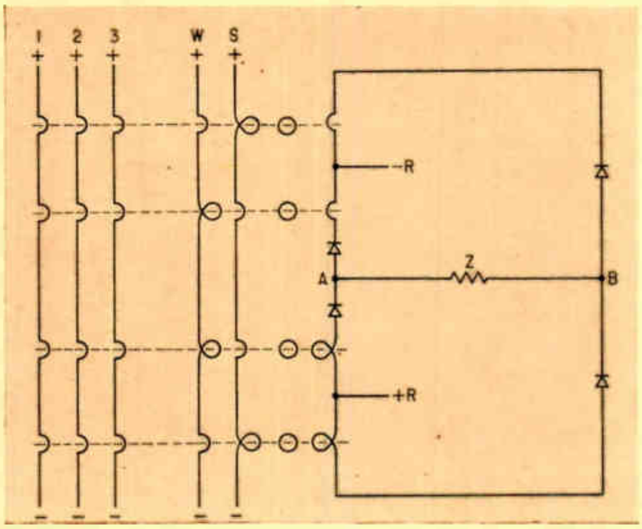


Fig. 19—Reactron-type multiple-winding core-diode logic circuitry. Resistor Z represents circuit load. Circuit uses 4 cores, 4 diodes

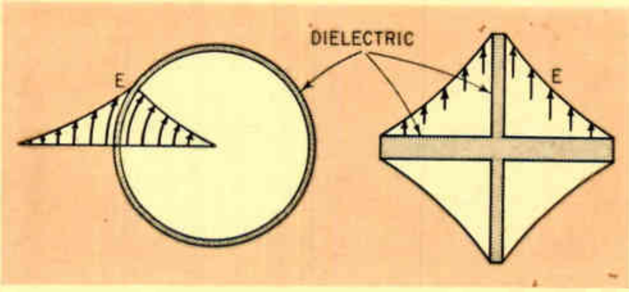


Fig. 20—Cross-section of O- and X-type hollow waveguide

at information rates in the megacycle range.

To produce the negative-resistance characteristics, a *p-n* element about 2 × 3 × 20 mm is prepared conventionally. Resistivities should be about the same, about 0.5 ohm-cm for the *p*-type region and 0.1 ohm-cm for the *n*-type region.

The element is then heated in an inert atmosphere to about 400-600 C, and the *p-n* junction is twisted about its long axis, as shown in Fig. 16; the ends are held in quartz clamps during this operation, and the high temperature prevents the semiconductor material from cracking or breaking under stress. After the element is cooled, it is fabricated as a diode by conventional techniques.

Crystal defects are produced by the deformation process. As shown in Fig. 17, this results in a negative-resistance characteristic in the forward direction, due to a barrier formed by the crystal defects.

The barrier is light-sensitive; a strong light will cause the barrier to disappear and restore the normal characteristic curves of the diode. When the light is removed, the barrier immediately recovers. The barrier is also temperature-dependent, tending continuously towards normal charcteristic as temperature rises. Value of breakdown voltage increases with twist angle.

Other componentry work at KDD has produced elements known collectively as "reactrons," which are multiple-winding magnetic-core devices for performing digital storage and logical functions. The reactron shown in quasi-exploded diagrammatic form in Fig. 19, for instance, is used for taking a majority decision of three inputs 1, 2 and 3. *W* is the writing-bias winding, *S* the reset-current winding, and *O* the output winding. Reading currents are applied to terminals *R*.

The "majority decision" from the three inputs is stored in the cores when a writing current is applied, by conventional coincidence techniques. If the result is positive, when reading potentials are applied at *R*, currrent will flow through the load *Z* from *A* to *B*; if negative, current will flow from *B* to *A*. The circuit works especially well with other magnetic components, including drums and relays. A 4-core circuit dissipates less than one watt peak, with average power about 250 mw at 250-Kc operating frequency.

Among other component work, Murata's mechanical filter (see ELECTRONICS, p 94, Feb. 12) has generated much interest as an inexpensive replacement for i-f transformers is small radios. The filter is now being mass-produced for both Japanese and U.S. manufacturers. Current research is attempting to produce a mechanical filter for f-m and other higher-frequency i-f's; present models are useful only in the 455-Kc range.

An engineering group at Sumitomo Electric is concentrating on development of circular and x-section waveguides (O- and X-guides) using the TE_{01} mode. These guides convey the wave along the boundary surface of the medium; propagation velocity is somewhat lower than in free space because the wave is concentrated in the vicinity of the surface. A thin dielectric plate parallel to the electric field concentrates the energy; a thin magnetic plate perpendicular to the electric field fulfils the same function. The two types of guide are shown in Fig. 20; they are particularly useful in the millimeter-wave bands.

The group has developed copper-pipe guides and helical mode filters. Two-inch-i.d. hollow copper-pipe guides tested at the firm's Osaka lab had lower attenuation constants than coaxial line, G-line or rectangular guides. Tests were conducted at 24, 35 and 50 Gc; attenuation, as illustrated in Fig. 21, was very close to the theoretical value for perfect copper waveguide.

CIRCUITRY AND EQUIPMENT—Examples of advanced equipment engineering in Japan are many, and likely to be more widespread than advanced research.

Two months ago, a consultant to Apollo Industries demonstrated a 6-transistor audio amplifier using 4 ma of current from dry cells with combined potential of 18 v. The amplifier drives two 8-in. coaxial speakers, was shown to Japan's Audio Engineering Society.

Kobe Kogyo has developed a 130-Mc f-m portable belt radio for Japan Airlines ground services. The crystal-controlled transmitter is made with 10 transistors and three subminiature tubes; the receiver is all-transistorized. Equipment operates on mercury-cell batteries, can transmit up to a mile with 250-mw power output, weighs about 5 lb all told. Frequency stability is 0.005 percent between −30 C and 50 C; and spurious or harmonic emissions are more than 40 db down from rated carrier power output; audio distortion is less than 10 percent at 1,000 cps. Transmitter modulates at the second amplifier, and the signal goes through seven stages of frequency multiplication and amplification after modulation. Receiver has

These color-separation prints were transmitted from Antarctic (that's snow, not sea) to Tokyo over radiophoto

link. Top is red print, middle blue, bottom green. Color from recombination process is quite realistic. Process

was developed at KLD lab specializing in visual communications and color techniques two i-f's, one at 10.7 Mc, the other a four-stage amplifier at 455 Kc that uses mechanical ball-type filters instead of i-f transformers.

Communications equipment, predictably enough, takes up a lot of engineering activity. KDD's parametron automatic request (ARQ) equipment has been production-engineered by Mitsubishi. The equipment detects mutilated telegraphic characters by noting the ratio between mark and space elements, stops the telegraph printer and stops the transmitter by jamming the start-stop circuit to STOP. The preceding three characters are then automatically retransmitted.

KDD has also developed bandwidth compression techniques and fading-compensation circuits using reactron elements similar to the ones described above. The big communications lab is working on analog-to-digital converters, using magnetic amplifiers to sense analog inputs which work into parametron digital circuits.

A large portion of NEC's engineering effort has recently been dedicated to over-the-horizon communications systems. One system in particular, operating in the 2,000-Mc range and designed as a multiplex radio link, uses a high-sensitivity receiver that permits dropping transmitter power to a tenth of ordinary values.

The high-sensitivity receiver improves threshold level and signal-to-noise ratio by 10 db each. One receiver configuration has a noise figure of 7 db; another configuration with added parametric amplifier circuitry (see

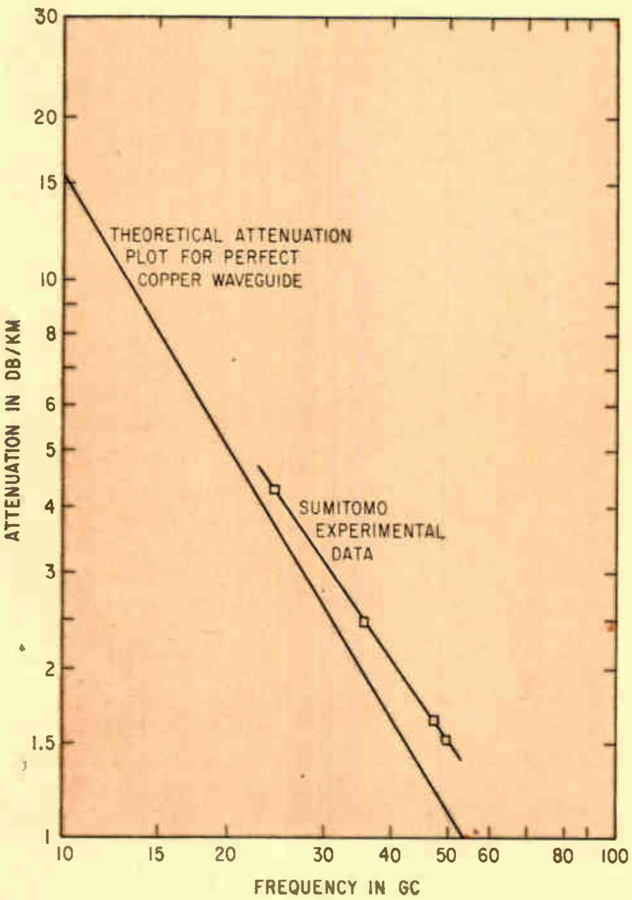


Fig. 21—Attenuation of O-guide, as measured at Sumitomo labs, is close to perfect theoretical plot

Fig. 22) has an improved noise figure of less than 3 db. The gain of the parametric amplifier section is about 15 db. Threshold level of the more complex receiver is −107 dbm for 24 channels, −104 dbm for 60 channels; signal-to-noise ratio is 29 db.

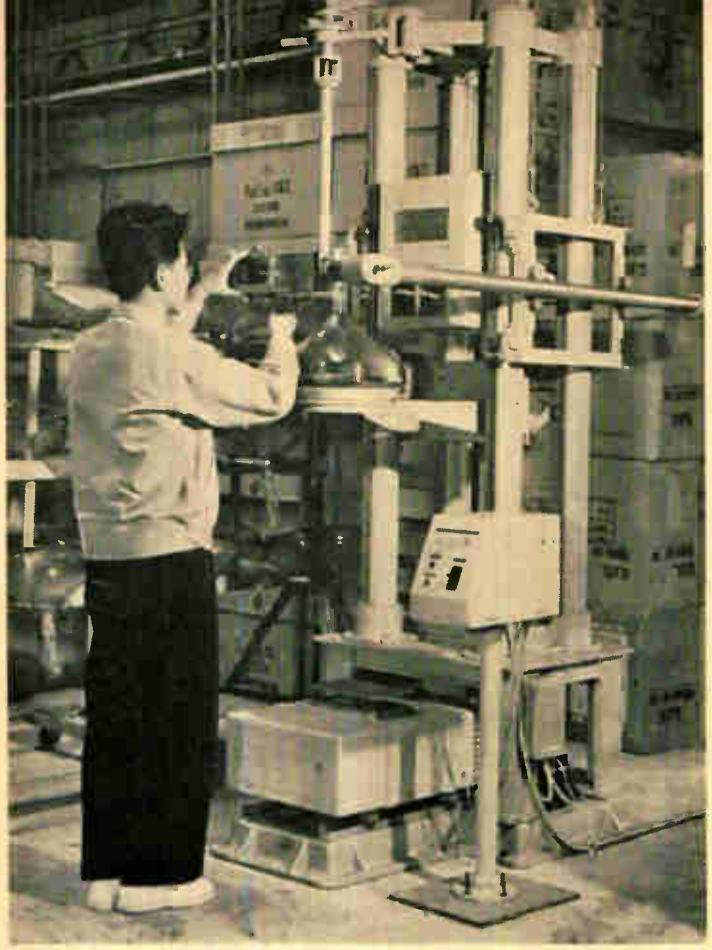
Sensitivity of the receiver results from a coherent demodulating technique involving feedback from a phase detector to a local oscillator and from a baseband amplifier to the same local oscillator. The phase difference between the received signal and the local oscillator signal adjusts the demodulator oscillator to operate at exactly the same frequency and phase as the received signal. If the demodulator oscillator voltage is kept at a relatively high level, the demodulator can produce an output even when the signal drops below the noise. Negative feedback from the baseband amplifier to the demodulator oscillator controls the oscillator so that the phase detector can be operated within a narrow linear portion of its characteristic curve.

The 2,000-Mc system has an additional advantage over lower-frequency systems otherwise used in Japan in that it is less susceptible to manmade noise. Other microwave systems being engineered include 12,000-Mc and 14,000-Mc multiplex equipment, transistorized and miniaturized, capable of being operated from a 24-v battery and using only 100 w. Equipment employs a single klystron for both transmitter and receiver local oscillator. Fifty-inch paraboloid antenna system is cross-polarized to simplify filtering. Transmitter puts out 100 mw.

In the computer field, research is going foward in transistorized equipment. At Keio University in Tokyo, a 200-Kc system operating on binary-coded decimal data and using magnetic-drum storage has been developed. Keio's emphasis, as a school, on economics has affected the engineering faculty's approach, so that more attention has been given to input and output than in many other laboratories. Both paper tape and direct input and output are used. Other computer research and engineering is being pursued by MITI's Electrotechnical Lab, NTT's Electrical Communication Lab, Tohoku University in Sendai, NEC, Toshiba, Hitachi, KDD, and Osaka University.

Toshiba has developed a transistorized sorter for magnetic tapes that can collate, sort and perform additions and subtractions, thus making it a primitive data-processor. Internal storage is only 30 12-digit words, limiting the sorting techniques and the speed of operation. NEC has produced a 30,000-bit magnetic-core matrix, large for Japan's computer technology, consisting of thirty 50 × 20 matrices. Net access time is 10 microseconds; serial-parallel conversion of the word (consisting of 6 serial digits of 5 parallel bits each) takes an added 40 microseconds.

Radiophoto work at KDD has produced a system for transmission of color pictures. The system requires three transmissions, one for each of the primary colors; the colors are separated at the source and recombined by the printing process. The picture is scanned through filters, and transmitted at a scan frequency of 5 lines per millimeter; the drum revolves at 60 rpm. Conventional subcarrier frequency-modulation is used. An electrostatic printing technique has also been developed by the lab; the received picture is used to develop a selenium plate



Polarimeter (closeup above) in use on Kobe Kogyo's tv-tube production line to test for strain in glass

charged to 7,000 v. Phenol resin inks (cadmium yellow, magenta and cyan), mixed with a tonal carrier composed of polystyrol granules and ground glass, are dusted over the charged plate. The plate is then placed in contact with paper and flashed with 7,000 v; the colors are bonded to the paper with tricholroethylene.

An 80-screen plate, etched to 20-micron depth and then plated with selenium, is used. The pit depth after plating is 25 microns. KDD is now experimenting with a drum printer to do the same job on a continuous basis.

At Kyoto University, a research group is working on developing a "phonetic typewriter" that will recognize the open syllables of the kana when they are spoken into a microphone, and print them by means of a typewriter. Frequency characteristics of the sounds are analyzed by the zero-crossing method; the frequency with which the signal crosses zero is sampled by digital techniques, and the frequency-distribution characteristics are used to control the selector circuits. A stopped consonant sound, for example, has low-volume high frequency components; an open Italian *a* has a lower sound with fewer harmonic components (or fewer centers of frequency-distribution concentration) than the double-*e* in *preen*, which is longer in duration than the *i* in *pin;* and as a general rule vowels are louder than consonants.

The system at the moment can recognize the five pure vowels, and the open syllables formed by these vowels when preceded by the voiceless *K, T, P, S,* and *H,* the voiced *B, D, G* and *Z.* The research group knows that the hard work is yet to come—recognising continuant sounds like *J, M, N, R*; semivowels like *Y* and *W*, and compound sounds with transients, such as *SH, CH, TS, TZ, DZ* and so forth. They are currently analyzing the practicability of abandoning the digital technique now employed and using octave filters to separate out the formants (the centers of concentration of frequency-distribution).

The kana syllabaries (there are two) comprise 50 basic sounds plus *n*, with 20 turbid sounds, 5 half-turbid sounds, and 75 more compound sounds (a compound sound for each basic, turbid and half-turbid sound). Most kana typewriters type only the first 75, printing twice for one compound sound.

INDUSTRIAL—In the industrial field a rotating phase-shift polarimeter developed by Kobe Kogyo is now being used to test transparent substances for strain and stress. While not electronic itself, the instrument is arousing interest in electronics circles; the Kobe firm is using it to detect strain in its tube glass and others are studying its use to detect residual stress in seals. The instrument measures samples 190 × 190 × 90-mm across the range from 0 to 600 millimicrons by measuring the relative phase retardation of light passing through the objective. A bright incandescent lamp serves as light source; a dial adjustment to match the color of the light against a standard permits reading value of strain or stress off the dial directly. Measurement precision is ±1 millimicron.

The same firm has developed an extension-rate meter which measures the difference in rotation speeds of feed and takeup rollers in sheet-steel rolling mills, applies digital techniques to translate this difference into the linear rate of production. Digital presentation of production data can be augmented by a recorder. Reading accuracy is 0.1 percent.

A train simulator developed by Hitachi for Japan

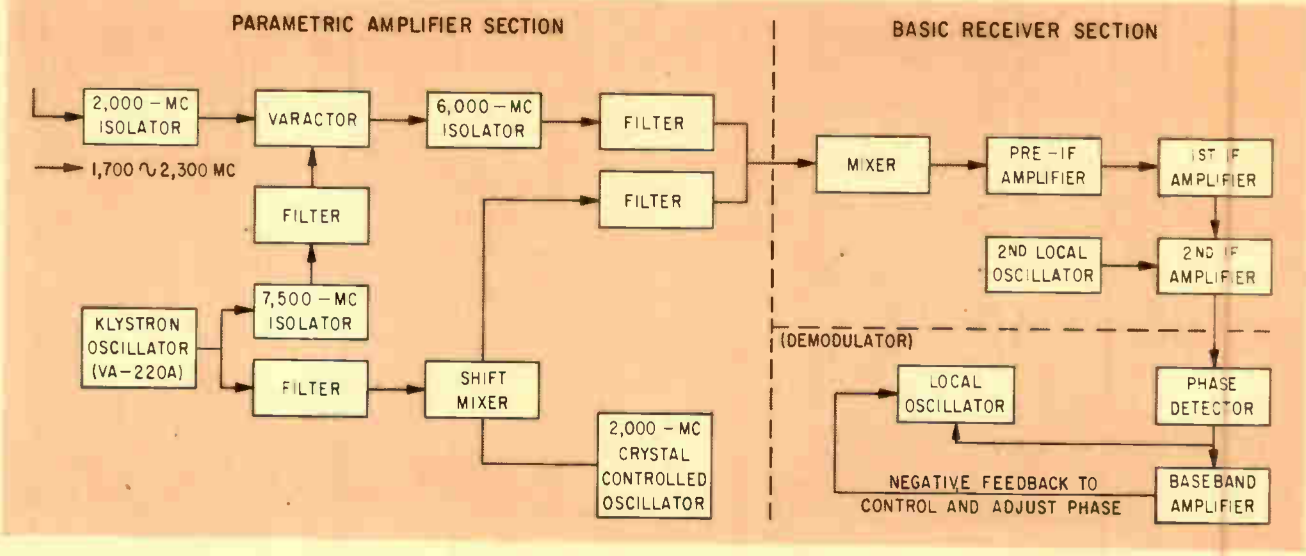


Fig. 22—PRO-2G receiver for 2,000-Mc over-horizon system. Parametric-amplifier section adds about 15db to receiver gain. Negative feedback in demodulator circuit keeps receiver LO and received signal in phase

National Railways regards the train as a dynamic particle whose movement can be calculated in terms of known or assignable quantities of weight, speed, tractive force, resistance of running, (mechanical resistance of the train and air resistance), grade resistance of track and brake force, plus distance of running and overall time of running.

Infrared and ultraviolet spectrum analyzers are being produced by Shimadzu. The infrared analyzer uses a Nernst glower (peak amplitude at 2 microns) as energy source. A hydrogen discharge lamp is the light source for the ultraviolet analyzer. Response curve of the lamp and its multiplier phototube (a 1P28 is used) peaks at 4,000 Angstroms.

Kobe Kogyo has developed a doppler speed meter for maritime use. The vessel transmits a c-w signal at a frequency *f* in the 150-170 Mc range. A fixed relay station—on the shore or at sea on a beacon buoy or lightship—receives the signal and transponds at *2f*. Equipment is miniaturized and ruggedized, uses 250 va, can measure speeds in the 5-40 knot range with ±2.5 percent precision.

The firm has also developed an image-converter system using a Graphicon storage tube (see Fig. 23). The system is designed for relaying of plan-position radar data over standard communications lines for video presentation, and is destined for use in Japan's weather and air traffic control systems. Write time required for accumulation of the graphic image on the tube can be used for communication of other data.

Radio-frequency measurement work conducted at KDD labs has produced h-f direction-finders which can measure multiple signals and scatter signals. Frequency range is from 3 to 33 Mc. Sensitivity is −27 to −40 db related to 1 microvolt/meter. Bearing of the energy is indicated by a sharp pulse on a crt. A recording-type d-f has also been developed, and a communications-zone indicator (COZI) of advanced type is now in the final stages of development.

Other studies—using this direction-finding gear—have investigated the deviations in arrival angle of vhf signals in ionospheric forward scatter over the 1,000-mile path between Okinawa and Tokyo. The studies have determined that fluctuation in bearing relates to propagation mode, rises with distance, and is affected by ionospheric conditions.

In the medical field, a smog detector for recording percentages of sulfurous acid and soot in the atmosphere was developed by researchers at Tokyo Medical & Dental University. The device uses a hydrogen-peroxide solution to oxidize the gas, a gas suction tube and suction pump, and an amplifier for the gas measurement: a photoelectric counter records soot deposits on rolling filter-paper tape. The counts are analyzed and amplified to operate a pen recorder, which is time-shared between gas and soot channels.

Industrial organizations such as Kobe Kogyo and Shimadzu have developed atmosphere-analysis equipment to measure radiation intensity.

COMPARTMENTALIZATION—Research in Japan exists in almost airtight compartments, each project going forward without reference or relation to any other project. This, coupled with the phenomenon of bought or borrowed research, gives the frontier of scientific knowledge in Japan its peculiar spiked topography: a smooth and slowly expanding sphere of knowledge, smaller than the scientific base in many industrial countries, with sharp spikes representing individual leaps forward by isolated researchers.

Throughout most of the scientific community, individual leaps forward are quickly smoothed out as related fields of research catch up and make use of the advanced knowledge. But in Japan, there are several commercial, cultural and philosophical conditions which militate against this integration of knowledge.

Firstly, despite the overwhelmingly eclectic nature of of the Japanese—they will try anything once, and keep what they like, rejecting or altering the rest—they are also stubbornly chauvinistic. Goto's parametron has

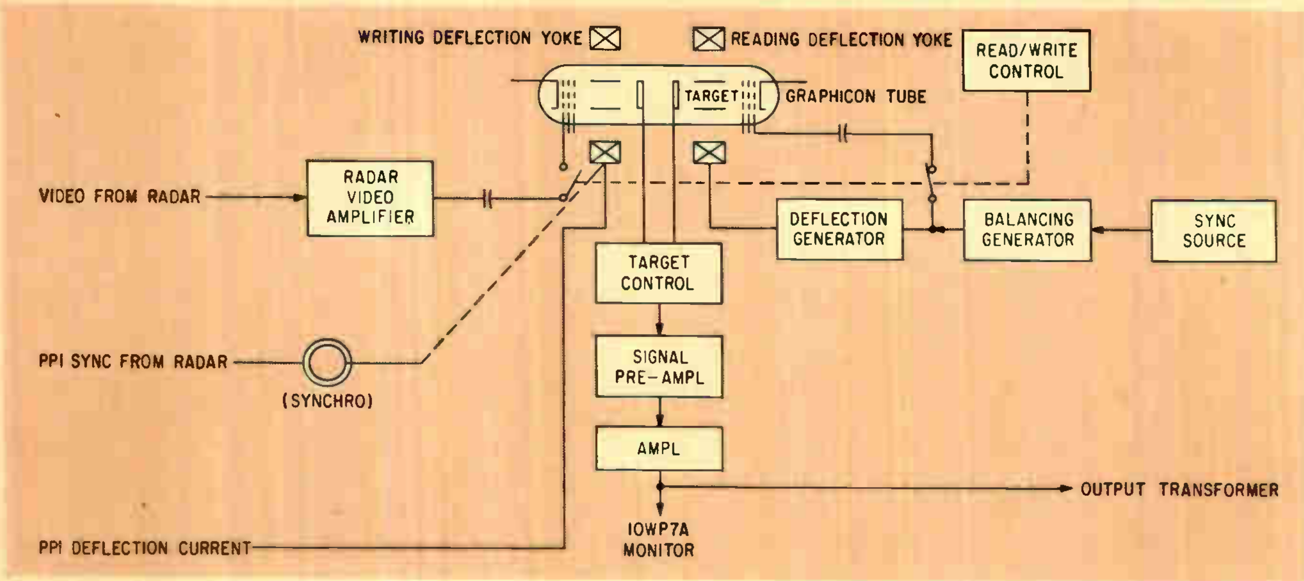


FIG 28—Radar-to-video image converter uses image-storage tube. System is designed to relay radar data over telephone lines for tv-type presentation, will be used by weather and air-traffic control agencies

caught on throughout the Japanese computer industry, not just for its efficiency as a computer component, but more because it is a Japanese invention. The computermakers in Japan are exhausting the possibilities of the parametron instead of attempting to improve on it or so alter the logical approach to data-processing as to render it obsolete.

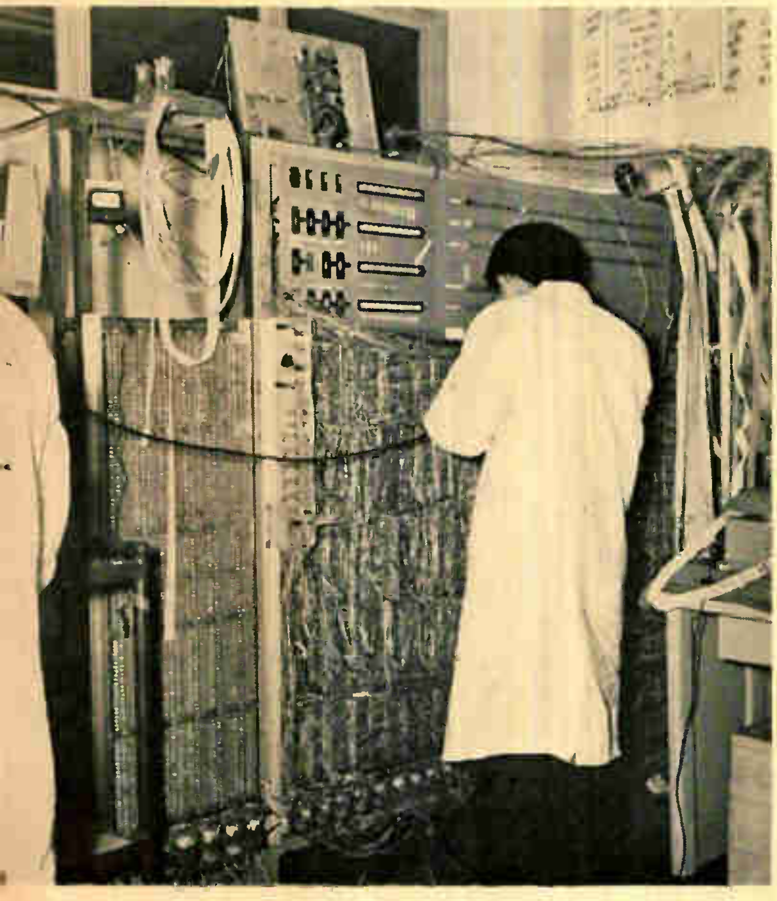
This also demonstrates the faddist nature of the Japanese. It is not unusual for everybody in the industry to adopt something and then cling to it, abandoning it only when another fad comes along. In such an atmosphere, research cannot thrive.

Secondly, the fiercely competitive nature of Japan's university system leaves its imprint on the engineer; he remains suspicious of sharing his invention with others during the formative stages, and hesitates to borrow from other fields of knowledge. Thus Kyoto University's work on the phonetic typewriter does not employ the services of a phonetician, who could keep the small research group out of a number of blind alleys. In effect, the men developing the system are having to rediscover all the things that Andrew Bell and his scientific heritors have already discovered.

This preference for working alone may also have its roots in the deeply ingrained necessity on the part of Japanese men to save face. (To ask for the help of a professional phonetician might expose the Kyoto researchers to embarrassment in that they would have to admit not knowing a technology basic to their work.) Within the framework of Japan's culture, this results in an understandable hesitancy either to disclose preliminary or intermediate results which may later be proved wrong, or to ask for help. The healthy interplay among sciences and scientists is missing from Japan's research community.

STIFLED ENGINEERS—Engineers in Japan may ultimately shake off the traditions of Japan's business and industrial practice, but so far they labor under this added burden. In large companies especially, their most important job requirement is a kind of conformity with a highly conservative background.

A smart and capable young engineer would not be



University students in their last two years must put in 10 or more hours a week in lab, spend a couple of weeks there almost exclusively. But lab space is limited, equipment and facilities seldom the most modern given a job which required him to supervise elders of equivalent background; that is, a college-trained 28-year-old might supervise older men with only high-school or middle-school training, or women, but not older college-trained men. If he were given the job, the older men would probably undermine him, and with a considerable degree of impunity. Even if they didn't, the tradition of aquiescence to elders which is deeply ingrained in Japanese thought would vitiate his actions and lead him to seek out the suggestions and approval of the older men.

Consequently the best years of an engineer's life, when he is freest to think and most likely to think creatively, are, in many Japanese firms, spent under a blanket of forms and manners which suffocate originality. One after another, engineers wishing to take part in the excitement of science seek out government laboratories, where pay scales may be half what industry pays, but where they can work constructively.

A small number abandon all assurance of security to work for smaller companies, where the air is even freer. It is in these laboratories that an attitude close to that found in the U. S. and European industrial research labs can be found.

POLITICS—It is a paradox (one of many) in Japan that although compartmentalization will keep engineers from knowing—or doing—anything about allied engineering fields, sentiments and opinions are not really separated from each other. And so politics, which has no place in science as an abstract pursuit of knowledge, definitely does affect Japanese engineering opinion, and to some extent can aim and focus research projects.

For instance, the companies working on contracts for the Self-Defense Agency admit to great difficulty in hiring engineers for rocketry projects. The whole field of space research, upper atmosphere research, satellites, and so forth, has fallen behind in Japan, because (according to all the opinions ELECTRONICS could sample) rockets and missiles are irrevocably tied together and missilery is an exclusively military science.

The excitement of participating in the challenging fields of rocketry and space research has apparently small meaning to most engineering students. Political opinions of their professors have much to do with this: Japanese students rely, to a degree unthinkable in the U.S. or Europe, on the opinions of the *sensei* (literally "elder," but meaning "teacher"). Much of the left-wing strength in Japan is in the universities and among intellectuals; and the official stand of the Socialistic and other left-wing groups is pacifist.

One industrial chief suggests that economic security may also be part of the reason. The spectacular rise and fall of militarism in Japan—from February, 1936 until August, 1945—suggests that there is no future for an engineer in military projects. Perhaps if rocketry becomes more clearly a peaceful science—as nuclear research has already become—the Japanese engineers may pursue it as avidly. Atomic research is big in Japan, and despite the meteorological and other uses to which rocketry could be put, rocketry is small.

Most students (identifiable by black uniform) work their way through college. This one took on parttime job as translator at Osaka Trade Fair

Components made in Japan will increasingly seek overseas markets as domestic needs are filled

Electronics in JAPAN 電

Part 4

MARKETING and EXPORT

Status of Electronics Business

DOMESTIC MARKETING of electronic products by Japanese manufacturers has been helped materially by the government's restrictions on imports. Tight controls on currency outflow have meant tiresome battles for foreign exchange allocations, with the single alternative of buying Japanese products. Simultaneously, the government saw to it that consumer or industry requirements were anticipated by electronics research and engineering, being especially easy on technical assistance agreements where the technical assistance was predictably needed.

The aggressive marketing policies of several relative newcomers to electronics—Matsushita especially, and more recently, Sony Corp.—have pushed the whole market up. Conservative heavyweights like Toshiba, Mitsubishi and Hayakawa had to match Matsushita, and most of them tried. Matsushita's "National" trademark, with its Western overtones, sparked a host of English-language trademarks, some of which sit ill on the Japanese tongue, others of which will sit ill in Western ears. Yaou's "General," Hayakawa's "Sharp," Fukuin Electric's "Pioneer," New Hope's "Fleetwood" are all examples of the trend toward Westernization of public image. Other examples—"Constant," "Global," "Union," "Cathy"—are less felicitous.

On a more significant level, Matsushita's establishing a nationwide network of retail outlets and service centers was a marketing challenge that the big competitors met even if they didn't—as Toshiba, Hitachi and Mitsubishi did not—Westernize their product names. Now all big producers of home appliances maintain such franchised dealers and service centers.

Matsushita also offered financial terms to capital-shy consumers, which—more than any other single factor—may explain the rapidity with which he copped a large share of market in the white-metal appliances, radio and television. Now the banks are beginning to realize that there may be income for them in extending consumer credit.

Advertising and public relations have boomed as the industry stopped dividing up its markets by gentleman's agreement and began competing. The more sophisticated techniques of advertising, promotion and public relation are not completely assimilated, and seem sometimes primitive to Western taste. But at least the foundation for modern competition has been laid, and under the screen of government protection, mistakes while learning have not been disastrous.

Now, as the government proceeds with its liberalization of import restrictions, Japan's manufacturers are girding for competition at home, and at the same time honing their techniques for exploring overseas markets.

Some are setting up subsidiary firms in areas where market exploitation is planned. Sony has set up a U.S. subsidiary, for instance, and several of the big companies plan on following suit. Others are tying in to established trading companies or industrial concerns; still others are opening branch offices.

COMPETITION—The main areas in which Japan's electronics industry expects to compete are consumer goods and components. The industry is consumer-oriented, as has been pointed out; and componentry is a field to which Japan's resource structure is peculiarly suited.

Another field is coming up fast, and still another is a dark horse behind it. Instrumentmaking is the one; automatic controls is the other. With the burgeoning of atomic research in Japan, electronics went to work developing precision nuclear instruments, and several companies have made remarkable progress, notably Shimadzu and Kobe Kogyo. Laboratory instruments in general production may not be the equal of some European and American precision instruments, but they're hotly competitive.

The field of automatic controls is a funny one to see growing in underemployed Japan, but it's growing there nonetheless. Its growth at the moment is erratic and in some areas seemingly aimless, primarily because of inadequate foundation, secondarily because it is being force-fed by government instead of growing naturally. In some respects, the Japanese computer technology is outmoded, and in some respects advanced; on such an uneven base, the automatic control technology cannot rest firmly.

Numerically controlled machine tools are a late fad in the capital goods field, and it is highly improbable that Japan's electrical industry will ever be able to compete effectively in this field. The production expense for heavy machinery is too great. But in making the controls alone, the Japanese have a competitive advantage again—making the machine tool requires expensive imported raw materials and as-yet unassimilated precision fabricating techniques; but making the electronic controls alone is squarely in the Japanese ballpark.

Competition for Japanese manfacturers has taken on, in a couple of instances, a weird twist with bitter associations. Kataoka Electric, a small Tokyo manufacturer, makes variable capacitors with the tradename "Alps." Lately an Indian company, Standard Electric Co., has been marketing an almost identical product, similarly packaged, similarly marked, with the tradename "Alpes." Sony Corp. has similarly met imitative competition in the European market. Perhaps it is an accolade to the majority of Japanese industry that less highly developed nations choose to imitate her products—as she once imitated the products of other nations.

EXPORT—Japan is not yet one of the world's great exporting nations, but she wishes to be. Her major exports in 1959 were clothing, iron and steel and electronic products. Total value of electronic exports to U.S. exceeded total iron and steel exports; radio receivers alone were a big enough export item to rank third. Some 90 percent of radio receivers produced in Japan in 1959 were exported, half of them to the U.S.

During 1959, according to Finance Ministry customs-clearance statistics, total value of electronic exports to the U.S. (f. o. b. Japan) was $75,642,000, more than triple 1958 figures. Most of the increase was in radio receivers; exports of receivers, chiefly transistorized types, rose from $17.9 million in 1958 to $62.4 million in 1959. Most spectacular commodity gain was made by transistors, rising from $7,000 in 1958 to $1.6 million in 1959.

Electronic exports accounted for 15 percent of Japan's net increase in U.S. export sales in 1959. Electronics, in other words, is bearing the brunt of redressing the export-import balance: Japan ran a $1,430-million trade deficit in 1957, which was cut to $167 million in 1958. But it is wise to remember that Japan is a major buyer of U.S.-produced raw materials including such commodities as coking coal and cotton. Even in the electronics field, Japan buys more radio communications gear, radar, loran, measuring instruments, X-ray apparatus, radiation-measuring gear, computers, automatic controls, tv picture tubes and magnetic tape than she exports. Consistently over the years, the U.S. provides largest percentage of her imports.

Japan does not trade extensively with the Communist world, even including her former supplier and market in China. In 1958, for instance, she imported $5,000 worth of measuring and control gear from the Soviet bloc—$4,000 from Red China and $1,000 from the

TABLE IV — Major Electronic Exports

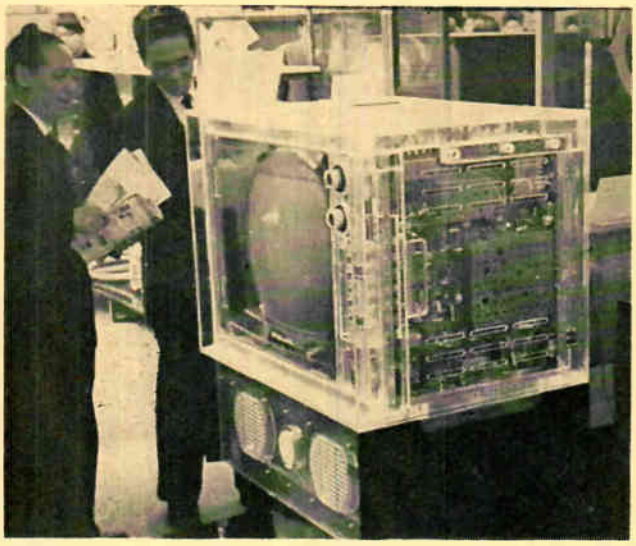
	1955 units	1956 units	1957 units	1958 units	1959 units
Radio receivers	91,846	576,974	1,131,492	3,787,555	9,157,281
Tube types					(884,243)
Types with more than three transistors					(6,146,882)
Other types					(2,126,156)
Television receivers	61	853	6,116	14,740	26,620
Radio-phonograph combinations	86	1,240	4,345	9,835	94,127
Recorder-reproducers (office type)	192	1,358	3,060	12,195	67,462
Tubes	2,095,000	3,073,000	3,762,000	n.a.	14,272,000
Transistors	n.a.	n.a.	11,187	351,508	4,741,483
Microphones	28,685	52,574	172,450	121,430	219,840
Speakers	115,795	198,280	449,305	505,393	1,085,745
Variable capacitors	n.a.	336,000	711,000	704,000	1,423,000
Other capacitors	n.a.	4,329,000	16,183,000	14,385,000	24,527,000

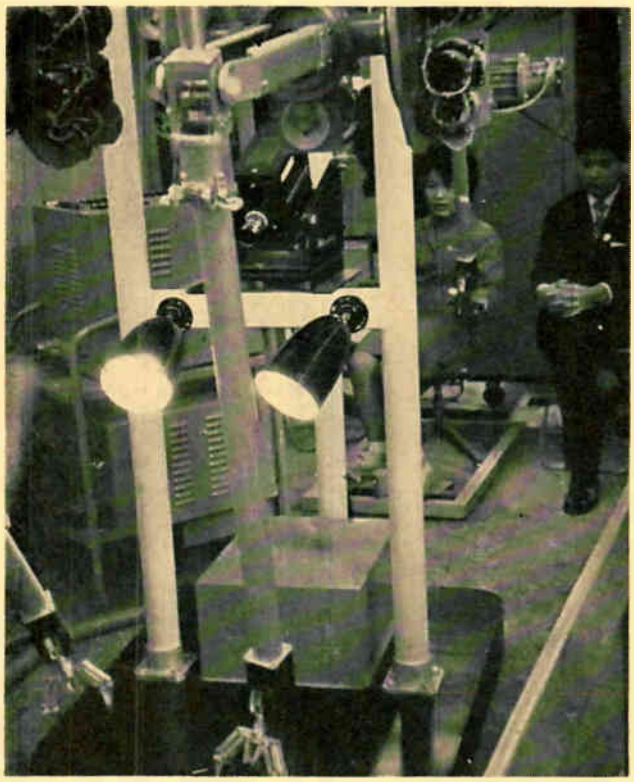
Source: Finance Ministry

TABLE V — Japan's Exports to U.S.

	1958		1959	
	units	$1,000	units	$1,000
Radio Receivers	2,506,920	17,902		
Tube types			456,580	2,552
Types with 3 or more transistors			3,990,184	57,272
Other types			1,604,980	2,549
Television receivers	500	3	3	n.a.
Radio-phonograph combinations	1,794	59	20,745	547
Recorder-reproducers (office type)	7,794	449	41,313	1,617
Tubes	1,237,971	314		
Receiving tubes			7,704,379	2,034
Other tubes			207,249	54
Transistors	10,620	7	2,393,365	1,581
Other semiconductor devices	n.a.	n.a.	597,132	92
Microphones	80,232	177	160,538	321
Speakers	128,507	420	454,855	1,155
Variable capacitors	256,040	32	419,224	112
Other capacitors	5,910,303	256	8,505,975	421
Amplifiers for telegraphic and telephonic apparatus	n.a.	n.a.	34,241	460
Radiotelegraph-radiotelephone amplifiers	910	40	4,399	46
ALL ELECTRONIC EXPORTS TO U.S.		**21,773**		**75,642**

Source: Finance Ministry





New products from Japan range from color tv (top) to heavy machinery like this tv-guided manipulator, but so far few capital goods are competitively priced

USSR—and $3,000 worth of office machinery from the USSR, a tiny part of her purchases of these commodities during that year.

JAPAN'S TRADE OFFICIALS—Japanese industry is still to a marked extent under the thumb of government. What government cannot accomplish by direct action through the various ministries, it accomplishes by indirect pressure through the industry organizations such as the Radio Engineering Association, TeleCommunications Association, Electronic Industries Association or Electronic Industries Development Association.

These associations function almost autonomously, and work as relay points for transfering pressures from government to industry. If the bureaus determine, for example, that the field of computers is insufficiently engineered, they let this be known to EIDA, which sorts through its files to find where computer engineering may reasonably be done. These firms are then informed that it would be profitable for them to do some engineering and development in computers—and they go to work.

The three ministries of Finance, Post & Communications and International Trade & Industry govern to a large extent the engineering and production policies of the electronics industry. Postal Ministry rules the Radio Research Laboratory, NHK, NTT and the overseas communications agency. Finance Ministry has the final word on any commercial transaction involving an outflow of currency, and so is vitally concerned with import and export policy. MITI keeps an eagle eye on the quality and quantity of exported goods and on standards of electrical and electronic devices.

One political phenomenon in Japan has been known to trip the unwary: the opinions of section chiefs in the bureaus frequently make policy—or make hash of policy. Politics being the volatile instrumentality it is in Japan, the ministers do not always keep their fingers on the pulse of their own ministry, and have been known to make public commitments which the career bureaucrats thought unwise. In these cases, the minister not infrequently backs water and the opinion of the minor official carries.

This can cause serious problems in industrial development. The section chief in Postal Ministry may have one opinion and his opposite number in MITI may have another; the inevitable result is inaction. The establishment of color tv standards in Japan illustrated this. Post had to allocate bandwidths and spectra, and was concerned mostly about economical spectrum usage. MITI was equally concerned about this and about the healthy development of the industry. They met head on in considering the U. S. NTSC standards; Post said no, too wasteful; MITI said yes, practical and competitive. It took a long time; MITI eventually won, but Post is still fighting a delaying action.

For all these reasons it is difficult to speak of an official Japanese position on any matter excepting the most general ones. Japan wishes to compete in world markets. She knows she must compete fairly and without giving undue offense to manufacturers in those markets. She knows she cannot invade and undercut a market and get away with it. But these broad generalities, to which almost everyone agrees, can be hashed up by bureaucrats when it comes to particulars. And protectionist outcries from abroad only cause a sullen withdrawal, and give the bureaucracy cause for its widely held pessimistic opinion that Japan will always be subject to discriminatory practice, will never be permitted to trade in a free market.

JAPAN'S WORLD POSITION—Japan's emergence as an economic threat to sectors of electronics and other U. S. industry cannot be met hysterically. There are many dangerous undercurrents that must be considered;

the surface currents are deceptive.

First, Japan is a keystone in America's Pacific policy, and in the Free World's Asian sector. Linked to the West by technology and industry, she is an Oriental country nonetheless, and it would take decades of concentrated endeavor to change that. Her strongest curtural ties are to China and Malaysia, no matter how the Latin American music blares over U. S.-styled radios and television sets. If she cannot enter into healthy commercial intercourse with the Western hemisphere and Europe, she will seek economic sustenance elsewhere—and China and the Asian Soviet would be only too happy to have her industrial plant at their command.

Distance and ethnic barriers notwithstanding, Japan must be kept in the Western industrial and technoligical community. American and European governments realize this and are struggling to find ways to integrate Japanese industrial strength painlessly into the Free World's overall technological foundation. Japan's conservative government also realizes it, and is in many ways ramming measures to accomplish the integration down the throats of the Socialist and other groups who would push the island nation into a helpless, nerveless neutrality—not only politically, but also economically.

The leaders of Japan's industrial community realize that their futures—and their nation's fortune—lie in Western trade. They also realize that they have the obligation of supplying industrial leadership to the rest of free Asia. But their approach is pragmatic, tinged with what some call pessimism and others fatalism: they will trade where they can, and if Europe and the Western hemisphere barricade themselves, they will have to trade with what's left. While not welcoming this, they are prepared to go along—exactly as they went along with the gunbatsu in 1936, even though the gunbatsu were morally wrong.

One special export-import problem is that imports are more profitable for trading companies—through whom most commercial transactions clear—than exports. Exports as a result are handled by small (occasionally fly-by-night) firms, while the big reliable trading firms shy away. These small traders are more willing to exploit immediate opportunities to turn a fast buck, sometimes succeed in dumping shoddy merchandise on the international market despite the best efforts of government and the industry's self-policing organizations.

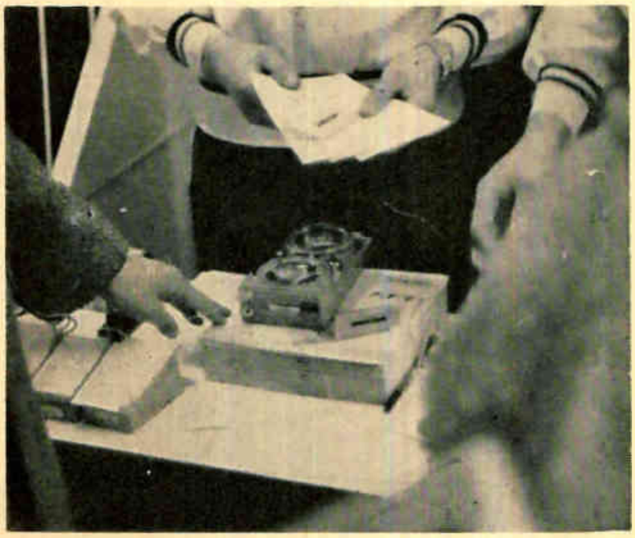
TRADE LIBERALIZATION—One strong fresh wind of change now blowing in Japan's business community bears the label trade liberalization. The whole idea of doing away with government controls on imports and on monetary outflow, and letting industries sink or swim, is not only new to postwar Japan; it is new to Japanese business practice.

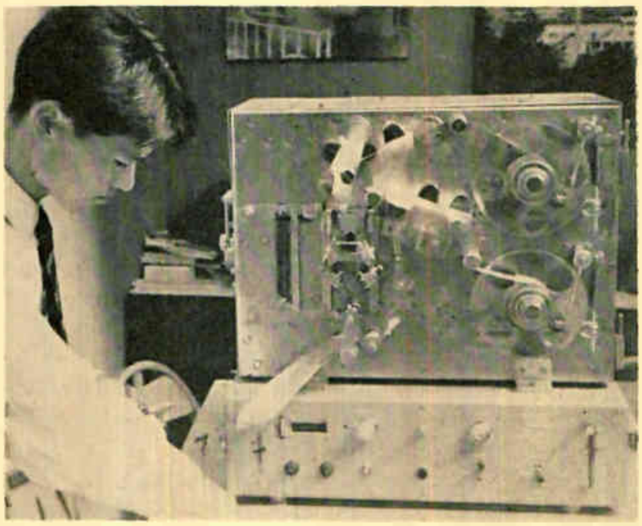
The "second black ship" is the name given the government's liberalization program by businessmen. The first black ship was Commodore Perry's gunboat, which in 1854 refused to leave Suruga Bay without a trade agreement. In Japan, where industry has been both controlled and spoonfed by government for so long, free-market trading practices mean both fear and hope to businessmen.

The government and many of the Kanto industrialists are being pushed and prodded along the road to liberalization by the hard facts of international trade. Britain lumped Japan and the communist bloc together to exclude them from the benefits of its import liberalization. Officials of the International Monetary Fund and the General Agreement on Tariffs and Trade (GATT) have demanded an end to Japan's import restrictions, holding up the threat of tit-for-tat retaliation, and refusing to grant Japan "most-favored-nation" status.

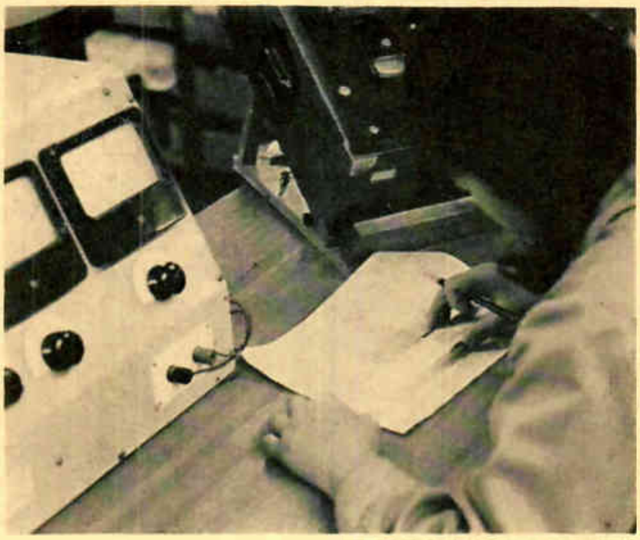
Japanese industrialists, and especially the Kansai industrialists and merchants, know that world trade is the only answer to Japan's problems. As a resource-poor nation, she must use her greatest resource—manpower—to bargain with (this single fact explains the growth of her optical and electronics industries; both require a higher proportion of talented fabrication and a lower proportion of raw material than other industries).

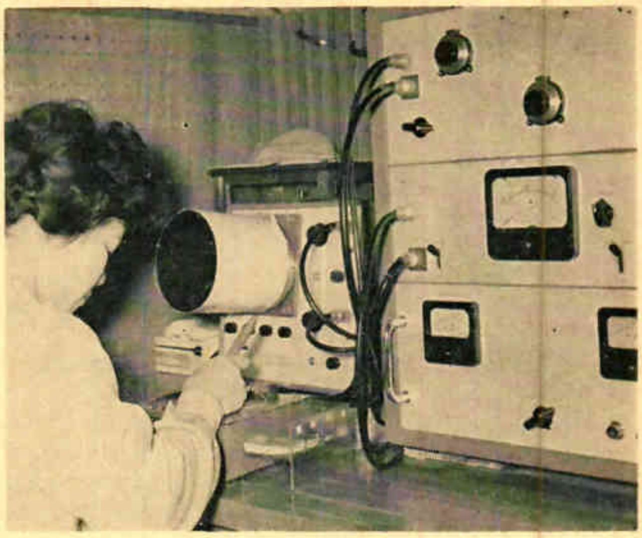
With the end of her exclusive domination of Southeast Asian markets, and the closing off of mainland China as a market for fabricated products, Japan has for the last ten years sought markets elsewhere. North and





Tape recorder development, pushed by government, produces both miniature sets (left) and precision instruments





More people doing more research (left) and precision testing means a healthier industry for Japan

South America are her principal hopes; despite all Japan can, should and is trying to do as an industrial leader of underdeveloped Asia, her products find wider markets in industrialized nations than in backward ones. "How many precision instruments," asks one electronics executive drily, "do you think we can sell in Cambodia . . . or even India."

The Japanese government's decision insofar as trade restrictions are concerned will not seriously affect the electronics industry, either in Japan or the United States. Most of the goods already off the restricted list are sundry consumer goods (baseball bats, musical instruments, needles, tennis rackets), of which only transistor radios fall in the electronics category. Television receivers have been eased but not freed.

U.S. manufacturers of consumer electronics will now be able to compete in the Japanese market, but only the alleged infatuation of the Japanese for foreign merchandise will be able to overcome the price differential—and government spokesmen do not feel that import inroads will have serious consequences so long as the quality of domestic products remains high.

Coalmining and textile industries are fighting hardest against trade liberalization, and the unions that operate in those industries have made common cause with management. Many unions fear that employers, in an effort to increase productivity and strengthen competitive positions, will cut back employee complements and intensify work schedules.

Good management will begin to be meaningful for probably the first time in Japanese industrial history. Japan's industrial organization supports a large number of supernumerary white-collar employees. In paternalistic tradition, relatives of directors and officers find comfortable berths, usually in the front office and not infrequently in sinecures. Besides, many firms have convoluted and irrational accounting practices; a Westerner long resident in Japan and most friendly to the country remarked once "whoever teaches the Japanese cost accounting will revolutionize Japanese business."

In addition to this, government protection has permitted many companies to develop whole lines of products which intelligent competition will demolish overnight. In the free market, companies that have efficient management, rational office practice, sound and competitive products and—in electronics—a healthy approach to research and engineering will survive. The rest will either be beaten to the wall, or will make enough noise in the halls to government to receive renewed protection of some other kind.

BANK OPPOSITION—Chief among the opponents to the trade liberalization schemes are the big and powerful commercial banks: Mitsui, Mitsubishi, Yasuda, Fuji, Dai Ichi, and (to a lesser extent) Sumitomo. Their opposition is significant to electronics because all have interests in electronic manufacturers.

Two are directly concerned—Mitsubishi and Sumitomo—because as reorganized zaibatsu the bank exercises more or less direct control over one or more electronics producers. Sumitomo controls not only its own big electronics companies, but also ITT affiliate Nippon Electric, and in addition is the principal source of capital for most companies in the Kansai that aren't tied to other banks.

Two others—Dai Ichi and Mitsui—are less direct but in some ways more powerful. Mitsui is probably the largest commercial bank in Japan, controls Tokyo Shibaura and its 12 subsidiaries, and has a lot to say in the management of many Kanto companies from big and burgeoning Sony Corp. to little Origin Electric. The Dai Ichi bank controls the Furukawa interests, originally copper mining and smelting, now big in electrical cables and machinery; among the Furukawa group are the Fuji companies, including Fuji Electric, Fuji Communications Apparatus, Fuji Electrochemical and Kobe Kogyo.

Fuji and Yasuda Banks are depositories for some of the companies, like Hitachi and Yaou, that have managed to escape the clutches of the zaibatsu banks. (Matsushita gandydances just out of the reach of both Sumitomo and Mitsui, as does Sanyo; interestingly enough, the president of Sanyo is related to Matsushita.)

The reason for the bankers' objection to liberalization is rooted in the fiscal controls which are the means by which the government controls and protects industry. Only a very limited amount of money is permitted to leave Japan. As a consequence, foreign capital investment is discouraged since money, once in Japan, cannot easily be reconverted. So long as foreign capital is discouraged, the country remains capital-shy, and in this situation, interest rates grow high and the banks make money. (Interest rates of 15 percent and more on long-term commercial loans are not unusual in Japan.) If other sources of capital could be tapped, the interest rates would fall.

This artificial state feeds on itself. Since capital is scarce, industry cannot form capital reserves from profits. In order for stock to compete in the exchange, it must return a handsome dividend. The statistical average is around 5 percent; 10 percent is a usual dividend; 12- and 20-percent dividends are not unheard of. All too frequently, the bank and the shareholders take all the profits there are and when the time comes to pay for plant expansion or improvement, or for research projects, the money managers have to go hat in hand to the banks again.

But despite the fact that the long-range health of the industries they largely control requires "drastic and immediate steps to liberalize import restrictions" (in the words of one of the smartest operators among the Osaka merchants), the banks look to the short range and discourage the government from speeding the relaxation of the restrictions.

TABLE VI — Sources of Japanese Imports

Value in $1,000	1956	1957	1958
Office appliances	14,051	18,951	21,288
Wireless equipment	8,411	6,024	5,795
Electrical measuring apparatus	1,424	1,922	2,385
Other measuring apparatus	11,799	19,011	21,144
By ORIGIN			
Office appliances	14,051	18,951	21,288
U.S.	12,602	16,098	17,340
France	50	101	1,278
West Germany	563	1,011	1,201
United Kingdom	193	491	385
Switzerland	276	279	373
Sweden	291	330	743
Wireless equipment	8,411	6,024	5,795
U.S.	6,322	4,363	4,785
United Kingdom	1,193	954	634
West Germany	129	115	117
Netherlands	606	291	114
Belgium	79	57	43
Measuring instruments	11,799	19,011	21,144
U.S.	8,716	14,521	16,310
West Germany	1,087	1,178	1,802
United Kingdom	719	1,222	1,000
Switzerland	641	1,020	958
France	120	219	224

Source: Japan Export Trade Recovery Office

LIBERALIZATION PLAN—The government plans to break down the trade barriers gradually, taking into consideration the competitive power of domestic industry. Among segments of the industrial economy expected to be seriously depressed by liberalized trade policies are nonferrous metals, ferroalloys, chemical machinery. Machine tools, automatic-control equipment, computers, electric wire and cable and much other machinery are expected to suffer at first but, according to government estimates, "should benefit in the long run." Producers of optical systems, transistor radios and high-grade toys will experience either a favorable effect or none at all. Affected slightly will be producers of radio and tv sets, communication gear, and most of the rest of the electronics industry.

Trading firms, of course, are expected to profit most from the liberalized policies.

The government program will withdraw 90 percent of all its import curbs within the next three years. Fifty percent of the restrictions will be off by October of this year, and 70 percent by April of next year.

Liberalization of trade is far more complex in Japan than in the U. S., where tariffs are the principal means of trade controls. First, it means transferring items from one classification, involving the allocation of foreign currency by the government, to an "automatic approval" class. Then it means freeing the exchange rate and allowing the yen to stabilize at its own level; sanctioning the free conversion of yen into foreign currencies; and permitting Japanese to hold foreign currency and foreigners to maintain yen accounts in Japanese banks.

The transfer of categories is causing the least pain. It is the relaxation of currency restrictions which scare the government planners, the banks and even some of the industrialists.

Until last September, the exchange rate was officially set at 359.2 yen to the dollar for purchases and 360.8 for sales. A 0.5-percent fluctuation was permitted as of Sept. 12, and in the near future this permissible fluctuation may be extended to 0.75 percent. In recent weeks, the rate has tended to stick to its low limit (357.75), indicating the confidence of the financial community in the firmness of the yen.

(Japan now holds some $1.3 billion in foreign exchange, more than three times its average holding in recent years and more than four times what is considered necessary to keep the yen stable.)

Recently the length of time which trading firms are permitted to hold foreign currency was extended from 10 to 20 days, allowing these firms to conduct some transactions in the foreign currency and save the 1.4-yen-per-dollar exchange margin. Nonresident yen accounts will be another permission to be extended soon, allowing foreigners to settle accounts in yen without forming a Japanese company or going through Finance-Ministry red tape for exchange licenses.

The big step will be encouragement of foreign capital investment by relaxation of controls over currency outflow. This step will certainly not be taken until the government is sure that profit outflow will be matched or exceeded by foreign currency income. It will also have to overcome the vested shortrange interest of the

TABLE VII — Japan's Export-Import Balance

Unit: $1,000	1958			1959		
	Export	Import	Bal.	Export	Import	Bal.
Radio receivers	34,464	72	+	108,090	66	+
Television sets	874	43	+	2,137	69	+
Radio communications apparatus	416	1,001	—	1,503	1,264	+
Radar	58	944	—	20	568	—
Loran	6	46	—	6	49	—
Other wireless systems	n.a.	n.a.		745	460	+
Tape recorders	741	41	+	3,190	75	+
Measuring instruments	378	1,076	—	397	1,590	—
X-ray apparatus	n.a.	n.a.		178	243	—
Radiation equipment	296	548	—	76	160	—
Electron microscopes	225	—	+	693	—	+
Computers	2	10,098	—	8	18,850	—
Automatic control equipment	1,469	7,255	—	1,095	8,988	—
Tubes	2,348	1,756	+	4,261	2,185	+
Receiving tubes	n.a.	n.a.		(4,102)	(158)	+
Semiconductor devices	n.a.	n.a.		3,344	254	+
Transistors	(372)	(175)	+	(3,174)	(163)	+
Tv picture tubes	11	42	—	37	40	—
Capacitors	803	13	+	1,505	30	+
Microphones	291	782	—	468	107	+
Speakers	1,142	32	+	2,886	25	+
Magnetic tape	69	538	—	117	860	—
Miscellaneous, n.e.c.	3,888	1,586	+	5,895	1,290	+
TOTAL	**47,850**	**26,048**	+	**140,234**	**37,294**	+

Source: JEIDA

TABLE VIII — Shifts in Japan's World Trade

JAPAN EXPORTED TO	U.S.	MAINLAND CHINA	KOREA AND FORMOSA	SOUTHEAST ASIA	EUROPE	OTHERS
1934-36	17%	18%	21%	19%	8%	17%
1956	22%	2%	6%	26%	10%	34%
AND IMPORTED FROM	**U.S.**	**MAINLAND CHINA**	**KOREA AND FORMOSA**	**SOUTHEAST ASIA**	**EUROPE**	**OTHERS**
1934-36	25%	12%	24%	16%	10%	13%
1956	33%	3%	2%	19%	7%	36%

banks in keeping the supply of capital in Japan as low as possible and in their hands.

And it will probably be sweetened (to Japanese taste) by legal restrictions on the percentage of total investment in any company that may be held by aliens; the Japanese have a longstanding aversion to foreign control of their industry. But, as canny Japanese businessmen will tell you, "the step will be taken; we are a capitalistic, not communistic nation, and a capitalistic nation must have capital—anybody's capital, and the more the better."

U. S. ACTION—Action by U. S. government to ban or limit Japanese exports here is unlikely—for several cogent reasons. Diplomatically, it is unsound; Washington knows we must keep Japan from trade with the Soviets. We cannot ask Japan to liberalize her trade restrictions to allow us to sell freely in Japan and deny her reciprocity. Further, there is no real competition in any field but consumer products, although instruments and controls are coming up.

Commercially—and this may be the clincher—it is unfeasible. Too many giants of American industry have too much financial stake in Japan's industry.

Motorola, for example, sells transistor radios made by Toshiba, as does International General Electric outside the U. S. and Canada. Emerson markets transistor radios made by Standard Radio of Tokyo, though not under the Emerson trademark. Sanyo's transistor radios are marketed outside North America under RCA Victor trademarks, and in the U. S. by Channel Master.

Ampex, IBM and Remington Rand are among U. S. companies with Japanese subsidiaries—RemRand has a subsidiary and an affiliate. Ampex has arranged with Sony—which was one of the first, and is still the major, Japanese producer of professional tape recorders—to build the Ampex-style videotape recorder, which will be exported through the Ampex subsidiary in Geneva, Switz. If MITI permits, Ampex will also license other Japanese firms to build its recorders.

Stock ownership by U. S. firms is limited at the moment, but important. GE still owns part of Toshiba; ITT owns part of NEC; Westinghouse is the largest shareholder in Mitsubishi Electric. The relationship can get pretty complex: a Connecticut bank owns a lot of shares (in trust) in Philips of the Netherlands, which in turn has a piece of Matsushita. RCA, Columbia and EMI of England all have interests in Japanese firms. International Rectifier Co., through a Far East affiliate, has much of its materials research done in cooperation with a Japanese university.

The outcry to the Office of Civil and Defense Mobilization last year was instigated mostly by "havenots"—firms who stand to gain nothing from burgeoning Japanese business. The "haves" effectively muzzled EIA (both havenots and haves being members) from making a firm presentment to OCDM—and so the subject quietly languishes (see box, next page).

U. S. industry is capable of competing on free-market terms with Japan's. The standard of living in the Far East is rising, and Japan is leading in the rise; the inevitable result will be increasingly higher labor costs. This will tend to lessen the cost advantage Japan's industry enjoys as a result of lower salary payments.

Her industry is already unable to compete in the capital-equipment fields, mostly because of the cost of both raw materials and precision production. In these

Higher living standard for workers will raise manufacturers' cost of production, cut Japan's competitive edge fields, despite the efforts of government and industry, she remains an importer rather than a supplier. Balanced against exports to the U. S. of $75,642,000 in electronic gear last year are over $50 million worth of measuring apparatus, office machinery and wireless equipment—three recognizably electronic commodity classes. In every case, the U. S. was first supplier; had not her imports been under fiscal control, U. S.-Japan trade in electronics would have come closer to balance.

There are areas in which, in the foreseeable future, Japan will continue to have a decided cost advantage that will permit her to undersell in world electronics markets. But just as surely, she will continue to be a good market for U.S.-made equipment—the moreso as her export sales increase her domestic prosperity and provide her with the funds she needs to buy.

WASHINGTON—Keeping a federal eye on Japanese imports and other foreign trade trends in the electronics industry are these government agencies and departments:

OFFICE OF CIVIL & DEFENSE MOBILIZATION—*This agency—part of the executive office of the President—is charged with handling petitions for import restrictions on grounds of national security and defense essentiality. It is now considering an appeal by the Electronics Industries Association and several of its member companies for a curb on imports of transistors and other semiconductor devices, primarily from Japan. OCDM has the responsibility for recommending to the President what action if any should be taken on such petitions.*

OCDM has received legal briefs from domestic petitioners, foreign suppliers and importers. Officials are now sounding out other government agencies for their opinion on whether imports of semiconductor devices should be curbed because they threaten the ability of domestic producers to meet mobilization requirements.

EIA's brief argues that rising imports from Japan—mainly of entertainment-type transistors—are eating away the profits U.S. firms put into research and development of military semiconductor devices.

Japanese counter-argument is that U.S. suppliers of military devices do not depend on profits from entertainment product sales, and many are not in this business at all. The Japanese contend their U.S. sales are made up mostly of entertainment products. Further, argue the importers and some U.S. manufacturers, most Japanese imports stem from licensing arrangements made by U.S. companies, or are sold in the U.S. by Japanese branches or subsidiaries of American producers.

OCDM staffers say so far the domestic petitioners have not proved their case. OCDM director Leo A. Hoegh reflected this view recently when he wrote EIA for additional supporting evidence to back up its point. A final decision in the case is due sometime this Summer or Fall.

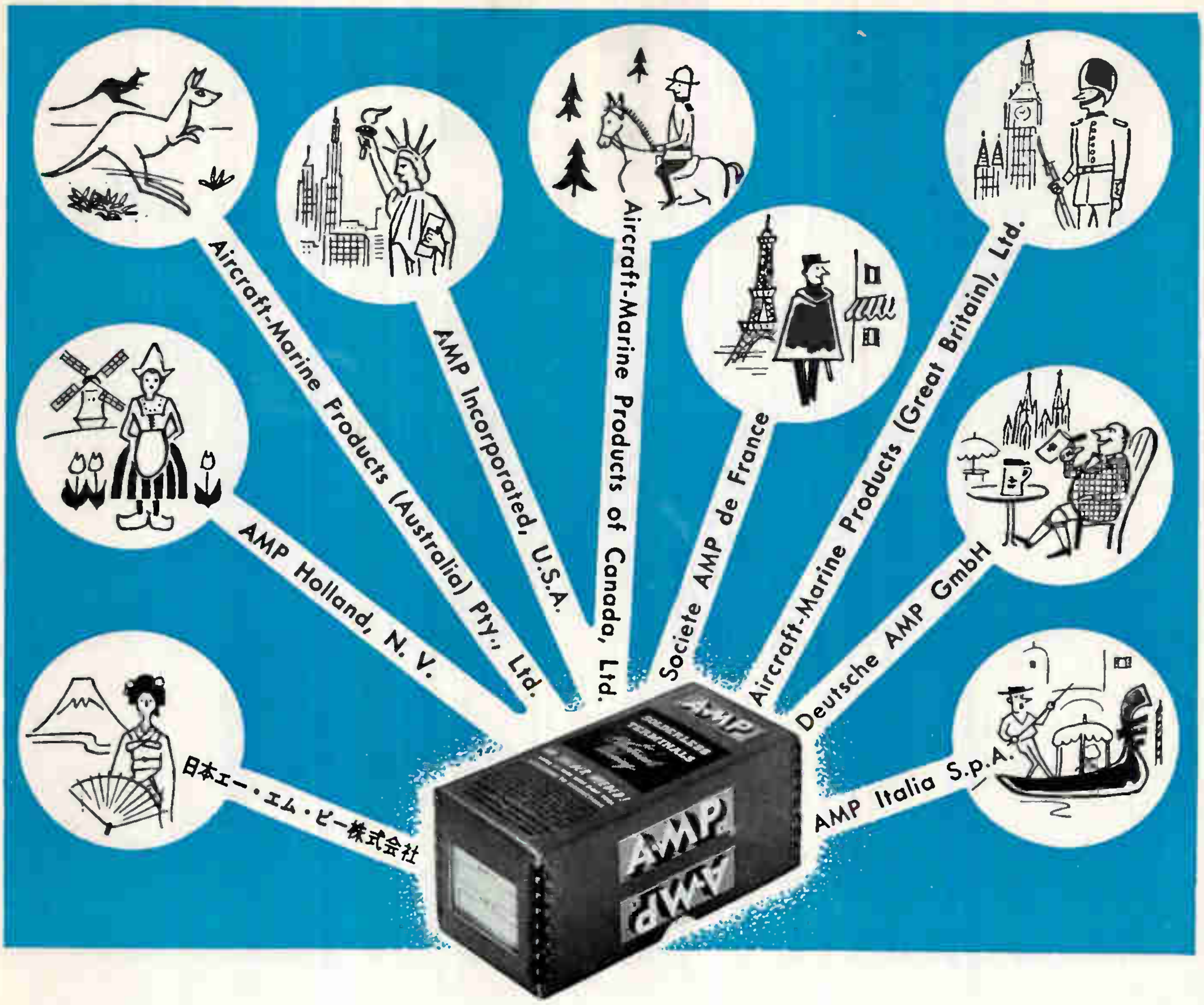
BUSINESS & DEFENSE SERVICES ADMINISTRATION—*This agency of the Commerce Department is industry's liaison office. Its electronics division is keeping tabs on both electronic imports and exports, including the rising imports of electronic products from Japan. So far, transistor radios are the big item, but staffers expect the trend to spread to other products such as tape recorders.*

However, they also note that U.S. exports of electronic products are on the rise, including exports to Japan. Some Commerce officials point out that it is in specialized items such as electronic products that the U.S. export hopes are brightest, and these officials reflect administration attitudes that promotion of exports, not curtailment of imports, is the best long-range solution to U.S. trade problems.

As part of the administration's overall new export promotion drive—which includes improved exporter credit facilities for sales on short- and medium-term credit overseas—BDSA's electronics division is organizing a series of export promotion committee meetings with domestic industry leaders in the next several months.

DEFENSE DEPARTMENT—*Directly concerned with military defense capacity, the Pentagon's Electronic Production Resources Agency is charged with keeping watch over domestic industry's ability to meet mobilization needs. Shortly before EIA filed its petition with OCDM, this agency reported to the Defense Department that domestic capacity is adequate for both present and projected U.S. military requirements.*

TARIFF COMMISSION—*So far, this import-dispute settling board has not received any appeals for tariff or quota protection against foreign imports. If domestic seekers of trade protection fail at OCDM, however, they may turn to this agency for help under provisions of the tariff law designed to help industries suffering from foreign competition.*



世界を結ぶこのマーク！

世界各国の一流電気機器メーカーの殆んどがAMPターミナル及び完全に圧着する様に設計されたAMP工具を使用しております。

AMPターミナルと工具を使用する事により，信頼のできる優れた製品を生産すると共に，作業の簡素化，時間の節約を計り，コストの引下げに役立ちます。

貴社におかれても是非一度AMP製品をお試し下さい。

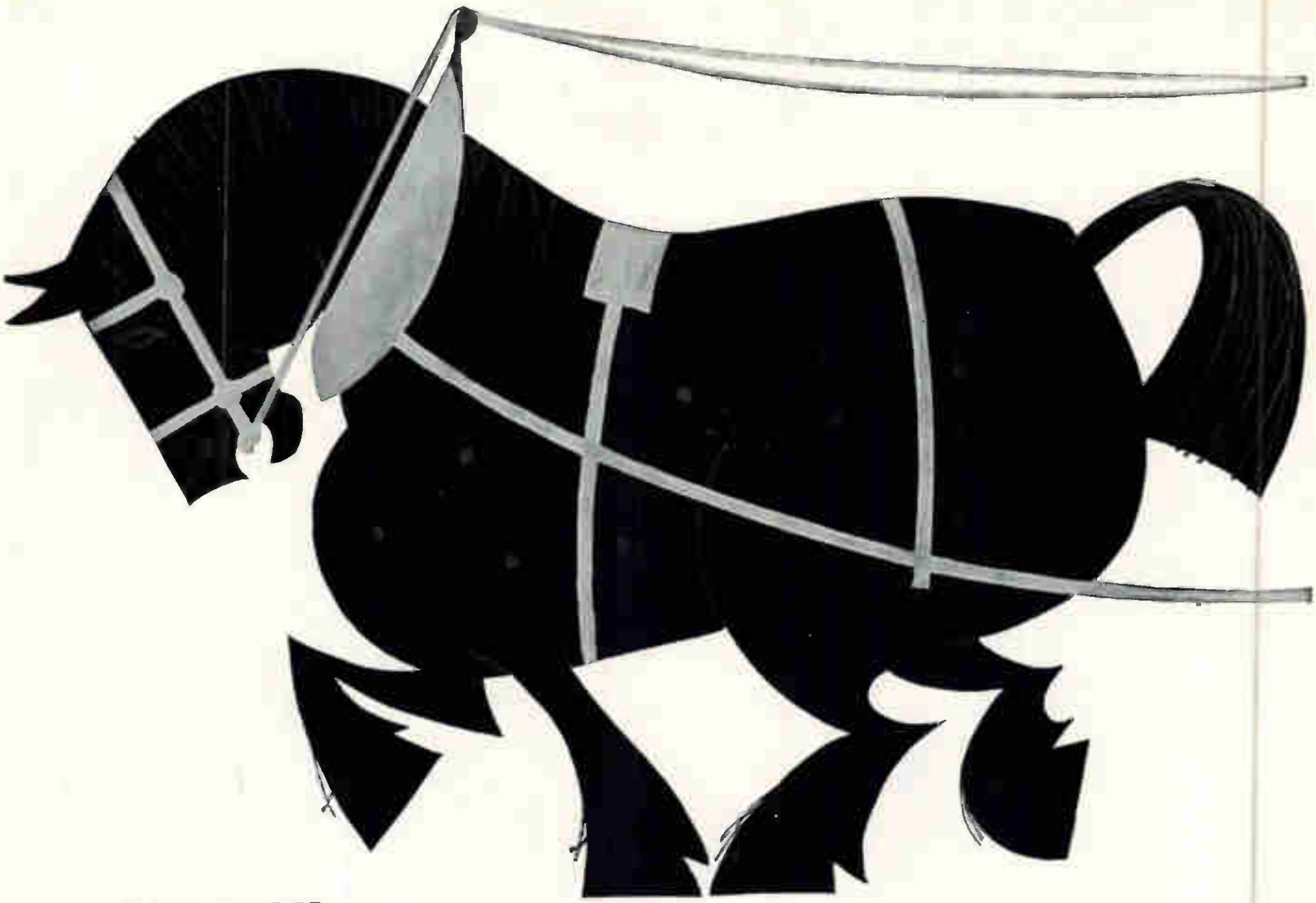
For translation of this ad and additional information concerning AMP's world-wide facilities, write to:

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • West Germany

CIRCLE 101 ON READER SERVICE CARD



ONE INTEGRATED SOURCE for Ceramic-to-Metal Seals

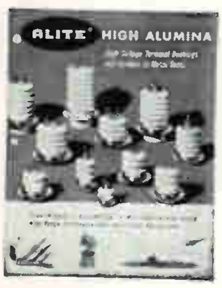
Standard types of Alite high voltage bushings are available in various sizes and configurations.

In *all* phases of planning for ceramic-to-metal seals—from design to finished assembly—you can rely on ALITE for the know-how and "*do*-how" required to produce highest quality ceramic-metal components for critical applications.

High alumina Alite is the ideal material for making rugged, high performance hermetic seals and bushings. It has superior mechanical strength, high temperature and thermal shock resistance, plus reliable electrical characteristics. Our complete high temperature metalizing and bonding facilities assure delivery of the finest seals available—mass-spectrometer tested for vacuum-tightness.

Please contact us for valuable performance data and information regarding ceramic-to-metal applications . . . no obligation.

INSIDE LOOK AT ALITE—



Fact-packed, illustrated Bulletin A-40 gives vital technical data and product information. Write today.

ALITE DIVISION **U. S. STONEWARE**
Orrville, Ohio

New York Office
60 East 42nd St.

12F-1

Available now for reliable, high-speed switching!

SYLVANIA

2N705

2N710

2N711

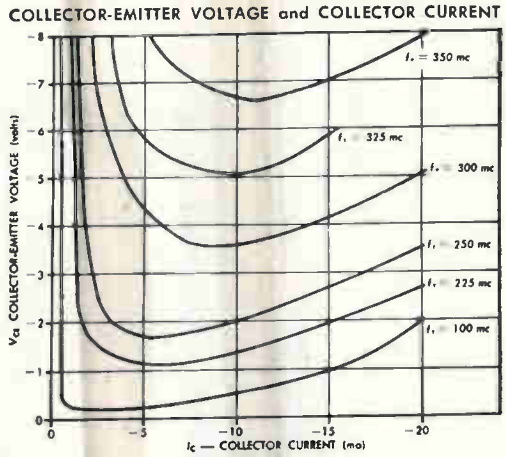
MESA TRANSISTORS

New, PNP diffused-base germanium units . . . designed, produced and controlled specifically for reliable performance in high-speed switching service.

As with all Sylvania computer-type semiconductor devices, rigid quality controls are applied to the manufacturing processes and materials for Mesa Transistors. These assure exceptionally high performance, electrical uniformity and long life. Tests that simulate extreme environments give maximum assurance of reliability.

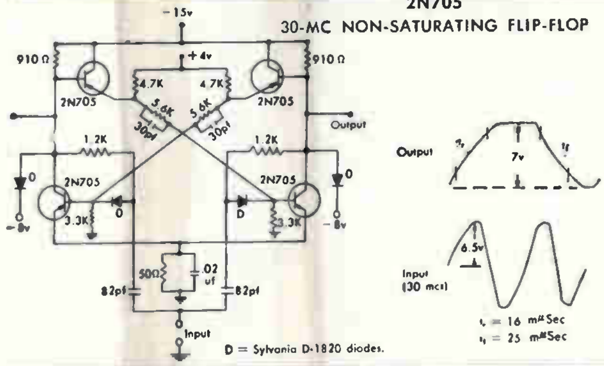
Sylvania Mesa Transistors are available through your Sylvania Field Office or your local Sylvania franchised Semiconductor Distributor. For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 225C, Woburn, Mass.

2N705 GAIN BANDWIDTH PRODUCT vs. COLLECTOR-EMITTER VOLTAGE and COLLECTOR CURRENT



Note: The product of high frequency beta times the frequency of measurement gives the frequency f_T at which beta is unity.

2N705 30-MC NON-SATURATING FLIP-FLOP



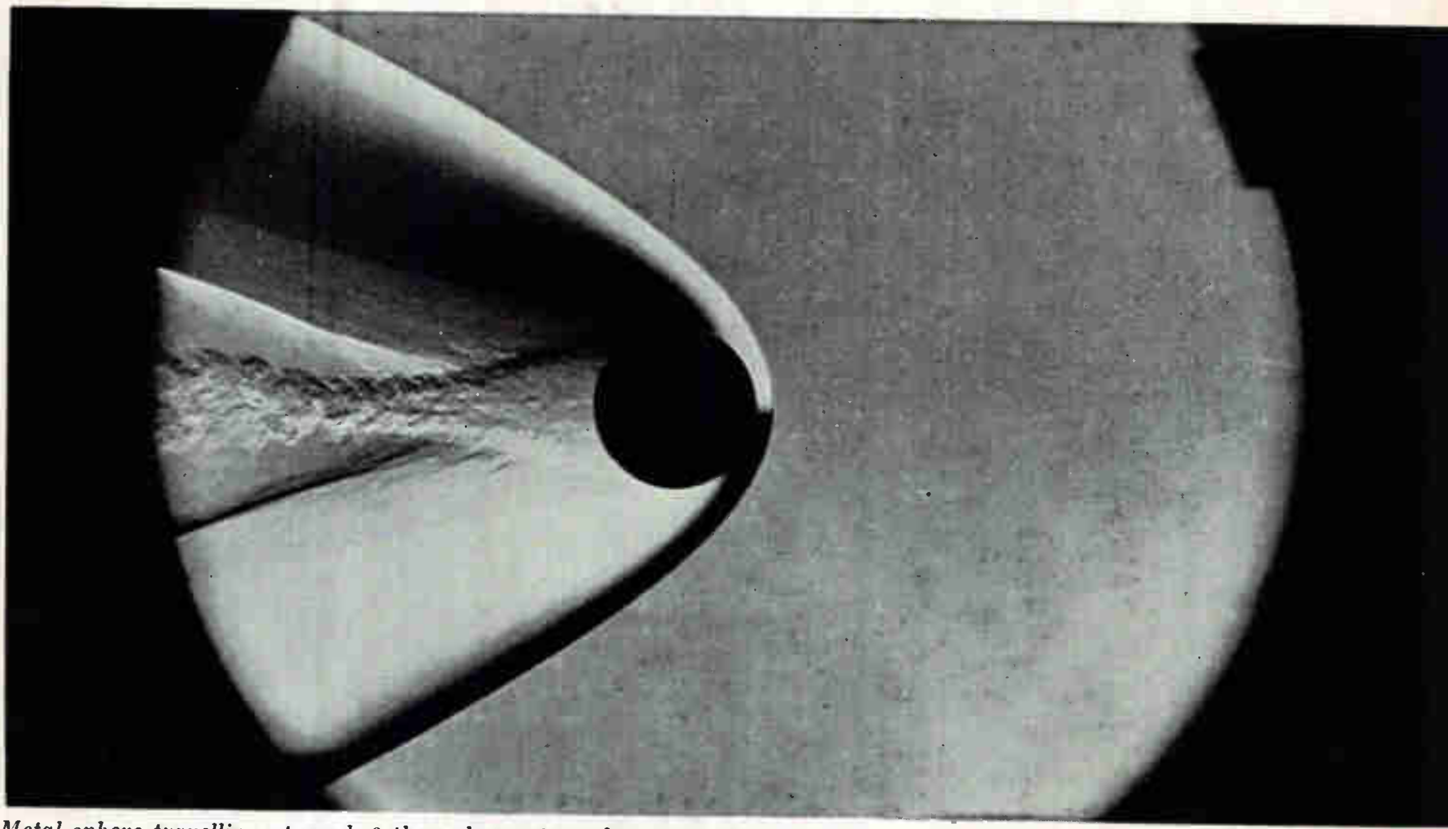
D = Sylvania D-1820 diodes.

ELECTRICAL CHARACTERISTICS AT 25°C

Characteristics	2N705 Min.	2N705 Typ.	2N705 Max.	2N710 Min.	2N710 Typ.	2N710 Max.	Units
BV_{CBO} $I_C = -100\ \mu A$, $I_E = 0$	−15.0	—	—	−15.0	—	—	V
BV_{EBO} $I_E = -100\ \mu A$, $I_C = 0$	−3.5	—	—	−2.0	—	—	V
BV_{CES} $I_C = -100\ \mu A$, $V_{BE} = 0$	−15	—	—	−15.0	—	—	V
h_{FE}	25 @ $V_{CE} = -.3V$ $I_C = -10$ mA			25 @ $V_{CE} = -.5V$ $I_C = -10$ mA			
V_{BE} $I_B = -.4$ mA, $I_C = -10$ mA	−.34	—	−.44	−.34	—	−.50	V
I_{CBO} $V_{CB} = -5V$, $I_E = 0$	—	-	−3.0	—	—	−3.0	μA
V_{CE} $I_B = -.4$ mA, $I_C = -10$ mA	—	—	−.30	—	—	−.50	V
$t_d + t_r$ $I_{B1} = -1.0$ mA, $V_{CC} = -3.5V$ $V_{BE}(off) = 0.5V$, $R_C = 300\ \Omega$	—	60	75	—	60	75	mμSec
t_s $I_{B1} = -1.0$ mA, $V_{CC} = -3.5V$ $I_{B2} = 0.25$ mA, $R_C = 300\ \Omega$	—	75	100	—	75	100	mμSec
t_f $I_{B1} = -1.0$ mA, $V_{CC} = 3.5V$ $I_{B2} = -0.25$ mA, $R_C = 300\ \Omega$	—	80	100	—	80	100	mμSec

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**



Metal sphere travelling at mach 6 through an atmosphere generates a plasma

Missile Communication

DURING REENTRY BLACKOUT

Communication blackout that occurs during missile reentry because of plasma sheath formation can be eliminated by using a sufficiently high communication frequency

By K. M. BALDWIN, O. E. BASSETT, E. I. HAWTHORNE,
Avco Research and Advanced Development Division, Avco Corp., Wilmington, Mass.
and E. LANGBERG,
Elcon Laboratory, Cambridge, Mass.

HYPERSONIC rockets or missiles re-entering the earth's atmosphere after a space journey become enveloped in a sheath of ionized gas or plasma that is caused by the compression of air in the front regions of the missile. Radio signal attenuation is so great in this plasma sheath that communication between a missile and a ground station is blocked out during this portion of the flight. In general, blackout does not cover the whole radio frequency spectrum and is a function of the speed and aerodynamic characteristics of the missile.

One solution of the blackout problem is to use a frequency that is only slightly attenuated by the plasma. Another solution is to record those events of interest during this time and transmit after the blackout or else recover the data from a capsule ejected before the missile is destroyed.

The word plasma was first used by Langmuir[1] to describe that region of an ionized gas where electrical neutrality exists, that is, where there are an equal number of electrons and positive ions. Langmuir produced his plasma by a d-c electric field. In this type of plasma the gas is relatively cool; the plasma produced during reentry is extremely hot. Furthermore, the composition of high temperature ionized air is neither as simple nor as well known as many of the monatomic gases. However, the same parameters characterize the electrical properties of both hot and cool plasmas. The photograph shows the plasma region of a metal sphere traveling through air at mach 6.

One fundamental concept is the plasma frequency, which is proportional to the square root of the electron density. This term does not necessarily imply that plasma oscillations occur, although they may. The frequency is usually in the upper uhf or microwave region for plasmas associated with reentry.

Another significant term is the electron collision frequency. This term relates to the dissipative loss of r-f energy through collisions of electrons with neutral atoms and molecules, and to a small extent with positive ions. At the high temperatures where thermal ionization occurs, the gases which contribute significantly to the number of collisions are O_2, O, N_2, N, NO, and A. Plasma frequency and collision frequency have been determined from theoretical and experimental data as a function of temperature and air density[2]. For an electromagnetic wave propagating in a thermal plasma, the various electrical properties of the plasma are specified in terms of these two frequencies and the signal frequency.

Temperature and density of the heated air determine the degree of ionization and the collision frequency. These parameters are determined by the aerodynamicist as a function of missile geometry, velocity, re-entry angle and trajectory[3]. The hottest region in the shock layer is around the stagnation point (the foremost point of the missile). If there is a flare in the rear of the missile, further compression and heating of the air takes place, while if the diameter reduces, the shock layer becomes thicker and cooler.

In the event that the missile oscillates as it descends, the temperature distribution in the shock layer will change. The exact nature of this change will depend upon vehicle shape and the amplitude of the oscillation. This can result in a sharply changing plasma density and intermittent blackout.

The velocity at which a missile moves through the air at any altitude will, in general, determine the maximum air temperature in the shock layer. A high-drag, lightweight vehicle will slow down rapidly and peak heating will occur at higher altitudes than for a low-drag, heavy vehicle. In the altitude-velocity range of interest, electron densities and collision frequencies are lower at high altitudes. Thus missiles differing in performance, even though they re-enter with the same initial velocity, will suffer radio blackout at different altitudes.

Electrical properties of the plasma depend on signal frequency,

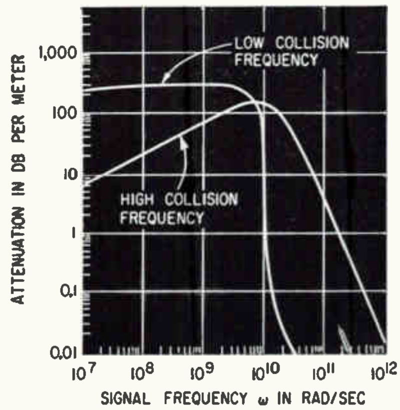


FIG. 1—Signal attenuation in a plasma drops off rapidly above a critical frequency

and if signal frequency is greater than plasma frequency, attenuation drops to a low value. This is true for all values of collision frequency that might reasonably be encountered. An alternate approach is low frequencies, useful if the medium is sufficiently conductive, that is, the collision frequency is relatively large. Propagation through the plasma is somewhat analagous to skin depth penetration in this case. However, if the collision frequency is low, no advantage is gained by low frequencies. Figure 1 shows typical attenuation profiles at two altitudes.

The vhf system is a conventional pam-fm-fm system operating in the standard IRIG (Inter-Range Instrumentation Group) telemetry band. The system includes the ejectable data cassette, which is the only major novel addition. The data cassette is essentially a backup device, a second source of information if communication fails during reentry[4].

Figure 2 is the block diagram of the system. Inputs from sensors include 0 to 4 volt signals and low-level—below 50 millivolts—signals. Slowly varying inputs are commutated in the conventional fashion. Low-level inputs are amplified to a desired common level. Commutated data are made to modulate subcarrier oscillators. The entire complement of individually modulated inputs is then used to modulate an fm transmitter. Figure 3 shows the packaged canister, housing the vhf system less the data cassette.

Antennas for this vhf telemetry system needed an isotropic pattern, high efficiency, light weight and compatibility with environmental conditions. Specially developed flush-mounted radiating elements, mounted diametrically opposite on the vehicle surface for special cross-polarization, were used; the radiation pattern is shown in Fig. 4A.

Figure 5 and the photograph show the recoverable data cassette, which has material for aid in search and recovery. The recovery package includes an aerodynamic drag skirt, a rescue and search beacon, flashing lights, radar chaff, die-marker, shark repellent, and power supplies. The output of the mixer is fed to the data cassette for storage on the magnetic recorder during blackout. A programmer initiates this process during the re-entry trajectory. Following blackout the cossette is ejected from the missile, slowed by aerodynamic drag and impacts in the ocean.

The vhf data cassette system has many advantages and some serious limitations. Its main advantages are the relative ease of design, availability of hardware and compatibility with existing range installations. It has adequate range, provides adequate data capacity and is reasonably small and light. Further improvements in making the system smaller and lighter do not appear to be worthwhile since a point of diminishing returns is reached because of the basic requirements for batteries, power converters, programmers, and data cassettes.

A major disadvantage of the vhf data cassette system is the inability to communicate directly, in real time, during the blackout phases of the re-entry trajectory. The ejectable data cassette adds to the weight, complexity, and unreliability of this system, and at best these important re-entry data are obtained on a non-real time basis. A drawback of this system is the difficulty in recovering the data cassette —a problem so obvious and so severe that it requires no further comment.

The sharp attenuation cut-off characteristic of a plasma allows a lower signal frequency limit to be specified by simply noting the maximum value of plasma frequency along any transmission path through the shock layer. When the signal frequency exceeds this maximum plasma frequency, attenuation drops to a low level and attenuation along transmission paths through typical shock-layer thicknesses will usually not prove prohibitive. This frequency generally falls in the microwave region.

The exact choice of frequency depends upon several practical considerations. Foremost is the availability of suitable equipment and components. This limitation becomes important in the upper microwave spectrum. Atmospheric propagation must also be considered. Strong attenuation due to water vapor and molecular oxygen absorption makes many frequencies unsuitable. However, the situation is not as serious for missile-to-ground as for ground-to-ground communication because of the reduction of water vapor and oxygen density with altitude. Roughly 75 percent of the water vapor is concentrated below 20,000 feet, while oxygen density reduces exponentially with altitude. Cloud cover may be important since water vapor absorption is higher in clouds than in clear air.

On the basis of plasma characteristics, equipment and atmospheric propagation, K,-band was selected for direct re-entry telemetry operation. Development of the complete system involved solving other basic problems associated with the operation of microwave equipment in a

Package has flashing lights, radar, chaff, shark repellant, ocean dye

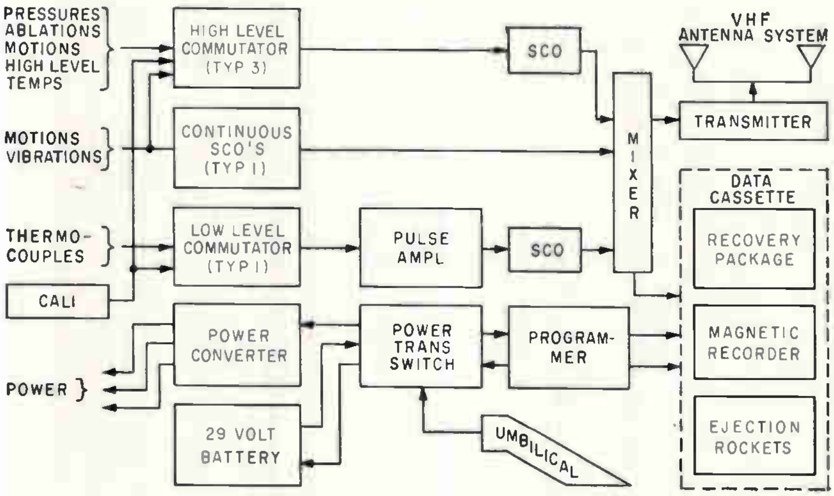


FIG. 2—Magnetic recorder stores data during reentry blackout

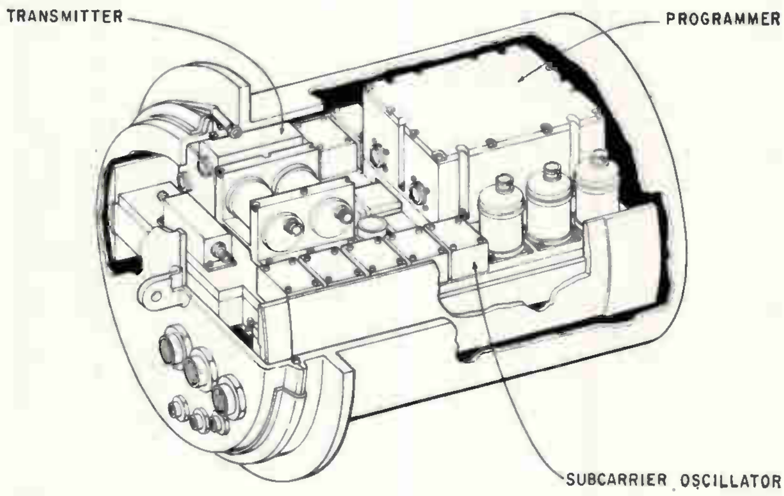


FIG. 3—Telemetry system is packaged in a canister

missile environment.

Highly directive, line-of-sight transmission paths and the limited range characteristic of any microwave link place limits on the receiver location. The possible transmission paths through the cooler, lower density plasma regions around the missile place other restrictions on receiver locations. One solution is to locate the receiver in an airplane. However, stabilization, necessary where narrow-beam antennas are used, requires a special servo system. On the other hand, a ground station can be more elaborate, and better performance may be expected. Both systems have been considered and the system is adaptable to either location.

As the missile moves along its trajectory, the highly directional microwave antenna must track the missile. Temporary loss of signal resulting from missile oscillations or null regions in the antenna pattern can be allowed for by providing a memory unit which continues the tracking function at the same rate as when the signal was last received. To avoid fading because of changing polarization, the receiver uses polarity diversity reception; automatic frequency search is used to counter transmitter drift.

Development of a suitable missile-borne K_a-band antenna system posed special developmental problems of antenna gain, pattern coverage and antenna window materials. The antenna system consists of eight radiating elements, equally spaced around the re-entry vehicle at a suitable point on its surface (in a reasonably cool region, with adequate capability of forward-oriented radiation). Each element is a pyramidal horn, flush-terminated in a conductive ground plane, which eliminates wave trapping in the skin of the vehicle. The radiating apertures themselves are sufficiently large to limit the radiated power density at the surface of the antenna. An upper limit of allowable electromagnetic power density is necessitated so that ionization enhancement will not occur. A very adequate antenna pattern results, as shown in Fig. 4B, with an acceptable interference pattern (scalloping) in the transverse plane between adjacent elements. The overall gain is of the order of 0 db, except for small regions of 3 to 6 db loss. However, this type of design results in an unusually wide beam pattern.

A block diagram of the receiving system is shown in Fig. 6. The receiving antenna is an 18-inch parabolic dish (gain of 41.5 db) having a scanning beamwidth of 2.8 degrees (3 db point) and a resolution and tracking error of the order of 0.5 degree. The receiving system itself is a superheterodyne, diversity reception type system, with a video base band combiner. The i-f bandwidth of the receiver is 6 mc, while the video bandwidth is only 3 mc. The receiver noise figure is of the order of 13 db. Theoretical results indicate that s/n requirements for the receiver are 10 db for tracking and 12 db for acquisition. Directional characteristic of the K_a-band receiving system requires an auxiliary means to aid in initial acquisition prior to reentry.

The system represents one of many possible versions of a K_a-band system for telecommunications with a reentry vehicle. It was designed and constructed with the aid of Federal Telecommunications Laboratory (now ITTL), Crosley, and Melpar, Inc. The system may serve as a basis for many applications in addition to telemetering data from a reentering missile.

A wide variety of performance characteristics may be expected depending upon operating range, plasma conditions, and weather conditions. Typical performance characteristics are shown in Table I.

Data capacity of the direct reentry telemetry system merits special mention. Because of magnetron limitations, ppm is best for maximum data capacity and minimum complexity, consistent with a required s/n. Furthermore, a simple ppm-pdm converter, readily available, enables the system to be compatible with existing range data processing systems. Comparison with vhf telemetry, limited by IRIG standards, readily reveals that the direct reentry telemetry system has a comparable or greater data capacity. If a common 2 percent error criterion is adopted, then a data rate of about 1,000 samples per second is attainable over 500 miles with s/n ratio of 15 db or better. Corresponding IRIG data rates can reach 1,500 samples per second or less. If a range of 300 nautical miles is adequate, then a 4,000 sample per second rate can be achieved. A more sophisticated design of a ppm modulator is possible with a corresponding increase in complexity of ground equipment. These rates are doubled by means of two-stage subdivision of the time period between pulses. The fundamental limitations on the data rate is imposed by magnetron duty cycle and peak power. With available magnetrons, the rates quoted above are achievable today with a promise of further improvement in the near future.

A typical ppm modulator is shown in Fig. 7 for the simplest of the above described systems. This has a 1,000 samples per second data rate with an error of 2 percent or less. A suppression technique for the start pulse is employed for transmission of each data sample to increase the data rate. Adequate accuracy is provided by the frame synchronization pulses. This modulator, furthermore, is lighter and smaller than a corresponding vhf fm/fm modulator. From magnetron limitations on pulse rate, a corresponding pcm system would yield a much lower data capacity.

The system is not a cure-all for reentry telecommunications. It has several drawbacks and limitations. A summary of major disadvantages includes directional characteristics, state-of-the-art limitations on magnetrons, hardware, component reliability and precision; dependence on atmospheric conditions; line of sight limitations; ground equipment complexity and less flexible choice of modulation.

However, the system does possess important advantages, including penetration of ion sheath, small size and weight of transmitter, small and efficient antenna system, low power requirements, large data capacity, possible range measurement capability, small tracking error, and no atmospheric, galactic or man-made noise interference.

The most important advantage is the ability to penetrate the ion sheath and thus eliminate blackout duriny reentry. As already indicated, this depends greatly on the aerodynamics of the vehicle. Under some reentry conditions it may be necessary to go to still higher frequencies.

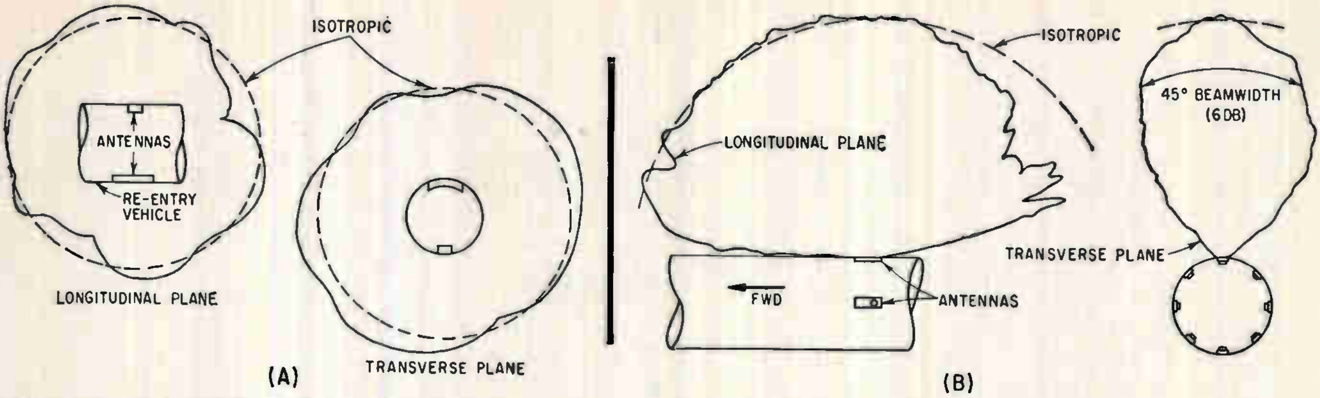


FIG. 4—Antenna pattern of the vhf system (A); antenna pattern of the Ka-band antennas (B)

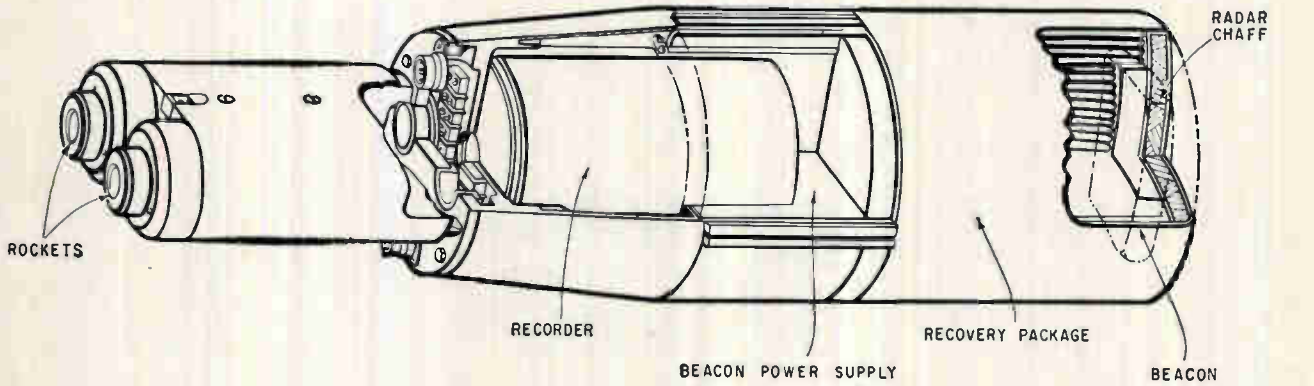


FIG. 5—Recoverable data cassette contains recorded information and signalling equipment to aid in search and recovery

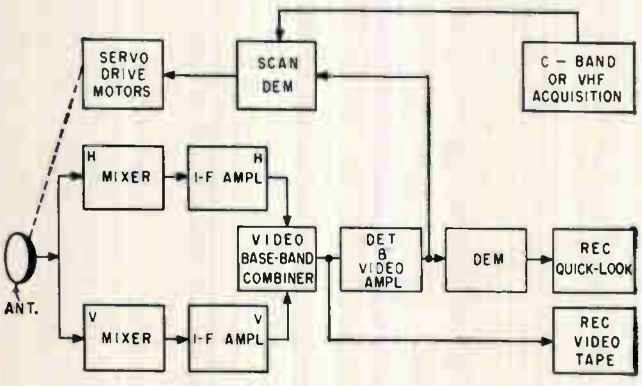


FIG. 6—Receiver system uses servo driven antenna to obtain maximum reception of signal during missile reentry

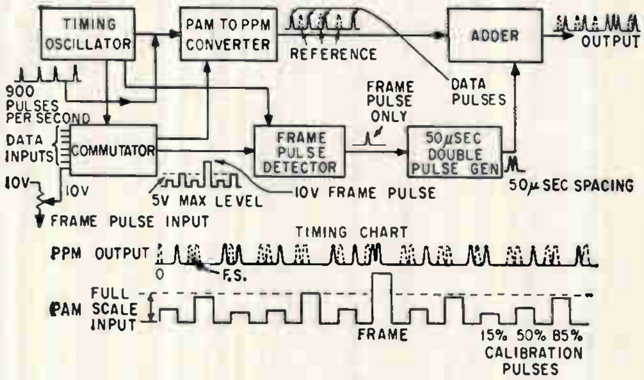


FIG. 7—Pulse position modulator has 1,000 samples per second data rate with an error of less than 2 percent

TABLE I — TYPICAL DIRECT REENTRY TELEMETRY SIGNAL-TO-NOISE RATIO

Signal			Noise	
Output of beacon	76	dbm	kT power/Bw	−174 dbm/cps
Transmitter antenna gain	0	db	Bw (6mc/sec)	68 db
Receiver antenna gain	41.5	db	Receiver input noise	−106 dbm
Polarization (loss)	− 1.5	db	Receiver noise figure	13 db
Atmospheric absorption (loss)	−3	db	Total noise power	−93 dbm
Scanning (loss)	−2	db		
R-F plumbing (loss)	−5	db		
Free space (100 mi.)	−159	db		
(200 mi.)	−166	db		
Total signal power (100 mi.)	−53	db		
(200 mi.)	−60	db		
s/n ratio (100 mi.)	40	db		
(200 mi.)	33	db		

REFERENCE

(1) I. Langmuir, *Phys Rev,* **33,** p 964, 1929.

(2) E. Langberg, K. Baldwin, and J. Yos, Radiation and Propagation of Telemetry Signals During Hypersonic Reentry, *IRE Proc 1958 National Symposium on Telemetering,* Sept. 1958.

(3) K. Baldwin, Transmission of Microwave Telemetry Signals from a Reentering Vehicle, *Proc 1959 National Telemetering Conference,* AIEE, May 1959.

(4) R. E. Schmidt, J. R. White, and R. A. Porter, A Time Redundancy Instrumentation System for an ICBM Re-entry Vehicle, presented at the IRE National Convention, N. Y. City, March 25, 1959.

Negative-Resistance Amplifier Design

Design criteria for negative-resistance amplifiers are given. Equations relating gain, gain-bandwidth and stability are presented, as well as experimental results

By J. B. SCHULTZ and H. B. YIN,
RCA Victor Home Instruments,
Camden, N. J.

ADVENT of the tunnel diode makes possible a negative-resistance amplifier with low noise and high gain at very high frequencies[1, 2]. This is commercially attractive because of its small size, low power requirements, and potentially low cost. To take full advantage of these capabilities, an understanding of the operation of the device as an amplifier is necessary.

This article deals with two types of negative resistance devices; first, the voltage controlled negative resistance element (such as the tunnel diode) which exhibits an N-shaped current-voltage characteristic and second, the current controlled negative resistance element (such as the four-layer transistor diode) which exhibits an S-shaped characteristic.

Design considerations for stable operation are presented. Appropriate expressions for power gain, bandwidth and gain-bandwidth product are included, together with experimental results.

Consider the N type device first. Between the bias voltages E_1 and E_2, shown in Fig. 1A, it possesses a negative resistance characteristic which has a definite minimum negative resistance value (see Fig. 1-B), or a definite maximum negative conductance value (see Fig. 1-C). This device may be used in a series or parallel circuit such as shown in

Negative-residence amplifier uses tunnel diode

Figs. 1G and 1H. In either configuration the negative resistance cancels portions of the positive resistance in the circuit. The power gain across the load for the series circuit is:

$$G = \frac{4 R_s R_L}{(R_s + R_L - R)^2} \quad (1)$$

and for the parallel connection is:

$$G = \frac{4 g_s g_L}{(g_s + g_L - g)^2} \quad (2)$$

A general criterion for stable operation of an amplifier which contains an N-type negative resistance device is that the net resistance as viewed from a constant current generator anywhere in the system is always positive. Applying this criterion to the series configuration, stable operation is obtained when $R_s + R_L < |-R|$. To maintain this relationship for all bias voltages, the inequality $R_s + R_L < |-R|$ must be satisfied when $|-R|$ is at its minimum value (see Fig. 1-B). Thus, since $|-R|$ can only increase with changes in bias, the stability of the circuit is assured. Likewise, for the circuit in Fig. 2B the stability criterion is satisfied for all bias voltages when $g_s + g_L > |-g_{max.}|$.

For an amplifier containing an S-type negative resistance, stability is assured when the net resistance as viewed from a constant voltage generator anywhere in the system is positive. Conditions for stable operation of an amplifier using a negative resistance device is shown in Table I.

An N-type negative resistance element is always associated with a shunt capacitance C. An amplifier using such device is shown in Fig. 3A. The expression for the power gain becomes:

$$G = \frac{4 g_s g_L}{(g_s + g_L - g)^2 + \omega^2 C^2} \quad (3)$$

Equation 3 states that the circuit of Fig. 3A is essentially an R-C amplifier whose gain is maximum at d-c, and is then expressed by Eq. 2.

Equation 3 also states that the power gain decreases as the frequency increases. At some frequency f_c where $\omega_c^2 C^2 = (g_s + g_L - g)^2$ the power gain will be 3 db lower than its maximum value, and therefore:

$$f_c = \frac{(g_s + g_L - g)}{2 \pi C} \quad (4)$$

The gain bandwidth product $(G)^{1/2}$ (f_c) can be obtained by combining Eqs. 2 and 4:

$$G^{1/2} f_c = \frac{(g_s g_L)^{1/2}}{\pi C}. \quad (5)$$

For a given negative resistance element, once g_s and g_L are chosen,

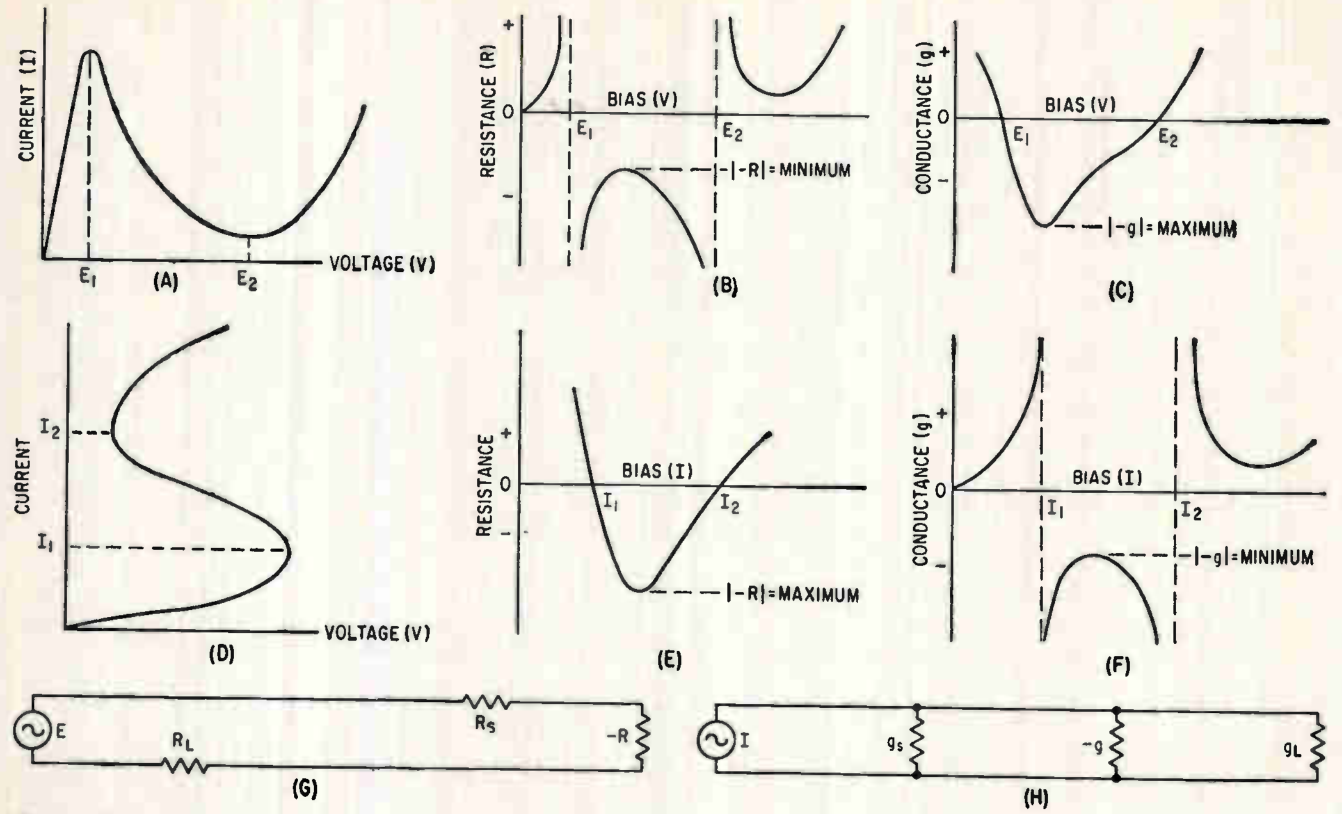


FIG. 1—N-type current voltage curve (A), resistance variation with bias (B) and conductance variation with bias (C); S-type current voltage curve (D), resistance variation with bias (E), and conductance variation with bais (F); negative-resistance series operation (G) and parallel operation (H) amplifiers. Curves (A) to (C) relate to voltage-controlled negative-resistance elements; (D) through (F) are drawn for current-controlled negative-resistance elements

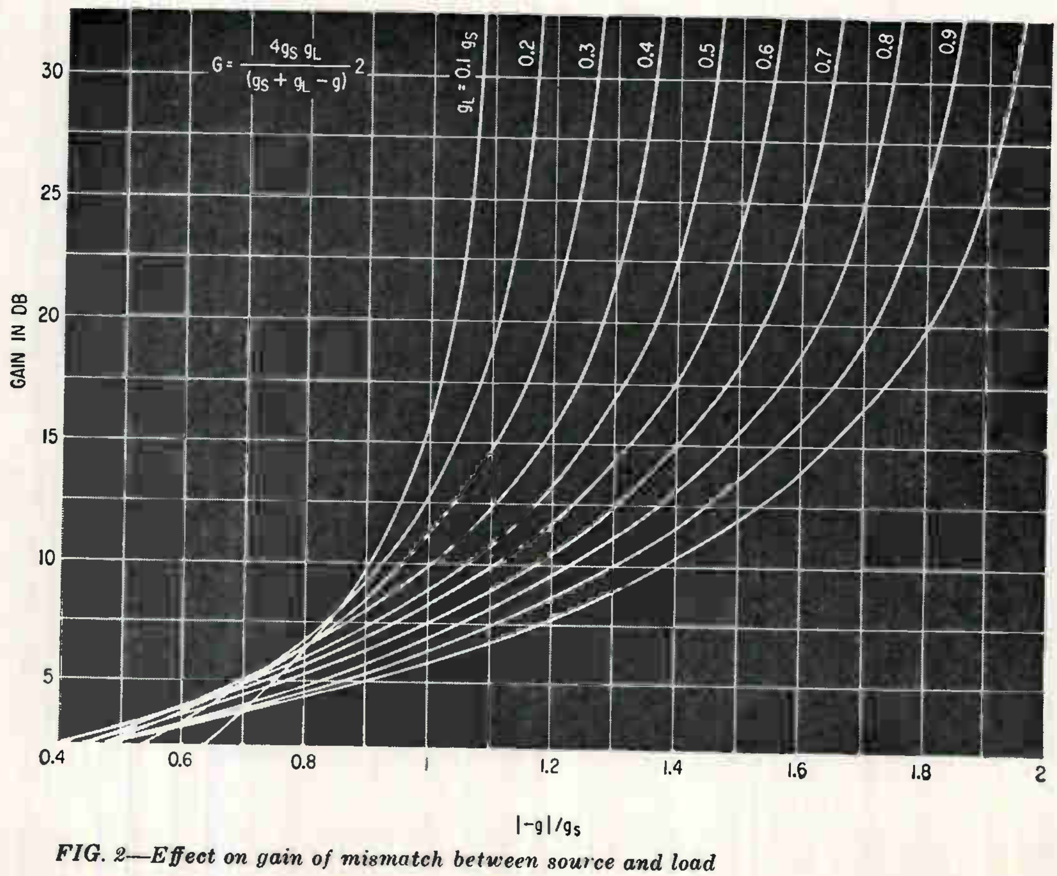


FIG. 2—Effect on gain of mismatch between source and load

and if C is constant, the gain-bandwidth product is independent of any change of the negative conductance. For given values of g_s and g_L the gain-bandwidth product will be greater if C is smaller. Also, Eq. 5 provides a means of determining the value of C.

Equations 1 and 2 state that the gain of such an amplifier depends upon the source as well as the load impedance. Figure 2 is a plot of Eq. 2 illustrating the effect on the power gain of mismatch between the source and load for a given negative conductance. For any given power gain, the greater the ratio $|-g|/g_s$, the less critical is the circuit adjustment for stable operation. For 20-db gain $|-g|/g_s = 1.8$ when $g_s = g_L$, while $|-g|$ can vary more than 10 percent before oscillation will occur. For the same amount of gain when $g_L = 0.1 g_s$, $|-g|/g_s = 1.04$ and $|-g|$ can only change about 6 percent before oscillation occurs. These curves also provide necessary information about the tolerance on terminations before oscillations occur.

An S-type negative resistance element always has a series inductance associated with its negative resistance. Such an amplifier is shown in Fig. 3B.

The expression for the power gain becomes $G = 4 R_s R_L/[(R_s + R_L - R)^2 + \omega^2 L^2]$. Similarly, $f_c = [R_s + R_L - R]/2\pi L$ and $G^{1/2} f_c = (R_s R_L)^{1/2}/\pi L$. Here, the gain-bandwidth product is also independent of the negative resistance and will increase as the series inductance (L) decreases. From the above description, a wide band, high gain amplifier can be designed.

By adding the proper reactance, bandpass amplifiers such as shown in Figs. 3C and 3D are possible.

For the circuit shown in Fig. 3C the power gain expression is $G = 4 g_s g_L/[(g_s + g_L + g_t - g)^2 + (\omega C - 1/\omega L)^2]$. At resonance $\omega_o C = 1/\omega_o L$, whence, neglecting the tuned circuit losses, g_t, $G_o = 4 g_s g_L/(g_s + g_L - g)^2$ which is the same as Eq. 2. Analysis of low-pass amplifiers, therefore, also applies to bandpass amplifiers. The bandwidth of such an amplifier can be obtained by equating $(g_s + g_L - g)^2 = (\omega C = 1/\omega L)^2$. If $\omega_o >> 2\Delta\omega$, then $2\Delta f = (g_s + g_L - g)/2\pi C$ and the gain-bandwidth product becomes:

$$2\,\Delta f \times G^{1/2} = \frac{(g_s\, g_L)^{1/2}}{\pi C} \qquad (6)$$

A point of interest is that Eqs. 5 and 6 are identical. This indicates that the gain bandwidth product remains the same for both low-pass and bandpass amplifier configurations. For S-type negative resistance devices, a similar analysis can be used.

Tunnel diodes as N-type negative resistance devices were used for amplifiers as shown in Figs. 3A and 3C. Experimental results have shown that when operating tunnel diodes, extreme care must be exercised to avoid any stray reactances. The most troublesome item is stray inductance in series with the diode. As a rule, uhf techniques must be used at all times. Performance of low-pass and bandpass amplifiers are given in Table I.

Both S and N type negative resistance devices can be used for amplification. High, stable gain can be realized over a wide frequency range extending through vhf. Depending on circuit parameters, any power gain can be obtained regardless of the value of the negative resistance.

TABLE I—Negative-Resistance Amplifier Design Considerations

Criteria for Stable Operation [a]

Mode of Operation	N—Type Element	S—Type Element
Series	$R_s + R_L < \lvert -R_{min} \rvert$	$R_s + R_L > \lvert -R_{max} \rvert$
Parallel	$g_s + g_L > \lvert -g_{max} \rvert$	$g_s + g_L < \lvert -g_{min} \rvert$

Low-Pass Amplifiers [b]

Diode	DC Gain	f_c	$G^{1/2} \times f_c$
B-11	12.5 db	85 Mc	357 Mc
B-30	14.1 db	32 Mc	163 Mc
B-187	14.5 db	32.5 Mc	172 Mc

Bandpass Amplifiers [c]

f_o	Gain	$2\Delta f$	$G^{1/2} \times 2\Delta f$
73.5 Mc	29.5 db	4.6 Mc	138 Mc
108 Mc	28 db	4.6 Mc	116 Mc
164 Mc	25 db	5.5 Mc	98 Mc

([a]) Stability criteria refer to Fig. 1 ([b]) Values of g_S and g_L are equal and are adjusted for the desired power gain ([c]) Diode B-24 used throughout and g_S was adjusted to the gain figures shown to counteract changes in Q with frequency

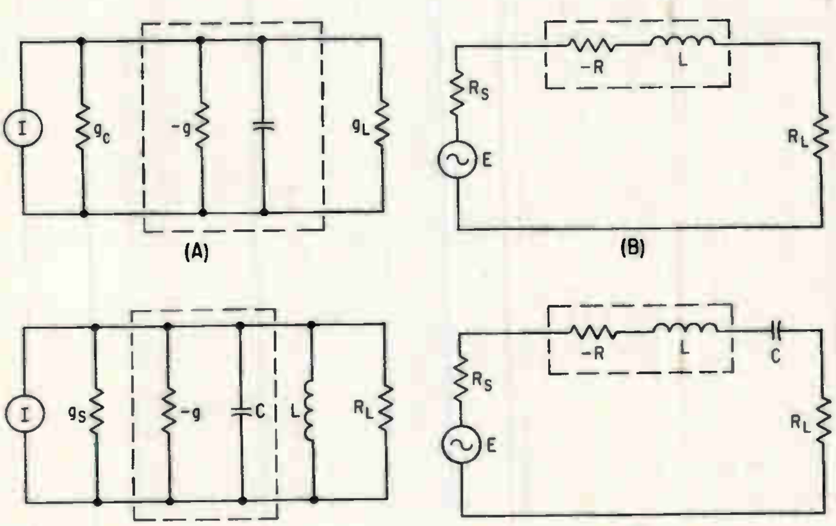


FIG. 3—Negative resistance N-type amplifier showing shunt capacitance (A); S-type negative-resistance amplifier with series inductance (B); N-type bandpass amplifier (C); S-type bandpass amplifier (D)

REFERENCE

(1) H. S. Sommers, Jr., Tunnel Diode As High Frequency Devices, Proc IRE., p 1201-1206, July 1959.
(2) K. K. N. Chang, Low Noise Tunnel Diode Amplifier, Pro IRE., p 1268-1269, July 1959.

CRYSTAL CODANS GIVE

Accurate Receiver Tuning

Advances in crystal-controlled carrier-operated anti-noise circuits feature simple design, low power drain and high dependability

By RONALD L. IVES,
Palo Alto, California

ALTHOUGH THE CODAN, or carrier-operated antinoise circuit, has been a useful and valuable receiver adjunct for nearly thirty years, the conventional circuits, operated from the receiver avc circuit, have too broad an acceptance for present-day crowded channel conditions. In addition, some of them, by injecting control tube contact potential into the receiver avc system, lower overall receiver sensitivity appreciably.

During World War II, a number of crystal-controlled codans were developed along sound principles, but these were not widely adopted because of circuit complexities. Recent advances make possible construction of crystal codans which are simple, low in power requirements and highly dependable. The basic circuit is shown in Fig. 1.

In this circuit, any audio tube, say the first, is biased off by a Zener diode in the cathode circuit. To insure that the Zener will develop its rated cutoff voltage, a keep alive current is supplied it from B+ through a high resistance (R_1). If controlled tube is a pentode, the screen current will normally supply the necessary keep alive, and R_1 is unnecessary.

When the potential across R_2 is low or zero, the tube is cut off, and passes no signal.

The actuating circuit produces a positive output when a signal is received. It consists of a crystal, a voltage-doubling rectifier, a smoothing capacitor and a load.

The crystal, whose series resonant frequency is the i-f center frequency, is d-c isolated from the i-f system by C_1. Whenever an i-f signal of the requisite frequency is applied to the crystal, it is passed through, and is rectified by D_1 and D_2. This rectified output is smoothed by shunt capacitor C_2 and applied across the R_2 and the padder.

Any desired portion of this voltage is tapped off by the potentiometer arm, and applied to the grid of the controlled tube through the grid resistor (R_g). When this voltage is sufficient to overcome the cutoff bias in the cathode circuit, the tube goes into operation, and a signal passes.

As the voltage output of the crystal and rectifier circuits is likely to exceed 100 when used with a communications receiver while the cutoff bias of a first audio tube is usually less than 100 volts, some sort of regulation is necessary. Regulation prevents saturation of the controlled tube. The simplest control method is to connect a diode from the arm of R_2 to the high end of the Zener diode. This diode (D_3) makes it impossible for the arm of R_2 to be more positive than the lower end of the cathode resistor (R_k) of the tube. Thus, if R_k is of the proper value, the tube will be operating with optimum bias whenever it is gated on.

The padder resistor eliminates a dead zone at the low sensitivity settings of R_2. Its value is best found by experiment.

In use, tuning across the band causes signals to snap in and out, with complete silence between signals. Acceptance bandwidth of this codan is approximately 1 cycle per kilocycle of i-f frequency. Considerably sharper tuning is attainable by use of various crystal lattices and phasing circuits. These are costly and increase circuit complexity.

Acceptance bandwidth can be increased by use of two crystals, one a few hundred cycles above the i-f center frequency, the other an equal amount below it. Bandwidth will be approximately twice the separation of the crystals, but a wide separation (more than 1,500 cycles) will cause a hole in the middle, so that the codan may operate only when the carrier is being modulated. This characteristic, if desired, can be accentuated by use of a shunt crystal, to dump the i-f center frequency. Tuning with this arrangement is most difficult unless a resonance meter or panoramic adapter is used.

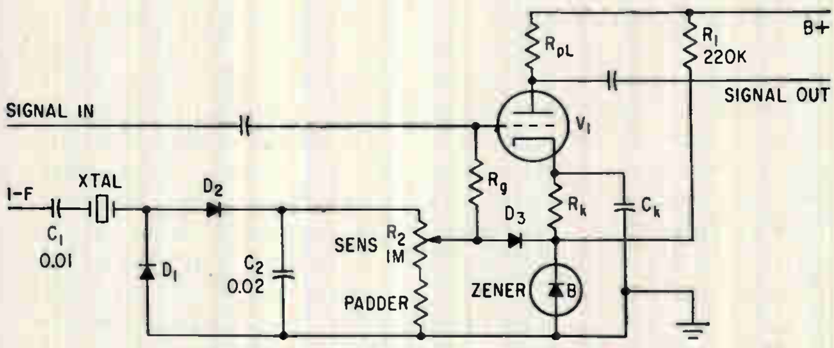


FIG. 1—Simple crystal-controlled codan circuit has bandwidth of approximately 1 cycle per kilocycle of i-f frequency

DESIGNING Solid-State Static Power Relays

By RICHARD F. BLAKE,
Manager, Electronics Dept.,
Walter Kidde & Company, Inc.
Belleville, N. J.

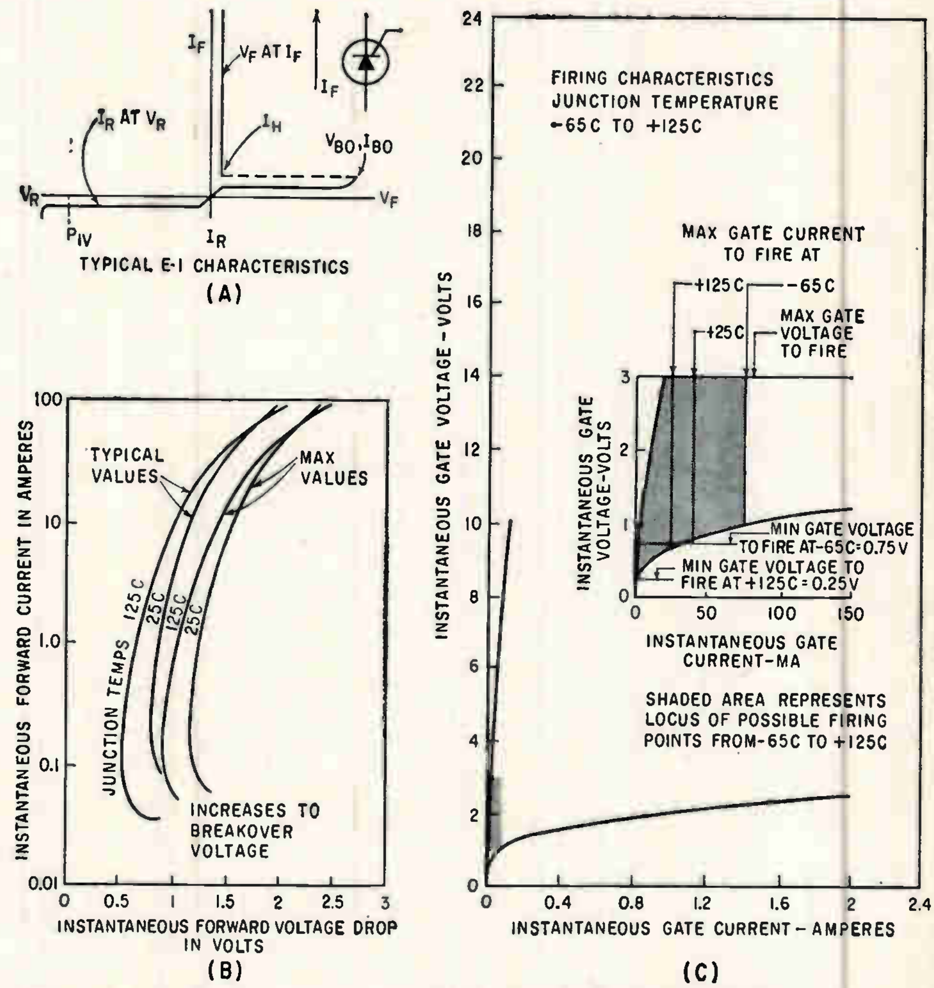


FIG. 1—Typical E-I characteristics of SCR (A) and forward conduction (B) and gate firing (C) characteristics of C-35 units

THE RAPID EVOLUTION of solid-state components and advances in circuit design have resulted in improved control and switching elements. Static relay and static contactor units are available now with contact ratings which range from milliwatts to kilowatts. These units have fast response, long life and high reliability under adverse environmental conditions. They avoid many of the problems of mechanical relays such as contact contamination in storage, contact bounce, and malfunction under shock and vibration.

These devices differ from static switching, gating, and amplifying circuits by providing snap on and off action and electrical isolation between actuating and load circuits. Also, there is no interaction between actuating and load signals.

The improved performance of the static device over the mechanical device is dramatically shown by a light flasher application. Here, the static device is mechanically and electrically interchangeable with the existing light flashers, sells for approximately the same price, and extends the maintenance-free operating life from a few hundred hours to 10,000 hours.

Static relays, circuit breakers, and similar solid-state devices are an effective supplement to the mechanical units but will not replace all mechanical relays and circuit breakers. However, when properly applied, they do represent a new level of performance capability and reliability which cannot be achieved by existing mechanical designs and the present state of the mechanical art. Therefore, static relays find application where reliability and performance are at a premium.

The power relay, contactor and circuit breaker must inherently be based upon the utilization of the new silicon controlled rectifiers (SCR) with their inherent characteristics of: (a) high voltage and current ratings—up to 400 v with inrush currents to 500 amperes; (b) high temperature ratings—up to 150 C junction temperature; (c) high surge current rating—over 10 times average current rating; (d) low forward drop when conducting—typically 1 volt; (e) fast turn on and turn off times—typically 1 to 20 microseconds; and (f) low-power actuation requirements—typically 100 milliwatts.

Of particular interest is the high surge capability for short periods (up to 10 times average current capability) and low gate power requirements. Average forward current ratings range from 1 to 75 amperes with larger units under development. Conduction and gate firing characteristics of a SCR (GE—C35) are shown in Fig. 1.

An a-c contact may be made, as shown in Fig. 2A, by utilizing two controlled rectifiers in a back-to-back configuration. This contact will conduct in both directions when both gates are properly actuated.

Silicon controlled rectifiers are used in relays and circuit breakers having contact rating ranging from milliwatts to kilowatts

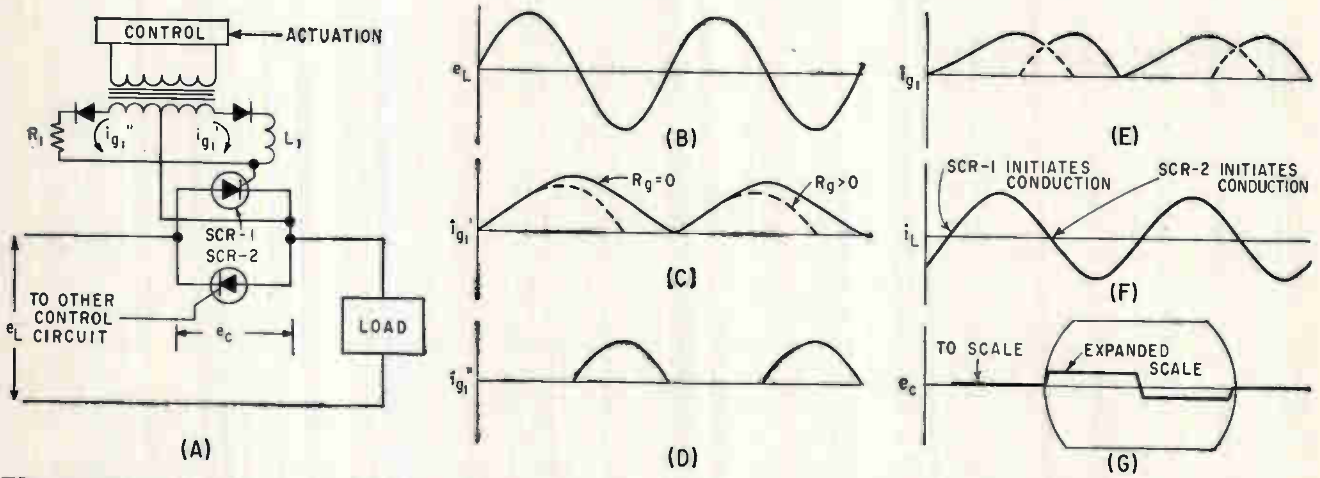


FIG. 2—Waveforms for circuit (A) are: line voltage (B), half-wave gate current L_1 only (C), half-wave gate current R_1 only (D), composite gate current (E), load current lagging power factor (F) and contactor drop (G)

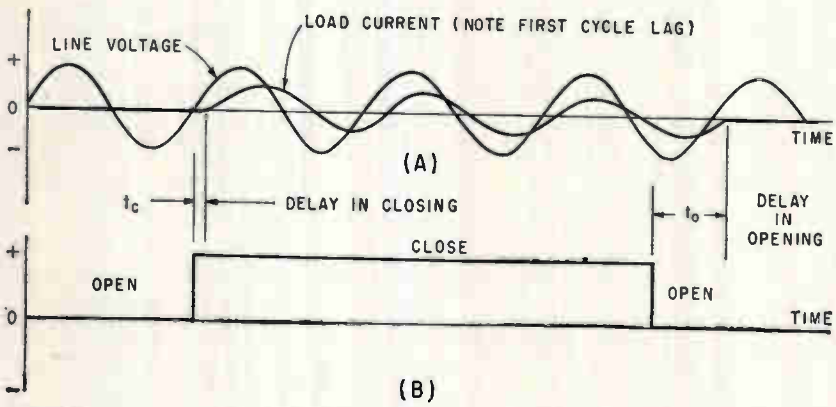


FIG. 3—Transient closing and opening contact currents for inductive load (A) and contactor actuation (B)

The primary design problems are to actuate the gates from a control signal which is electrically isolated and to maintain the following design parameters: (a) the gate must be fully actuated for at least 60 degrees before and after the line voltage passes through zero so that the appropriate controlled rectifier will be ready for conduction at the time of zero current crossover even for low load power factor; (b) when the control signal is removed, the gate excitation must return to zero almost instantaneously so that the contact will turn off the next time the load current passes through zero crossover; (c) the gates of the controlled rectifier are the most delicate part of the unit, and it is of primary importance to achieve full excitation without exceeding their power dissipation ratings and without reversing the gate voltage beyond the values specified.

Using the C35 as a design example and referring to Fig. 1C which shows the gate firing characteristics, it can be shown that the gate actuation requirements are achieved for all conditions of operation by applying approximately 6 v to the gate through a 30-ohm series resistor. If this load line is superimposed upon the gate actuation requirements, it will be noted that at all times the gate power dissipation is within the allowable ratings and that, regardless of changes in the gate characteristics from unit to unit and with temperature, the gate is fully excited.

Gate power may be derived from the a-c supply by a small transformer rectifier. However, this circuit is inadequate in that the gate voltage goes to zero at the time that the line voltage passes through zero, which is, of course, the worst possible instant. This objection may be overcome by a capacitor storage circuit, but this type of circuit has the disadvantage of slowly decaying after the control signal is removed, with a correspondingly slow turn-off time. The recommended circuit is shown in Fig. 2A.

The operation of the circuit is also shown in Fig. 2: the line supply voltage is plotted in Fig. 2B; the gate current with a half wave rectifier and the inductor L_1 only is shown in Fig. 2C. It will be noted that the maximum gate current is maintained for a considerable conduction angle. However, the curve R_g (total resistance of gate loop) $= 0$ is idealistic and the actual gate current, $R_g > 0$, is illustrated by the dashed line in the figure.

A detailed analysis shows that the current is not generally sustained for a great enough angle to give reliable operation of the contact for all conditions of power factor, and it is desirable to supplement this gate current as shown in Fig. 2D. This current is derived with a simple half-wave rectifier operating on the alternate half cycles of supply, and the composite gate current is shown in Fig. 2E. It will be noted that relatively large gate currents are supplied for power factor variations from zero lagging to zero leading and the important criteria of the gate current returning to zero within the cycle of line frequency is also achieved. The need for gate excitation over a considerable angular range is illustrated by the load current shown in Fig. 2F, and the typical drop across the static contact is shown in Fig. 2G. This drop, typically 1, results in only minor waveform distortions and has a minor effect on voltage regulation characteristics.

Typical operation of the contact is shown in Fig. 3, which illustrates the time delay in closing, the transient current in the initial cycles and the time delay in opening with a controlled rectifier. The first cycle of load current can look highly inductive and can lag by more than 90 degrees in its point of zero crossover under certain conditions. It is especially important to be aware of this starting transient to avoid malfunction under certain load conditions. The gate excitation circuit previously shown in Fig. 2 provides for these conditions. The time delay in opening is determined by the time for the gate excitation to reduce to zero (which is very rapid in this case) and by the additional time for the load current to pass through zero, which permits the controlled rectifier to extinguish.

A typical a-c power relay is shown in Fig. 4 where transistor switching circuit Q_1 is inserted in a full-wave diode bridge. The transistor is utilized to program the a-c power from the supply to the gate circuits. The control circuit is completely isolated electrically from the load circuit and no power is drawn from the line except when the unit is actuated. This simple circuit requires a step input which may be derived from a large number of bistable circuit elements or by a static relay.

The design of a static latching d-c contact (Fig. 5A) is very simple since it utilizes a single controlled rectifier with a transformer coupled to the actuating source. A pulse input turns the contact on and it remains on until the supply power is removed. There are many applications for this simple type of d-c contact for squib firing, arming, programming, and similar circuits, but for the general application, it is necessary to develop d-c contacts which are capable of turn-off as well as turn-on.

Turn-off may be achieved as shown in Fig. 5B. If spst operation is desired, it is a simple matter to substitute a low-power dummy load in place of load 2. Operation is the same as before in that when a positive pulse is applied to the input terminals, *SCR*-1 will be turned on. Commutating capacitor C_1 will be charged as shown, and the relay is now ready for operation. When a negative pulse is applied to the input, *SCR*-2 is turned on, applying power to load 2, and the potential at the cathode of *SCR*-2 rises by an amount equal to the supply voltage. Since the capacitor cannot instantaneously discharge, the cathode of *SCR*-1 instantaneously rises well above the supply voltage, causing *SCR*-1 to turn off. Capacitor C_1 then rapidly discharges through load 1, and load 1 is now open-circuited. Note that there is a short make-before-break operation which is in the neighborhood of approximately 50 to 100 μsec.

The circuit shown can be cycled at rates up to 500 cps and is satisfactory where the loads are fixed and the transient spike on the load just prior to turn-off is not objectionable. However, for many applications, a more sophisticated turn-off circuit is desirable, as shown in Fig. 5C. In this design, the voltage rise above the supply voltage is limited by D_1 and D_2 and they provide a path for the circulating current during the turn-off interval. The time duration is determined primarily by the LC time constant. Capacitor charge is reversed and stored during the turn-off interval and is not dissipated in the load. The net result is that the load voltage does not rise above the supply voltage during turn-off and that the turn-off time is controlled by a tuned circuit and is relatively independent of the load impedance.

This type of relay can be designed for d-c supply of from 28 to 400 volts and for load currents varying from a few milliamperes to motor starting applications with inrush currents as high as 500 amperes. Multipole operation is easily achieved with additional sili-

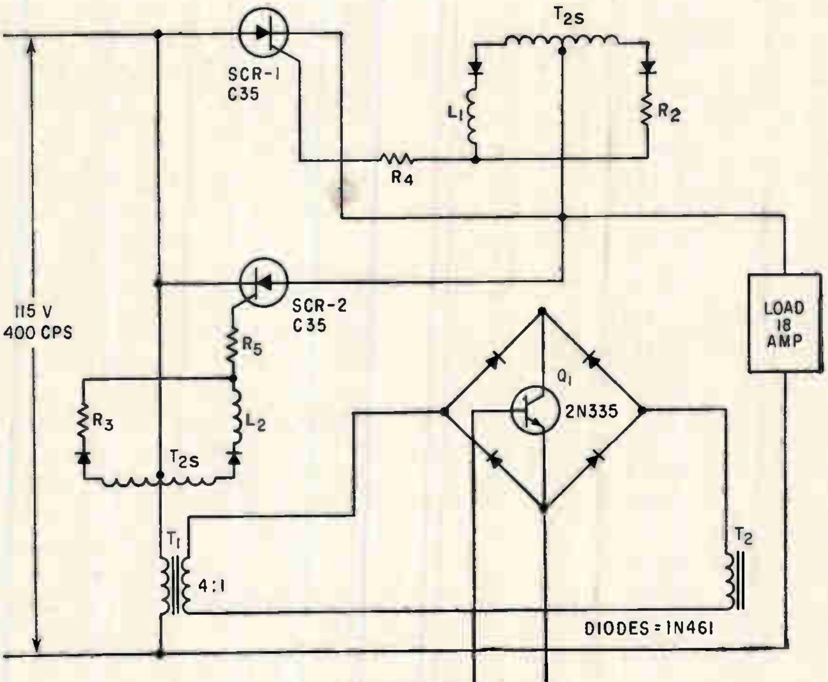


FIG. 4—Alternating-current static contactor uses diode bridge

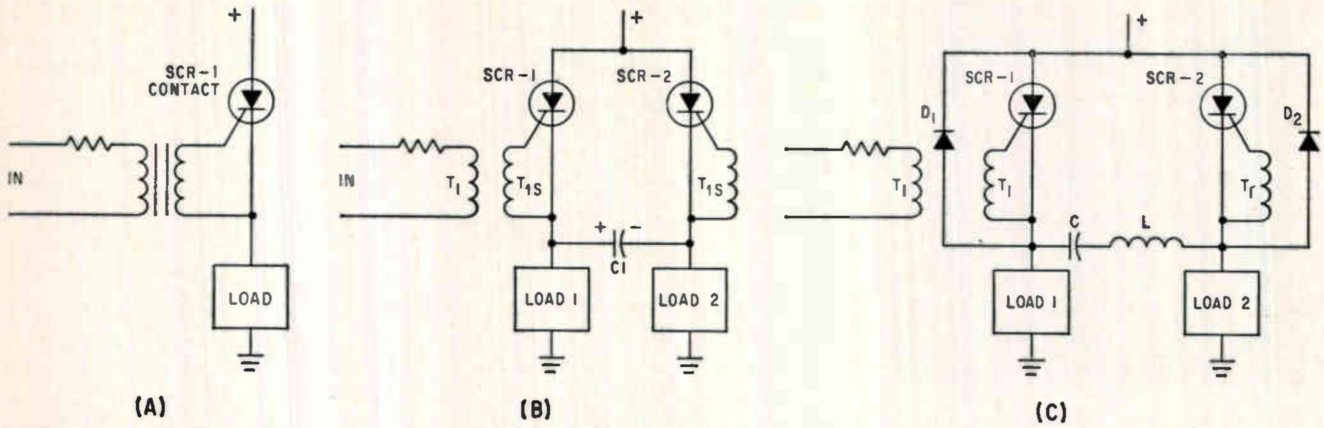


FIG. 5—Latching circuit (A), spdt d-c relay (B) and improved spdt d-c relay (C) feature simple circuits

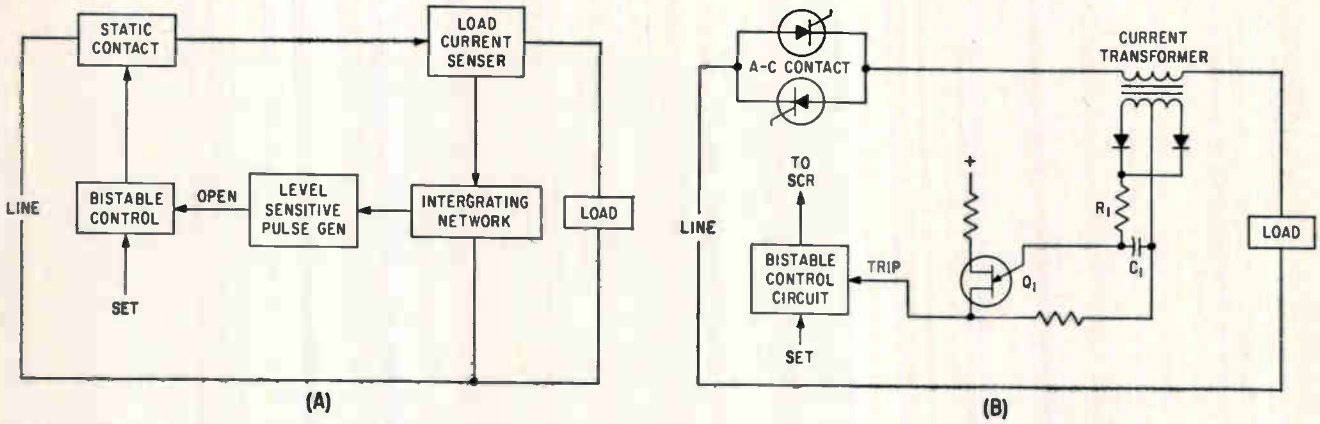


FIG. 6—Block diagram (A) and simplified schematic (B) of static circuit breaker

con controlled rectifiers. A single turn-off circuit can be used to deactuate several poles simultaneously for single throw operations.

A simplified block diagram of a static circuit breaker is shown in Fig. 6A. The breaker consists of a static contact, a load current sensing current, an integrating network which determines the time-overcurrent product and a level sensitive deactuator circuit. When the time-current product exceeds the amount specified by the integrating network-pulse generator combination, the pulse generator fires, tripping a bistable control circuit which in turn opens the static contact. This type of contactor is set in the closed position by a simple external trigger or pulse.

It is anticipated that for a-c circuit breakers a simple current transformer will be utilized as shown in Fig. 6B. Output of the transformer is rectified and integrated by R_1-C_1. Energy is stored in C_1 until it builds up beyond the value specified by unijunction circuit Q_1, at which time a pulse is generated, tripping the bistable control circuit. The time-current characteristics are defined by the integrating network R_1-C_1 and the trip point of Q_1. The d-c supplies for the bistable control circuit and Q_1 are derived by a simple transformer rectifier operating off the line, and the time-current characteristics may be shaped to any desired function by an amplitude shaping network operating on the output of the current transformer.

Temperature compensation can be achieved by using a thermistor in conjunction with R_1. It may be desirable, under certain conditions of high current, to bypass R_1 to create immediate trip capability upon overcurrent. It is anticipated that this type of circuit can be designed to trip within one-half cycle (a-c applications) or within 100 microseconds (d-c contactor) after being subjected to high overload current. This fast trip capability under short circuit is a primary advantage of the static type of design and can actually be utilized to prohibit the build-up of current from a generator.

The bistable control circuit can be a very simple Eccles-Jordan multivibrator which, in turn, actuates the relay circuit shown in the preceding discussions. These circuits are of the trip-free type and permit reset after overload is removed.

Automatic reset of the circuit breaker after a specified period of time may be accomplished by inserting a timing circuit in the bistable control circuit. The relay can be reset a specified number of times rather than at a specified rate by using a counting circuit. Resetting the circuit breaker automatically when the overload has cleared can be accomplished by inserting a bridge type of measuring circuit which senses the load impedance when the contact is opened.

Much of the work described here has been for USASRDL, Fort Monmouth. E. Demers and R. Langfelder have developed many of the circuits described.

BIBLIOGRAPHY

Proc of Static Relay Symposium, 12-13 April 1960, U. S. Army Signal Rand D Lab., Fort Monmouth, New Jersey.

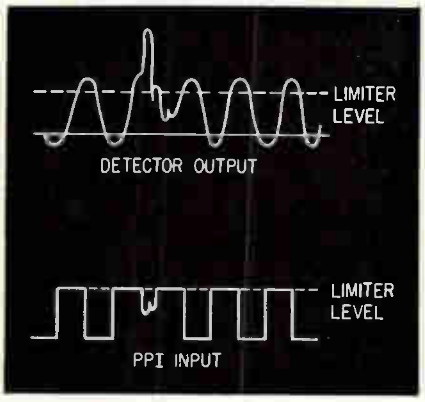


FIG. 1—Desired pulse rides on top of tone interference

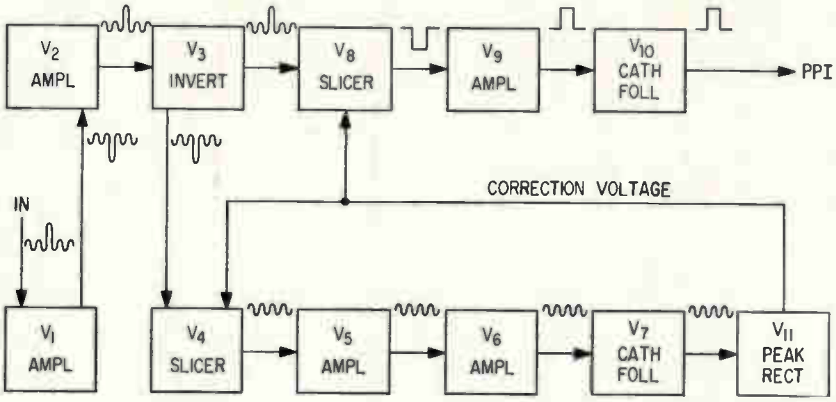


FIG. 2—Pulse and tone are accepted by circuit. Output voltage of peak rectifier adjusts to peak of tone signal. Other circuits remove tone signal

REDUCING INTERFERENCE IN

Ionospheric Sounding

During back-scatter experiments, tone signals from interfering stations on the same frequency disturbed pulse reception. This Australian-designed circuit is used to separate the desired pulses from the unwanted tone signals

By K. PERRY
Dept. of Physics, University of Queensland, St. Lucia, Brisbane, Australia

DURING a series of 16-Mc back-scatter experiments, it was found that unwanted transmissions on the same frequency were ruining recordings. Some interfering stations were so strong that they completely blocked the receiver, while others were transmitting tones that disturbed pulse reception.

The type of receiver used cannot use avc as this would mean that a weak echo at one range would be lost if there were a strong echo at another range. One answer to the strong interfering stations was found by using a remote cutoff pentode as an r-f amplifier and reducing the i-f gain to the point where mixer noise was just below the received weak echoes. Video gain was then increased to compensate for the lowered i-f gain. This resulted in a receiver with a large dynamic range which was virtually impossible to block with a c-w signal. When a c-w signal is present, it and the wanted echo add algebraically and upon detection only the echo pulse is extracted.

A far greater problem was the case of the stations transmitting tone signals on the same frequency. A typical output of the detector and the PPI input signal of a pulse riding on a tone is shown in Fig. 1. It appears that a form of tv sync separator could be used to extract the pulse. However, the interfering tone varies in amplitude and the separator must vary its slicing level accordingly. First thoughts on the problem indicate that it may be a matter of rectifying the tone and applying it to a slicer. This would be adequate if the pulse duty cycle were low, but in back-scatter reception this is not so. When echoes are reflected off an inclined atmospheric layer or large ripple, the returning echoes become very broad and can extend in range for many hundreds of kilometers.

Figure 1 shows that the pulse rides on top of the interfering tone signal, so that the negative-going portion of the tone could be rectified and used as the slicer level. Figure 2 shows the block diagram of a device that does this while Fig. 3 shows the schematic of the device.

The incoming signals are amplified by V_1 and V_2 and applied to inverter V_3. The signal from V_3 is applied to correcting circuit slicer V_4 which extracts what is now the positive-going portion of the tone. The tone signal is now inverted and

Premium humidity protection . . . in a low-cost silicon rectifier

RATINGS AND SPECIFICATIONS	(60 CPS Resistive Loading)	
	1N2094/ T400	1N2095/ T500
Maximum allowable PIV	400V	500V
Maximum allowable RMS voltage	280V	350V
Maximum allowable continuous reverse DC voltage	400V	500V
Maximum allowable DC output current— (at 85°C ambient) (at 50°C ambient)	500ma 750ma	500ma 750ma
Maximum allowable one-cycle surge current	15 amps	15 amps
Maximum peak recurrent forward current	5 amps	5 amps
Maximum surge current (4 ms)	35 amps	35 amps
Maximum full-load forward drop (full cycle avg. at 85°C)	.5V	.5V
Maximum leakage current (full cycle avg. at 85°C)	250μa	250μa
Ambient operating temperature	—55° to +100°C	
Storage temperature	—55° to +100°C	

First premium quality silicon rectifier at economical prices, the Mallory Type T gives you outstanding resistance to humidity. Repeated tests prove Type T passes *four times* the humidity test requirements of MIL-202A, method 106 for hermetically sealed units. They consistently pass 500 hour tests in boiling water.

In addition, Type T rectifiers offer you—

- Excellent heat resistance—rated for 85° C.
- Low reverse leakage current.
- Low forward voltage drop.
- Long service life—pass 4000-hour tests under load without failure.
- High reliability—100% inspection protects against premature failure.

Write or call for literature and a quotation.

Elkon Division
Semiconductor Dept.
Du Quoin, Illinois

P. R. MALLORY & CO. Inc.
MALLORY

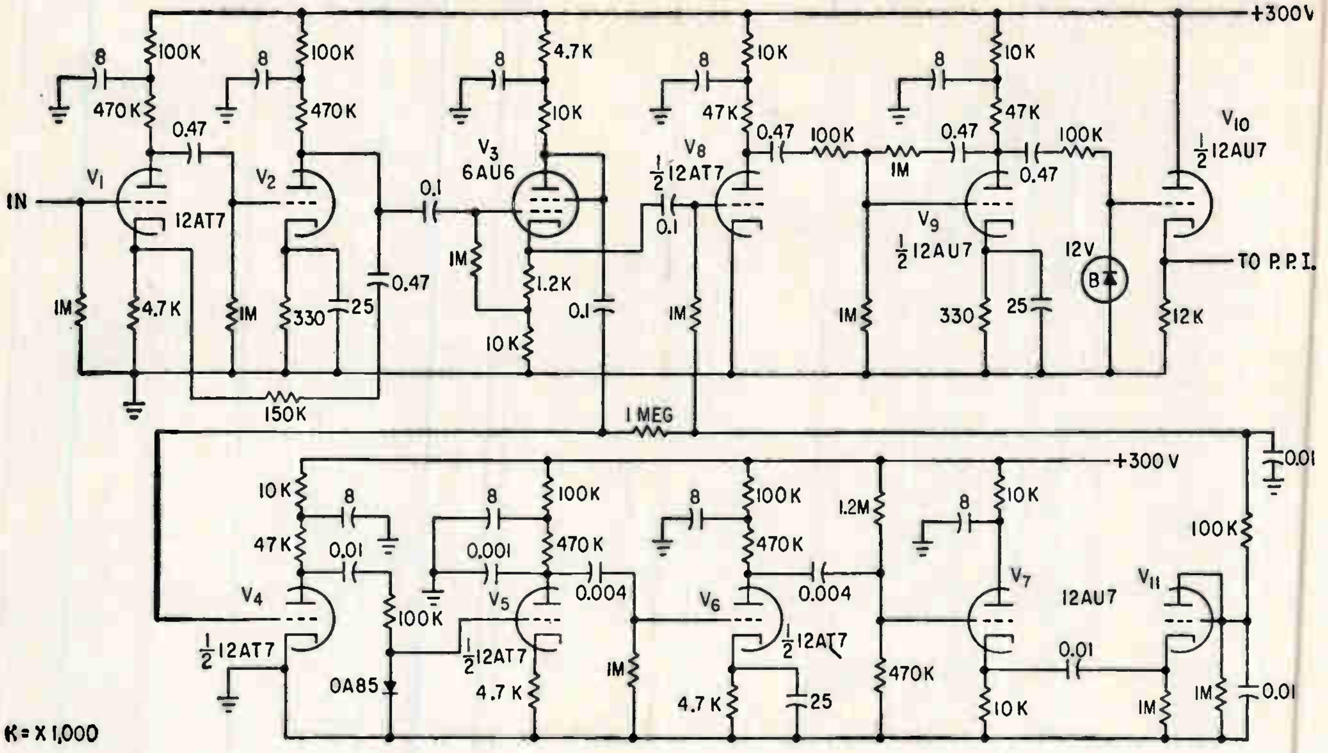


FIG. 3—Composite pulse and tone signal enter at V_1. Negative correcting voltage from peak rectifier V_{11} is applied to slicer V_8 to remove the desired pulse from the associated tone interference

passed to amplifiers V_5 and V_6. The negative-going output of V_6 is applied to peak rectifier V_{11} through cathode follower V_7. The output of the peak rectifier is applied back to the input of slicer V_4. Because of servo action, the output voltage of the peak rectifier rapidly adjusts itself to the peak of the tone signal. The peak rectifier correcting voltage is also applied to the other slicer V_8 so that the desired echo pulse is extracted.

The pulse is then amplified by V_9, limited at V_{10} and then applied to the PPI. In the correcting circuit, time constants are so arranged that a bandpass characteristic is obtained, preventing hum and tube noise from generating unwanted correcting voltage.

The response time of the system is determined by the time constant of the rectifier. If necessary, this could be reduced by using a full-wave rectifier and less filtering.

In the particular setup used, the receiver was fed from the transmitting antenna by way of a TR switch. The ground pulse caused a large negative excursion in the presence of c-w in the detector output that defied elimination. This condition would have generated a large correcting voltage at the slicers. A gating pulse was applied to the final i-f stage screen grid to remove the bright ground pulse from the PPI.

Trigger input tube V_1 (see Fig. 4) has its grid returned to the high voltage. Sufficient resistance is inserted in the grid circuit to keep grid dissipation to a safe level. The negative portion of the trigger pulse cuts off V_1 for a period determined by the R-C time constant in its grid circuit. The positive-going pulse generated at the plate of V_1 is inverted by unity-gain anode follower V_2 and applied to cathode follower V_3. As cathode follower V_3 is normally conducting, its cathode voltage is approximately 100 v. This voltage is used as screen grid voltage for the last i-f tube.

During the blanking pulse, the large negative pulse from V_2 cuts off V_3, thus reducing its cathode voltage which automatically removes the voltage from the i-f tube screen grid. The ground pulse is then blanked. This device was designed for a transmitter pulse of 400 μsecs at a prf of 25 pps.

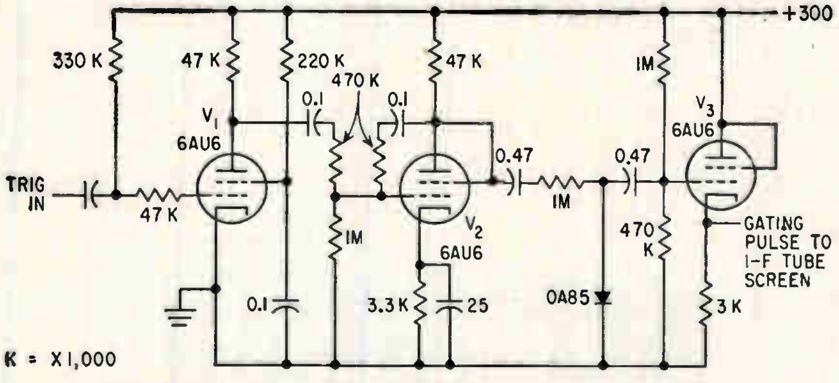


FIG. 4—Gating pulse generator removes screen-grid voltage from receiver i-f to remove bright ground pulse from the ppi cathode-ray tube

Program Controls Furnace Temperature

PREPARATION of high-purity materials remains a factor of major importance in studying the electronic properties of inorganic compounds[1]. One of the more obvious methods of compound preparation, that of precipitation from solution, must be rejected due to the introduction of contaminants from the solution, containers, filters, etc. Several investigators[2, 3] have found that the direct fusion of stoichiometric amounts of highly purified elements in clean non-reactive containers, either in vacuum or in an inert atmosphere, remains one of the simplest and best procedures. This latter method was successful only after overcoming a major fusion problem.

In practice the non-reactive container is a fused silica tube sealed under vacuum after loading the elemental constituents. The degree of difficulty in fusing the sample is, among other things, a function of the heat of formation of the compound from the elements. The furnace fusion cycle must be adjusted in a manner to allow adequate dissipation of such heat; otherwise a great pressure build-up will result, followed by an explosion. By using samples of constant geometry, charge composition and charge mass, the explosion point in a given temperature cycle is reasonably reproducible.

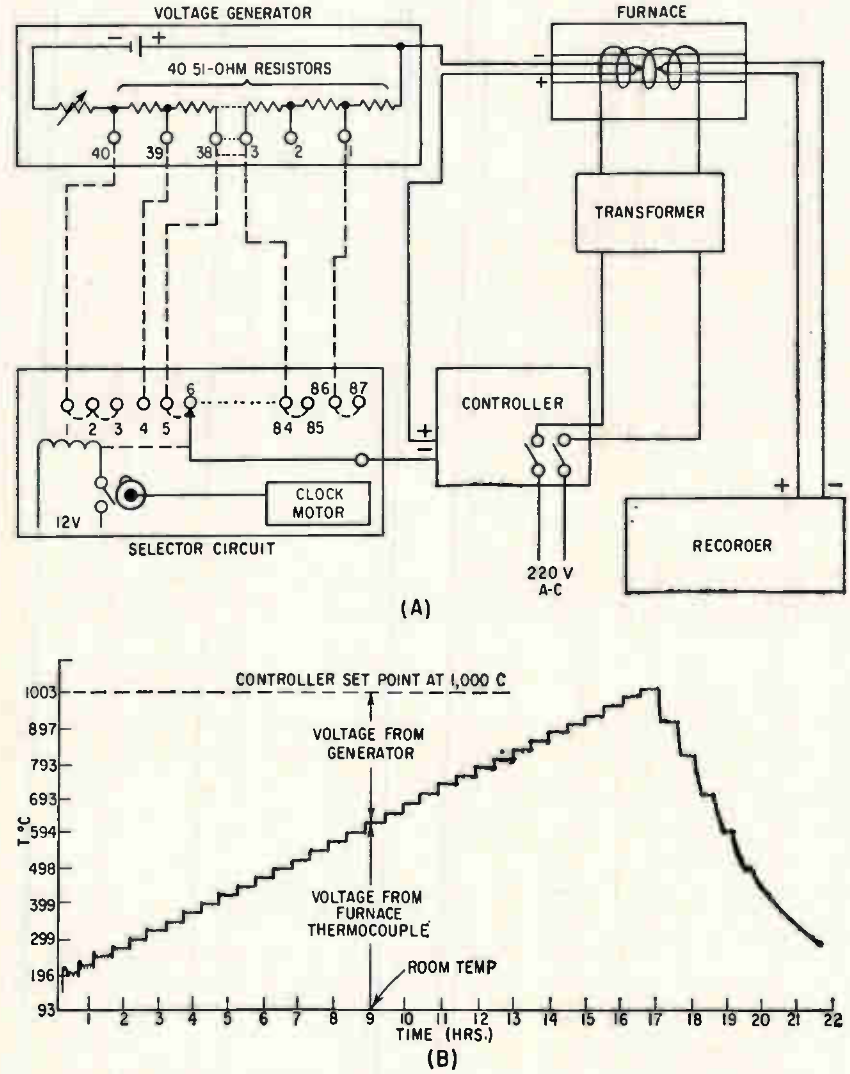


FIG. 1—Programmed selection of resistance controls furnace temperature (A), while temperature profile of furnace run is shown at (B)

The explosion can usually be avoided in subsequent samples of the same type by heating at the usual rate of 100 C to 400 C per hour from room temperature to a point 25 C to 50 C below the previously determined explosion point, and holding there for one to four hours before resuming heating. Normal completion of the cycle would involve increasing the temperature from the hold temperature to a point about 50 C above the liquidus temperature of the system, and then cooling.

During cooling, the principal problems are generally associated with wettability of the fused silica container or the differential in the coefficients of thermal expansion between the fused silica and the contents, or both. The container may crack because of differential stresses but this too can often be mitigated by cooling slowly and allowing the compound to anneal and relieve the stresses that cause cracking.

A means of automatically adjusting and controlling fusion cycles becomes not only desirable but necessary to operate with any degree of efficiency. A device that has successfully met these needs[4] has been constructed.

Automatic Control

Although there are several different types of control units available for providing variable temperature cycles, none met the requirements of simplicity, low cost, compactness and flexibility as well as the digital programmer designed and built for this use. The programmer and its operation as an integral part of the fusion furnace circuit are shown in Fig. 1A. Voltage from the controller thermocouple is not introduced directly into the controller, but is modified by adding generator voltage in series with it. The temperature controller operates

122 Help Wanted, Men

122 Help Wanted,

te!
positions
icular
ole
ONIC
EERS

ed openings
fied Graduate
extensive de-
opment expe

qualified for
e positions,
would like to
ou. Technical
require the
most cases
izenship pre-

rical
ign
neer

ng oppor-
r an Elec-
sign Engi-
th back-
design of
circuits,
its selec-
wire siz-
electrically
Ground
quipment.

RONIC
NEERS

ected for this
ll have held
responsible
m bills of ma-
ugh finished
tory and be
initiating a
manufacturing
d production
p.
he must have

ENGINEERS

ENGINEERS & SCIENTISTS SEMICONDUCTORS

Have you and your company continued to grow as you anticipated? In less than 6 months Pacific Semiconductors, Inc. has expanded from less than 1,200 to more than 2,000 employees. Based on conservative sales estimates, at least another 50% growth is assured for the remainder of 1960—and 1961 WILL BE EVEN BETTER!

In recent months Pacific Semiconductors, Inc. has developed the first micro miniaturized diode as well as transistors ranging in power up to 1500 watts output.

And this is only the beginning! Our rapid growth opens stimulating and challenging opportunities in the exciting commercial field of solid state devices. The following are typical of present openings for engineers and scientists seeking career positions in a field of unprecedented growth:

ADVANCED CIRCUIT DESIGNERS

BSEE or MSEE with minimum of four years experience in original design of advanced instrumentation circuitry. Must have the ability to conceive and bring to fruition circuitry to measure advanced state-of-the-art devices.

APPLICATIONS ENGINEERS

BSEE or MSEE to resolve customer inquiries concerning highly advanced silicon transistors, diodes and rectifiers. Previous experience in circuit design of electronic equipment involving miniaturization is desired.

DEVICE DEVELOPMENT ENGINEERS

Engineers or Physicists to engage in device design and process parameter optimization of high frequency and fast switching transistors. Will study product performance and recommend improvements. Advanced degree preferred.

PROCESS ENGINEERS

Engineering or Physical Science degree with training in semiconductor theory and ability to transform experimental process into pilot and full production operation. Will perform studies on existing processes and formulate improvements. Openings in Diode, Transistor, and Microelectronics groups.

QUALITY CONTROL AND RELIABILITY ENGINEERS

Background in E E, Ch E, or IE with knowledge of statistics to work on complete analysis of semiconductor manufacturing operations, work out final and reliability inspection and test procedures, and specify equipment and reports required.

TRANSISTOR CHARACTERIZATION ENGINEERS

Degree in Electrical Engineering to perform measurement of transistor parameters and circuit performance capabilities up to several hundred megacycles. Applicants should have 5 – 10 years experience in high-frequency measurement and/or equipment design, and/or high-speed switching design work, at least part of which should preferably be in transistorized equipment.

U. S. Citizenship not required.

These are but a sample of the many interesting openings available at Pacific Semiconductors, Inc. If you feel that you are qualified for the above or for other positions in the fascinating and rewarding world of semiconductors, write in confidence to:

D. E. Grantham, Technical Staff Recruiting

PACIFIC SEMICONDUCTORS, INC.

10451 West Jefferson Blvd., Culver City, California

ENGINEERS

Sales Engineers

Rapid expanding production of outstanding line of semiconductor devices creates challenging opportunities for Sales Engineers who can SELL. Current openings in Boston, Baltimore, Syracuse, Cincinnati, and Minneapolis—others soon to follow. Excellent base salaries plus bonus for top effort. Electrical Engineering degree desirable with experience in sale of electronic components to military and commercial customers. Send resume to:

LARRY LONG

PACIFIC SEMICONDUCTORS, INC.

14520 S. AVIATION BLVD.
LAWNDALE, CALIF.

ENGINEERS

Engi

A new dev
gram now
quires an i
for highly
neers in
areas:

Instrum
Engi
Indu

B.S. in E.E.
5 years'
precision te
Prefer tho
edge of a
measuremen
trical and
write techn
procedures
tions.

Servo
Engi
Elect

Extensive e
quired in o
lowing fie
ment of
stability
systems; or

ENGINEERS

ELECTRONICS

Aggressive Young Company needs Specialists

Permanent positions available for qualified men seeking challenging, stimulating positions. Liberal salary

ELECTRONICS

when the sum of thermocouple and generator voltages equals the controller set point. By using a stepping switch in the selector circuit, magnitude of the added voltage can be changed as a function of time. As a result furnace temperature also varies with time according to the plug-in wiring connections between the voltage generator and the selector circuit.

The generator uses a 1.5-volt dry cell and a series resistance circuit drawing about 20μa. Voltage drop across each 51-ohm precision resistor is equivalent to about 25 C for a chromel-alumel thermocouple. The 40 precision resistors provide a maximum voltage equivalent to 1000 C, which can be reduced by any multiple of 25 C.

The selector circuit steps successively through 87 different positions, remaining in each position for 15 minutes. Hence it takes 21¾ hours for the selector circuit to complete one cycle. The selector circuit can be wired to select for each 15-minute interval any equivalent voltage between 0 C and 1000 C, which will be added to the thermocouple voltage to produce the control signal. Each 15 minutes a new control signal can be established, independent of either the previous or the following signal. Wide fluctuations in control point can be obtained, limited only by the time constant of the furnace. Heating rates, cooling rates, and holding times and levels can be selected easily and reproducibly. The actual furnace cycle is recorded from a recorder thermocouple. The temperature profile for an actual furnace run is shown in Fig. 1B, where the relationship between generator output and furnace thermocouple voltage is indicated.

This work, by N. L. Hozak, J. S. Cook and D. R. Mason of the University of Michigan, was supported by the National Science Foundation and the U. S. Army Signal Corps.

REFERENCES

(1) J. A. Kafalas and P. H. Robinson, Purification of Semiconductor Materials by Chemical Means, *J of Electrochem Soc*, 105, p 164c, Aug 1958
(2) G. Busch and U. Winkler, Elektrische Leitfahigkeit und Hall-effekt intermetallischer Verbindungen, *Helv Phys Acta* 26, p 395, 1953
(3) H. J. Hrostowski and M. Tannenbaum, Recent Work on Group III Antimonides and Arsenides, *Physica*, 20, p 1065, 1954
(4) L. Thomassen and D. R. Mason,

Phase Diagram for the Binary System $CdTe\text{-}In_2Te_3$, Abstract in *J Electrochem*, 106, p 206c, 1959

Electronic Conductivity In Organic Solids

RECENT Conference on Electronic Conductivity in Organic Solids at Duke University in North Carolina attracted over 100 American and foreign scientists. Emphasis was on basic scientific progress and discoveries rather than applied research or applications. Interest in the subject has mounted steadily since World War II on both sides of the Iron Curtain, and a plastic semiconductor has been reported from Russia (ELECTRONICS, p 68, Jan 22). Some of the reported progress at the conference is expected to accelerate immediate further research, which should speed up progress in applications.

A paper of high interest was presented by Dr. Kepler of du Pont, on the subject of pulsed photoconductivity in anthracene. Dr. Kepler provided the first report on the definite measurement of the mobility of electrons and holes in anthracene, an aromatic hydrocarbon. Corroboration of Dr. Kepler's results by two other scientists indicates that there are no hole traps in the bulk of the anthracene, providing important information about the carrier velocity in the crystal. This mobility factor determines the transient response.

Research by Dr. Boroffka of Germany, Dr. Kepler, and others adds to the understanding of electrode effects (interface of electrode and material) on the conductivity of organic hydrocarbons. The research shows that most, if not all, of the carriers are generated by interactions at the electrode-material contact, meaning that the material is probably not intrinsic, in the semiconductor sense of the word, so that generation of carriers is not dependent upon the presence of impurity donors or acceptors. The conference provided the first direct evidence of the importance of the electrode-material interface in generating carriers.

The conference did not get into the area of applied research, and the Russian development of polymer semiconductors was not discussed.

Low-Cost Transducer Opens Up New Uses

By FRANK MASSA, President, Massa Division, Cohu Electronics, Inc., Hingham, Mass.

SEVERAL REQUIREMENTS for a rugged ultrasonic transducer for indoor and outdoor remote control applications has led to the development of an efficient low-cost structure which is now being mass produced with accurately-controlled performance characteristics.

The small, ultrasonic transducer incorporates a novel vibrating system including a specially electroded piezoelectric disc bonded to a second plate. One basic design uses the external surface of a rugged, waterproof housing as the radiating surface, and a second makes use of the resonant mode of a free edge vibrating disc.

The transducer design is easily adapted for efficient operation in air at frequencies in the range of 15 Kc to 80 Kc. At the higher ultrasonic frequencies band widths up to about 8 Kc are possible, which permits use of the transducer in portable walkie-talkie systems using an ultrasonic carrier to replace the radio frequency transmitter.

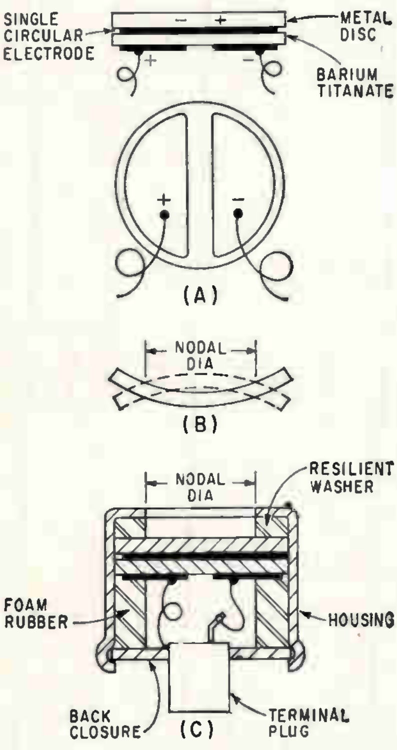


FIG. 1—Free edge transducer operates in the 40 Kc region

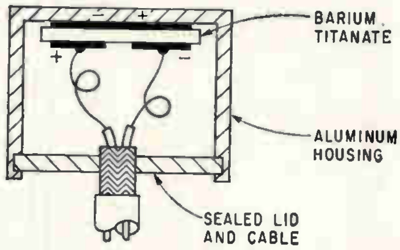


FIG. 2—Clamped edge transducer operates in the 23 Kc region

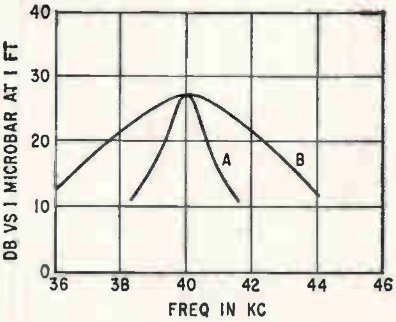


FIG. 3—Transmitting response characteristics of the free edge transducer

In the free edge transducer design, Fig. 1, if a barium titanate disc is polarized as shown, an alternating current supplied to the semiconductor electrodes will cause the composite disc to vibrate as in Fig. 1B. At the fundamental resonant frequency of the composite disc the vibration will be a maximum. For a free edge disc, the mode of vibration is such that the outer peripheral portion moves out of phase with the center portion.

To avoid destructive interference, the radiation from the outer peripheral portion is prevented from reaching the atmosphere by shielding the area with a soft washer. The complete mechanical arrangement of the assembly is illustrated in the cross sectional view in Fig. 1C.

A second transducer structure utilizes a bi-laminar element with a clamped peripheral edge as shown in Fig. 2. The combination of the aluminum base and the ceramic disc vibrates as a peripherally clamped plate when alternating current is supplied to the electrode terminals. In effect, the sound generating diaphragm is actually the vibrating portion of the rugged, hermetically sealed housing, which permits transducer use out of doors for ultrasonic garage door openers, traffic counting, control systems, and other similar uses.

A typical ultrasonic carrier application is in large convention halls or legislative assembly halls where small individual ultrasonic carrier transceivers placed on each desk replace the noisy, high powered conventional p-a system. The auditorium is equipped with several permanently installed low power ultrasonic transducers which transmit the speech-modulated carrier and fill the room with "silent sound". The modulated ultrasonic carrier is picked up by the transducer in each desk set and the sound reproduced through a small individual loudspeaker or earphone.

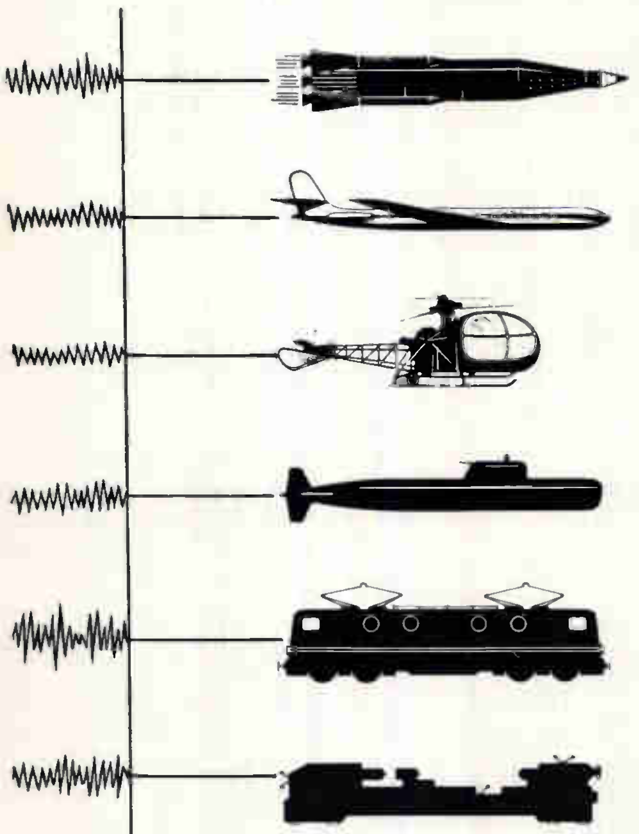
Each individual talks back through his transceiver and his transmitted modulated ultrasonic signal is picked up by the permanent room-mounted receiving transducers and instantly fed through the system to the transmitting transducers to be picked up by each of many individual receiving sets. Such a system operates on very low power and prevents the necessity of filling the room with high level sound as in present conventional public address systems.

The intelligibility of speech is greatly enhanced because of the individual low level reproduction that takes place by the ultrasonic system and also because of the relative independence of the ultrasonic carrier p-a system to room reverberation disturbances.

The large scale availability of these transducers has opened up many fields of applications in ultrasonic remote control systems, carrier frequency systems, burglar protection, counting systems and many other related uses.

Figure 3 charts transmitting re-do away with

VIBRATION



VIBRACHOC kills vibration. Everything that runs, turns, flies or sails owes its performance and safety to VIBRACHOC.

For the health of men and machines and the well-being of your firm.

VIBRACHOC, the all-metal shock-absorber.

Our technical department is at your disposal to examine yours problems.

VIBRACHOC

Licence Robinson Technical Products Inc U.S.A for Western Europe

39, RUE DES MATHURINS, PARIS
TÉLÉPHONE : ANJ. 80-61

CIRCLE 202 ON READER SERVICE CARD

RAPID ADVANCES ARE BEING MADE WITH

PRINTED CIRCUITS

...and you ought to know all about them!

ARE YOU AWARE...

- that you now can produce printed circuits on two sides of a base board *without mechanical conductors?*
- that you can eliminate eyelets, eyelet setters and machine operators?
- that you can reduce rejects . . . cut out failure in use from vibration . . . increase the efficiency of the circuit?
- that unless the base board is properly cleaned and prepared, failure is virtually certain?
- that new uses, new economies, new production short-cuts are being developed daily . . . and that you can get in on the latest know-how right now?

The MacDermid representative has the know-how to help you with any of your problems.

Write today for your free copy of MacDermid's new "Printed Circuit Manual"

It's loaded with production tips, technical data sheets, information on the best chemicals and compounds to produce printed circuits efficiently . . . plus timely warnings that may save thousands of dollars on your production line.

For your free copy, just write . . .
MacDermid, Dept. E, Waterbury 20, Conn.

MacDermid INCORPORATED
...right to the Finish!
WATERBURY, CONNECTICUT

CIRCLE 129 ON READER SERVICE CARD

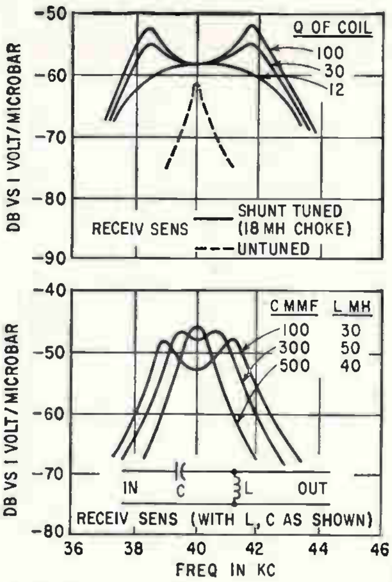


FIG. 4—Receiving response characteristics of the free edge transducer

sponse characteristics of Massa's Model TR-7 transducer supplied with 100 milliwatts of available power. Curve (A) represents untuned transducer fed from 4,000 ohm impedance source. Curve (B) is series tuned with 18 mh choke fed from 500-ohm source or shunt tuned with 18 mh choke and fed from 40,000-ohm source.

Figure 4 gives the receiving response characteristics of the TR-7 transducer.

Semiconductive Uranium

ACCORDING TO H. W. Nelson and R. L. Carmichael of Battelle Memorial Institute, a review of the known properties of uranium compounds suggests that some of these materials may possess semiconductive properties of interest in high-temperature applications[1].

Since so little work has been done with these compounds, remarks about their properties and potential uses must be regarded as speculation until definite parameters pinpoint their technical and economic feasibility. However, since there is a great need for semiconductive materials that will function effectively at high ambient temperatures, the ultimate potentialities warrant further investigation.

Of the uranium compounds most

likely to exhibit the type of bonding found in semiconductors, monocompounds uranium-tellurium and uranium selenium would be of most interest.

Back in 1954, R. Ferro reported that UTe and USe crystallize in NaCl-type structures with lattice constants of 6.163 A and 5.750 A respectively. It is expected that melting points are well above 1,000 degrees C.

It is reasonable to expect that these compounds are semiconductors with energy gaps higher than 1 ev. And if so, they may have important applications as solid state devices. Uranium telluride is especially interesting since it has the highest molecular weight of the series.

Experimental work would be required to assess the true value of uranium Group VI semiconductors.

REFERENCE

(1) H. W. Nelson and R. L. Carmichael, Potential Nonnuclear Uses for Depleted Uranium, Battelle Memorial Institute, Contract W-7405-eng-92, Bulletin TID-8203, Office of Technical Service, U. S. Dept. of Commerce, Wash., D. C.

Varactor Diodes

VARACTOR DIODES, used as high-efficiency sub-harmonic oscillators in microwave computers, are now available in experimental quantities from Microwave Associates, Inc., Burlington, Mass.

This series of five miniature pill varactor diodes have cut-off frequencies from 30 KMc through 120 KMc and have outside dimensions of ⅛ in. by ⅛ in. One of their major uses is in traveling-wave broadband parametric amplifiers. The diodes can be supplied to ±10 percent capacitance tolerance for such uses.

Stray susceptance is kept at a minimum as a result of the extremely close tolerances maintained in fabrication. As a high-frequency harmonic generator, power outputs up to 20 milliwatts are reported in tripling X-band input power to the 35 KMc region.

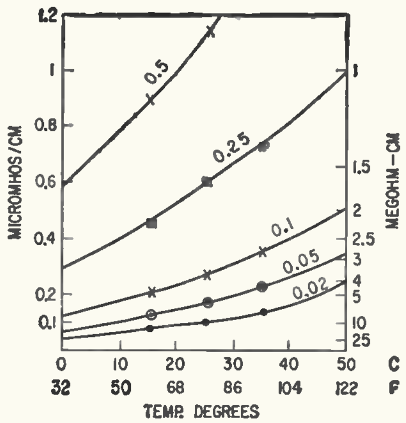
These pill varactors have ceramic-to-metal seals for ruggedness. The package shunt capacitance is approx. 0.2 pf. Series lead inductance is about 0.8×10^{-9} henries.

Making and Using High-Purity Water

By ROBERT BRUNS, The Permutit Co., Division of Pfaudler Permutit Inc., New York, N. Y.

WATER DEMINERALIZERS customarily produce water of an average or minimum acceptable quality well below ultimate quality. Some recent applications, however, require a constant quality near the ultimate: water virtually free of particulate matter, dissolved solids and gases.

To produce this "ultimate water" requires advanced applications of ion exchange techniques and an understanding by the user of several basic factors. These include temperature, impurity (or electrolyte) content, input water quality, reproducibility of resin regeneration, flow rates, equipment design and resin quality.



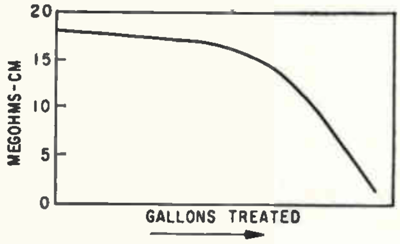


FIG. 2—Specific resistance as function of gallons treated in demineralizer

FIG. 1—Effect of temperature and salt concentration (in ppm) on specific conductance and resistance (left)

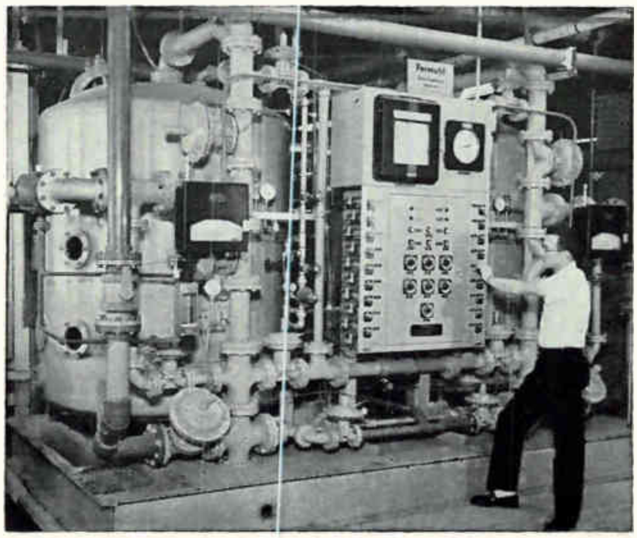
Specific conductance (in micromhos per cm.) or its reciprocal, specific resistance (in megohms-cm.) are measures of quality. These vary according to temperature and electrolyte. Figure 1 approximates these variations with salt as the electrolyte. Mixed resin beds can produce water of widely varying quality, depending on the end of run cutoff point (Fig. 2). Acceptable endpoints may be 1 megohm for crt screening or high voltage anode cooling, 10 megohms for washing alloy type transistors, or 15 to 18 megohms for washing more sensitive transistors.

When the range between peak quality and minimum acceptable quality is decreased, resin capacity ratings are lowered. High regeneration levels are needed for maximum resin sensitivity and reasonable capacity. Since the mixed anion and cation exchange resins will be only partially exhausted when removed from service, they will tend to remain mixed, preventing hydraulic separation before regeneration.

Exhaustion is therefore induced before regeneration by washing the mixed resin with sodium chloride, sodium hydroxide or sodium sulphate. Very high level regeneration techniques are then needed to insure against sodium displacement.

In this work, good quality standard polystyrene cation resins and type 1 highly basic anion resins have been used. Regenerant quantities are as high as 40 pounds of 66° Baumé H_2SO_4 per cubic foot of cation exchange resin and 40 pounds NaOH per cubic foot of anion resin. Input water is pretreated so that it arrives at the beds with a resistivity of about 0.1 megohm and low silica content.

Ultimate water is extremely unstable, particularly at elevated tem-



Automatic mixed bed demineralizer (350 gpm, 18-megohm)

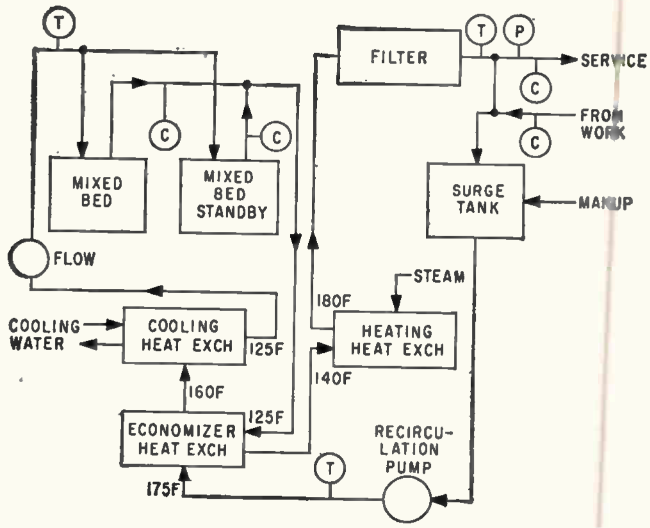
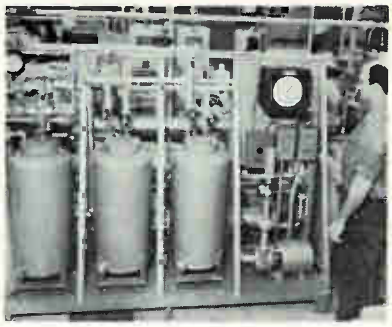


FIG. 3—Flow diagram of recirculating demineralizer



Small, recirculating demineralizer used on transistor production line

peratures. It degrades rapidly even on contact with such relatively inert materials as polyvinyl chloride, oxidized aluminum and tin. The higher the quality, the more rapid the initial rate of degradation.

When the water is transported, flow rates should be high and contact materials as inert as possible. In the 2 or 3 minutes it takes to travel 200 feet in PVC piping, for example, resistivity has been observed to decrease from 17-18 megohms to 13-15 megohms.

Equipment should be installed as close as possible to the point where the water is used. Special equipment may also be used for polishing demineralizer service receiving input from a central plant 2-stage or mixed bed demineralizer, which also supplies processes with less critical requirements. Since very high quality water cannot be stored, equipment must be sized to meet peak demand.

After 18-megohm water has been used in a process like washing transistors, it will still have a resistivity of perhaps 1 megohm. Since this is better than pretreatment may yield, the used water can be recirculated through the polishing demineralizer.

A flow diagram of equipment designed to produce transistor rinse water is shown in Fig. 3. Rinse water returned to the surge tank is automatically supplemented with makeup water as required. The heat exchangers are not required if water is to be used at ambient temperature. In this case, the water is used at 170 F. Returned water is therefore cooled to 130 F, the maximum temperature of the resin bed, and reheated after processing. The third heat exchanger is an economizer which transfers heat from returning water to outgoing water.

Treated water is filtered (to remove occasional resin particles picked up) through a 5-micron cellulose cartridge filter and is finally filtered through a 0.45-micron membrane. Feedback of treated water into the surge tank is provided, to help maintain input water quality and protect pumps in case flow is shut off at the point of use.

The plant is constructed of stainless steel and aluminum, with aluminum and Teflon piping. Instrumentation includes 4 cells, *C*, measuring resistivity after process stages and upon return, a resistivity indicator with 4-point selector switch, flow indicator, thermometers, *T*, and pressure gage, *P*. Because the resins cannot be regenerated in place, the demineralization units are installed with quick-opening couplings. Spent units are replaced and spent resins regenerated at a central staion. The photos show equipment installed at Philco Corp., Lansdale, Pa.

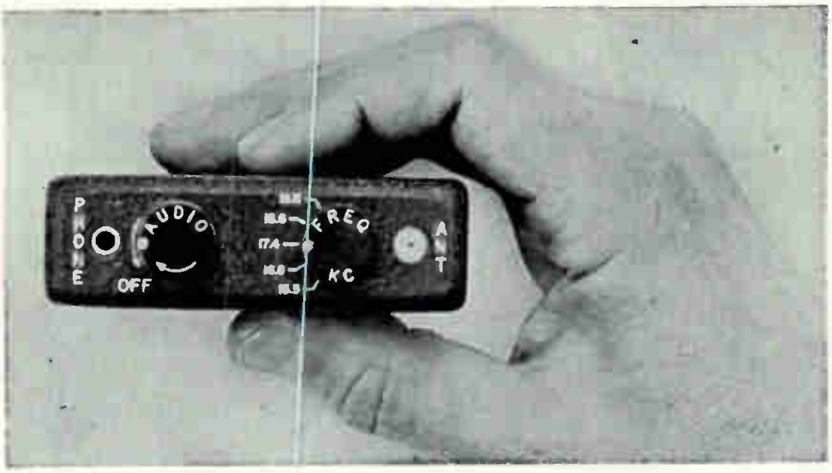
Frame of Radiation Beams Tests Cable

NONDESTRUCTIVE, continuous method of testing cable insulation for concentricity and uniform thickness has been devised by Britain's Atomic Energy Authority.

Radiation from 2 isotope sources is split by lead blocks into 2 slightly divergent pairs of thin beams. These form a frame of radiation in the center of which is the conducting wire. As long as the wire remains in the middle of the frame while the cable moves through the device, the intensity of the four beams emerging from the cable will remain the same, since they will be passing through appreciably equal thicknesses of the same material.

However, if there is a thin spot in the covering material, causing the wire core to move to one side, one beam will be affected since the metal will have a different degree of absorption of the radiation. Detectors employed to pick up the emergent beams indicate this change in intensity and can be linked to show on which side the thinning lies.

New On The Market



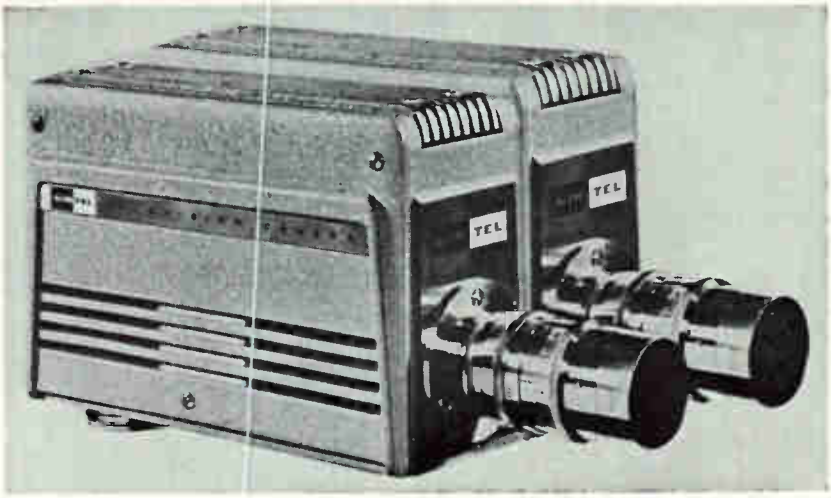
VLF Receiver

TRANSISTORIZED, DEVICE

RECEPTION of world-wide very-low-frequency fleet broadcast signals can be accomplished with a light-weight receiver developed by Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood, Calif. The model 289-1 receiver makes five frequencies available, crystal-controlled between 14 Kc and 20 Kc; bandwidth is 500 cps; sensitivity 0.005 microvolt.

Image and i-f rejection is 80 db; agc control 60 db on keyed c-w reception, output impedance is 600 ohms and the audio is 100 mw. Power supply is a 4-volt mercury battery capable of 100-hr continuous operation; antenna is ferrite, 7/16 by 1 5/16 by 4½ in., weighing 6 oz. Receiver is 1 by 3¾ by 4 in. weighing 10 oz.

CIRCLE 301 ON READER SERVICE CARD



3-D Tv System

CLOSED-CIRCUIT

POSITIVE manipulation of radioactive or other dangerous materials 1,000 ft away can be accomplished with a three-dimensional closed-circuit television system developed by the Kin Tel division of Cohu Electronics, Inc., 5725 Kearny Villa Rd., San Diego, Calif. The system consists of two standard closed-circuit tv cameras and a monitor/control console housing two monitors, two camera control units, and a polarized optical system.

The optical system presents the overlapping images from each camera on a single viewing plane, with one image polarized horizontally and one polarized vertically. Observation of this image through glasses or a viewing hood with horizontally and vertically polarized lenses provides a true three-dimensional presentation.

The standard console uses 14-in. monitors, but can be supplied with monitors from 8 to 27 inches. Remotely controlled zoom lenses, pan-tilt units and other system accessories can be used.

CIRCLE 302 ON READER SERVICE CARD

Thermoelectric Material

USES FOUR ELEMENTS

DEVELOPMENT of a new semiconductor alloy of bismuth, tellurium, selenium and antimony is announced by General Thermoelectric Corporation, P. O. Box 253, Princeton, N. J.

Known as Neelium, the new semiconductor material is used to make

thermocouples. A module consistting of eight thermocouples is called a Frigistor.

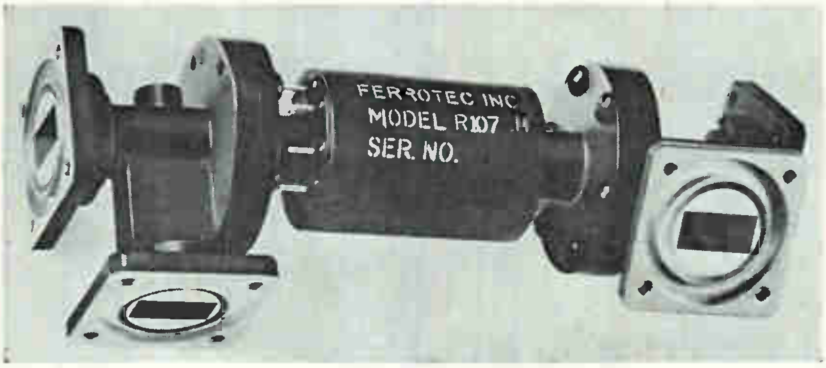
Neelium is made into blocks that have a volume of 0.337 cu in. Frigistors containing eight thermocouples measure 1 by 1 by ¼ in. The assembly, designated Model F-8, is sealed in a plastic case. Only metallic-parts exposed are the copper connector bars that serve as heat transmission elements. All surfaces are ground and lapped for maximum heat transfer.

A typical value for the figure of merit for Neelium is $Z = 3 \times 10^{-3}$ C^{-1}, measured with the hot junction at +55 C. The material provides a cold junction temperature of −25 C under these same conditions.

Heat pumping capacity for an eight-couple unit is as high as 10 to 15 watts. There are units that use currents as low as 5 amperes at 0.5

volt. Frigistors for cooling of high-frequency germanium transistors with flat L, U or square shape cold junctions permit operations at temperatures up to 150 C. Cooled silicon power transistors will operate at temperatures of over 300 C.

CIRCLE 303 ON READER SERVICE CARD



Ku-Band Switch
USES FERRITE

A NEW Ku-band high-power fast ferrite switch enables two microwave antennas to be time-shared by a common transmitter and receiver while maintaining high isolation between the magnetron and load.

Developed by Ferrotec, Inc., 217 California St., Newton, Mass., the model R-107H is capable of handling peak power levels of 100 Kw, at 100 watts average, and can be switched at speeds under 10 microseconds. Switching is performed using less than 70 watts peak and 2 watts average power. The fast-switch operates over a 2 percent band between 15.7 and 16.9 Gc, with loss of only 0.5 db, maximum vswr of 1.20, and isolation between ports greater than 20 db. The switch is operable over the full temperature range −40 C to 100 C.

The switch uses the Faraday rotation principle, with a ferrite structure between a pair of two-mode transducers. The output transducer is oriented 45 deg with respect to the input transducer.

CIRCLE 304 ON READER SERVICE CARD

Magnetic Disk
STORES 100,000 BITS

DIGITAL storage using a flexible rotating disk of paper-thin magnetic Mylar has been developed by Laboratory for Electronics' Computer Products division, 1079 Commonwealth Ave., Boston. Designated the series DB-100, it is intended for commercial application.

The Mylar material maintains a small, controlled separation between the storage-disk medium and the read/write heads of the memory unit through use of basic fluid motion principles. The disk, 7½ in. in diameter, stores 100,000 bits of information on 32 tracks, up to 3,000 bits per track.

Low mass of the revolving disk, positive separation between disk and back plate, air-tight sealing of the unit and simplification of machining are advantages of the new memory. It may be mounted either horizontally or vertically with no difference in performance. It can be used in either fixed-station or mobile computer systems of special or general-purpose type. It requires no warmup and can withstand severe thermal shock, operating within a temperature range 30 to 150 F. The DB-100 weighs approximately 15 lb and measures 9 by 9 by 5 in.

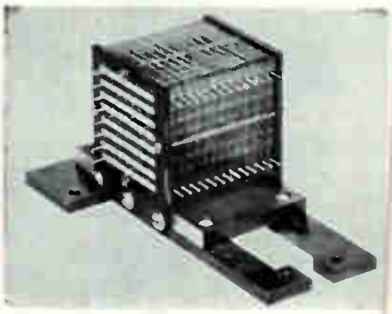
CIRCLE 305 ON READER SERVICE CARD

Magnetic-Rod Memory
MICROSECOND CYCLE TIME

MEGACYCLE rod memories are available from National Cash Register, 1401 E. El Segundo Blvd., Hawthorne, Calif. The memory should be able to replace a number of high-speed flip-flop registers.

The novel memory was developed around an assembly of glass rods 0.010-inch in diameter that are electroplated with a magnetic alloy and wound with many small coils.

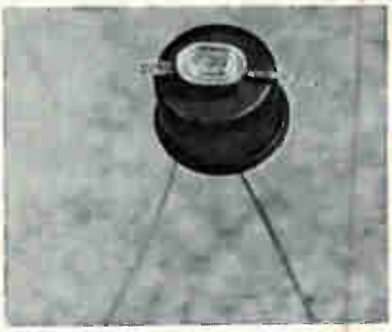
The complete read-write cycle, including access time, requires one microsecond. Rod memories have been built to operate with a 0.5-microsecond cycle; one intended to



operate in 0.25 microsecond is under development.

The rod element has operated over a temperature range of −100 C to 200 C without appreciable change in switching characteristics. It can be switched in less than 50 nanoseconds with moderate currents.

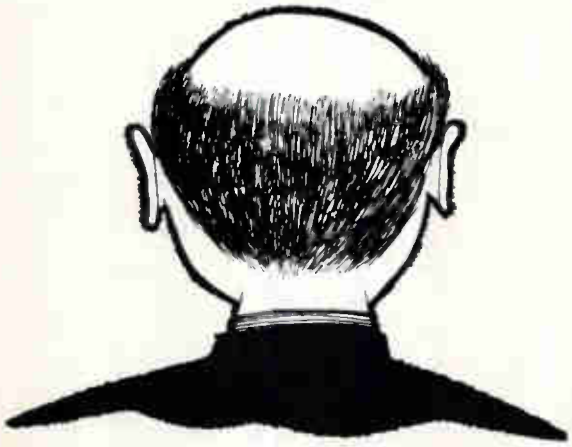
CIRCLE 306 ON READER SERVICE CARD



Transistor Enclosure
MICROMINIATURE SIZE

A NEW microminiature transistor enclosure small enough to permit component densities on the order of 1,000,000 parts per cubic foot has been developed by the Lansdale

IT'S WHAT'S IN HERE THAT COUNTS



Do you know, for instance ... which electronic stocks are hottest? Who's in the news and why? About "Three Approaches to Microminiaturization"? About the newest product ideas hitting the market? What's up in production? Opportunities overseas? What's going on in Washington?

It pays to know more than the next man! The questions above are just 6 reasons why you should subscribe to *electronics*.

IF YOU'RE ON THE TAG END OF A ROUTING SLIP, get your own subscription. Knowing what's going on is the first step to going *up*.

Fill in the coupon below right now ... it will pay big dividends.

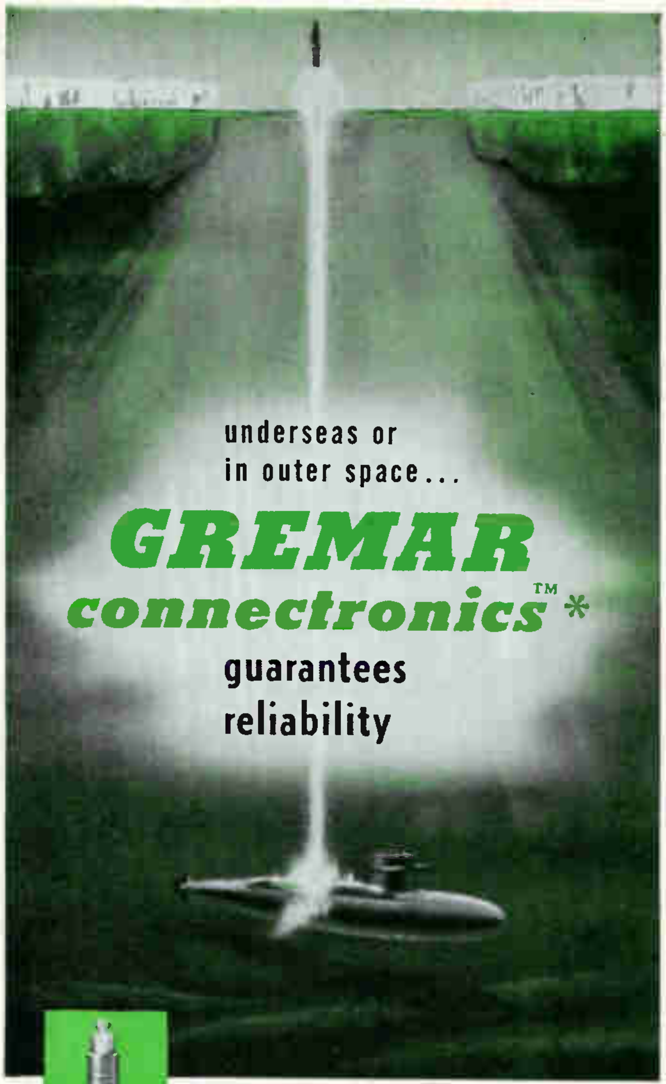
FIND WHAT YOU NEED IN... electronics

_____Renew my subscription for 3 more years.
_____Enter my new subscription.

U.S. Subscription Rates: _____3 years $12. _____1 year $6
Canadian rates $10 for 1 year. Foreign rates $20 for 1 year.

Name_____
Street_____
City_____ Zone_____ State_____
Company_____
Street_____
City_____ Zone_____ State_____
Your Title_____ Department_____
Product Manufactured or Service Performed_____

Mail reply to: electronics, 330 West 42nd Street, New York 36, N.Y.



GENERAL DYNAMICS' Electric Boat Division specifies Gremar hull antenna fittings for our latest atomic powered, POLARIS — armed, missile subs: George Washington and Patrick Henry. Why Gremar?

*BECAUSE GREMAR CONNECTRONICS™ concentrates engineering, production and quality control on RF Connectors *only* . . . guarantees 100% conformance to your most exacting specs.

BECAUSE GREMAR DELIVERS . . . by stocking America's most complete line of RF Connectors and Fittings . . . by maintaining a shelf stock of more than 500,000 assembled units . . . of over 2,000 types . . . and 4,000,000 component parts ready for fast assembly!

SPECIFY GREMAR for top-level reliability and performance in RF Connectors. Write for literature on any series of standard RF Connectors . . . or send us your specs on special requirements.

Helium mass spectrometer leak test performed on critical hermetic seal problems can detect a leak that would pass only 1 oz. of fluid in 500 years! Just one of 142 separate quality checks performed to make Gremar RF Connectors specified for use in all major missile programs.

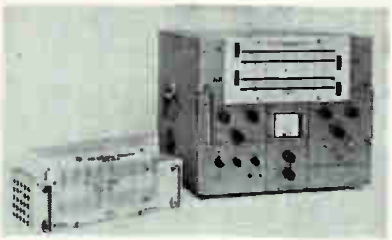
GREMAR
MANUFACTURING COMPANY, INC.
RELIABILITY THROUGH QUALITY CONTROL
Dept. A Wakefield, Mass., CRystal 9-4580

div., Philco Corp., Lansdale, Pa.

The enclosure is a flat package measuring 0.125 in. wide, 0.180 in. long and 0.060 in. high. About 42 such enclosures can be mounted on a one-square-inch multielement wafer, and still add only about 1/8 inch to its thickness.

The design features a cold-welded, metal-to-glass, hermetically sealed package providing a minimum seal length of 0.050 in. It will house any type of standard computer transistor.

CIRCLE 307 ON READER SERVICE CARD



Microwave Oscillator

PLUG-IN GENERATORS

MICROWAVE oscillator featuring plug-in generator heads has been developed by Alfred Electronics, 897 Commercial St., Palo Alto, Calif.

Each generator head of the model 605 consists of a backward-wave oscillator and solenoid, and is designed to be inserted into the rear of the oscillator. Heads are available in steps of 1 to 2, 2 to 4, 4 to 8, 8 to 12.4 and 10 to 15.5 Gc.

The model 605 is priced at $1,750. Heads vary from $1,590 to $1,990.

CIRCLE 308 ON READER SERVICE CARD

Crossed-Field Amplifier

FORWARD-WAVE TYPE

DEVELOPMENT of crossed-field forward-wave amplifiers for pulse and c-w application at a variety of frequencies and power levels has been announced by Litton Industries, Electron Tube division, 960 Industrial Rd., San Carlos, Calif. Performance details are classified.

In comparison with the O-type traveling-wave amplifier, the crossed-field forward-wave device offers higher average c-w power, higher efficiency, broader bandwidth, and smaller size and weight per unit of power output. The field orientation in the crossed-field amplifier permits the microwave circuit to be wrapped into a circle. This results in pronounced size and weight reductions as well as allowing family-type design. The crossed-field amplifier uses a permanent magnet.

The non-reentrant beam forward-wave crossed-field amplifier has no electronic or other inherent feedback mechanisms, offers high gain, broad bandwidth, great power capability and no noise or spurious oscillation in absence of r-f drive.

The tube may be of interest to qualified government contractors.

CIRCLE 309 ON READER SERVICE CARD

Nuvistor Tetrode Tube

SMALL IN SIZE

IMMEDIATE availability of the developmental Nuvistor small-signal tetrode in limited sampling quantities has been announced by the Radio Corp. of America, 30 Rockefeller Plaza, New York.

The tetrode is about one third the size of conventional radio-frequency amplifiers and consumes approximately one half as much heater power.

The tube requires 6.3 v on the heater and draws 0.165 amp heater current. Control-grid-to-plate capacitance is 0.01 micromicrofarad. As a class A1 amplifier with 125 v on the plate and 9.6 ma plate voltage, the tube affords a transconductance of 10,200 micromhos.

Absolute maximum ratings are plate voltage 250 v, cathode current 20 ma and plate dissipation 2.2 w.

CIRCLE 310 ON READER SERVICE CARD

Attenuators

HIGHLY ACCURATE

WAYNE KERR CORP., 1633 Race St., Philadelphia 3, Pa. Four separate attenuators have been developed to cover a range of 0 to 61.5 db in 0.5 db steps to an accuracy of 0.1 db. Insertion loss is less than 0.05 db with a power rating of 1 w. Frequency range is d-c to 70 Mc with characteristic impedances of 50, 75, 92 and 600 ohms. Price: $110 to $130. Availability: Delivery from stock to 4 weeks.

CIRCLE 325 ON READER SERVICE CARD

Test Oscillator

FOR TELEMETRY

CROSBY-TELETRONICS CORP., Westbury, N. Y., has developed an advanced telemetering test oscillator which is being used to ground check components in the Polaris missile program. Model TO-258, designed with high frequency stability, provides accurate calibration of subcarrier units in the f-m/f-m telemetering system. High frequency stability and deviation control calibrated directly in percent make the instrument ideal for production testing and other applications utilizing standard test frequencies. Models can be supplied with any 20 frequencies from 20 cps to 100 Kc. Selection of frequencies is made by push-button.

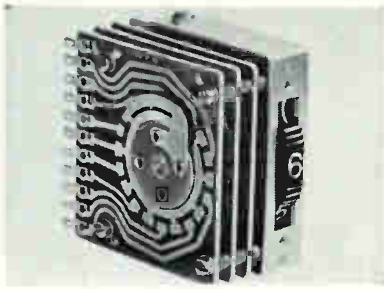
CIRCLE 326 ON READER SERVICE CARD

Power Supplies

D-C/D-C LINE

ARNOUX CORP., 11924 W. Washington Blvd., Los Angeles 66, Calif. A new line of d-c/d-c power supplies, primarily for missile and other airborne applications, is designed to step up d-c power and for precision regulation against line and load variation, even under large ambient temperature changes and other severe environmental conditions. Meets MIL-E-5272C. The solid-state units provide maximum reliability, minimal size and a range of voltages from 5 v d-c to 250 v d-c in 34 standard models.

CIRCLE 327 ON READER SERVICE CARD



Thumbwheel Switch
MULTIDECK UNIT

CHICAGO DYNAMIC INDUSTRIES, INC., 1725 Diversey Blvd., Chicago 14, Ill., has developed a multideck 8, 10 or 12 position thumbwheel switch uniting high reliability with a simpler approach to complex switching problems. Series TMBD-P-10 is available with 2, 3 or 4 XXXP or epoxy p-c modules. These consist of any combination of binary and digital rotary thumbwheel switches all manually operated by a single ¼ in. black Delrin thumbwheel. Instant, accurate readability is provided by exposing only one large, clear white or red number at a time through bezel opening. Numbers can be lighted if desired. Contacts are precious metal alloy and mounting frames corrosion-protected aluminum.

CIRCLE 328 ON READER SERVICE CARD

T-W Amplifier
ULTRA LOW NOISE

WATKINS-JOHNSON CO., 3333 Hillview Ave., Palo Alto, Calif., announces a full octave band ultra low noise traveling-wave amplifier. The WJ-211 covers the 2,000 to 4,000 Mc band with spot noise figures in the order of 2.7 db and fixed voltage noise figures below 4.8 db across the band. It is expected to find wide use in radiometry, telemetry and radar applications. Externally, the new tube is compatible in size, weight and power supply requirements with present solenoid-focused low noise tubes, so that retrofitting changes are minimized. Long life is anticipated because of the low cathode operating temperatures (typical 650 C) and excellent tube vacuum. Price is $1,950, with 4-8 weeks delivery.

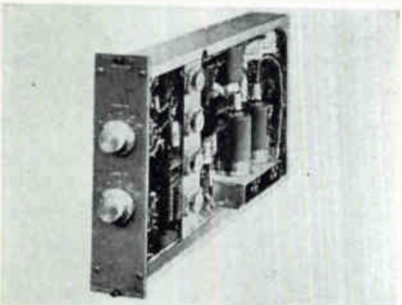
CIRCLE 329 ON READER SERVICE CARD

Broadband Mixer Diode

IMPROVED NOISE RATIO

SYLVANIA ELECTRIC PRODUCTS INC., Woburn, Mass., announces a new broadband mixer diode designed for use in advanced radar, countermeasures, and communications link equipment. Type 1N286A has a maximum conversion loss of 7.5 db and a maximum output ratio of 2.0 times over the entire 10,000-20,000 Mc frequency range. This is 1 db and 0.5 improvement over its prototype (type 1N286).

CIRCLE 330 ON READER SERVICE CARD



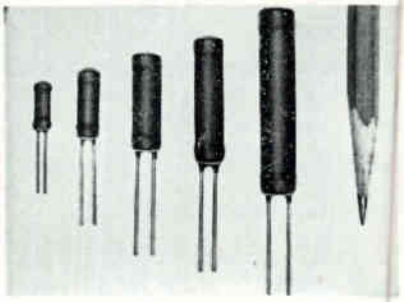
Data Amplifier

TWO-CHANNEL

OFFNER ELECTRONICS INC., 3900 River Road, Schiller Park, Ill. Type 492 is a completely transistorized data amplifier. It employs a circuit which inherently gives constant amplification, so that a gain accuracy of 1/100 percent is readily maintained without requiring exceptional stability from individual circuit components. This results in both high reliability and economy of design. Type 492 is a true differential input amplifier, and sev-

eral hundred volts may be applied between the input and ground without giving interference. Gains of 100, 250, 500, and 1,000 are selectable by a panel switch. Output impedance is less than 0.1 ohm. Two amplifiers are contained in each module and a total of 16 channels can be mounted in $8\frac{3}{4}$ in. of standard 19 in. rack space.

CIRCLE 331 ON READER SERVICE CARD



Wirewound Resistors
BASE MOUNTED

DALE PRODUCTS, INC., 1316 28th Ave., Columbus, Neb. Dalohm type PRS wirewound, miniature precision resistors are base mounted with two parallel leads; needing only an area equal to their circumference for mounting purposes. Especially designed to meet power requirements in printed circuits where space is at a premium, they offer ideal solution to miniaturization design problems. They are available in 4 wattages—3, 5, 7 and 10, and in 5 sizes ranging from $\frac{9}{16}$ by $\frac{3}{16}$ to $1\frac{3}{32}$ by $\frac{3}{8}$. Tolerance range is 0.05, 0.1, 0.25, 0.5, 1 and 3 percent. Resistance range is from 0.05 ohm to 175 K ohms. PRS-2 provides 100 percent power up to 100 C and derates to 0 at 275 C. The other four sizes provide 100 percent power to 25 C and derate to 0 at 275 C.

CIRCLE 332 ON READER SERVICE CARD

Pressure Transducers
SUBMINIATURE

STATHAM INSTRUMENTS, INC., 12401 W. Olympic Blvd., Los Angeles 64, Calif. Series 295 pressure transducers are designed to be easily stacked for maximum use of space. Series includes absolute, gage and both bi- and uni-directional differential pressure transducers. The absolute pressure transducers have a range of 0-5 to 0-5,000 psia. With 7 v d-c or a-c excitation, they provide a 42 to 56 mv nominal output. Gage pressure transducers range from 0-5 to 0-5,000 psig. They are rated for 5 v d-c or a-c excitation and have a nominal output of 30 to 40 mv. Bidirectional types vary from ±2.5 to ±25 psid. They are rated at 5 v d-c or a-c excitation and furnish a ±20 mv nominal output. Unidirectional types have a 0-5 to 0-1,000 psid range. Their output is 40 mv at 5 v d-c or a-c excitation. Compensated temperature range for all is −65 F to +250 F.

CIRCLE 333 ON READER SERVICE CARD

X-Y Oscilloscope

DIFFERENTIAL-INPUT

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 503 differential-input X-Y oscilloscope with sensitivity of 1 mv/cm is designed for the d-c to 450 Kc range. It utilizes a minimum number of tubes (equivalent 17 plus rectifiers) for the maximum degree of reliability. Vertical and horizontal amplifiers are identical. Characteristics include: input stages electronically regulated, calibrated steps to 20 v/cm, adjustable between 14 steps and to over 50 v/cm uncalibrated, differential input and constant input impedance (for easy probe use) at all sensitivities. Other features include: functional panel layout, 8 by 10 cm viewing area, 21 calibrated sweep rates with 5 degrees of magnification, electronically-regulated power supplies, and extremely adaptable trigger facilities.

CIRCLE 334 ON READER SERVICE CARD

Logic Blocks

MINIATURIZED

DYNAMIC CONTROLS CO., 2225 Massachusetts Ave., Cambridge, Mass. The Digipac line of miniature logic blocks includes a flip-flop, clock, delay, inverter, gate, pulse amplifier, and indicator. Circuits operate with wide margins at speeds up to 1 Mc, and are intended for use in permanent and semipermanent control systems. Power and logic connections are on opposite ends of the Pac, and either may be grounded without causing damage. Contacts are gold plated. The average Pac occupies 1½ cu in., weighs 1 oz, and dissipates 50 mw. Prices range from $20 to $39.

CIRCLE 335 ON READER SERVICE CARD

Mixer-Preamplifier

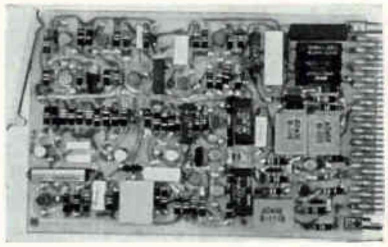
LOW NOISE

LEL, INC., 380 Oak St., Copiague, N. Y. The MMC-2 further extends the range of the company's matched microwave receiver mixer-preamplifier units to cover the 5,150 to 5,850 Mc bands. It has an i-f center frequency of 30 or 60 Mc, a minimum gain of 25 db, and an overall noise

CIRCLE 147 ON READER SERVICE CARD

figure of less than 7.5 db. Overall mounting space needed is no greater than that required for the mixer unit alone.

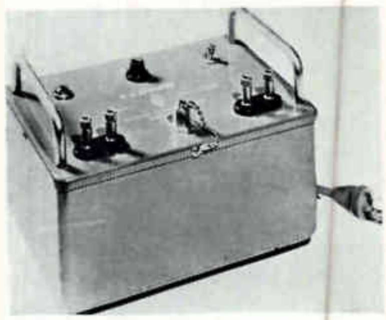
CIRCLE 336 ON READER SERVICE CARD



Sample/Hold Module
ALL SOLID-STATE

ADAGE, INC., 292 Main St., Cambridge 42, Mass. The SA1 is designed to sample rapidly moving wave forms and to hold the sampled value long enough to be converted to digital form in the company's Voldicon. Useful as a separate device, it is functionally equivalent to an input operational amplifier connected through a switch to an RC filter followed by a low impedance output amplifier. With the switch closed, the output follows the input in about the same fashion as a 2 μsec RC delay network. When the switch opens the voltage is held within 0.05 percent for one millisec. Unit is assembled on a 5 in. by 8 in. plug-in p-c card and can be incorporated as an accessory in any of the basic Voldicons.

CIRCLE 337 ON READER SERVICE CARD



D-C Amplifier
MULTIPURPOSE

HOUSTON INSTRUMENT CORP., P. O. Box 22234, Houston 27, Texas. The M-10A multipurpose-chopper stabilized d-c amplifier has a current output proportional to a millivolt input, making it useful for many laboratory and industrial applications. Two models (M-10A and M-10) are available which provide 0-5 and 0-10 mv input, respectively, with 5 megohms input impedance. Output of both is 0-1 ma for use with 0-1 ma meter movement recorders and meters so that signals from strain gages, remote thermocouples and other transducers in the frequency range of 0-2 cps may be measured. Used with an 0-1 ma or 0-100 μa meter, it becomes an 0-5 mv or 0-10 mv v-t millivoltmeter. With suitable shunts, it may be used as a current or voltage amplifier. Accuracy is 1 percent, linearity is ½ percent and drift is less than 50 μv referred to the input.

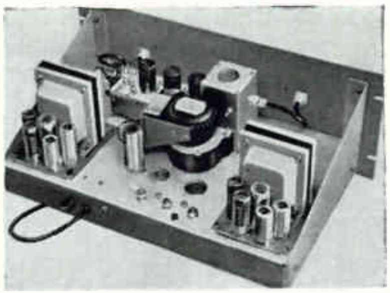
CIRCLE 338 ON READER SERVICE CARD

Test Sockets

FOR SEALED COMPONENTS

BARNES DEVELOPMENT CO., 213 W. Baltimore Ave., Lansdowne, Pa., has available test sockets in 150 standard configurations to accept a wide variety of relays, chokes, transformers, packaged circuits and other components. They accept headers with hook, pin, turret and other types of terminals. All sockets have two mutually insulated contacts to each terminal for use in contact resistance measurement, or for added testing reliability. Contacts are beryllium copper with gold plating, and each contact has a maximum resistance of 0.005 ohm. Sockets are constructed of mica-filled epoxy or urethane rubber and are suitable for environmental testing.

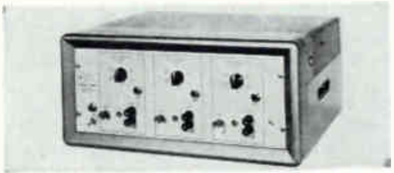
CIRCLE 339 ON READER SERVICE CARD



Telemetry Preamplifier
LOW-NOISE UNIT

LEL, INC., 380 Oak St., Copiague, N. Y. The TP-1P is a low-noise telemetry preamplifier complete with power supply and is designed for rack mounting in mobile field equipment vans where short transmission lines are used between antenna and preamplifier. Unit has a 3.2 db nominal noise figure, a gain of 38 db and a 32 Mc minimum pass band centered at 231 Mc.

CIRCLE 340 ON READER SERVICE CARD



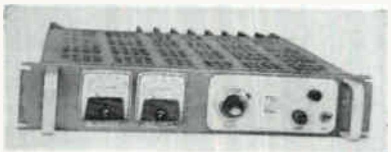
Cathode Follower
THREE-CHANNEL

COLUMBIA RESEARCH LABORATORIES, MacDade Blvd. and Bullens Lane, Woodlyne, Pa. Model 4003 cathode follower provides faithful reproduction of input signals as low as 1.0 mv over a frequency range of 0.02 cps to 1.0 Mc. Designed for steady state vibration and shock studies, the instrument's input impedance of 5,000 megohms and output resistance of 290 ohms makes it ideal for coupling the output of high impedance accelerometers to low impedance test and measuring equipment. Unit has a gain of 0.98, an output noise level of 75 μv, and a transient response capable of reproducing a 25 v pulse with a 0.4 μsec rise time and a 1.0 μsec decay time. The wide dynamic range of the instrument is provided by a high overload voltage of 42 v peak

CIRCLE 209 ON READER SERVICE CARD

to a transient as well as to a sinusoidal input signal, which can be extended by more than 100 times through the use of a built-in shunt capacitor switch.

CIRCLE 341 ON READER SERVICE CARD



D-C Power Supply
TRANSISTORIZED

NJE CORP., 20 Boright Ave., Kenilworth, N. J. A very high power-to-volume ratio—within a panel height of 3½ in.—has been achieved in the QR series transistorized d-c power supply. A typical unit, model QR-36-4, has an output of 0-36 v and 0-4 amperes which may be employed as either a positive or negative output, and may be floated up to 500 v peak above or below ground. Input power is 105-125 v, 55-65 cps, single phase; maximum ripple is 1 mv rms; static load regulation is ± 0.01 percent or ± 1 mv; static or dynamic line regulation is ± 0.03 percent or ± 3 mv. Maximum load transient response time is 25 μsec. Dimensions are 3½ by 19 by 16⅝ in.; approximate weight, 41 lb; price, $485.

CIRCLE 342 ON READER SERVICE CARD

Hybrid Transformer
FOR CRYSTAL FILTERS

ALLEN AVIONICS, INC., 255 E. 2nd St., Mineola, N. Y. Type 2000 series miniature hybrid transformer for use in crystal filters. Units are epoxy cased with p-c construction. Operating temperature is from −55 to +125 C with temperature coefficient as low as −40 ppm/deg C. Frequency range from 50 Kc to 50 Mc, high Q, tight coupling, controlled L ratios.

CIRCLE 343 ON READER SERVICE CARD

Literature of the Week

UHF ATTENUATORS Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif. A full line of precision coaxial attenuators and terminations, 2, 6 and 10-position turret-type step attenuators are presented in the 16-page catalog AT-3 with complete descriptions, applications, illustrations, specifications and curves.

CIRCLE 380 ON READER SERVICE CARD

INERTIAL GUIDANCE Sterling Precision Corp., 17 Matinecock Ave., Port Washington, N. Y. A 24-page brochure, No. 153, combines specifications and photos on precision turntables, rate tables, air bearing and fluid bearing tables, electronic test equipment and consoles and various related products.

CIRCLE 381 ON READER SERVICE CARD

CHROMATOGRAPHY Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Type 26-212 high-speed process chromatograph and the use of chromatography for closed-loop process control are subjects of a set of illustrated four-page brochures.

CIRCLE 382 ON READER SERVICE CARD

HERMETIC SEALS Dage Electric Co., Inc., Beech Grove, Ind. Catalog 1259 lists basic types of precision hermetic seals which are regularly available for evacuated or pressurized enclosures. Each type of seal is clearly illustrated and listings give complete dimensional specifications.

CIRCLE 383 ON READER SERVICE CARD

VACUUM FIRING FURNACE Kahle Engineering Co., 3322 Hudson Ave., Union City, N. J. Machine No. 3423 continuous firing vacuum furnace is illustrated and described in a single-page bulletin.

CIRCLE 384 ON READER SERVICE CARD

TANTALUM FOIL CAPACITORS Ohmite Mfg. Co., 3612 Howard St., Skokie, Ill. With the introduction of a line of etched tantalum foil electrolytic capacitors, the company has released a new bulletin describing this line and the existing plain foil line.

CIRCLE 385 ON READER SERVICE CARD

MULTICOUPLER PERFORMANCE Trak Electronics Co., 49 Danbury Road, Wilton, Conn., has available a booklet which discusses multicoupler characteristics, their measurement, and their effect on system performance.

CIRCLE 386 ON READER SERVICE CARD

MODULAR IN-LINE SWITCH The Digitran Co., 660 South Arroyo Parkway, Pasadena, Calif. Catalog 7300-A covers the Digiswitch unit, an electromechanical switching device which commutates a dial setting input to a coded electrical output.

CIRCLE 387 ON READER SERVICE CARD

INSTRUMENTS Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge 39, Mass. A 6-page illustrated catalog contains detailed technical specifications of a line of variable electronic filters, laboratory power amplifiers, wide-range RC oscillators, and regulated power supplies.

CIRCLE 388 ON READER SERVICE CARD

TUBING DATA Alpha Wire Corp., 200 Varick St., New York 14, N. Y. Important engineering data on the Alphlex tubing line (including dielectric strength, temperature rating, flammability, and military specifications, all in tabularized form for easy reference) are now available in a 2-color, 8-page catalog.

CIRCLE 389 ON READER SERVICE CARD

WIRE CATALOG Mechtron Division, Tensolite Insulated Wire Co., Inc., 1000 N. Division St., Peekskill, N. Y. An 8-page illustrated catalog describes the company's enameled wire, magnet wire and ultra-thin wall instrument wire.

CIRCLE 390 ON READER SERVICE CARD

DECIMAL SCALERS Eldorado Electronics, 2821 Tenth St., Berkeley 10, Calif. Description, operation and specifications of the series SC-750 transistorized decimal scalers are given in bulletin No. D-750.

CIRCLE 391 ON READER SERVICE CARD

CIRCLE 153 ON READER SERVICE CARD

Mueller: the small first steps

NEWLY-ELECTED as vice president of R&D for Astro-Space Laboratories, a subsidiary of Belock Instrument Corp., Dr. Frederick K. Mueller is a soft-spoken man whose mannerisms show his precise way of thinking.

The one-time deputy director of the Army Ballistic Missile Agency's guidance control laboratory comes to his industry post with a considerable number of accomplishments behind him. After he schooled at Hildburghausen, Germany, his work in design engineering led him in 1938 to the development of the first all-inertial guidance system—for Wernher von Braun.

Working for the U. S. government's Guided Missile Development project in Ft. Bliss, Tex., he developed the stabilization of the Redstone and Jupiter missiles.

During his years with the U. S. Army, Dr. Mueller has held such offices as chief of the Gyro and Statistic branch and director of the von Braun development operation division.

In 1954, he received his United States citizenship (and he rarely misses an opportunity to praise his new country).

For a man whose work is his pleasure and whose pleasure is his work, "Fritz," as his friends sometimes call him, is an astute observer of the American scene. In commenting on the education of engineers here, he terms it for the most part excellent and does not feel that its detractors are on very firm ground.

When asked about the apparently high rate of missile shoot failures in America as compared with the number of successful Soviet launchings, he smiles and says, "I'm sure we hear only of their successes and never of their failures." He also feels the practice of letting Americans know of both successes and failures is a good thing. "The people should be kept informed," he says. "When too much is kept hidden from public view, it is bad for the country that does it."

One of the more recent developments with which Mueller is identified is a system for controlling the attitude of space vehicles by what amounts to a three-dimensional gyroscope. Despite the hard-headed reality that produced this and other systems, however, he still has room in his mind for dreams.

When asked about his motives for having devoted the major portion of his adult life to space-oriented research, his face assumes a very thoughtful expression. "It's hard to put in words," he says, "but I think man has an inner drive that makes him want to learn all he can about what is around him. I think someday man will travel to the planets and maybe beyond. The kind of work we're doing now, these small slow steps, will someday be remembered as the basic efforts that made it possible."

Mueller is completely at home in exchanging thoughts and information on electronics, mechanics and problems related to guidance systems. Although competent to deal with a variety of details, he prefers not to bother with the obvious. This is evident when he discusses a new system, for example, and leaves to others the smaller points of detail that free him to deal with new concepts.

The classified nature of his work, as well as its complexity, have left him little time for dabbling in hobbies. Except for swimming, his main relaxation consists in the very work that has occupied so much of his life and thought.

Eimac Appoints Product Manager

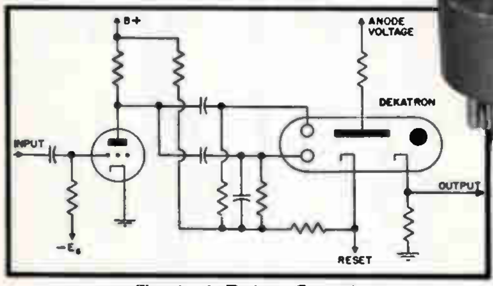
George M. W. Badger has been appointed to the newly-created position of product manager, power klystrons with Eitel-McCullough, Inc., San Carlos, Calif., manufacturer of Eimac electron-power tubes.

Badger came to Eimac in 1953 as research engineer. He was project engineer on early development of the company's power klystrons, and later was in charge of Eimac's

NOW—Complete Line

dekatron®

Electronic Counting Tubes
(up to 20,000 counts/sec.)



Typical Drive Circuit

Now available—only complete "Hand Book of Counting Tubes" in print. Tube specifications, applications, sample circuits, design criteria are included. Available at $1.00 a copy through Dekatron Tube Section, Baird-Atomic, Inc.

No C. O. D. or purchase orders, please! Cash, check or money order accepted.

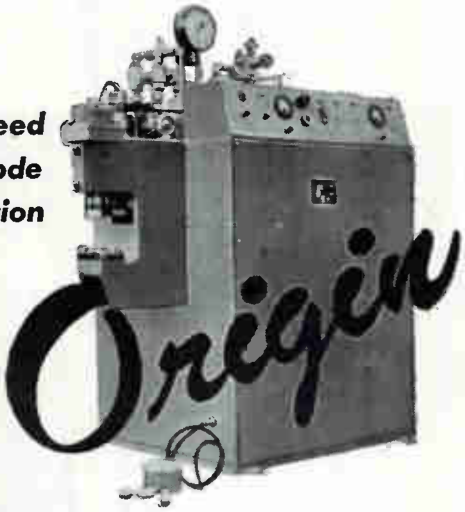
Baird-Atomic, Inc. Baird Atomic
33 UNIVERSITY RD., CAMBRIDGE 38, MASS.

Instrumentation for Better Analysis

CIRCLE 203 ON READER SERVICE CARD

Spot Welders

speed diode production



Semiconductor manufacturers in Japan use Origin's spot welders on production lines.

In diode sealing, the high thermal efficiency of this welding method, known as the Riken (The Institute of Physical and Chemical Research) system, prevents oxidation and change in crystal structure. Joint strength is highly uniform. Low power input and high power factor give economy of operation.

Models are available in capacities from 2.5 KVA to 15 KVA. Please ask for catalog.

Origin also produces superior silicon germanium and selenium rectifiers.

ORIGIN ELECTRIC CO., LTD.
Takadaminamicho, Toshimaku, Tokyo, Japan Cable Address: ORIGINELE TOKYO

CIRCLE 204 ON READER SERVICE CARD

what is LOW COST?

Your initial purchase price is only a fraction of the true cost of your components.

We can reduce your cost, because ELECTRO-MEC precision potentiometers and digitometers are delivered

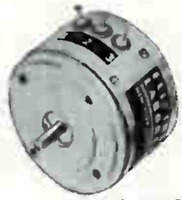
- on time
- with certified calibration data, including recordings of output function for both linear and non-linear instruments.

Therefore you

- save on receiving inspection cost
- enjoy assured performance after installation
- incur no production schedule delays.

You can rely on the experience and workmanship of ELECTRO-MEC

TYPE 9



TYPE 14

TYPE 18

TYPE 30

RELIABILITY = LOW COST

Only a few of our instruments are shown here.

Write or phone our engineering department.

ELECTRO-MEC LABORATORY, INC.
47-51 33 Street, Long Island City 1, New York
STillwell 6-3402 Teletype: NY 4-2126

CIRCLE 155 ON READER SERVICE CARD

color television laboratory.

Prior to joining Eimac, Badger helped pioneer development of the Lawrence color television picture tubes. He left the position of Eimac's manager, research and development, to assume his present post.

Appoint J. A. Oliva To EIA Committee

Joseph A. Oliva has been appointed to the Government Liaison Committee for Tubes and Semiconductors of the Electronic Industries Association. This committee represents the semiconductor industry in Government negotiations.

Oliva has had considerable government experience, especially in the area of industry-government problems. He is chief military application engineer for the International Rectifier Corporation of El Segundo, Calif.

Hazeltine Corporation Elects New President

Directors of Hazeltine Corporation, Little Neck, N. Y., have announced the election of Webster H. Wilson

SALES ENGINEERS

We are placing on the market several new products including recording and controlling instruments and require Sales Engineers for our Houston, St. Louis, Chicago, Detroit, and Cleveland districts. Prefer Electrical, Mechanical, or Chemical Engineers. Can offer excellent opportunities for qualified men. Successful candidates will be given a factory course at Waterbury before assignment to one of the above districts.

Write Mr. H. E. Beane, Vice President,

THE BRISTOL COMPANY
Waterbury 20, Connecticut

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

POSITIONS VACANT

New York law office engaged in all phases of patent law has an opening for patent lawyer with training in the electrical field. Recent law school graduate will receive consideration. Enclose photograph with resume. P-4409, Electronics.

Electronic Engineer (Instrumentation) $7510 per annum to begin, at Walter Reed Army Institute of Research, the primary research facility for the Army Medical Service in advanced study of medical problems. Work consists of design and development of components for research equipment used in the detection, counting, recording of alpha, beta gamma radiations in humans and biological samples. Well equipped biomedical research laboratory with special interest in whole body counting. B.S. degree in engineering plus three years experience, one of which must have been in nucleonics. Will consider applicants with less experience at entrance salary of $6285 per annum. Positions are in career civil service. Travel and transportation of household goods allowances. Write Civilian Personnel Office, Walter Reed Army Medical Center, Washington 12, D. C.

Excellent opportunity for qualified electrical and/or electronic engineers in expanding Research and Development Division. Project Engineers have complete responsibility for the development of instruments and control systems related to the pulp and paper industry. Please send resume to The Champion Paper and Fibre Company, Hamilton, Ohio, to the Attention of Kenneth L. Kaist, Asst. Personnel Director, General Personnel Administration.

BUSINESS OPPORTUNITY

Oriental Imports and Exports. Lines wanted —Import and export, specializing in Japanese electronic products. Nationwide coverage. S. W. Petersen, 1727 16th Ave., Seattle 22, Wash.

—PROFESSIONAL SERVICES—

ERCO RADIO LABORATORIES, INC.
Radio Communications Equipment
Engineering - Design - Development - Production
Our 30th Year in Air to Ground Communication and Radio Beacons
Garden City • Long Island • New York

EUGENE MITTELMANN, E.E., Ph.D.
Consulting Engineer, Physicist
ELECTRONICS FOR INDUSTRY
Analysis, Research and Development
549 West Washington Boulevard
Chicago 6, Illinois
CEntral 6-2983

TELECHROME MFG. CORP.
Electronic Design Specialists
COLOR TELEVISION EQUIPMENT
Flying Spot Scanners, Color Synthesizers, Keyers, Monitors, Oscilloscopes and Related Apparatus
Telemetering for Guided Missiles.
J. R. Popkin-Clurman, Pres. & Dir. of Eng.
28 Ranick Dr. Amityville, L. I., N. Y.

as president. The 36-year old electronics firm is listed by the Department of Defense as one of the nation's leading defense contractors.

Wilson had been executive vice president for operations of Hazeltine Electronics Division and a director of Hazeltine Corp. since 1958. He succeeds William A. MacDonald, who continues as chairman of the board.

Litton Industries Hires F. I. Scott, Jr.

FREDERICK I. SCOTT, JR. has joined the engineering staff of the Litton Industries' Electron Tube Division, San Carlos, Calif.

Prior to joining Litton's staff, Scott was employed by Eitel-McCullough, San Carlos, and for eight years was a design and development engineer for RCA, Harrison, N. J.

Electro-Sonic Labs Names Chief Engineer

WILLIAM DJINIS has been appointed chief engineer in charge of all scientific activities of Electro-Sonic Laboratories, Inc., Long Island City, N. Y.

Djinis has acquired broad experience as head of the Physics Research Department of General Bronze Electronics Corp., and previously as head of the Engineering Physics Group of Vitro Laboratories and senior project engineer of Reeves Instrument Corp. He has made substantial contributions to the atomic, infrared, microwave and computer fields.

INDEX TO ADVERTISERS

Audited Paid Circulation

* See advertisement in the June, 1959 Mid-Month ELECTRONICS BUYERS GUIDE for complete line of products or services.

* See advertisement in the June, 1959 Mid-Month ELECTRONICS BUYERS GUIDE for complete line of products or services.

This Index and our Reader Service Numbers are published as a service. Every precaution is taken to make them accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

We've Got to Compete

"MADE IN JAPAN" used to imply some degree of shoddiness. There was also an implication that the product was less than original. Today these implications are often invalid, where electronic products are concerned. That's why this issue of ELECTRONICS is devoted in large part to Japan and Japanese electronics.

Associate Editor Frank Leary, just returned from Japan, found abundant evidence that the Japanese are now contributing to the advancement of electronics in several important areas. They can no longer be thought of merely as makers of inexpensive products for the world market. And while almost one hundred million dollars worth of Japanese electronic goods will enter the United States during 1960, it is also true that an industry of this size could not have been built without a substantial flow of American materials, components, instruments and other products to Japan. It has been to some extent a two-way street, and will continue to be.

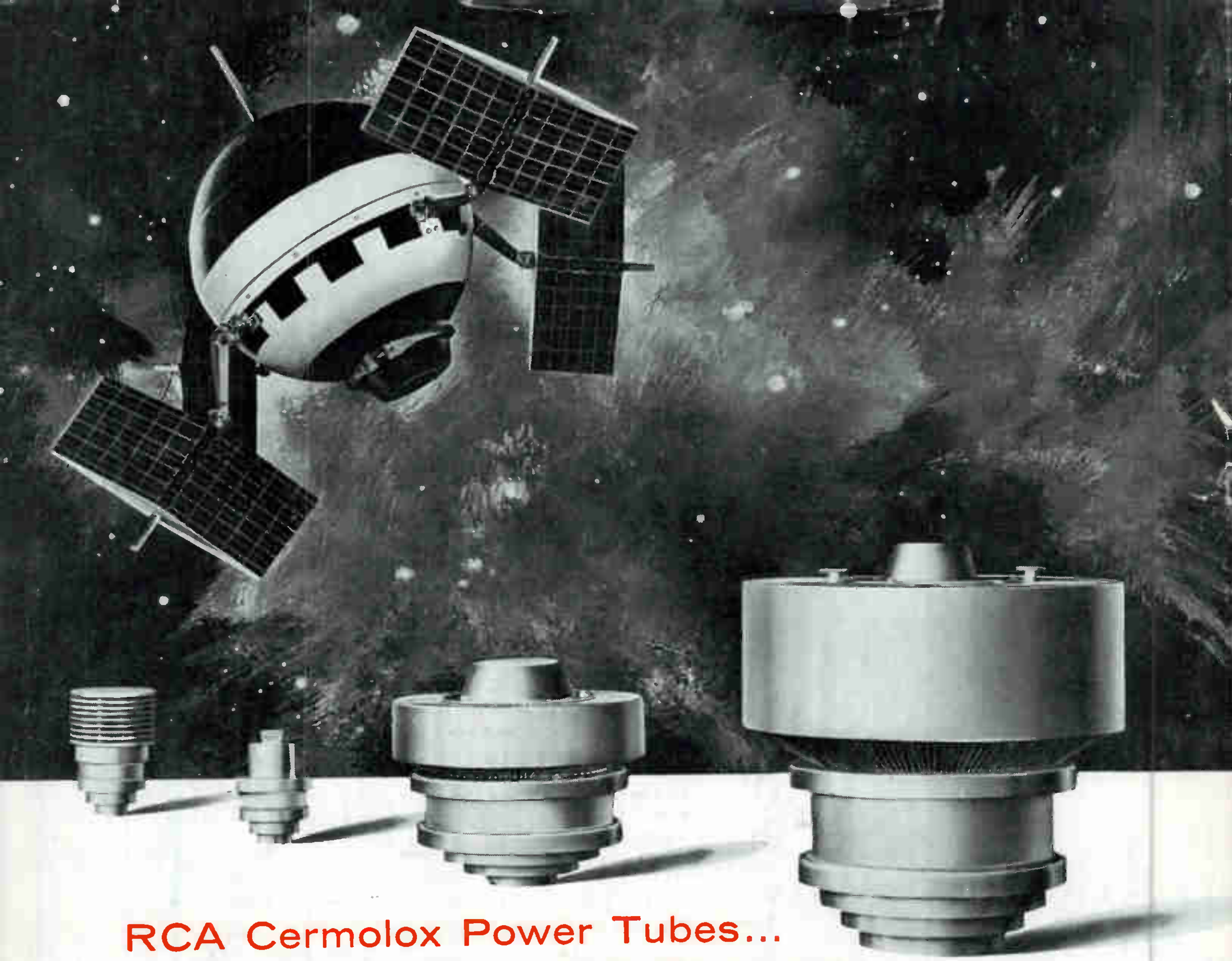
We talk about cheap foreign labor. Is Japanese labor really so cheap? Read what Frank Leary has to say about fringe benefits and other costs not widely appreciated here.

Engineers? Those of us who have spent any time around Cambridge, Massachusetts or Los Angeles, California, or indeed any large American university, have met many Japanese students, and teachers. Better-than-average, as we recall. With a directness of purpose about them. Where are they now? Many are back home in Japan. But are they being used efficiently? What are they doing? What are their problems?

Japan's competition is something the U. S. electronics industry has to face. And one fact is certain: tariff barriers are not a good long-term answer. Even in the short term they are a deterrent to clear thinking.

James Girdwood

PUBLISHER



RCA Cermolox Power Tubes... Chosen to Orbit with Pioneer V

In orbit and on the ground, four RCA Cermolox Power Tubes play key roles in Pioneer V guidance, control, and long-range communications systems.

- IN THE GROUND GUIDANCE SYSTEM at Cape Canaveral—the RCA-6816 and RCA-7213 helped put the artificial planetoid into its escape trajectory and solar orbit.
- IN THE CONTROL SYSTEMS in England and Hawaii—three types, the RCA-6816, RCA-7213, and RCA Dev. Type A-2545, are used to produce the 10-Kw signals which will be used to communicate with the planetoid, and control its transmitter, till it is 50 to 75 million miles from earth.
- IN THE ORBITING PLANETOID—two RCA Dev. Type A-2629 tubes were chosen for use in the 150 watt transmitter to test the feasibility of communications over interplanetary distances.

The tubes used in these systems are typical RCA Cermolox types. Like Space Technology Laboratories, Inc., designers of Pioneer V, you too, may find the successful link to your design problems in the unique and dependable line of RCA Cermolox Tubes. For further information about the use of these or other RCA Cermolox tubes in your applications, contact your RCA Field Representative or write to the Marketing Manager, RCA Electron Tube Division, Industrial Tube Products Department, Lancaster, Pa.

RCA Cermolox Power Tubes Used in Pioneer V Project

Type No.	CW Service Max. Plate Input (Watts)	Max. Frequency For Full Input (MC)	Max. Plate Dissipation (Watts)
6816	180	1215	115
A-2629*	180	1215	115
7213	2500	1215	1500
A-2545*	28000	400	10000

*RCA Development Type — Available on Sampling Basis.

RCA ELECTRON TUBE DIVISION FIELD OFFICES...Government Sales: Harrison, N. J., 415 South 5th Street, HUmboldt 5-3900 • Dayton 2, Ohio, 224 North Wilkinson Street, BAldwin 6-2366 • Washington 6, D.C., 1625 "K" Street, N.W., District 7-1260 • Industrial Products Sales: Detroit 2, Michigan, 714 New Center Building, TRinity 5-5600 • Newark 2, N. J., 744 Broad Street, HUmboldt 5-3900 • Chicago 54, Illinois, Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900 • Los Angeles 22, Calif., 6355 East Washington Blvd., RAymond 3-8361

RCA®

The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA