November 11, 1960

electronics

Dendritic ribbon of controlled thickness provides dice for 600 MADT transistors a minute with no waste. Growth and etching process has made possible complete use of germanium ingot. *See p 98*

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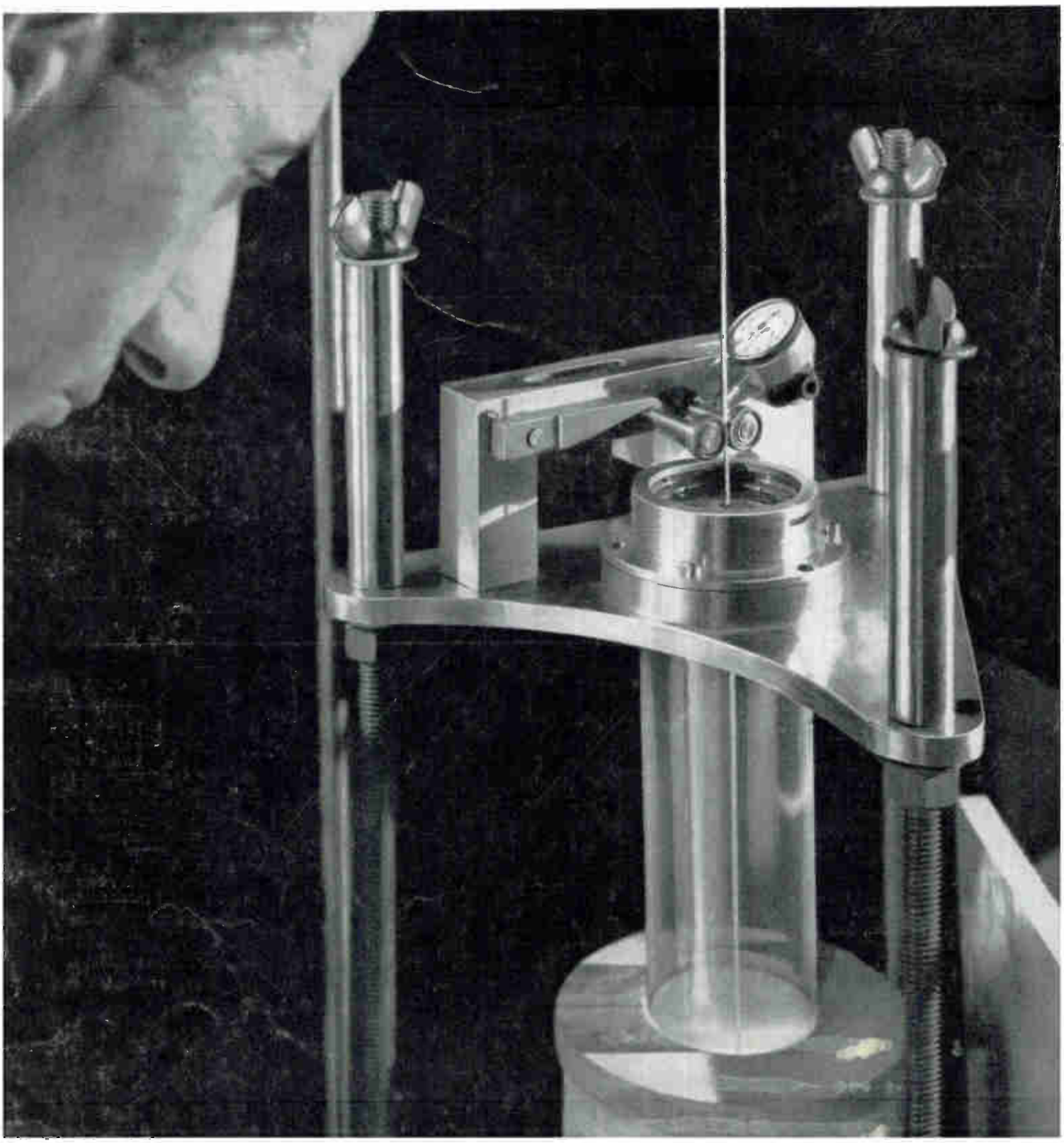

TESTED *waveguide and coaxial equipment*

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 1.1 (752A), 1.05 (752C/D). S through R bands, 2.6 to 40.0 KMC. $100.00 to $375.00.

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.

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.

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.

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.

362A Low Pass Filter

Compact models increase SWR measurement accuracy by suppressing harmonics; feature low insertion loss, broad stop band; M, N Band models, each $125.00.

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.

476A, 477B Detector Mounts

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

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.

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.

810/815B Slotted Sections

810B Slotted Sections 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.

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

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.

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

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. 805A, for 50 ohm Type N, 805B, for 46.3 ohm RG 44/U. 805A/B, $450.00.

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).

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)

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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 "Application Note 42" 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; 25 or 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 $135.00 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 G, H, J, 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 2 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

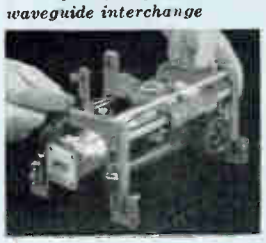
No computations! Provides instantaneous, automatic power readings *direct* in dbm or mw at all frequencies for which there are suitable bolometer mounts. For CW measurements, uses either 1/100 amp fuse or Sperry 821 barretter. Also measures CW or pulsed power with negative coefficient thermistor. Provides up to 16 ma bias current. Operates with hp 475, 476, 477, 485, 487 mounts. Range 0.01 to 10 mw. $250.00 (cabinet) $255.00 (rack mount).

IMPEDANCE MEASURING EQUIPMENT

-hp- 809B and 810B

-hp- 814B, 815B, 446B

Quick, easy waveguide interchange



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. 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.

November 11, 1960

electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

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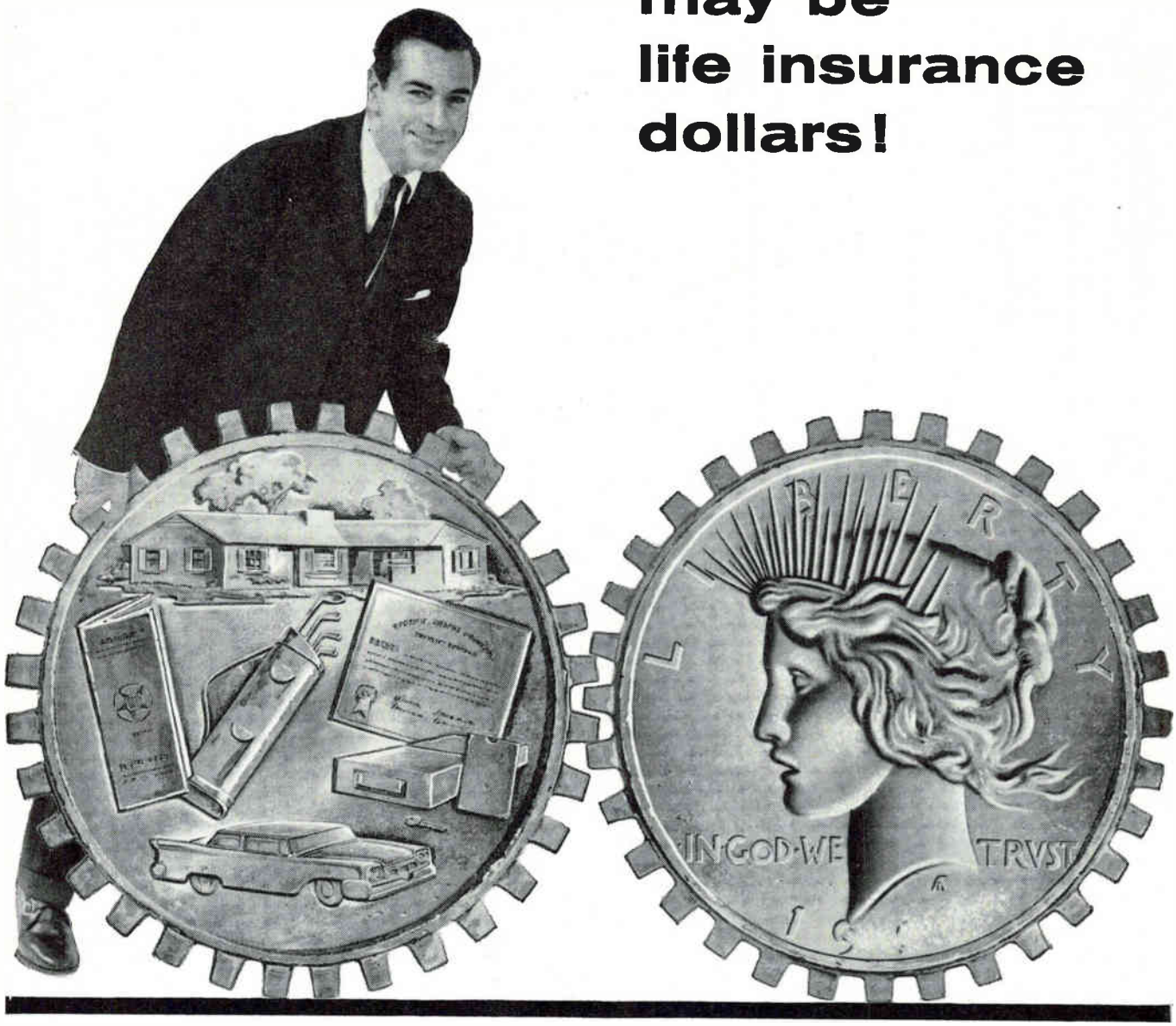
Your most effective dollars may be life insurance dollars!



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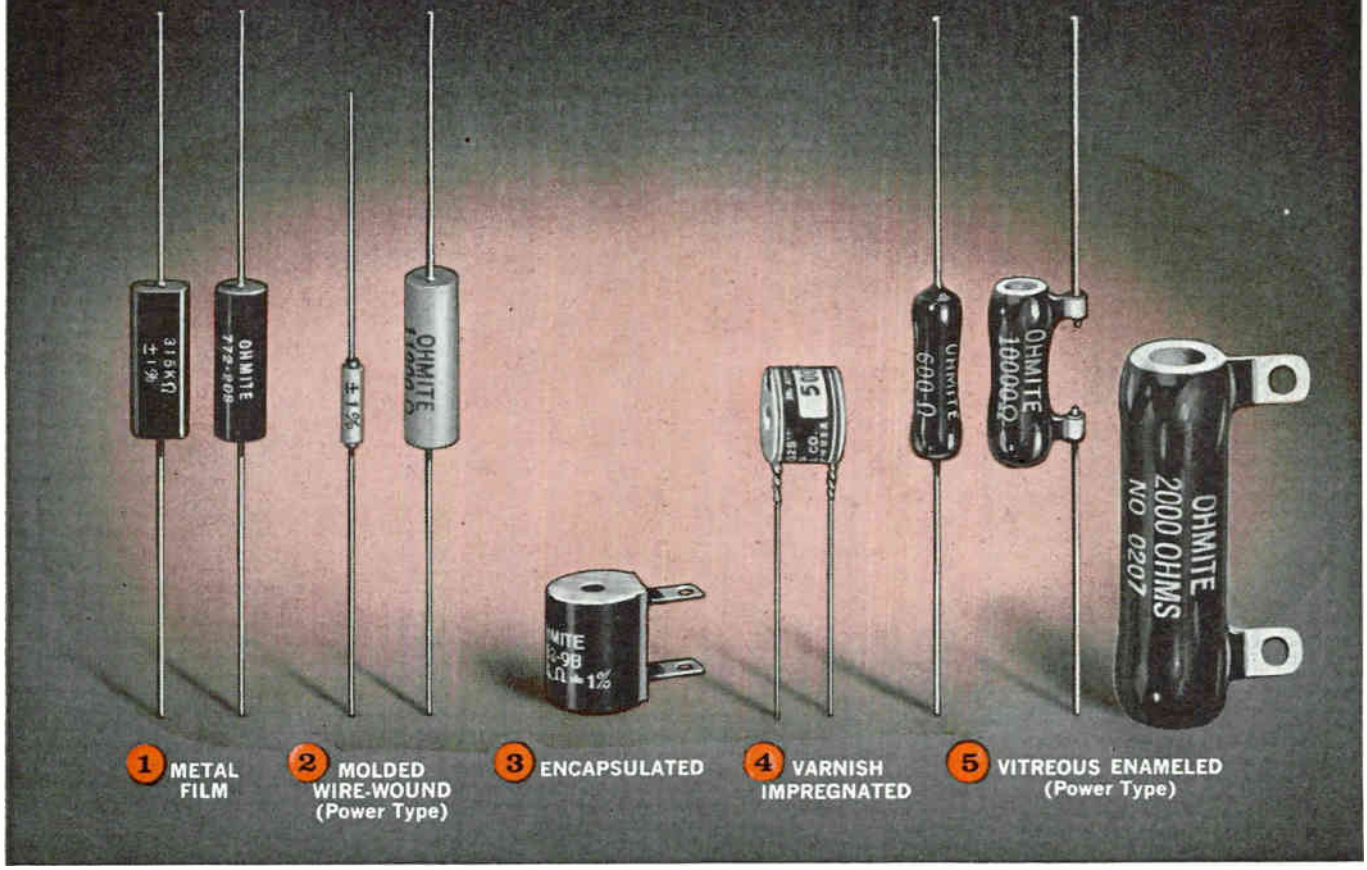

This large family of precision resistors offers you flexibility for varied applications and traditional Ohmite quality for the most exacting requirements. Many of these styles are stocked in a wide range of values by the factory and Electronics Distributors throughout the country.

METAL FILM (SERIES 77) Units consist of metal film on glass substrate, hermetically sealed in high temperature resin. They possess long load and shelf life, low noise level, excellent high-frequency characteristics, and exceed military specifications. Rated at 125°C and 150°C. Resistances from 25 ohms to 2.5 megohms. Wattages from ¼ to 2 watts. Cylindrical, semicylindrical, or flat-sided shapes with radial or axial leads. Tolerances are 0.1%, 0.25%, 0.5%, and 1%. *Bulletin 155.*

MOLDED WIRE-WOUND (SERIES 88, Power Type) These resistors utilize a single-layer winding on a ceramic core, welded connections throughout, and a molded silicone ceramic jacket. Uniform physical size in each rating. Supplied in 1, 3, 5, 7, and 10-watt sizes; resistances to approximately 50,000 ohms. Units meet MIL-R-26C specifications. Tolerances are 0.1%, 0.25%, 0.5%, 1.0%, and 3.0% (at 25°C). *Bulletin 153.*

ENCAPSULATED (SERIES 85 AND 86) Resistance wire, pie-wound on a steatite bobbin, is enveloped in an epoxy type resin. Welded connections throughout. Units meet and surpass military specifications. Series 85 has axial leads; Series 86, lug-type terminals. Designed to meet the requirements of MIL-R-93B. Resistance values to 3.1 megohms. Tolerances are 0.1%, 0.25%, 0.5%, and 1%.

VARNISH IMPREGNATED (SERIES 83, 84) Enameled wire is pie-wound or non-hygroscopic ceramic bobbin, and entire unit is vacuum impregnated. Radial wire lead, or radial lug terminals. Made to order only. Resistances from 0.1 ohm to approximately 5 megohms; ½ and 1-watt sizes. Tolerances are 0.1%, 0.25%, 0.5%, and 1%.

VITREOUS ENAMELED (POWER TYPE) Most Ohmite power resistors can be provided to close tolerances when precision as well as high wattage is desired. Depending on the requirements, the units are generally derated (often to 10% of free air watts) to minimize the effect of TC and maintain the best stability.

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electronics

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CROSSTALK

WE DERIVE considerable satisfaction from a trend detected in recent company-union negotiation, in this industry and others. In offers to bargaining units, management is taking its first step toward solving the difficult problem of negotiating smooth transition to more automated plants.

It is clear that U.S. companies must use more automatic controls and equipment to increase productivity in order to compete effectively in world markets and even at home. It has not been so clear that management also has a responsibility to prevent mass dislocations in the labor market. We note, however, that some new contract proposals contain programs for retraining and reassigning workers displaced by the introduction of labor-saving equipment.

The electronics industry has an enormous stake in this area, professionally, economically and personally. Professionally, the industry's engineers are responsible for many of the more sophisticated controls and systems. Economically, the industry stands to profit handsomely from widespread automation. Personally—well, it's safe to say that most of us would sooner see our inventions used for the betterment of our fellows than see them cause more hardship.

Electronics industrialists, then, have good reason to take the lead in showing industry in general how to make automation work to the advantage of the whole community. Automatic controls and mechanized production can bring about a better life for everyone if their fruits are equitably distributed. If they are exploited for the sole good of capital, then labor can be expected to exert pressure on government to stop or control the introduction of labor-saving equipment.

Perhaps the most important thing each company can do is to help its own workers find new niches in the world of automation. Retraining them into higher skills is one way.

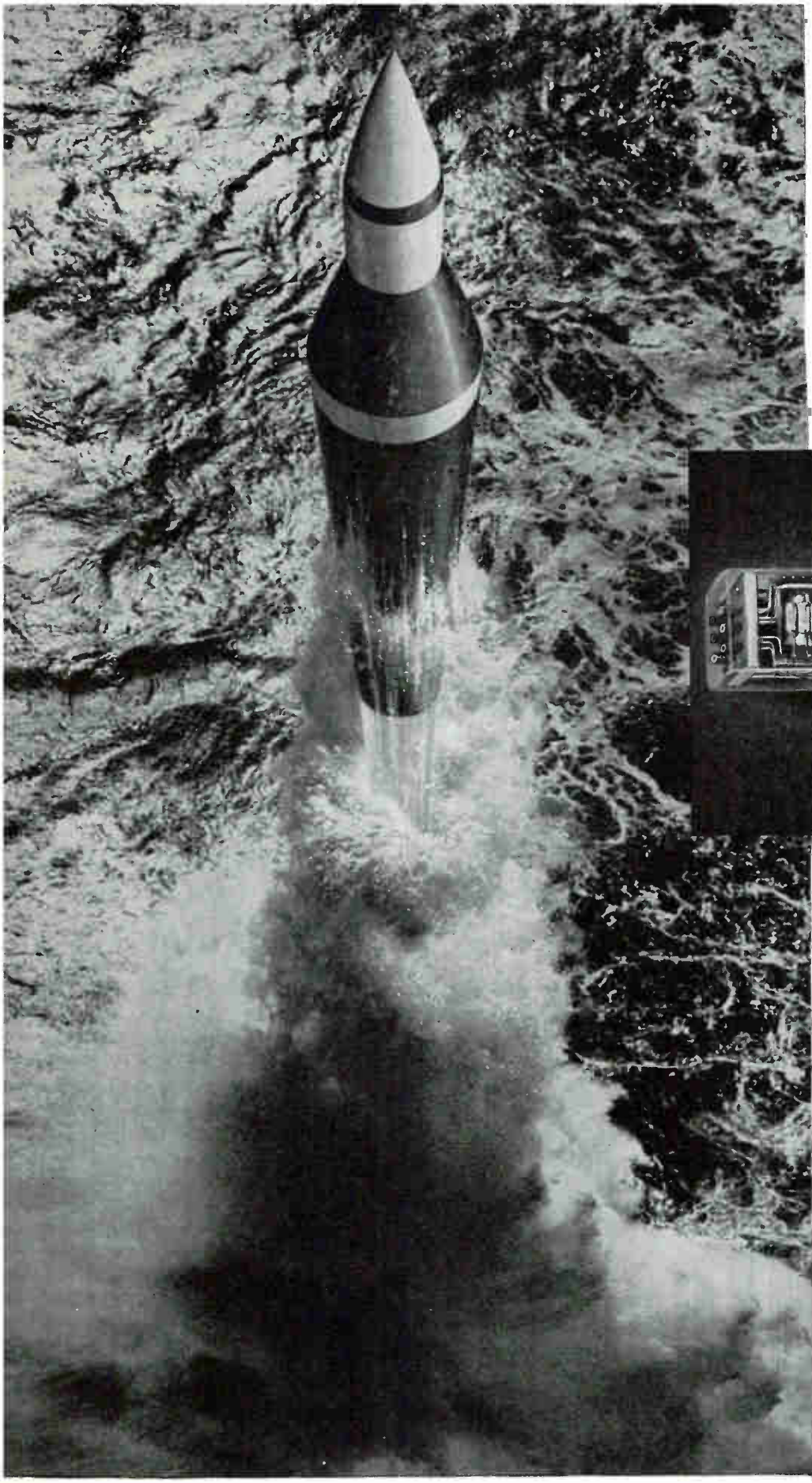
Unions, too, have a responsibility to cooperate in finding ways to ease the changeover. If a union is truly interested in protecting the long-term welfare of its members it will help management intelligently introduce labor-saving machinery; a healthier company is better for worker and shareholder alike. It will encourage its members to retrain themselves for the higher orders of responsibility that automated plants will require. It will actively participate in retraining programs. When unions try to stop the course of progress by featherbedding or other unrealistic practices they succeed merely in pricing American goods out of world markets, and so ultimately put many of their own members out of work.

NEREM HIGHLIGHTS. Northeast Electronics Research and Engineering Meeting in Boston next week will feature nearly 400 exhibits and 40 technical sessions at which more than 300 papers will be presented. Thus visitors, as well as those unable to attend, should find this issue's two-part conference preview by New England Editor Maguire helpful. His story on p 46 takes a look at business implications. And in the engineering section, his article (p 73) gives a penetrating analysis of technical developments and spotlights several significant papers.

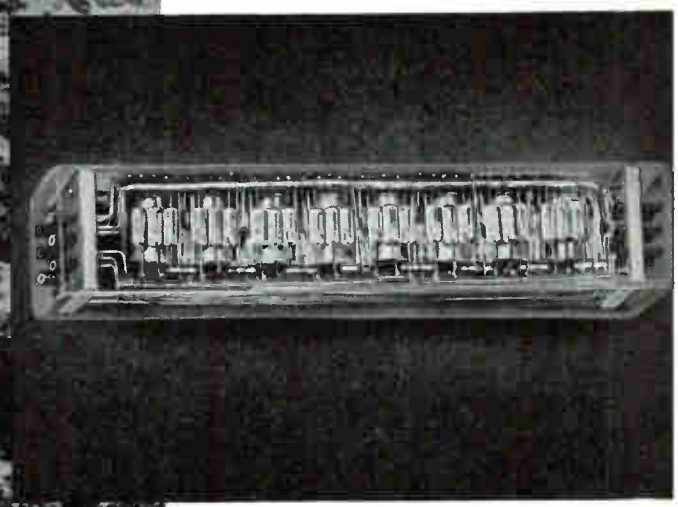
Coming In Our November 18 Issue

STEREO. Report on six proposed systems for compatible f-m stereo broadcasting was filed recently with the FCC by the field-test panel of the National Stereophonic Radio Committee. In our next issue, panel chairman A. P. Walker summarizes the engineering performance of the six systems. Walker, who is director of engineering for the National Association of Broadcasters, presents data relevant to frequency response, distortion, separation, crosstalk and spectrum utilization.

CIRCLE 5 ON READER SERVICE CARD→



RAYTHEON **WELD-PAK** CIRCUIT MODULES



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COMMENT

Ions, Music and Health

Since it's a pretty well established fact that free ions in the air affect one's mood (see "Ions Affect Health, Behavior," p 45, Feb. 26, and subsequent Comment), the next logical step in the development of that Ionovac speaker ("Hi-Fi Ions Impress Chicago Crowds, p 53, Oct. 14) is a circulating and filter system whereby one can select the polarity of the ions given off to match his mood to that of the material to which he is listening.

I suggest that safeguards be included, however, to negate the possibility of being exposed to high degrees of ionization and extremes of mood music at the same time.

It is conceivable that large amounts of positive ions plus *Valse Triste* could lead to wrist-slashing, while a teenager exposed to a rock-and-roll beat and negative ions could find himself in such a state of euphoria that the walls couldn't contain him.

GUY C. RAUER
WEJL RADIO
SCRANTON, PENNA.

The euphoria of the teenager we don't doubt; but positive ions might, if we interpret the evidence correctly, nullify rather than amplify the effect of a moody piece. The effect is to slow up the system, decrease the sensitivity to emotional stimuli of other than a thalamic type; one might be irritable, cross, prone to anger, quick to fight—but would probably not be extremely sad.

We hope that all the ions produced by the Ionovac are negative; not only do we regard euphoria as preferable to depression, but we also remember that negative ionization favorably affects health as well as behavior.

Upgrading Tv

In your Crosstalk ("Upgrading the Consumer," p 4, Oct. 21) it seems to me that you did not mention the main issue. You discuss upgrading the consumer to appreciate better technical quality of tv reception. What is really needed is an upgrading of television programs in this country.

I spent four years in England myself, and the reason why travelers come back singing the praises of British television is not because of its technical performance but because of the high quality of its programs.

After all, why bother to include d-c restoration, 4.5-Mc bandwidth, and so forth in order to see the same poor show? I think the basic mistake which the radio and television producers make is underestimating the intelligence of the American public. There are of course many fine programs on the air, but what is needed is upgrading the tv industry rather than upgrading the consumer.

C. V. NELSON
GORHAM, ME.

Although broadcasters may—it is a moot point—operate at the low end of the curve, they do follow a kind of free-market process in arriving at programs; they do, as they must, give the viewer what he seems to want.

As far as we're concerned, this argument is of only personal interest. Our professional interest, as we indicated in our Crosstalk, is in the technological improvement of broadcasting.

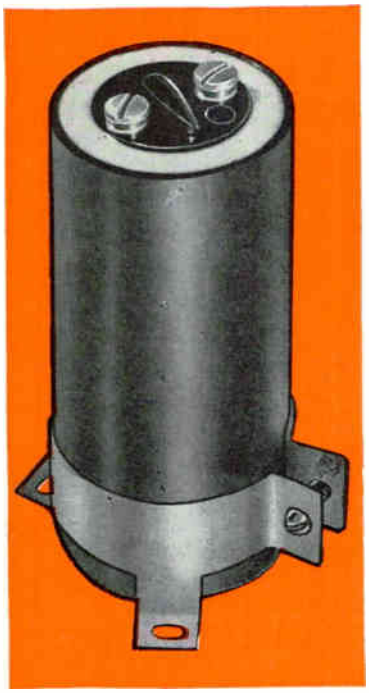
Comlognet

In your Oct. 21 issue is an article on the USAF Comlognet ("USAF to Get Fast Data Link Net," p 37). In this article is the statement "The switching centers, in conjunction with the station terminals, will handle digital information of any type including digitalized voice for graphics."

What is the meaning of the word *graphics* as used here? What is "digitalized voice for graphics"?

WILLIAM W. DEAN
GENERAL ELECTRIC
SYRACUSE, N. Y.

It was a typo; the statement should have read ". . . digitalized voice or graphics." Graphics, of course, are graphical data in any form—pictures, charts, graphs and so forth.



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

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

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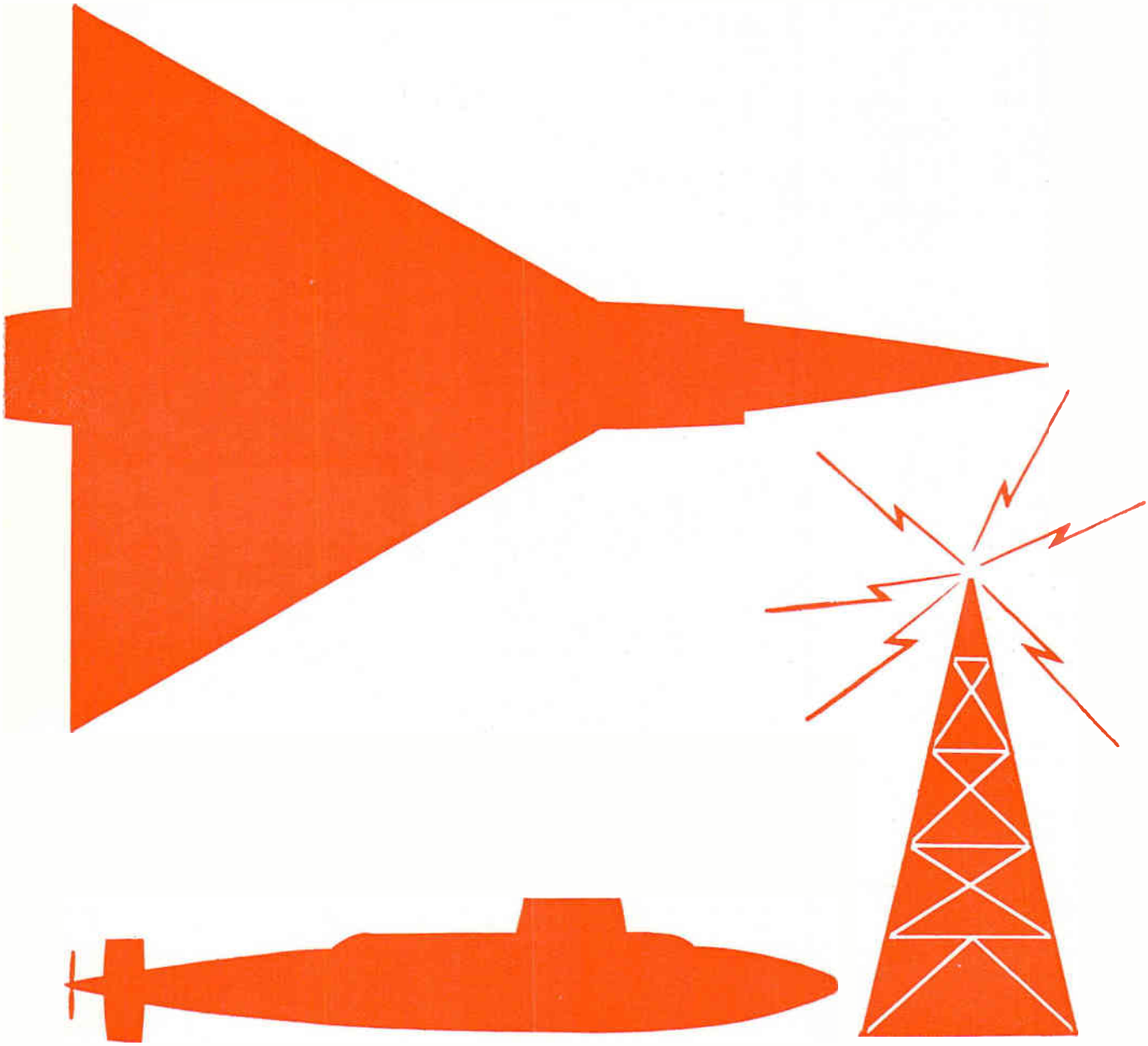

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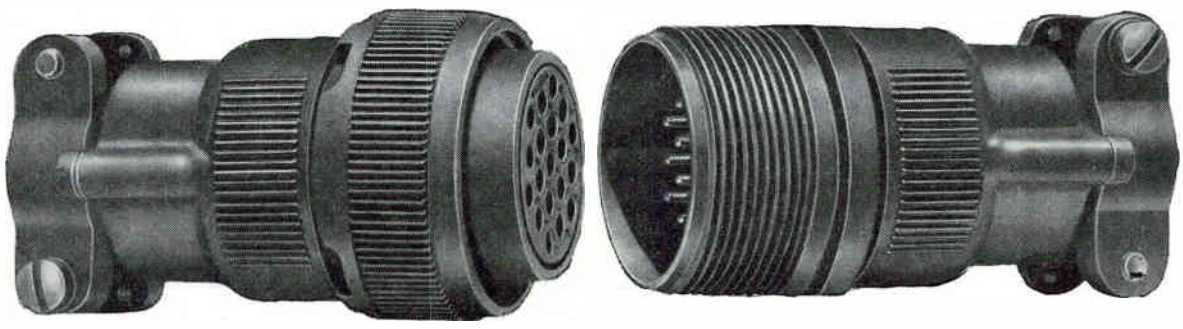

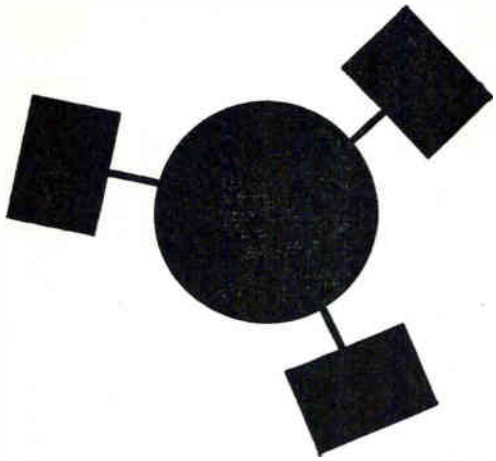

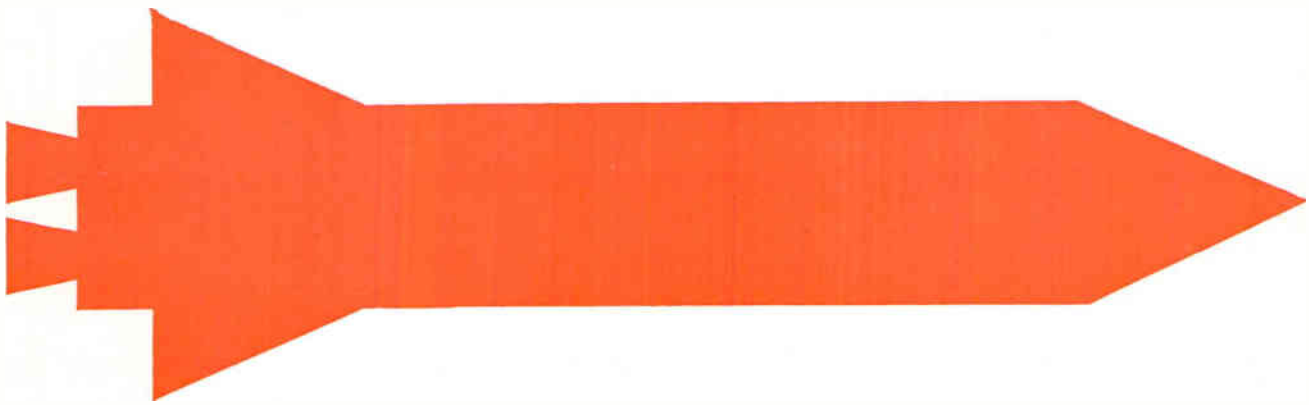

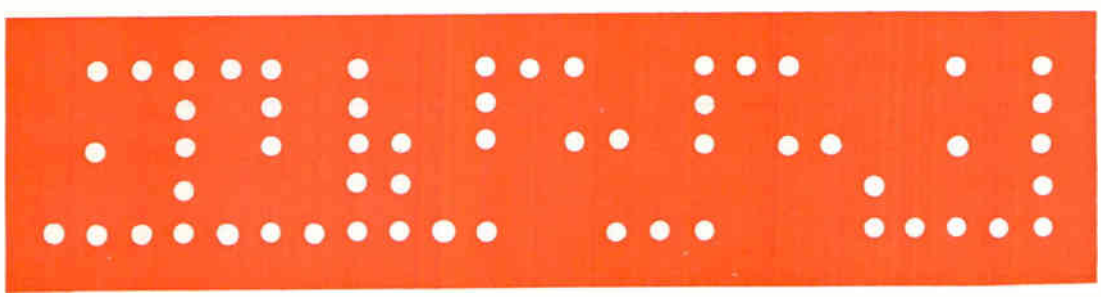

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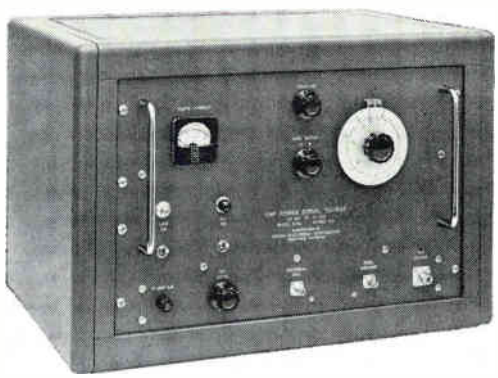

SPECIFICATIONS

Frequency range:	Model 215A-50, 25 to 50 MC Model 215A-150, 50 to 150 MC Model 215A-470, 150 to 470 MC Model 215A-1,000, 470 to 1,000
Power output:	50 watts ± 1.5 db, into 50-ohm load, adjustable 20% to 100% of full power
Output stability:	± 5% after warmup
Frequency stability:	± 0.05% after warmup
Dial accuracy:	± 2% Models 215A-50/150 ± 3% Models 215A-470/1,000
Resetability:	0.1%
Modulation:	External AM
Price:	$3,300.00.

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ELECTRONICS NEWSLETTER

B-70 Reinstatement Means Big Business

REINSTATEMENT of a significant part of the B-70 Mach 3 Valkyrie bomber program means about $85 million in business for electronics subcontractors. Prototype program had called for expenditure of $110 million; this figure has now been boosted to $265 million to account for building a dozen planes.

North American Aviation, prime contractor on the program, estimates that electronics firms will get 32 percent of the contract funds. Main electronics subcontractors are IBM for the bomb-navigation system, Westinghouse Electric for the defensive subsystem including counter measures, and Motorola for the mission and traffic control system including identification, operational communications, and flight navigation equipment. First B-70 is scheduled to fly late in 1962.

Besides its major role in air defense as a bomber, the B-70 eventually will provide a launching platform for the air-launched ballistic missile. Planes will carry long range search and fire-control radar.

Improved Tunnel Diodes Quintuple Trigger Speeds

GREATLY IMPROVED tunnel diodes have resulted from research programs in controlled production techniques at IBM. Developmental units announced last week switch at speeds faster than 0.4 nanosecond, permit operation of binary trigger circuits at speeds 5 to 10 times faster than presently possible. IBM spokesmen say the new diode also requires less power.

Key to the design advances is a new fabrication method involving an electronically monitored and controlled etch. The germanium is etched away under servo control to a junction diameter of 0.4 mil, reproduceable to a tolerance of ± 1 percent. Peak current from the unit is 5 ma.

Binary trigger circuits using the improved tunnel diodes have been operated at repetition rates as high as 300 Mc. Resistance cutoff frequency is 23 Gc.

Air Agency Tower Rule Rouses Broadcaster Ire

NATIONAL ASSOCIATION of Broadcasters has filed a statement with Federal Aviation Agency stating that FAA's claim of jurisdiction over antenna towers is "contrary to law, precedent and the public interest."

The air agency has proposed a new rule (see ELECTRONICS Crosstalk, p. 4, Oct. 14) which would require broadcasters to get FAA approval for antenna constructions, on the grounds that high antennas might constitute a hazard to air navigation. NAB claims that Federal Communications Commission alone has the authority to rule on antenna locations and heights.

Nickel-Cadmium Battery Will Last Ten Years

RECHARGEABLE nickel-cadmium battery designed for use in spacecraft will be announced this week by Gulton Industries. On accelerated life test, the battery showed a lifetime of ten years, according to Gulton spokesmen. It can be charged and discharged 20,000 times.

The battery is hermetically sealed, operates at low pressure to prevent bursting or leakage. It can withstand continuous overcharge at high rates. The design features claimed for the new battery include a ceramic-to-metal case seal which forms a molecular bond, porous synthetic plate separators, and a novel method of assembly. Battery can be recharged in space by solar cells, can also be used to supply power in remote locations on the earth.

Image Intensifier Sharpens Balloon-Borne Telescope

PHOTOELECTRIC image intensifier used with balloon-borne telescope is expected to make the 12½-in. telescope the equivalent of a 125-in. unit, says J. A. Hynek, chairman of Northwestern University's astronomy department.

Researching image conversion and balloon astronomy under two Air Force contracts, Hynek reports photoelectric intensifier has increased image brightness 30 times. Project is aimed at 100-fold brightness improvement.

Early next year Hynek plans to send two men and a small telescope 19 miles up in a sealed gondola. The experiment will use MIT-developed instrumentation to cancel balloon motion and permit tracking of a star. Height will eliminate atmospheric twinkle, add to precision of sighting. Tests in the infrared region may even show whether Mars' atmosphere contains water vapor.

Tracking Radar Planned for Thule

DEFENSE DEPARTMENT has decided to install RCA's tracking radar AN/FPS-49 at the ballistic-missile early-warning system site at Thule, Greenland (ELECTRONICS, p 47, Mar. 18). Up until now, BMEWS plans called for three RCA tracking radars at the Flyingdales site in England, but none at Thule or Clear, Alaska. Thule and Clear are equipped with GE's stationary surveillance radar systems AN/FPS-50. Whether Clear will get both systems, as Thule will, has not been announced. The 84-ft-dish tracking radar costs $15 million.

Institute Studies Rare-Earth Cathodes

IMPROVED CATHODE design is being sought for tube applications requiring high resistance to sparking and high emission density. Under contract with AF Cambridge Research Labs, Batelle Memorial Institute is evaluating thermal electron emission of rare-earth oxides, particularly gadolinium and neodymium oxides and mixtures of these.

The oxides are being put on refractory metal wires by electrophoresis. BMI is looking for a process to keep the particles from forming large agglomerates, so as to realize a dense and smooth coating. Study includes emission behavior of rare-earth oxide mixtures on refractory-metal bases, particularly rhenium, molybdenum, tungsten and tantalum.

(Continued on page 12)

Illinois Bell to Dedicate Electronic Central Office

ELECTRONIC CENTRAL OFFICE will be dedicated by Illinois Bell Telephone Co. in the little town of Morris, Ill., next Thursday afternoon.

The new concept in telephone switching uses no moving parts, functions in microseconds. System is the product of a massive research and development program, perhaps one of the largest ever sponsored by commercial enterprise, tracing back to Bell Labs' development of transistor.

Electronic Probes Test Body's Thermostat

ELECTRODES radiating a 3.7-Mc signal into the brain are helping Dr. Madelaine Fusco, physiology instructor at University of Michigan's Medical Center, study the thermostat controls in the nervous systems of all higher animals, including man.

Hypothalamus, deep inside the brain, maintains body temperatures within close tolerances. Hollow needle electrodes implated in the hypothalamus of dogs short-circuit the usual nerve network that reports changes in internal and surface temperatures. One-watt radiation from transmitter warms the dog, making him pant. Cold signal from circulating cool water causes shivering.

Information gathered in Dr. Fusco's experiment may help doctors interpret and control fever and other temperature abnormalities that are symptoms of disease.

New Device Attacks Wrong-Number Problem

AUTOMATIC dialing systems for interstate and nationwide long-distance telephone calls magnifies the problems of dialing errors. In the Netherlands, where the error rate for automatic long-distance calls is 14 percent, the Dutch firm of Reumhelm Electronics has developed an automatic system that prevents wrong connections.

Reumhelm spokesmen say their attachment can be used with telephone exchanges or individual telephones. The device is said to prevent a connection when the caller dials the wrong digit, when he erroneously makes a transposition of two adjoining digits, or when other common dialing errors are made.

New Currency Changers: Magnetic, Photoelectric

TWO NEW automatic currency changers were shown at the Automatic Merchandising Association show in Miami Beach, Fla., last week.

A solid-state device by ABT Manufacturing division of Automatic Canteen Co. of America uses ten transistors and diodes. It operates on photoelectric principles, giving a static check on the bill. The device will go into production about the first of the year. It will change bills up to $10, can recognize counterfeit currency. The company is working on changers to handle foreign currency.

An electron-tube device made by National Rejectors division of Universal Match can change bills up to $20. The device operates on magnetic principles, performs a moving check as the bill passes longitudinally over a single reading head. Trick is that the green ink used on currency is magnetically susceptible.

Also interested in currency changing are Lionel Corp., Vendo of Kansas City, Mo., and Rescon of Waltham, Mass.

Reveal Cable Connectors To Withstand 1,700 F

SOME REENTRY PROBLEMS of such projects as Dynasoar may be solved by a coaxial cable and connector combination to be marketed by Technicraft division of Electronic Specialty Co. The cable is made by McGraw-Edison.

Cable is now rated at 1,000 F, is expected to take 1,700 F. It comes in 0.170 and 0.270-in. outside diameters, can carry signals up to 5 Gc. Inner and outer conductors are copper. Dielectric is of the mineral type. Outer conductor is the outside of the cable. Connectors use a glass dielectric, are made from Invar.

Resonant-Reed Relay Locks and Latches

SELF-HOLDING resonant-reed relay for remote switching is under development by Mallory Electromagnetic division of P. R. Mallory. One model has four reeds tuned to 75, 95, 115 and 135 cps with bandwidth of ± 3 cps. However, reeds tuned to any nonharmonically related frequencies between 50 and 400 cps can be used. A small permanent magnet locks the relay out until a signal is received. After 0.5 sec, the coil holds the reed firmly until excitation current is removed.

The relay coil is rated at 75 to 225 mw; contacts are designed for 2 amperes, 110-v, 60-cps resistive load. Enclosure is roughly $2 \times 2 \times 1$ in.

Japanese Disclose Infrared Microscope

COUPLING AN INFRARED projector to an electron microscope permits study of displacement lines in silicon. Developed by Nippon Electric, ITT affiliate, the unit measures 70 by 40 by 18 cm, weighs 20 Kg. Its first applications will be in production of high-purity silicon. Wide use in medical and biological sciences also is predicted. The company plans to couple a television system to the microscope.

Special Computer Quotes Stock Prices

INSTALLED in the new offices of Los Angeles broker Waltston & Co. is the Quotron, a special-purpose digital computer made by Scantlin Electronics. Computer's magnetic-drum memory hooks into ticker-tape circuits, stores daily stock-exchange transactions. Interrogation and readout units complete the system. Desired information is received on paper tape.

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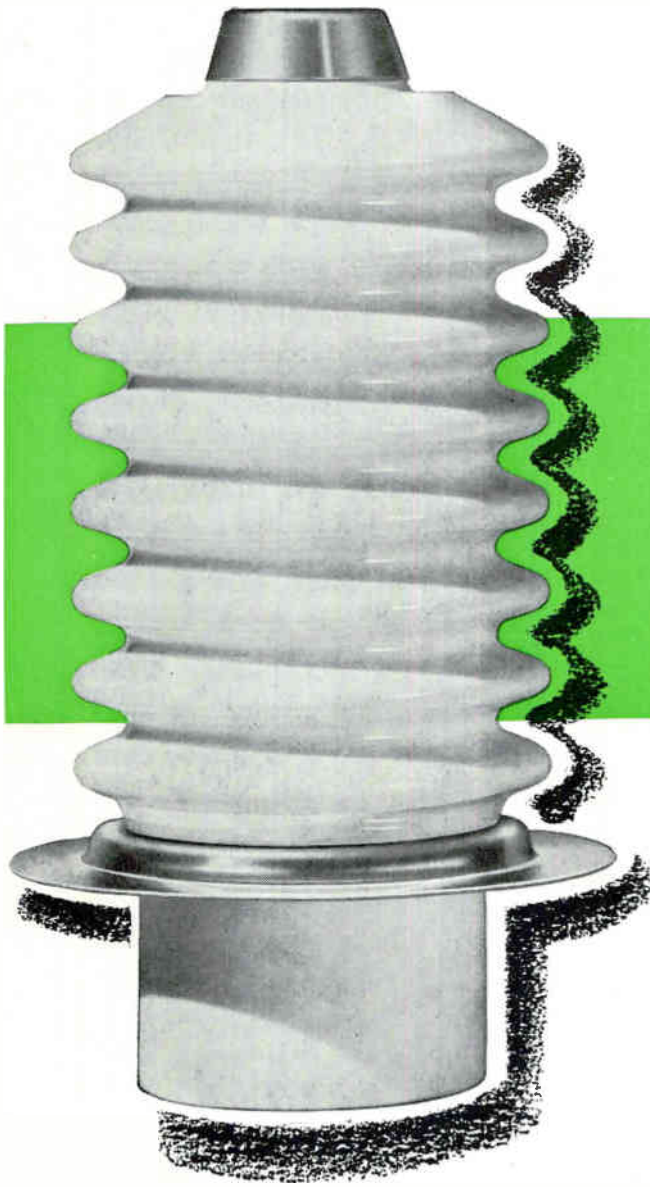

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WASHINGTON OUTLOOK

THE COMMERCE DEPT. reports a 40 percent increase in Japanese electronics production during January-June 1960 as compared to the previous six-month period. Total output was valued at $565 million, of which $320 million covered consumer products. Television receiver production in first-half 1960 rose 36 percent over the same period last year, radio receivers with three or more transistors increased 80 percent, radio-phonographs 139 percent.

Japanese production of electron tubes in January-June 1960 *amounted to* $90.4 *million,* 63 *percent over last year. Output of semiconductors was valued at* $37.2 *million, a gain of* 48 *percent.*

Relaying information from the U. S. embassy in Tokyo, the Department also reveals a sharp upward revision in estimated Japanese production over the next five years. Output of $1.3 billion is envisaged in 1964, 30 percent over 1959 production.

U. S. trade experts predict a big boost in exports to this country of Japanese stereo phonograph consoles, color television sets and tv sets using transistors.

THE POST OFFICE DEPT. has begun testing high-speed facsimile mail transmission between Washington, Chicago and Battle Creek, Mich. The speed-mail system is seen as a forerunner of a nationwide network of facsimile mail transmission linking 74 major cities, with trunklines to hundreds of smaller areas.

The project's major contractors: ITT's Intelex Systems, Inc., which has a development contract to design and build 14 *high-speed facsimile printers and eight mail scanners; General Dynamics' Stromberg-Carlson Div., which is developing high-speed scanners capable of reading and transmitting a standard letter-size page every four seconds by commercial coaxial cables or microwave links; Haloid Zerox and Pitney-Bowes.*

STILL MORE PRESSURE to consolidate military procurement comes from a new Congressional report on economic aspects for military procurement and supply. The report was made by a joint economic subcommittee headed by Sen. Paul Douglas (D., Ill.), which investigated military contracting policies earlier in the year. Says the report: "If common supply and service activities were properly consolidated and organized under existing legislation" there would be vast savings in defense buying.

The report comes in the midst of a Defense Dept. study on the advisability of consolidating military procurement of many types of electronic end-items, components, spares and replacement parts. The study is due to be finished by the end of the year and covers an estimated $2 billion worth of annual electronics procurement.

U. S. MANUFACTURERS—including electronics firms—are still boosting capital outlays in production facilities abroad, especially in Europe. For all manufacturers, overseas spending on production facilities now averages 14 percent of the amounts invested at home.

There's no specific breakdown on electronics, however. The industry is lumped under electrical machinery manufacturing. This category shows $129 million worth of plant and equipment spending abroad in 1960, compared to $88 million last year.

EIA HAS STARTED a survey to determine the number of scientists and engineers in the electronics industry. Results will be turned over to the Pentagon to help determine possible adverse effects which major shifts in defense programs could have on the reservoir of professional electronics manpower.

Preliminary Pentagon estimates show about 140,000 electronics engineers and scientists in the U. S. Of the total, 110,000 are believed to work for private industry and from 80 to 90 percent in defense-related work.

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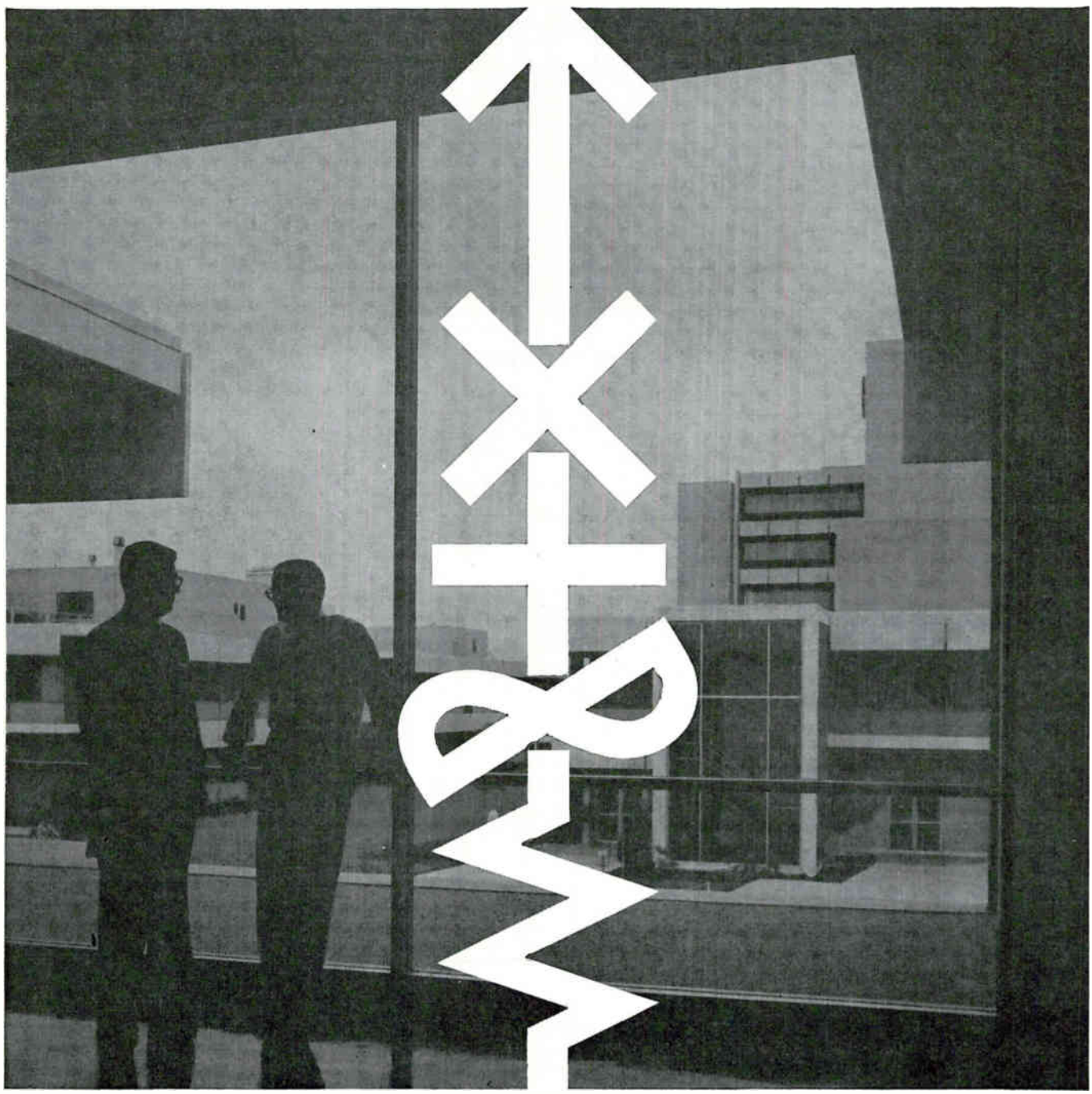

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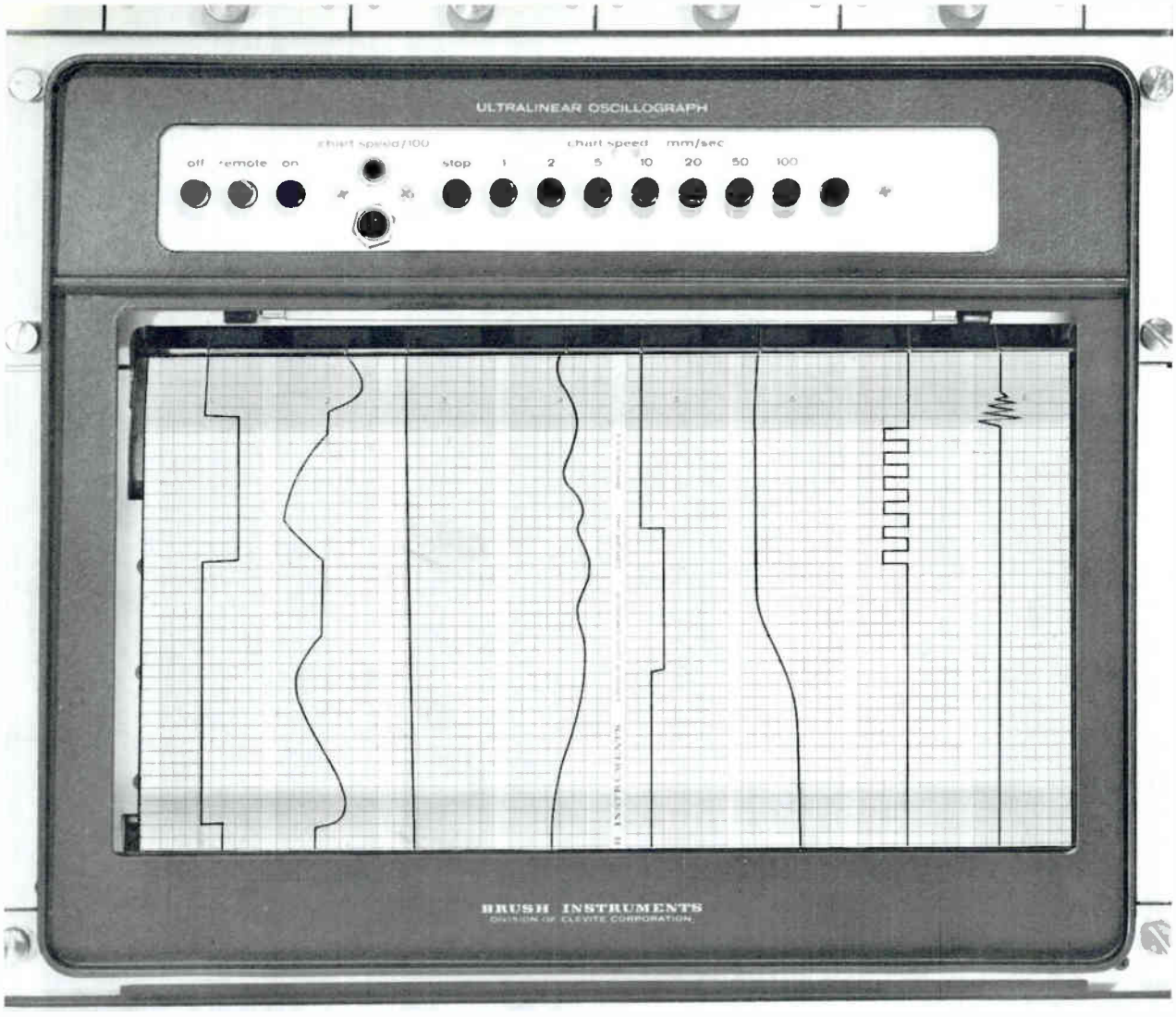

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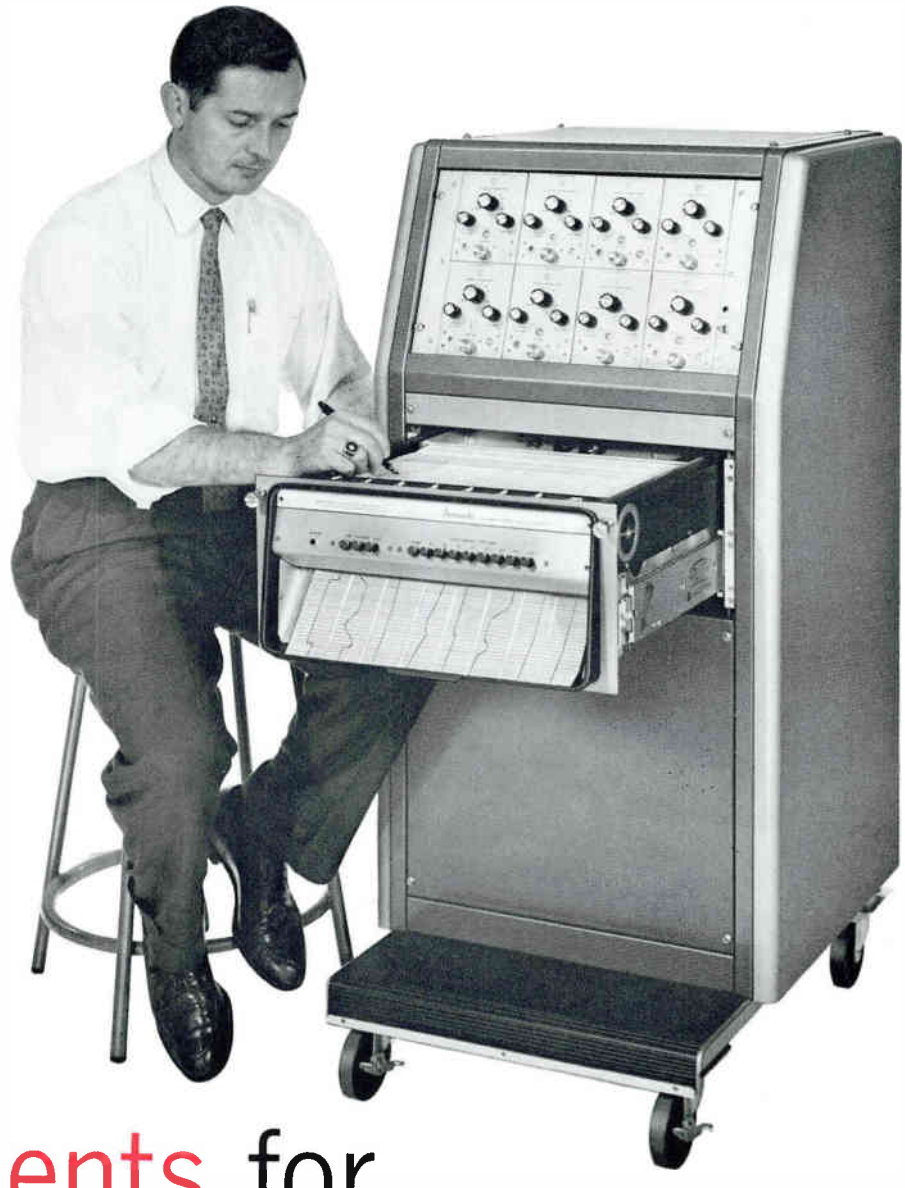

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New Mergers Announced

GENERAL INSTRUMENT CORP., Newark, N. J., has announced acquisition of a 30-percent ownership in **Materials Research Corporation.** The Yonkers, N. Y., firm is engaged in both basic research in metallurgy and electronics, and manufacture of scientific instruments. Cash obtained from the purchase of 42,857 of MRC's outstanding 142,857 shares will be used to expand the research company's laboratory and production facilities.

Houston-Fearless Corp., Los Angeles, announces acquisition of 100 percent of the stock and all assets of four companies in electronics and related industries. The expansions move HF into the fields of gyroscope design and manufacture, nuclear instrumentation, ground support systems and digital data systems for military and industrial use. The four companies are, **Uniconn Inc.,** Plymouth, Conn., gyroscope manufacturer; **Nuclear Research Instruments,** Berkeley, Calif.; **Parabam, Inc.,** Hawthorne, Calif., (digital data systems) and **Allen Research and Development,** Buena Park, Calif. The acquisitions were made by stock and cash transfers.

Gulton Industries, Metuchen, N. J., has acquired the electronics business interests of **Electric Machinery Manufacturing Company's Mullenbach division** in Los Angeles. Electric Machinery is a subsidiary of **Worthington Corp.** The newly-acquired group manufactures thin ceramic sheet material used in switches, subminiature capacitors and relays. Gulton, in a similar field of manufacture, acquired **Systems Research Group Inc.,** Mineola, N. Y., last July.

Hermetite Corp., Boston, and **Accurate Specialties,** New York, report they are holding exploratory talks on merger possibility. Hermetite manufactures glass-to-metal and ceramic seals for the electronics industries. Accurate Specialties manufactures high-purity metals and ceramics.

Spectrol Electronics Corp., San Gabriel, Calif., a wholly-owned subsidiary of **Carrier Corp.,** announces purchase of the assets of **Bamford Corp.,** Santa Monica, Calif. The newly-acquired company produces miniature trimmer potentiometers. Spectrol manufactures a variety of components, including solid-state converters. The acquired facilities will be moved to San Gabriel and integrated with Spectrol's operation.

Megadyne Electronics, Inc. and **CWS Waveguide Corp.** will hold shareowner meetings next week in Wilmington, Del., to vote on the proposed merger of the companies into **Megawave Electronics Corp.** The managements and directors of both companies have already approved the combination. Megadyne, situated in Port Chester, N. Y., manufactures magnetic amplifiers, saturable reactors, power supplies and other items. CWS, of Lindenhurst, Long Island, N. Y., manufactures microwave components for radar and communications applications.

National Cash Register Co., Dayton, O., for the third quarter of 1960 reports sales of $109,990,886, a rise of six percent over the same period of 1959. Net income for this year's third quarter was $4,591,-504, up three percent over last year's third-quarter earnings of $4,475,345. For the first nine months of 1960, sales totaled $315,-768,220, compared with $298,953,-356 for the same portion of 1959.

Siegler Corporation, Los Angeles, reports earnings for the quarter ended Sept. 30, were $746,531 on sales of $20,218,288, a decline of eight percent from earnings of $815,616 on sales of $21,189,245 for the similar period last year. Per-share earnings for this year's first

quarter were 40 cents on 1,872,466 shares outstanding as of Sept. 30, 1960. A year ago, the figure was 50 cents on 1,634,026 shares. The increase in shares this year is due to a four-percent stock dividend, conversion of outstanding debentures and issuance of common shares following the merger of **Magnetic Amplifiers, Inc.**, with Siegler. Decline in earnings is partially attributed to a falling off of the company's heater business.

Standard Kollsman, Melrose Park, Ill., reports substantial increase in sales and earnings for the nine months ended Sept. 30. Consolidated net sales were $71,815,551, compared with $54,227,527 in a similar 1959 period. Net income for the nine months was $2,203,-580, equal to $1.10 per share as against $1,039,497, or 52 cents a share, in the year preceding.

Burnell and Co., Pelham Manor, N. Y., reports record highs during the first six months of the current fiscal year ended Sept. 30, in both sales and income. Sales were $1,-805,610, up 24 percent over last year. Income of $80,678 was up 41 percent over 1959 and was equal to 12 cents a share.

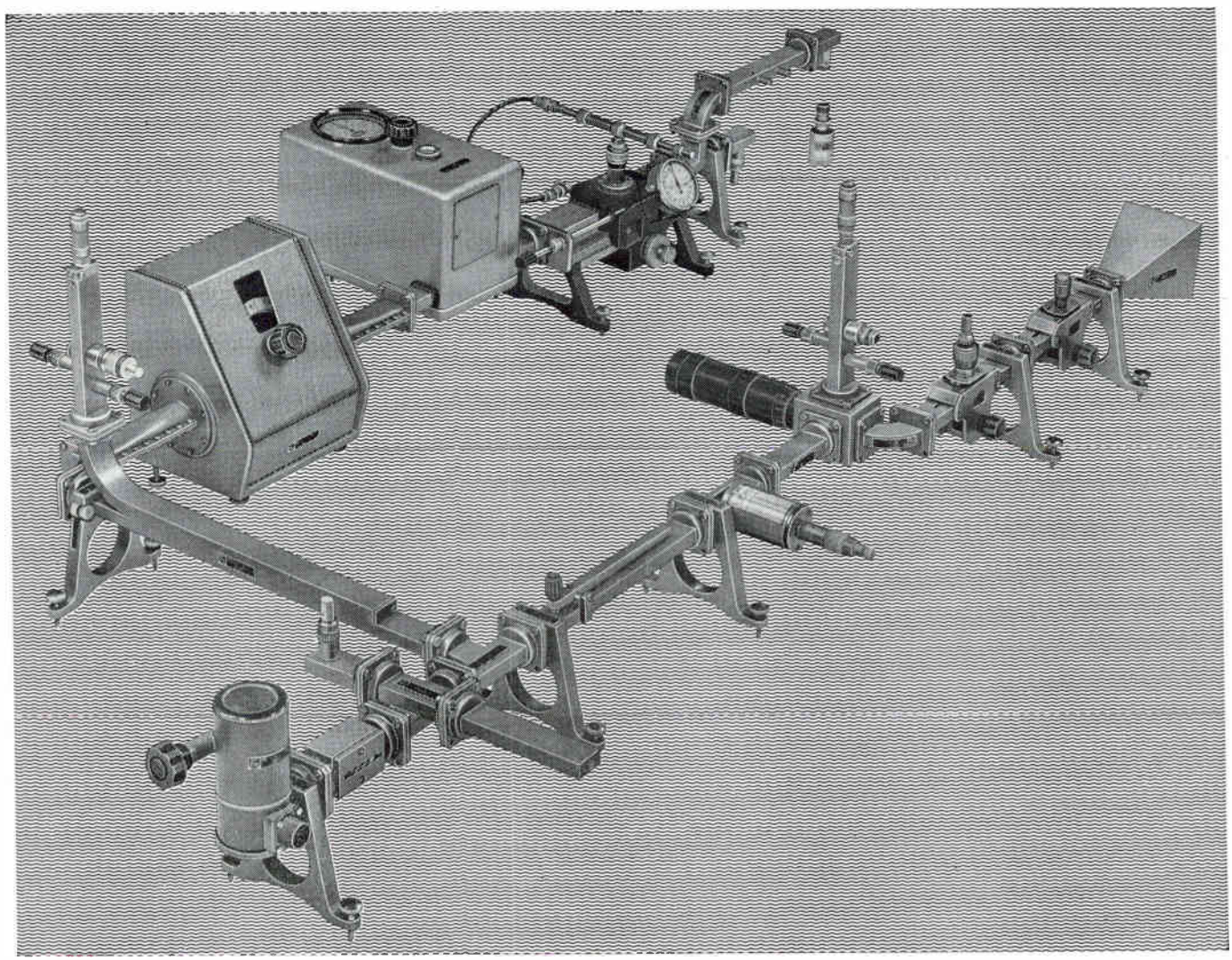
25 MOST ACTIVE STOCKS

	WEEK ENDING OCTOBER 28, 1960			
	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Tel & Elec	2,884	25⅞	23¾	25¼
Avco Corp	1,291	13⅞	12¾	13⅝
Texas Inst	1,006	165⅜	148¼	160¼
RCA	959	50¾	46½	50¼
Gen Electric	922	73⅞	70⅞	73
Sperry Rand	890	19⅜	18½	18⅝
Amer Tel & Tel	868	91⅞	89⅝	91⅝
Litton Ind	753	75⅝	68⅞	72½
Int'l Tel & Tel	751	37⅞	36⅜	37⅝
Gen Inst	669	34⅞	30⅛	32⅞
Varian Assoc	665	42	38⅛	40¾
Elec & Mus Ind	641	6¼	5⅞	6
Beckman Inst	546	80¾	75¼	78
Western Union	533	43⅛	40¼	40⅜
Bell & Howell	524	41⅝	39	40⅛
Fairchild Camera	522	162	145¼	151⅛
Univ Controls	506	15⅜	14⅜	14⅝
Polarad Elec	502	21	17	19⅝
Raytheon	490	32⅞	30¼	31⅜
Dyn Corp of Amer	461	7¾	6⅝	7⅜
Collins Radio	455	45¼	41¾	43¾
Gen Dynamics	394	37¼	35¾	36¾
Barnes Engin	357	30¾	25	29⅛
Telectro Ind	341	14	11⅛	12⅞
Cubic Corp	338	53	39⅝	42⅞

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.

Microwave equipment

for the X and Q band



Measuring bench for 8.2-12.4 kMc s

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Further information will gladly be supplied by:

N.V. Philips' Gloeilampenfabrieken, EMA-Department, Eindhoven, the Netherlands

For Canada: Philips Electronics Ind. Ltd., Leaside, Taranta 17, Ont.

X TYPE	DESCRIPTION	MAX. VSWR.	
PP 4020 X	Straight Waveguide Section	—	Length 10, 20, and 40 cm
PP 4025 X	E-plane Bend	1.07	Radius of curvature 29 mm
PP 4030 X	H-plane Bend	1.07	Radius of curvature 29 mm
PP 4035 X	Twist	1.10	Length 187 mm
PP 4040 X	Shunt Tee	—	Length 80 mm
PP 4045 X	Series Tee	—	Length 80 mm
PP 4050 X	Hybrid Tee	—	Decoupling > 40dB
PP 4070 X	Waveguide/Coaxial Adapter	1.50	50 Ω N-connector
PP 4080 X	Horn	1.25	Directivity: E-plane 20°, H-plane 25°
PP 4090 X	Multi-hole Directional Coupler	1.05	Directivity: >40dB, coupling factor 10dB or 20dB (± 0.2dB)
PP 4095 X	Cross-guide Directional Coupler	—	Directivity: 20dB, coupling factor 26dB (± 0.5dB)
PP 4110 X	Fixed Attenuator	1.10	Attenuation 6, 10 or 20dB (± 0.2dB), max. peak power 1 kW
PP 4130 X	Variable Flap Attenuator	1.15	Max. attenuation > 20dB
PP 4150 X	Variable Rotary Attenuator	1.15	Max. mean power 1 W, max. attenuation 50dB, accuracy ± 2%
PP 4170 X	Low-power Matched Load	1.05	Max. mean power 2 W
PP 4200 X	Klystron Mount	—	When using klystron 2K25 the output power is > 20 mW
PP 4220 X	Adjustable X-tal Mount	1.10	Sensitivity: 1 mV D.C. for 0.1 μW, 50 Ω N-connector
PP 4225 X	Broadband X-tal Mount	1.50	Sensitivity: 1 mV D.C. for 10 μW, 50 Ω BNC-connector
PP 4245 X	Tunable Thermistor Mount	1.10	Freq. range 8.2-11 kMc/s, 50 Ω BNC-connector
PP 4260 X	Calibrated Short Circuit	>100	Accuracy of the displacement 0.02 mm
PP 4280 X	Sliding Screw Tuner	from 20 to > 1.02	Insertion loss for a VSWR of 20 is > 2dB
PP 4290 X	Direct Reading Wavemeter	—	Freq. range 8.5-9.8 kMc s, absolute accuracy ± 2 Mc/s, loaded Q 10,000
PP 4300 X	Broadband Wavemeter	1.10	Relative accuracy 3.10^{-4}, loaded Q > 3,000
PP 4360 X	Measuring Cavity	—	Freq. range 8.65-8.95 kMc/s, loaded Q > 3,000, magnetic field for electron resonance 3,300 gauss
PP 4380 X	Standing Wave Detector	1.05	Accuracy of the probe displacement 0.01 mm, 50 Ω BNC-connector
PP 4385 X	High Precision Standing Wave Detector	—	Measurable VSWR between 1.005-2.000, accuracy probe displacement 2 μ, probe penetration 0-3 mm
PP 4421 X	Ferrite Isolator	1.15	Freq. range 8.5-9.6 kMc/s, forward att. < 0.8dB, reverse att. > 13dB, max. peak power 50 kW
PP 4422 X	Ferrite Isolator	1.20	Freq. range 8.5-9.6 kMc/s, forward att. < 0.5dB, reverse att. > 20dB, max. mean power 1 W
PP 4500 X	3 cm Noise Generator	>1.20	Noise factor 18.7dB (K50A), attenuation 0-13dB

Additional Instruments: **D.C. Microvoltmeter, type GM 6020 - Klystron Supply, type GM 4561 - Bolometer Bridge, type GM 4460**

Q TYPE	DESCRIPTION	MAX. VSWR.	
PP 4020 Q	Straight Waveguide Section	—	Length 5, 10 or 20 cm
PP 4025 Q	E-plane Bend	1.07	Radius of curvature 35 mm
PP 4030 Q	H-plane Bend	1.07	Radius of curvature 37 mm
PP 4035 Q	Twist	1.07	Length 50 mm
PP 4050 Q	Hybrid Tee	—	Decoupling > 35dB
PP 4080 Q	Horn	1.15	Directivity: E-plane 15°, H-plane 16°
PP 4130 Q	Variable Flap Attenuator	1.15	Max. attenuation > 20dB, max. mean power 200 mW
PP 4150 Q	Variable Rotary Attenuator	1.15	Max. attenuation 50dB, accuracy ± 3%
PP 4170 Q	Low-power Matched Load	1.05	Max. mean power 1 W
PP 4200 Q	Klystron Mount	—	When using klystron 55,335 the output power is 100 mW
PP 4222 Q	Adjustable X-tal Mount	1.25	50 Ω BNC-connector
PP 4260 Q	Calibrated Short Circuit	50	Accuracy of the displacement 0.02 mm
PP 4270 Q	Sliding Screw Tuner	from 10 to 1.03	Insertion loss for a VSWR of 10 is > 2dB
PP 4300 Q	Broadband Wavemeter	1.20	Relative accuracy 5.10^{-4} loaded Q > 3000
PP 4382 Q	Standing Wave Detector	1.03	Accuracy of the displacement 0.01 mm, max. probe penetration 1 mm, 50 Ω BNC-connector
PP 4420 Q	Ferrite Isolator	1.15	Freq. range 33-36 kMc/s, forward att. < 1dB, reverse att. 13-26dB, max. mean power 200 mW

Additional Instruments: **Klystron Supply, type 4485 - D.C. Microvoltmeter, type GM 6020**

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CIRCLE 23 ON READER SERVICE CARD

Impact of Technology on Marketing

By BRUCE HENDERSON,
Vice President, Arthur D. Little, Inc.

Henderson

CRITICAL IMPORTANCE of marketing today is due to the impact of technology.

If it were not for technology, marketing could settle down into a well-known established pattern in which only the skill of the salesman was really important. But technology is introducing ever more rapid change—change in products—change in the production cycle—change in risk—change in consumer behavior—change in physical distribution—change in competitor's capability—and perhaps most important of all—change on our insight into the relations between these complex forces in the marketing equation.

Fortunately, technology not only creates marketing problems by introducing change, but in turn, it provides the tools to deal with the problem.

Let's catalogue some of the impact:

First, new products—The birth rate of new products from new technologies like electronics was never higher and the variety was never greater. The introduction and the customer recognition of the values and the rapid obsolescense of the many old products becomes a marketing problem.

For the last 10 years industry has been pouring into R&D sums that increased each year. In 1953-54, this amounted to some $2,240,000,000, and six years later it is estimated at $4,426,000,000. Since from three to eight years elapse before the effects of R&D investment are felt, we shall see new products and the resultant obsolescense growing rapidly.

The food industry, aided by electronic & nucleonic techniques, offers examples with astounding changes. For example, yesterday taking a visitor through one of our labs, I ate some raspberries and some strawberries that looked fresh, smelled fresh, tasted fresh and felt fresh, but had been stored over a year at room temperature.

Second, technology is generating more complex and more sophisticated products at an increasing rate. Some of these are more complex in nature for industrial application, particularly electronics. Some are far more sophisticated for discriminating consumers.

Third, longer development cycles and greater capital commitment to the production facility are the natural result of the increased complexity both of products and of more highly automated production. Balancing the resulting increase in risk and inflexibility against the potential rewards becomes a marketing problem.

Fourth, since change is large but uneven, consumer behavior and values must change too. With the greater choice and complexity of products, the consumer becomes less the "economic man" seeking to satisfy his elementary needs and becomes more the "social man" striving for maximum satisfaction of cultural, psychological and social motivation.

Marketing must identify these even more subtle motivations and convert them into marketing plans, recognizing the greater cyclical vulnerability of some types of non-elementary needs. Russell Lynes has pointed out the problems cre-

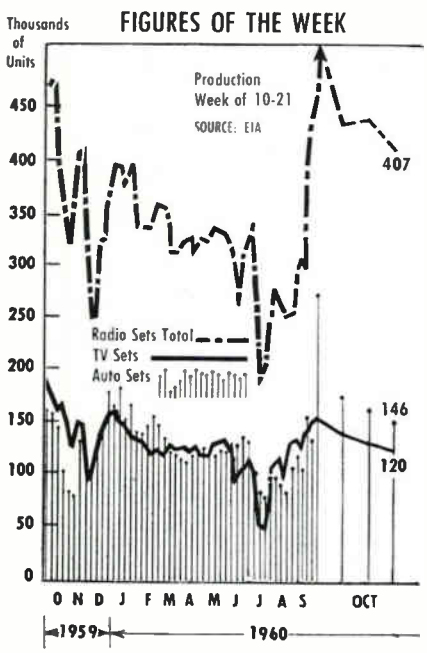
ated for marketing men by the "taste-makers."

Their whims and desire to be individual become tomorrow's fashion —whether it be vodka, martinis, sports cars or grey flannel suits.

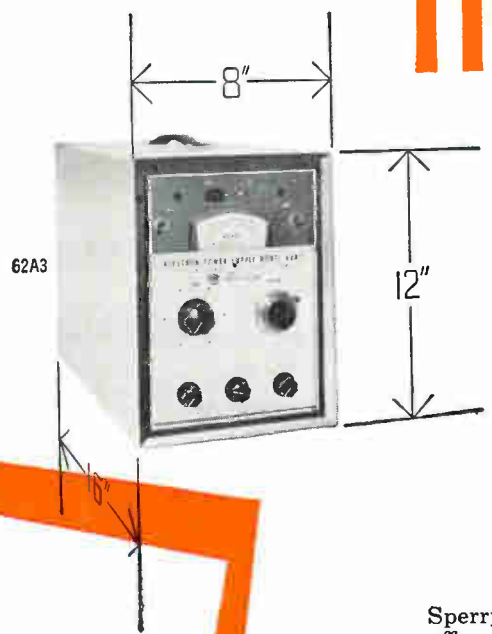
Because technology makes possible an almost infinite variety of products, consumer wants are not always easily interpreted, measured and forecast. They change for no apparent reason, requiring a high degree of sensitivity and flexibility in the marketing profession.

Fifth, the logistics of physical distribution are being changed. Personal services are becoming more expensive. Automatic preplanned data processing and handling equipment are becoming more effective. Alternative transport methods become more numerous and competitive (air—rail—barge —truck).

Both the costs and the rules of the game are changing for the marketing man who would optimize the marketing process. All of these things mean that marketing today is faced with ever more complex, ever more sophisticated, ever more rapidly changing problems. Solution by "feel" or by intuitive insight becomes less and less reliable except as checked and modified by intensive, fact-based analysis. While past experience is a valuable guide to the future, it is not sufficient to deal with change of this magnitude.



TIGHTLY PACKED



Smallest and lightest for its power on the market

SPERRY

50 YEARS 1910 1960

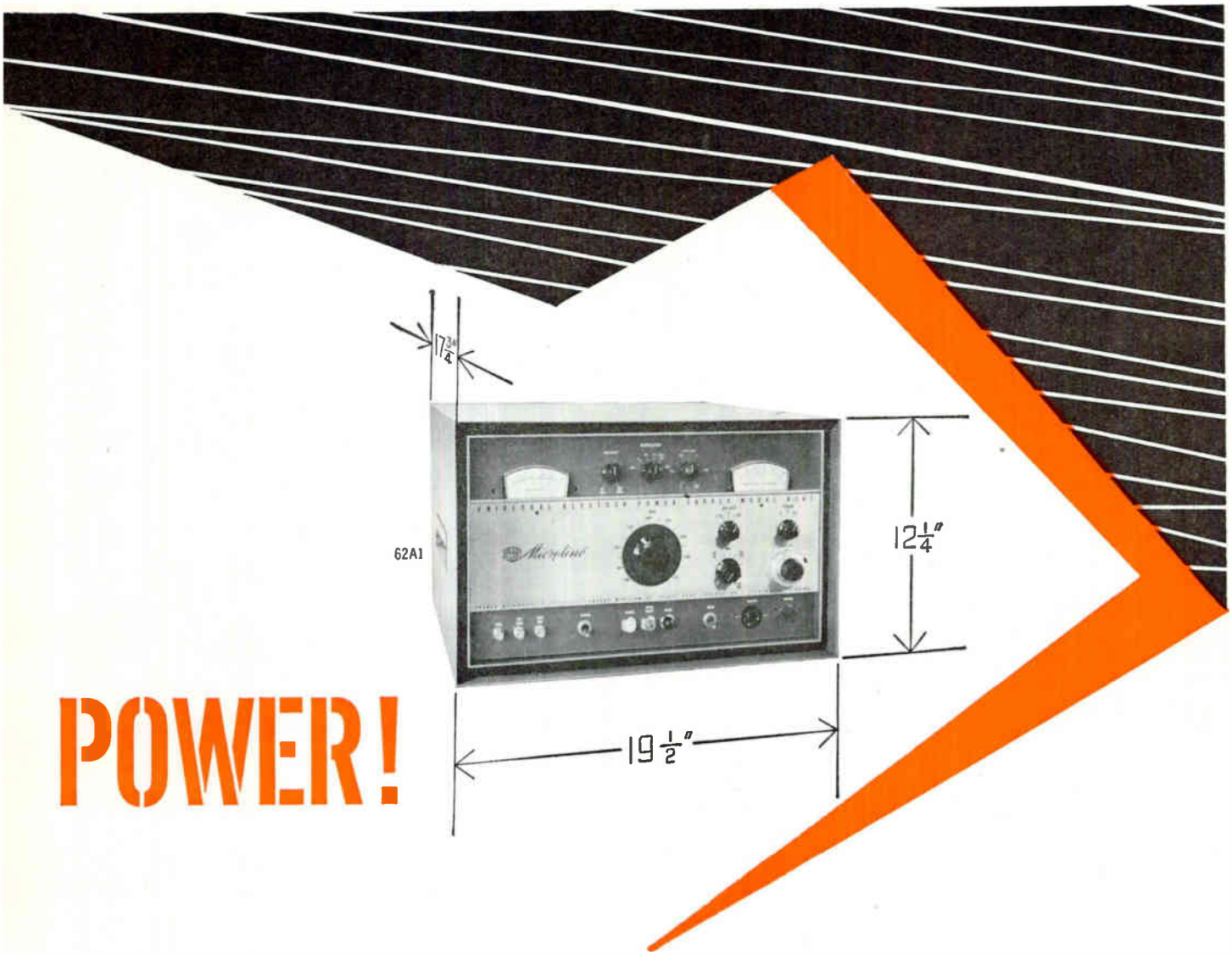
Sperry Klystron Power Packages are offered in two sizes to meet any laboratory requirements.

Model 62A1 Universal Klystron Power Supply delivers −200 to −4,000 volts from 0 to 150 ma. Extremely compact: 12¼" high, 19¼" wide, 17¾" deep. Weighs only 125 lbs.

Model 62A3, is today's most versatile 700 volt Klystron Power Supply. It is the smallest and lightest package of its power on the market. Delivers up to 70 ma. Ideal for average laboratory use—and at a moderate price. Weighs only 32 lbs. and measures 8" x 12" x 16".

Both units designed for ready adaptability to accessory connections. Excellent regulation, low ripple, stable operation.

Write for detailed information and applications of these packed-with-power units for general laboratory use.

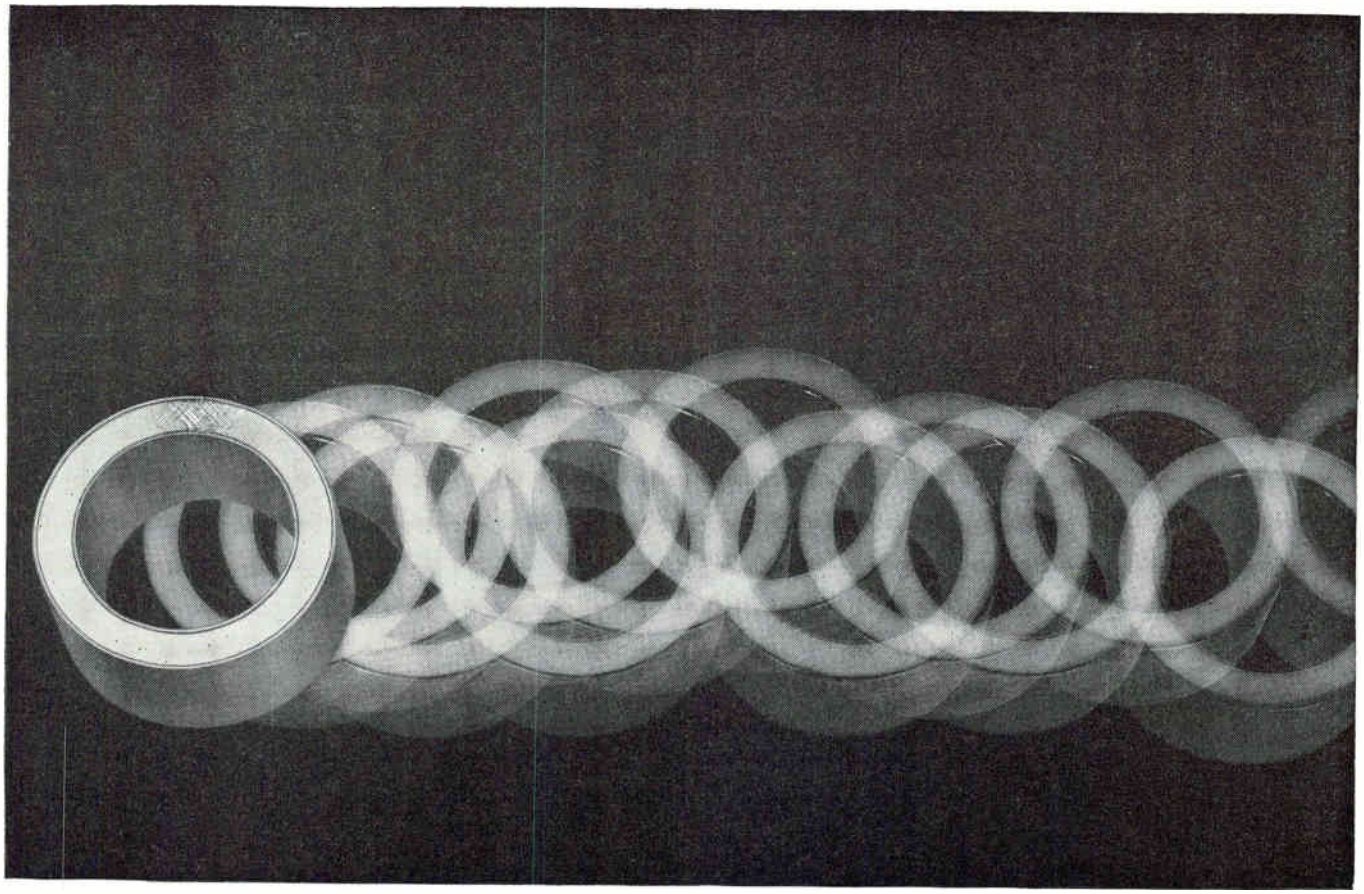


POWER!

SPERRY *Microline*® KLYSTRON POWER SUPPLY

MODEL 62A3		MODEL 62A1
−200 to −700 volts Continuously adjustable 0-70 ma. ±1 volt line regulation 5 mv. max. ripple	BEAM	−200 to −4000 volts Continuously adjustable 0-150 ma. ± 1 volt line regulation 3 mv. max. ripple
0-1000 volts 0.1% regulation 5 mv. max. ripple	REFLECTOR	0 to −1000 volts .01% regulation 3 mv. max. ripple
6.3 volts @ 0-2 amp.	FILAMENT	6.3 volts @ 4 amp., with provision for external filament supply
2% accuracy	METERING	2% accuracy
0-150 v., peak to peak, all waveforms *Sawtooth:* 40-400 cps. *Square Wave:* 200-2000 cps. *Sine Wave:* line frequency *External Modulation:* direct or amplified	MODULATION	0-250 v., peak to peak, all waveforms *Sawtooth:* 40-400 cps. *Square Wave:* 200-2000 cps. *Sine Wave:* line frequency *External Modulation:* direct or amplified
8" x 12" x 16"	DIMENSIONS	12¼" x 19½" x 17¾"
32 lbs.	WEIGHT	125 lbs.
$550	PRICE	$1300

SPERRY MICROWAVE ELECTRONICS COMPANY, *CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION*



the strong case for Centricores®

When you're considering magnetic cores it pays to get down to cases. The sturdy aluminum case for Centricores assumes special importance where impact, vibration, heat or mechanical pressure could cause trouble in a control loop you're designing, or where you want to miniaturize an inductive component.

The case is ruggedly rigid, so that you can apply your circuit windings without danger of distorting the core's magnetic properties. And the case is absolutely leakproof. You can vacuum-impregnate Centricores without danger of their damping oil leaking out or foreign matter leaking in. The tightly sealed case also guards against leakage in applications where high ambient temperatures are present, or where Centricores are used in rotating equipment.

Here's a tip on miniaturization. The rugged design of the Centricore case permits use of a thinner gage aluminum that shaves fractions of an inch off their size—fractions that can add up to precious inches where you want to scale down component dimensions. *Centricores are the slimmest magnetic cores on the market.*

Centricores are the most uniform. They give the exact performance you want, from core to core and lot to lot. Their remarkable consistency in insulation, dimensions, squareness, thermal stability and gain is the product of unique quality controls that begin with the very selection of raw materials and extend through final testing.

Write for complete data. Centricores are available from stock from our East and West Coast plants in all standard sizes and magnetic qualities, and in both aluminum and phenolic cases. We will match them within 5 per cent over the entire voltage-current loop, in sets, units or in multiples up to twelve. Write for detailed specifications today.

MAGNETIC METALS

Magnetic Metals Company
Hayes Avenue at 21st Street, Camden 1, N.J.
853 Production Place, Newport Beach, California
transformer laminations • motor laminations • tape-wound cores
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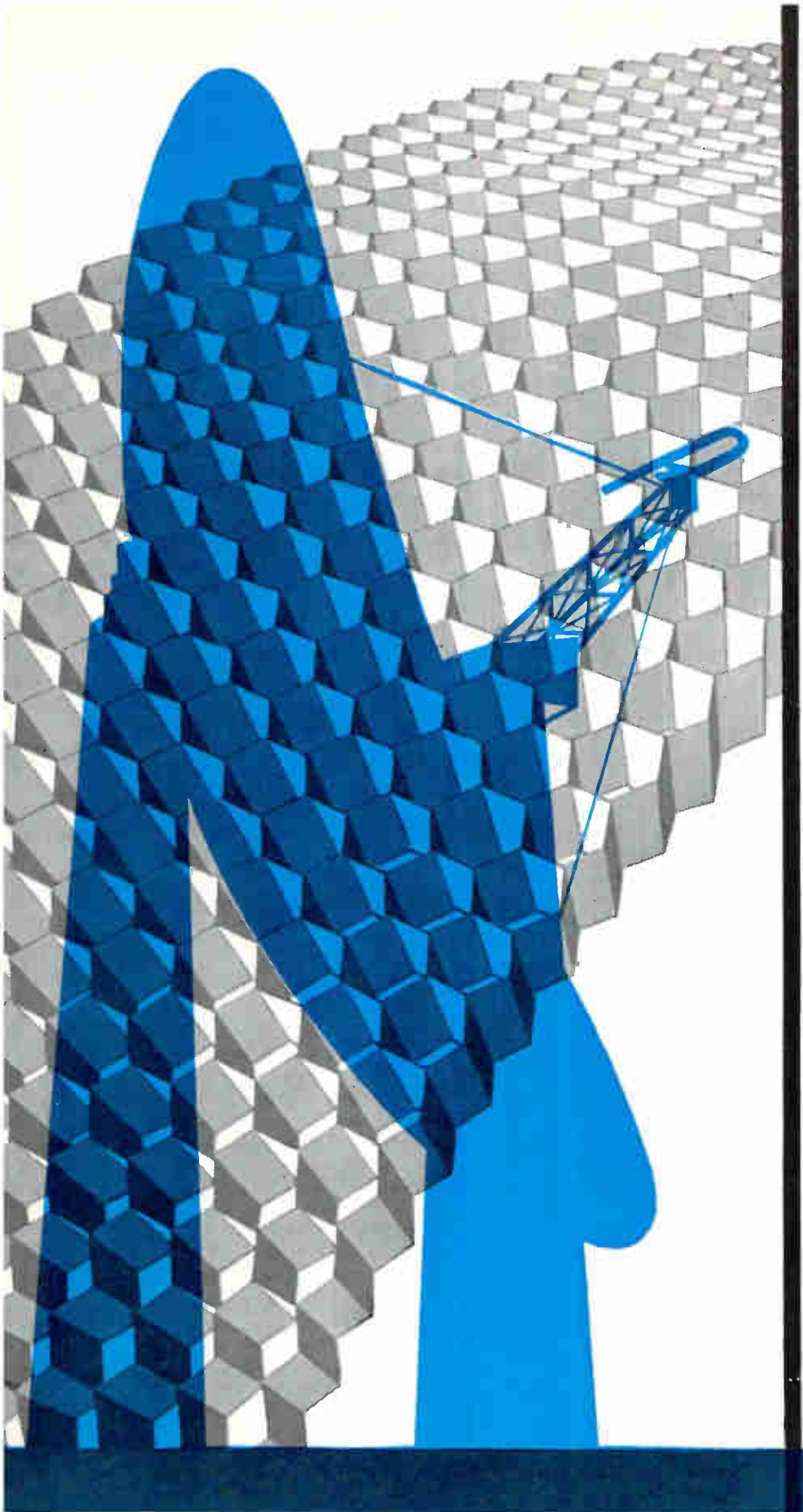


Three stories high.. the FPS-26 tells a story of Avco/Nashville radar capability

Now in production at Avco/Nashville is a huge reflector for the Air Force's FPS-26 height-finder radar. Researched and developed by Avco's Electronics and Ordnance Division, the entire FPS-26 stands three stories high. The reflector, made of high-rigidity, low-weight honeycomb sandwich construction, is housed in a radome 50 feet in diameter.

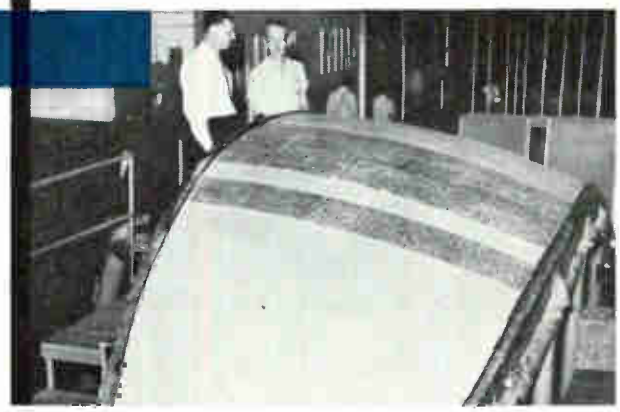
In contrast is another radar reflector also made by Avco/Nashville. It is a small, highly developed, carefully finished reflector for Mach 3 military aircraft. It is made of *Arcomb* stainless steel honeycomb.

These two reflectors indicate the range and scope of Avco/Nashville's capabilities in the field of radar reflectors as well as other structures with high-strength, lightweight materials.

In its large plant in Nashville, Tennessee, Avco/Nashville has specialists experienced in the design, tooling, and construction of radar antennas or reflectors. It also has facilities for producing pedestals for large radars.

Conventional radar antennas and those of sandwich construction are all within the demonstrated engineering and production capability of Avco/Nashville.

Inquiries about radar structures are invited from prime contractors. Write to: General Marketing Manager, Nashville Division, Avco Corp., Nashville, Tenn.



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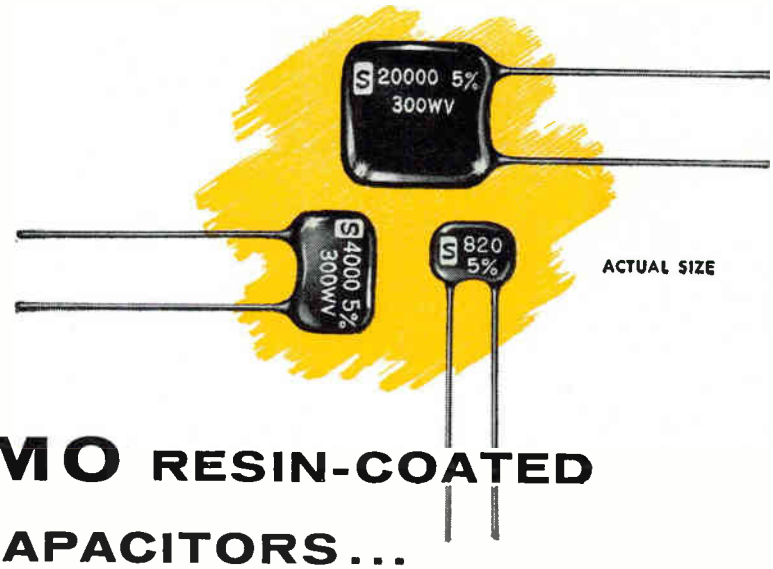
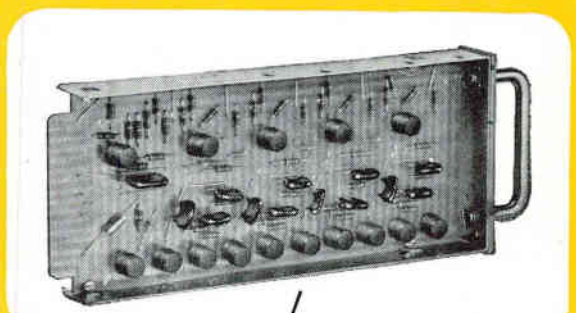
CIRCLE 29 ON READER SERVICE CARD

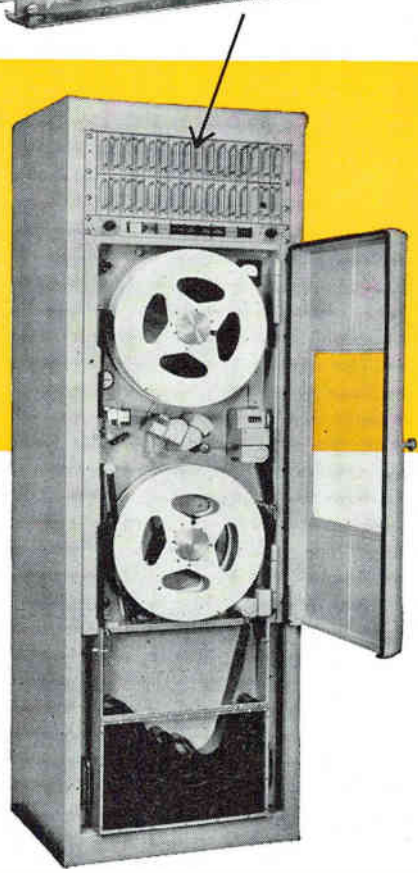


ACTUAL SIZE

NEW type D SANGAMO RESIN-COATED SILVERED-MICA CAPACITORS...

are significantly smaller... operate to +150° C... exceed proposed dipped-mica capacitor military specifications





Sangamo experience with mica capacitors and years of engineering know-how and quality development underline two new Type D Resin-Coated Silvered-Mica Capacitors. Designed for operation at temperatures of +125° C and +150° C, both offer the advantages of radial leads, small size, full rated working voltage without derating, and a clean, moisture-sealed protective resin coating. Physical and electrical features of the Type D capacitor are ideal for etched circuits, high component-density equipments, missiles, computers, and instrumentation devices. Type D capacitors are available with characteristics C, D, E, or F, in nearly all capacitance values.

Test these new Sangamo Type D Resin-Coated Silvered-Mica Capacitors — they more than meet proposed military specifications. Try them in your own circuits — they will fulfill all expectations of today's most critical applications. Those who know capacitors choose Sangamo for outstanding performance and long life.

... Type D Resin-Coated Silvered-Mica Capacitors are an important part of the transistorized circuitry of this Sangamo Type 460 Tape Transport System. Their small size, high-temperature performance, and reliability contribute materially to the transport's recording uniformity and play-back accuracy —

SC60-7

SANGAMO ELECTRIC COMPANY, Springfield, Illinois

— designing toward the promise of tomorrow

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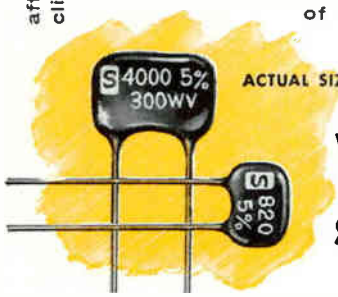
a continuing series on technical topics of specific interest to engineers

Folio 13 REFERENCE DATA FILE SANGAMO



What constitutes a superior dipped-mica capacitor?

Silvered-mica capacitors have achieved a reputation over many years of use for high stability and high reliability. Mica's inherent low power factor, high dielectric strength, low dielectric absorption and high insulation resistance have made mica capacitors most desirable in electronic circuits where good stability with respect to temperature, frequency, and aging are required.

But refinements of mechanical features were required for today's high component-density equipment utilizing etched-circuit construction. Some of the requirements that led to development of the dipped mica capacitor were:

1. A protective covering, that is thermally and mechanically rugged, impervious to moisture, and non inflammable.
2. Radial leads for rapid assembly, rigid mounting, and cool operation.
3. Small size and dimensional uniformity for more compact and standardized assemblies.
4. A glossy surface to which dirt does not adhere and which also enhances appearance.
5. Lower cost through improved automated manufacturing techniques.

Considering these requirements, Sangamo has designed two new Type D resin-coated, silvered-mica capacitors. They have a better coating resulting from finer materials used in the dipping process, and also possess the excellent performance characteristics previously established by other types of Sangamo silvered-mica capacitors.

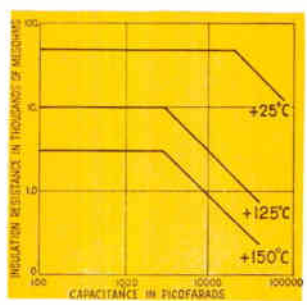
MECHANICAL DESCRIPTION: The mica is carefully selected for electrical excellence and dimensional uniformity. The silver is screened on the mica and fired to effect a positive bond. A positive low-resistance connection is assured by clips and leads of tinned brass pressure clamped to the section.

Good thermal shock characteristics, moisture resistance, and a glossy surface are provided by five separate resin coatings that do not appreciably alter the electrical characteristics of the silvered-mica section.

OPERATIONAL PERFORMANCE:

Type D capacitors are available in two maximum temperature ratings, +125° C or +150° C. Both can be operated at rated voltage without derating.

The insulation resistance for capacitance values is shown in Figure I for +25° C, +125° C, and +150° C.



These capacitors are available in C, D, E, or F characteristics over the temperature range of −55° C to +125° C or +150° C as shown in the following table:

TABLE I

Characteristics Available in Type D Resin-Coated, Silvered-Mica Capacitors

Characteristic	Temperature Coefficient ppm/° C	Capacitance Drift Per Cent	Availability of Characteristic
C	±200	±0.5	All Values
D	±100	±0.3	All Values
E	−20 to +100	±(0.1 + 0.1 pf.)	Above 20 pf.
F	0 to +70	±(0. 05 + 0.1 pf.)	Above 50 pf.)

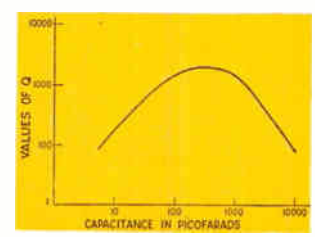
The moisture resistance is given as an insulation resistance greater than 10,000 megohms after a ten day cycle outlined in Method 106A, Figure 106-1 of Mil-Std-202B.

Thermal and immersion cycling is given as an insulation resistance greater than 10,000 megohms when subjected to temperatures between −55° C and +125° C or +150° C as outlined in Method 102A, test condition D and Method 104A, test condition B of Mil-Std-202B.

These capacitors will withstand a constant acceleration of 20 G's in accordance with Mil-Std-202B, Method 204A, test condition D.

Values of Q at various frequencies are shown in Figure II.

Type D capacitors can be stored at −55° C without injury. Case insulation strength is 200 per cent of rated voltage.

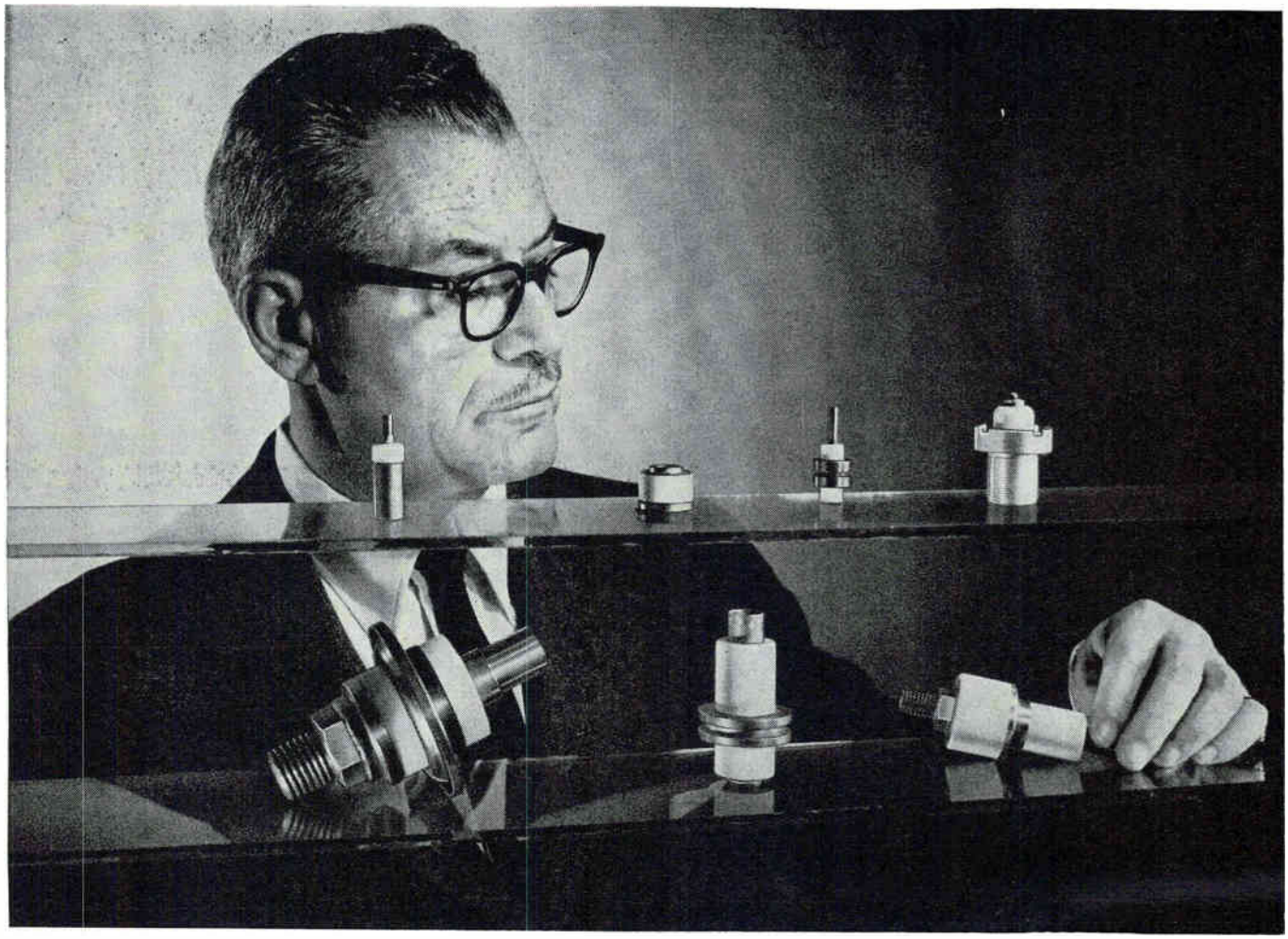


They will have an insulation resistance of 10,000 megohms at +25° C after an accelerated life test of 2,000 hours duration at 150 per cent of rated voltage, at high ambient test temperatures of +125° C or +150° C.

Acceptable Quality Levels (AQL) of completed units are fully met using the sampling plan set forth in Mil-Std-105A. This limits visual and mechanical AQL to 1.5%; Electrical AQL to 0.65%; and environmental AQL to 2.5%.

Sangamo also supplies the Type D as a non-standard capacitor in accordance with special requirements. Where maximum dimensions are critical and military humidity specifications do not apply, Type D capacitors are available with fewer resin coats. If circuit design requires a lower temperature coefficient, it can be provided when specified. Where improved reliability is an important factor, Type D capacitors can be 100 per cent short-term, accelerated life tested. In addition to straight lead design, Type D is also available with crimped leads which provide a positive stop when capacitors are mounted on etched-circuit boards.

SC60-8



Engineering hints from Carborundum

Use KOVAR® Alloy to solve problems in sealing to ceramics

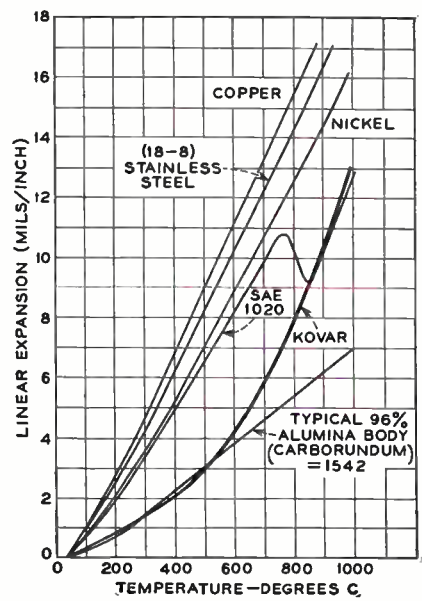
KOVAR, the original 29% nickel, 17% cobalt, 54% iron alloy, was developed for sealing to low expansion glass, but is now being used extensively for making pressure and vacuum tight seals with metallized ceramics of the low expansion type.

The curves at right show the expansion of KOVAR compared with a representative high alumina ceramic body. The expansivity match up to 500 C is very close, and the difference in expansion at higher temperatures is closer than with most common metals and alloys.

The fact that KOVAR is slightly higher in expansion at elevated temperatures is an actual advantage when the ceramic is on the inside of the unit since the resulting joint is placed in compression. The degree of compression is slight compared with that resulting from the use of a metal of higher expansion.

While a considerable difference in expansivity can sometimes be tolerated with the metal on the outside of thick sections of ceramic, this is not the case when the ceramic section is thin. Closer compatibility of expansivity, such as is obtained with KOVAR, is also required when the metal is on the inside of the ceramic or for sandwich or end type seals where both tensional and shear stresses must be kept to a minimum.

KOVAR alloy is stocked in a variety of sizes of rod, wire, tubing, sheet, cups and eyelets. Your inquiries are invited for prices, technical information and recommendations on specific problems. Write Dept. E-100 Latrobe Plant, Refractories Division, The Carborundum Company, Latrobe, Pa.



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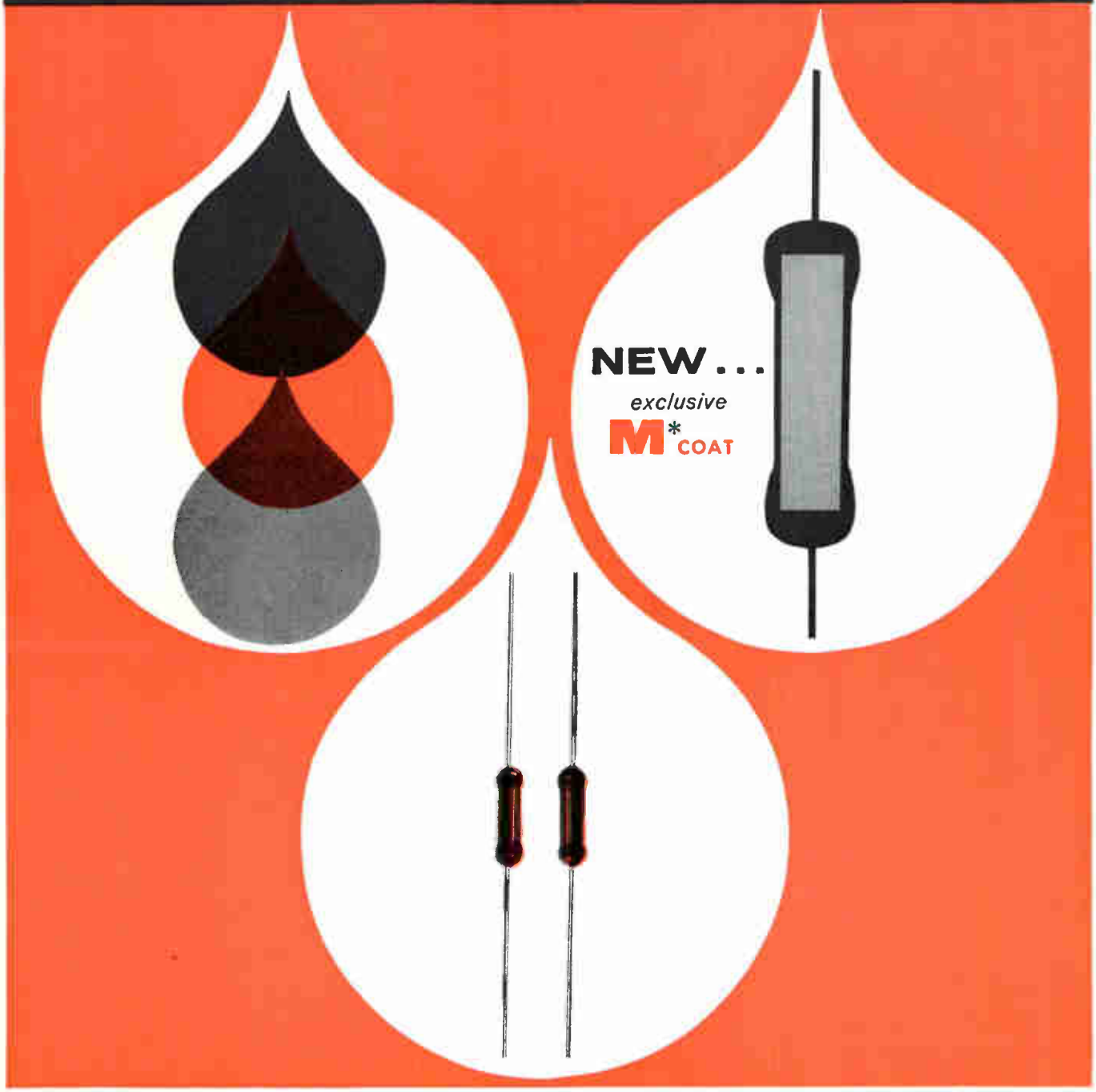

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IRC precision film resistors with M Coat take 30 cycles of moisture, 300% of the MIL-R-10509C Characteristic B requirement, tested in accordance with MIL standard 202.

M Coat adds greater protection for the resistance element, eliminates handling and assembly damage. Insulation resistance after 30 cycles of moisture is over 100 megohms.

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Write for Bulletin AE-15, International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

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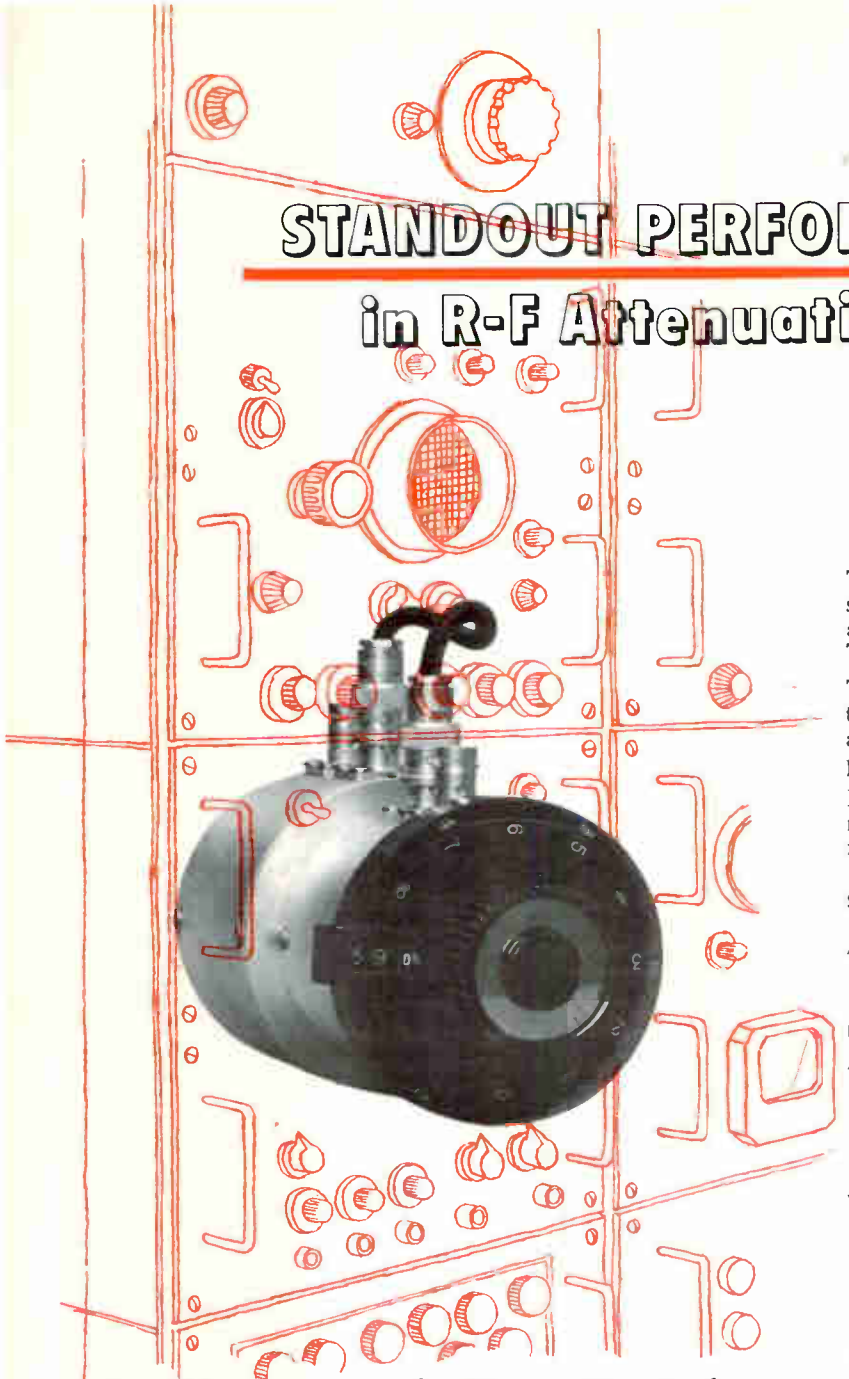
STANDOUT PERFORMER
in R-F Attenuation

Telonic® INDUSTRIES INC.



Telonic Industries presents the new, compact TAB-50 RF signal attenuator for operation from DC to 1250 mc with an attenuation range of 0 to 59 db in 1 db increments. TAB-50 DC to 1250 mc RF Attenuator

The new Model TAB-50 is a precision-built unit that fills the electronic design engineer's need for the universal RF attenuator. It can be used unmounted as a laboratory unit, or panel mounted as a component in instruments or systems.

Performance is unique — it exhibits low VSWR ratios, low insertion loss at the 0 db position, and high accuracy across its entire operating range.

SPECIFICATIONS

Attenuator steps		0 to 59 db (in 1 db steps through a dual, concentric knob and dial arrangement)
Impedance		50 ohms
Frequency range		DC to 900 mc (reduced accuracy to 1250 mc)
Accuracy	0 to 10 db	±0.2 db to 200 mc ±0.3 db at 400 mc ±0.5 db at 900 mc
	11 to 59 db	±2% ±0.2 db to 200 mc ±3% ±0.3 db at 400 mc ±5% ±0.3 db at 900 mc
VSWR		1.2:1 to 300 mc 1.35:1 to 900 mc
Insertion loss		0.1 db to 300 mc 0.2 db to 500 mc 0.4 db to 900 mc
Power rating		1 watt
Dimensions		Case Diameter: 3" Case Length: 4¾"
Weight		44 ounces
Price		$225.00

Telonic also manufactures other RF turret attenuators for various applications. Two typical units are the TA-50 and the TB-50 shown below.

Model TA-50
Attenuator steps:
0, 10, 20, 30, 40, 50 db
Price $65.00

Model TB-50
Attenuator steps:
0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 db—Price $95.00

FOR COMPLETE DATA ON TELONIC TURRET ATTENUATORS OR OTHER RF COMPONENTS AND TEST EQUIPMENT FILL OUT THE REPLY CARD AND DROP IT IN THE MAIL.

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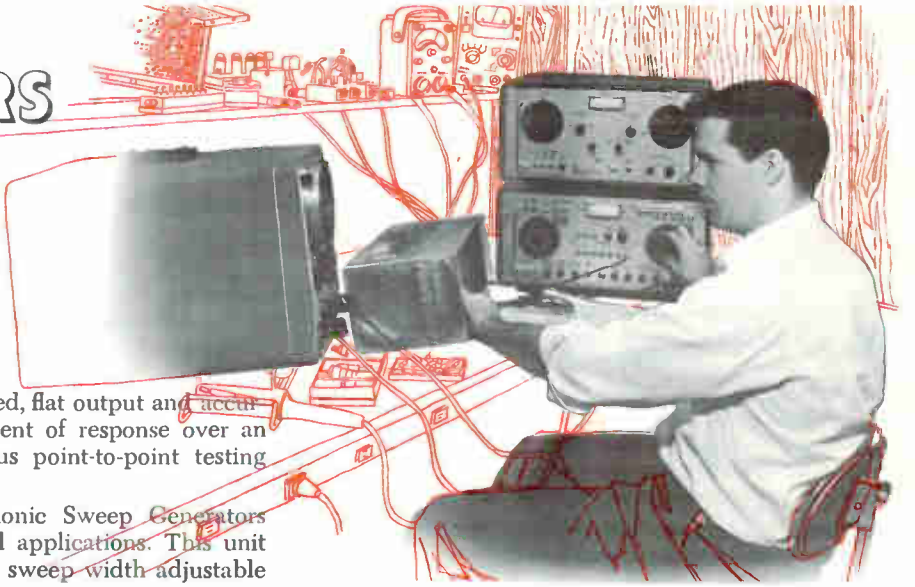
SWEEP GENERATORS



In RF Circuit Testing the ultimate quality check is frequency response —

— and Telonic Sweep Generators, featuring regulated, flat output and accurate attenuation, provide rapid, precision measurement of response over an entire frequency range at a single glance. Tedious point-to-point testing techniques are completely eliminated.

The model HD-IA shown here is typical of Telonic Sweep Generators available for both development and quality control applications. This unit has a center frequency range of 1 to 900 mc and a sweep width adjustable from 200 kc to 200 mc.

RF output of the instrument is .75 volts, peak to peak, in the low band, and 2.0 volts, peak to peak, in the high band — all voltages adjustable by the panel-mounted turret attenuator. Toggle switches on the front panel introduce birdy markers into the scope trace, and up to eight plug-in single frequency or harmonic markers may be used. Price — $995.00

Telonic Industries provides a complete line of sweep generators for use in the laboratory or on the production line. These instruments may be used for rapid frequency response testing of filters, tuners, mixers, amplifiers and all other types of RF equipment. The following chart shows some of the other models available.

Model	Center Frequency	Sweep Width	Range	Attenuation (db) (T) Turret (S) Toggle Switch	Output (into 50 ohms)	Remarks	Bulletin Number	Price List
HD-3	1-200 mc	200kc-200 mc	1-300 mc	T-0, 10, 20, 30, 40, 50	.75, p to p	Heterodyne type — wide sweep width and tunable center frequency	T-210	835.00
HD-4	10kc-10 mc	25kc-10 mc	10kc-15 mc	S-20, 20, 20, 10, 6, 3	1V, p to p	Video sweep — wide or narrow applications	T-213	695.00
HD-7	100kc-75 mc	250kc-50 mc	100kc-100 mc	S-20, 20, 20, 10, 6, 3	1V, p to p	Video and IF frequencies Higher video and IF frequencies		
LD-5	20-75 mc	.05-40% of CF	16-90 mc	S-20, 20, 20, 20, 20, 10, 5, 3, 2, 1	1uV-1V, RMS	Electronically swept • Fundamental frequency type • Wide range of output levels • Exceptionally stable, flat and free from spurious content	T-214	695.00
SD-2	215-450 mc	.02-10% of CF	200-460 mc	T-0, 10, 20, 30, 40, 50	.75V, RMS	Capacitive, sweep Center frequency tuning Exceptionally flat VHF — UHF — low microwave applications	T-207	745.00
SD-3	440-920 mc	.01-6% of CF	425-930 mc	T-0, 10, 20, 30, 40, 50	.75V, RMS			
ED-1A	1000-1700 mc	.25-100 mc	975-1515 mc	Vernier 0-10db	.25VRMS	Output is result of 2nd harmonic generation and filtering — and thus these ranges are obtained from the highly reliable SD type of oscillator	T-216	1495.00
ED-4A	1700-2500 mc	.25-100 mc	1675-2320 mc					

Complete information on sweep generators, accessories and other RF equipment made by Telonic is available on request; use the reply card below.

Telonic Industries, Inc. Beech Grove, Indiana

Please send complete data on the following:

☐ RF Turret Attenuators ☐ RF Detectors

☐ Sweep Generators ☐ RF Toggle Switch Attenuators

Model No._____ ☐ RF Filters

Name *Title or Dept.*

Company

Address

City *State*

Telonic® INDUSTRIES INC.

Q & A ABOUT D.V.S.T's

Q: Do you know the important differences between DVSTs (Direct View Storage Tubes) and conventional CRTs (Cathode Ray Tubes)?

A: The obvious answer concerns construction differences in the DVST (flood gun, various front-end meshes, etc.). But, more important is the new range of applications available to DVST users. These new applications result from DVST's high brightness, controllable persistence, storage capability, integrating properties—and the human factors compatibility which accompanies all of these advantages.

Q: Are all DVSTs alike?

A: Where storage time and brightness characteristics are concerned, most DVSTs are fundamentally similar. Significant differences exist, however, in other important criteria.

Q: What criteria should you look for in a DVST?

A: It depends, of course, on your particular application—but there are at least three important qualities you should check:

1. Half-tone rendition: When operating in the storage mode, DVSTs differ greatly in their ability to produce enough half-tones for photographic-quality detail.

2. Resolution: This important factor (together with half-tone rendition) is a measure of a DVST's ability to display a detailed, accurate picture. As a function of writing gun spot size, proper resolution depends on advanced developments in the field of high-performance electron guns.

3. Uniformity of writing, storage and erasure: DVSTs must present displays free from unwanted highlights—displays which will erase evenly and completely. Most important in influencing this capability is collimation (ability to arrange flood electrons in parallel array and then to strike the target assembly at a 90° angle).

Q: What does Hughes offer in the DVST line?

A: Everything you could ask for. (Warning! This is the commercial):

1. Outstanding half-tone rendition with DVSTs which store up to 7 shades of gray. (More than any competitive DVST!) They produce detail unmatched by any other storage tube.

2. Higher resolution resulting from advancements in electron gun design perfected by the famed Hughes Research Laboratories.

3. Exact collimation for uniformity of writing and erasure through the use of an advanced, Hughes-developed electronic lens system. This system features a precision machined metal lens integrated with the target assembly.

4. Brightness and storage time—more than competitive with any other DVST on the market today.

5. World's most complete line of DVSTs. Sizes: 3", 4", 5", 7", 10", 21"; electrostatic or electromagnetic deflection. Available with 1, 2 or 3 write guns.

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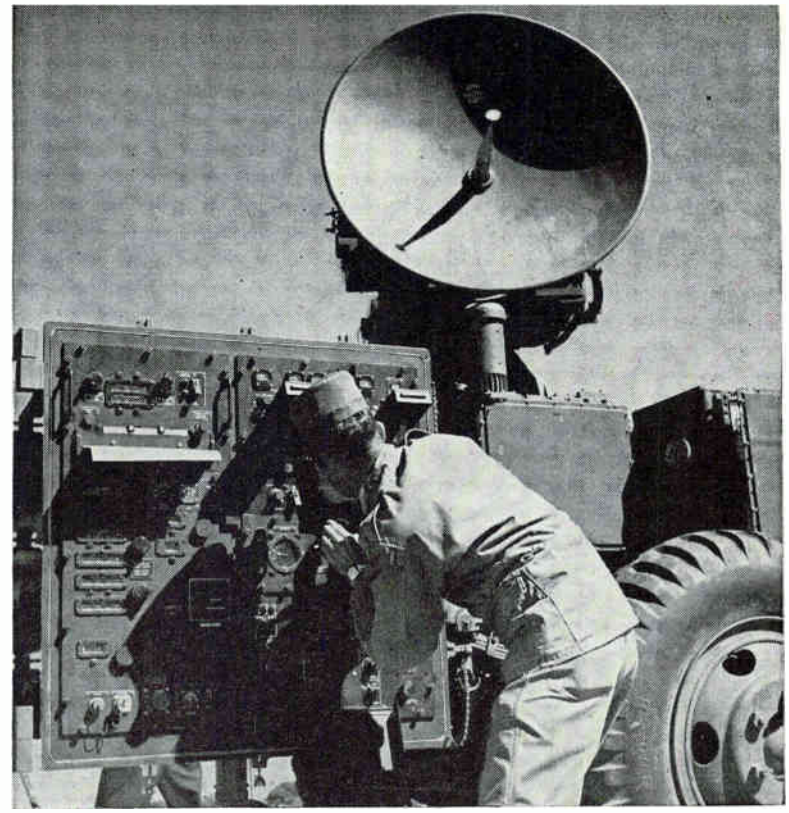
VACUUM TUBE PRODUCTS DIVISION

HUGHES AIRCRAFT COMPANY

Fort Huachuca: Arbiter of Army Electronics

By JOHN F. MASON,
Associate Editor



Drones are tracked by Sperry's N/USD-1 radar out to 60 mi

FORT HUACHUCA, ARIZ.—The 250 miles of desert wasteland stretching west from here is a gigantic proving ground for hundreds of millions of dollars worth of electronic equipment for the U. S. Army.

Army's mission here is to create an entirely compatible array of battlefield electronic equipment. This job is being tackled in three steps.

First, engineering tests are run on Signal Corps equipment to evaluate performance, reliability and maintainability. Equipment may go back to the manufacturer as a rejection or for modification.

If the equipment answers Signal Corps' needs, it goes on to testing within the battlefield environment for electromagnetic compatibility with other devices.

The final responsibility at Huachuca is to develop and propose complete command control systems for the modern army.

Fort Huachuca, which was established in 1877 to thwart the plans of the Apache chief Geronimo, is an ideal location for the U. S. Army Electronic Proving Ground (USAEPG). In spite of the impressive sunsets, the dry plains and rock mountains have still not attracted many settlers. As a result, the Army walked into a 75,000-acre, open-air laboratory, relatively free of manmade radiation.

Called the Electromagnetic Environmental Test Facility (EETF), the laboratory is in three parts:

The Electromagnetic Environment area (EME), located near Gila Bend, Ariz. at the north-west end of the installation, will investigate radio frequency interference.

The Drone Test Facility (DTF) runs the 250-mile stretch from Fort Huachuca westward to Yuma.

The Common Test Facility (CTF), at Fort Huachuca, provides communication and test facilities for the entire complex.

Pan American World Airways is prime contractor for engineering, installing equipment and operating the facility (EETF) under the supervision of the Proving Ground's commander, Major General F. F. Uhrhane. As major subcontractor, Bell Aerosystems is responsible for the EME area where radio interference is studied. Pan Am's two-year contract began in March and amounts to $18.8 million. Operating cost for the first five years is expected to total $90 million. Not included in this cost is the prototype gear being tested. This equipment, which includes almost every electronic device used by a modern army, is channeled into five departments:

The Combat Surveillance and Avionics dept. tests, evaluates and integrates all equipment to acquire combat intelligence. The payload is sensory equipment. Associated gear includes vehicles to put the sensors in the right place to spy on the enemy and equipment to record information and get it back home.

Army has four types of drones, ranging in readiness from operational to developmental. Sensors used in drones and in manned aircraft—fixed and rotary wing—may include: tv, infrared, magnetic mine detectors, radiation smellers, sidelooking radar, and radio-controlled cameras—still and movie—with automatic transmission back to the ground (for Fairchild Camera and Instrument's camera now undergoing tests, see ELECTRONICS, p 47, June 5, 1959).

Related airborne equipment includes navigation and communication systems, flight instrumentation and stabilization devices, data processing and ecm.

Ground equipment for aerial surveillance vehicles includes radio, data processing and reduction gear, magnetic recorders, display units, communications network, radar and theodolites.

The surveillance department is testing three types of point-to-point hypersensitive surveillance radar that pick up enemy vehicles and even troops, the AN/TPS-33, AN/TPS-25 and AN/PPS-4 (the last two are described in ELECTRONICS, p 33, Aug. 14, 1959).

The Signal Communications dept. will soon field test its new Automatic Electronic Switching system. Mounted on a 2½-ton truck, the system will replace the manual system that required several large vans.

Equipment in this system, Army says, includes: a transistorized tele-

phone (TA-341) developed by Stromberg-Carlson—a 4-wire local battery unit on which the conventional dial is replaced by key-set dialing; a lower echelon automatic telephone central (AN/TTC-14) developed by Kellogg Switchboard and Supply—a transistorized 20-line local switchboard expandable to 60 lines; automatic electronic telephone central (AN/TTC-13) developed by Stromberg-Carlson—transistorized, used for trunk switching only; and an automatic electronic telephone central (AN/TTC-12) by Stromberg-Carlson that serves 200 local subscribers and provides 50 trunks to other local switchboards and 30 trunks to the long-distance switching system.

The communications dept. is also testing other equipment:

Radio relay terminal set, AN/MRC-69, provides facilities for one or two 12-channel carrier telephone systems or a radio relay repeater. Major components are two f-m radio sets (AN/TRC-24) and two 12-channel telephone terminals (AN/TCC-7).

Another radio relay repeater (AN/MRC-54) that will use the TRC-24 radio is also being tested.

The antenna for the TRC-24 was developed at Huachuca's model shop and is now in operation in Germany. After formal acceptance of the equipment by the Continental Army Command the antenna will be farmed out to industry for large-scale production.

Industry will soon bid for large-scale production contracts on this Army-developed antenna

Weight of the antenna is about 40 lb. It consists of a folding-mast assembly carried on the roof of the equipment shelter and a lightweight broadband antenna array. The structure was erected at a demonstration here (see photo) in one minute and 53 sec. Each antenna consists of a logarithmically periodic structure comprised of a series of dipole elements cantilevered from a common boom. The antenna has a medium gain of 6 db over the 100 to 600-Mc band.

Huachuca has awarded an initial production contract to Motorola for about $11 million for a vhf, multiplexed ssb communications central, AN/MRC-66. The central is on a ¾-ton truck. Subscriber stations are mounted in jeeps. The system transmits voice, facsimile and teletypewritten messages.

Huachuca-developed troposcatter equipment (AN/TRC-80) provides 24 voice channels up to 150 miles and operates on a frequency of 1,700-2,400 Mc.

The Meteorology dept. studies the highly variable weather conditions from ground up to 2,500 ft. Instruments study energy balance, turbulence and movement of heat and moisture at the earth's surface. The Huachuca station works with 12 other micrometeorology stations in the northern half of the Western Hemisphere. Findings will affect missile operation and design.

The Automatic Data Processing dept.'s objective is to provide the field army with completely automatic data processing facilities. Realization of this goal will be delivery of the Army's Fieldata family of computers (ELECTRONICS, p 37, Apr. 3, 1959). The family will include small computers for the lower echelons, the Basicpac for more complex applications, and the large Mobidic, a general-purpose, completely transistorized computer. Huachuca now simulates battle problems with an IBM 709. Ramo-Wooldridge supplies technical assistance.

The Electronic Warfare dept. (EWD) is developing a family of multipurpose ecm sets in three basic configurations: ¾-ton truck, armored personnel carrier and the Otter aircraft. In addition, a series of air-deliverable, expandable ecm devices is being developed and tested. Ultimately these will be delivered by manned aircraft, drones and artillery. Army also has a classified miniaturized self-contained Manpack ecm transceiver for front-line troops.

The Electromagnetic Environmental Test Ficility, run by Pan Am and Bell Aerosystems, tests all electronic equipment in a battlefield environment for compatibility. The new army estimates a preponderance of 75,000 emitters in a 100-mile square area as opposed to 23,000 during World War II.

The test facility's task is to reveal incompatibilities, suggest modifications, provide realistic standards for new equipment, test Army frequency assignment plans, and test all electronic-communication gear prior to acceptance by the Army. Ultimately it is hoped to evolve a mathematical model to predict interference.

The model will be a storehouse of equipment characteristics and propagation phenomena and will contain the equations that interrelate them.

As testing continues the battlefield complexity will be increased. Eventually Army would like to test systems in an Army, Navy and USAF environment.

Interference testing is now a manual operation. For example, a man-carried transceiver might be tested with radar, telemetry, ecm gear and troposcatter equipment. In case of interference, environmental equipment is turned off one by one until the culprit is found. In some cases two or more transmitters may be heterodyning.

The recommendation may be modification of the equipment, a change of frequency, recommendation to use intermittently, or to simply live with the situation. The latter is especially true of equipment soon to be phased out.

Incompatibility tests will soon be accomplished by punched-card and computer automation.

The Army foresees a continuing need for the work going on at Huachuca. Results obtained here will benefit both military and civilian users of electronic equipment.

Pan Am will award a number of subcontracts as the program continues. They will be for gear such as: radar, microwave, telemetry, command control, recording, communications and data processing.

The final assembly line at Thomas Organ. Instruments are tuned with electronic stroboscopes in five minutes by factory workers

Electronic Organ Sales Surge, Tempt New Companies

MANUFACTURERS of electronic organs feel that 1960 will wind up as an outstanding year for sales. Market saturation to date is only a few percent. According to several industry marketing experts, retail sales for 1959 were $140 million. And profit margins are generous. Several companies are looking the field over and most manufacturers have design innovations in the works. Many new model organs use transistors. Tunnel diodes are being considered, based on their harmonic generation properties.

There are many reasons for the popularity of electronic organs. Tone and note sustention qualities make music played by an amateur sound more professional than with other instruments. The organs are easy to play; keyboard learning techniques help the beginner.

Several large electronics firms have been watching organ sales. The Magnavox Company, Fort Wayne, Ind., states it plans to produce a line of instruments. Westinghouse admits an interest in the field, gives no details. AMF gave the electronic organ market a look three years ago, built a model, has decided against entering the field. Two electronics giants and a motion-picture company have been linked with the organ market.

Here's what typical firms now in the business are doing:

Hammond Organ Company, Chicago, maintains a full line of instruments. They employ a mechanical tone-wheel system, which produces the magnetic variation needed for the original note, which is then amplified.

Baldwin Piano Company, Cincinnati, O. uses tuned-grid vacuum-tube oscillators and frequency-division blocking oscillators for producing tones beyond the basic twelve notes. Its line includes spinets and consoles. Firm experimented with a transistor model as early as 1952, still is active evaluating solid-state techniques.

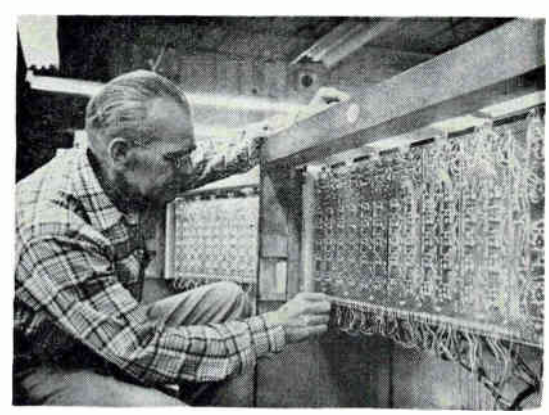
The Lowery Organ Company, Chicago, produces a full line of organs, from spinet through church models. Firm's latest is the Holiday Duo. It has two full 44-note manuals and a 13-note pedalboard, at $995. The three largest models have two 61-note manuals, a 25-note pedalboard and keyboard control of the organ stereo effect, whereby any manual or the pedalboard can be switched to a remote tone cabinet.

Conn Organ Corp., Elkhart, Ind., has recently introduced transistor keying in their line of instruments. The tones are generated by a vacuum tube, normally one for each note. In some models, a sharing system is employed, wherein a diode assures keying preference when several adjacent keys are pressed down.

An accessory instrument by the Wurlitzer Company, DeKalb, Ill., who also manufactures electronic organs, is known as the Side Man. It is a self-contained unit that provides a constant rhythm section sound effect for accompaniment in any of several patterns, including cha cha, tango, western, waltz and others. The tempo can be set by the user and rhythm patterns not built in may be created with a bank of ten push buttons, usable with the automatic patterns or independently.

Thomas Organ Company, a division of Pacific Mercury Electronics, Sepulveda, Calif., has announced three new transistor organs, using vacuum tubes only in the power amplifier. A recent slimline model priced at $1,495 includes a built-in Leslie speaker, stereo organ sound system, and controlled attack percussion which can be applied to one or all families of voices, and sustain to hold the note after it is keyed. The firm also produces an organ-phonograph combination. Stereo operation of either instrument, or one channel for each allows the use of a recorded lesson plan for training beginners.

Kinsman Electronic Organs, Laconia, N. H., has brought out two new models this year, one featuring two full 61-note manuals (keyboards), below the $2,000 figure. The firm is among those employing printed circuits, and features modular electronic construction. Their design uses vacuum-type tone oscillators and neon dividers.



Modular construction of Kinsman organ facilities assembly and service

The Allen Organ Company, Macungie, Pa. has been producing solid-state designs for 18 months. Its production includes many large custom organs. Toroids are used in the tank circuit of each tone oscillator, to assure frequency stability down to 16 cps. A separate transistor oscillator generates each note. The firm also employs a rotating speaker system. The speed of rotation is controlled by the performer to introduce activity into the distribution of sound, as occurs normally in a pipe organ.

Electro-voice, Buchanan, Mich., a recent newcomer, announced a two-manual spinet this year, in the $500 range. It uses neon divider chains following vacuum-tube tone generators. A full organ line is planned.

The W. W. Kimball Co., Melrose Park, Ill. produces a line of large organs that obtain their basic tone from optical recordings of a pipe organ, and reproduces them with a lamp for each key, a scanning system and photocells. They have also introduced a line of home organs featuring transistor circuits.

Organ kits are finding a receptive market. Electronic Organ Arts Corporation, Los Angeles, Calif., puts out a full line of kit organs. An independent Hartley vacuum-tube oscillator, stable to 0.08 percent in frequency, is used for every key, with an independent preamp for every stop. An external hi-fi system can thus be hooked into any preamp or any number tied together to separate channels allowing organ stereo operation.

Schober Organ Corp., New York, N. Y., plans to add a spinet organ kit in the $300 range sometime in the future, with vacuum-tube oscillators and neon divider chains. They have recently come out with an inexpensive strobe-disk tuner, available built, or as a kit. It is accurate to 1/100 semitone.

National Sonic Corporation, Sunnyvale, Calif., produces a kit spinet with two 44 note manuals. The keyboards are supplied wired, cables preformed, the printed circuit boards are left unfinished. Their circuit format employs vacuum-tube-oscillators and dividers, with a photoelectric system for the expression pedal control element to reduce wear.

IF YOU WANT TO TAKE A CHANCE ON FALLING IN LOVE WITH A COMPUTER

When we designed Recomp we had just two people in mind: the man who would use it and the man who would approve the investment.

We told our design engineers we wanted Recomp to 1] have a large capacity, 2] be versatile, and 3] be easy to program. Then we urged our cost engineers to see to it that Recomp stayed in the lower price range.

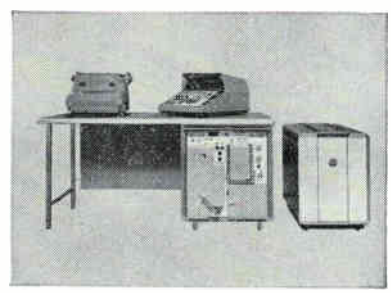
Quite honestly, this posed some problems. On occasion a designer would plead for his brainchild while the cost analyzers demurred.

No coins were tossed to settle such disagreements. If the designer could prove his idea made Recomp a better computer it was incorporated. That's how Recomp came to be the first solid-state digital computer on the market. And also why it was (and still is) the only compact computer with built-in floating-point arithmetic.

Fortunately when we were all through we found Recomp would sell at a sensible price. So, due to this strict attention to the computer's capability and cost, we're truly able to say **Recomp is the very best computer in the low-cost computer field.**

While they were at it, our engineers had some rather original ideas on how to present Recomp to you. "No gobbledygook," they said, "just give them the facts." So we painstakingly winnowed down a mass of superlatives to these plain facts:

1] Exclusive built-in floating point arithmetic.
2] Easy to program.
3] Efficient programming; 49 basic instructions expandable to 72.
4] Fast access time due to high-speed loops.
5] Magnetic disk memory with large capacity—up to 8192 instructions.
6] Large word length of 40 binary bits.
7] Each word contains two instructions.



8] Solid-state reliability.
9] Built-in square root command.
10] Large sub-routine and program library.
11] Active users group.
12] Built-in automatic conversion from decimal to binary.
13] Visual display of any word in memory.
14] Simple correction of errors.
15] Easily installed anywhere.
16] Can use conventional teletype equipment.
17] Low cost per computation.
18] High-speed input and output.
19] Programming training provided.
20] Large program exchange.
21] Coast-to-coast sales & service.

With all respect to our engineers, facts are fine but they can hardly do full justice to Recomp. For example, it's only fair to mention Recomp's appearance. Its soft color and modern shape bespeaks quiet efficiency; blends in the finest of surroundings. In this case you *can* tell the book by the cover. Recomp is truly a masterpiece of design (both in function and form). It's built to look as good as it is; a genuine pleasure to have around.

By the way, many of the points we listed above can be claimed by some other compact computers—but Recomp is the *only one* that can claim them *all,* and as standard equipment. You're never hemmed in on a problem by a lack of equipment.

True, you can get a computer that does more than Recomp, but this should only be if the size of the job justifies a much larger investment (and Recomp *does* have features you won't find in computers costing three times as much). Naturally, you can always find a computer that costs less.

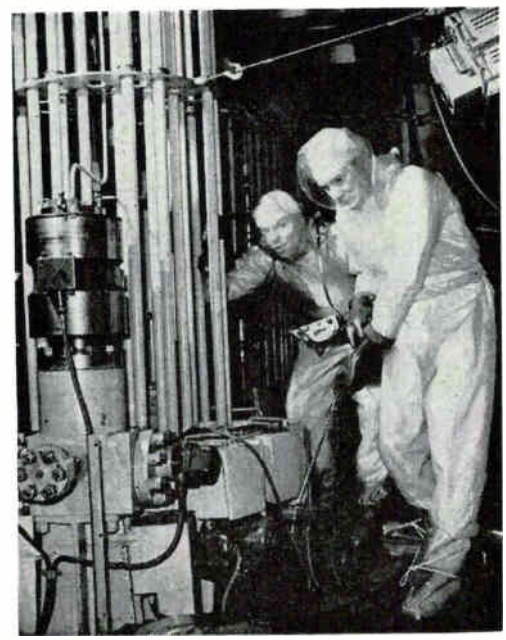
But if you want a low-cost compact computer that performs favorably with the giants in size and cost, you should make a date to see Recomp. However, it's only fair to warn you, unless you want to take a chance on falling in love with a computer, don't write AUTONETICS INDUSTRIAL PRODUCTS, Dept. 115, 3400 East 70th Street, Long Beach, California. The Autonetics Division of North American Aviation, Inc.

Russian icebreaker Lenin, shown here moving through Baltic ice, employs a television-equipped helicopter for ice formation reconnaissance

SOVIET

Nuclear Icebreaker Uses Helicopter Tv

Closed-circuit television is used aboard the Lenin. This provides continuous observation of the icebreaker's nuclear power plant installation



Soviet crewmen wear special plastic pneumatic clothes while checking radiation. Decontamination of the clothing is performed after use. As a safety measure, no regular duty watch is maintained in various active compartments

THE SOVIET icebreaker Lenin, powered by a 44,000-horsepower atomic-steam plant, is in regular service in the arctic. Power is developed in three reactors, with one normally on standby.

The ship can operate on six-foot ice, with a maximum thrust of 330 tons. Steam and a metal ram are employed for difficult ice formations. The crew and equipment spend long periods at sea, when the ship is on duty maintaining navigable shipping channels in the arctic. Refueling of the reactors is accomplished every two years.

Accompanying photos show the use of closed-circuit television aboard ship, the checking of radiation, and a section of the control room.

A view of part of the big ship's control room. The Lenin is equipped with a reserve control panel, was launched at Leningrad in December 1957

Epitaxial Techniques Lure Device Designers

WASHINGTON — Epitaxially grown semiconductor devices have replaced tunnel diodes as the glamor field of solid-state electronics.

So it seemed at the 1960 Electron Devices Meeting here late last month; 1,200 attended.

In 1959 tunnel diodes were the major topic at this meeting; this year only two of 18 papers in the semiconductor category dealt with tunnel diodes. Meanwhile, a complete session devoted to epitaxial devices was well attended and marked by spirited questioning of speakers.

Most of the papers in this category dealt with technique for growing films of germanium and silicon epitaxially on substrates of these materials. Intensive work is being carried on in this field. Speakers from Bell Labs, IBM, Fairchild Semiconductors, Motorola and Pacific Semiconductors represented a broad industry cross section and other semiconductor manufacturers were represented in the audience.

Majority of companies use variations of the vapor-deposition technique using hydrogen reduction of tetrachlorides of silicon and germanium. A. P. Hale told of experiments at Fairchild where evaporation techniques are being tried in a search for a simpler, more economical method. Although devices have been built, the advantages of evaporation remain to be proved, Hale said.

Most speakers held back detailed results obtained with epitaxial devices. However, George Russell of Motorola announced the availability of a germanium epitaxial transistor type 2N828, designed to replace the type 2N705 high-speed mesa switching transistor.

In another solid-state area, a new type of parametric amplifier was introduced by K. K. N. Chang and D. L. Cuccia of RCA. It uses a helix as a slow-wave structure, has variable capacitance diodes connected at intervals between the helix turns. Proper spacing of the diodes causes the helix to act as a filter with pass and stop bands that provide resonances at signal, idler and pump frequencies. Small and lightweight (less than 6 ounces), the new amplifier is simply constructed, needs no moving parts like stubs or slides. The amplifier is stable. Its developers claim it cannot be made to oscillate. Gain of 15 db across a 10-percent bandwith has been achieved with noise figures from 4.5 to 6 db.

Advances in devices other than solid-state were also described. Improvements in the Zenith electron-beam parametric amplifier have boosted performance into the L-band region. As reported by C. B. Crumley and R. L. Cohoon of Zenith, noise figures of 1.3 to 1.6 db with 40-Mc bandwidth have been obtained at 1,300 Mc with substantial gain. Crumley says it seems feasible to operate tubes like this in the X-band region or even higher.

Bell Laboratories introduced a new beam deflection tube for their pulse-code-modulated digital television system. The new encoding tube converts the amplitude of an analog voltage into an 8-digit binary signal at sampling rates up to 10 Mc. M. H. Crowell, who described the tube, showed typical off-the-air pictures of color tv transmissions encoded into 7-digit signals. The pictures showed no degradation of the signal after digital transmission.

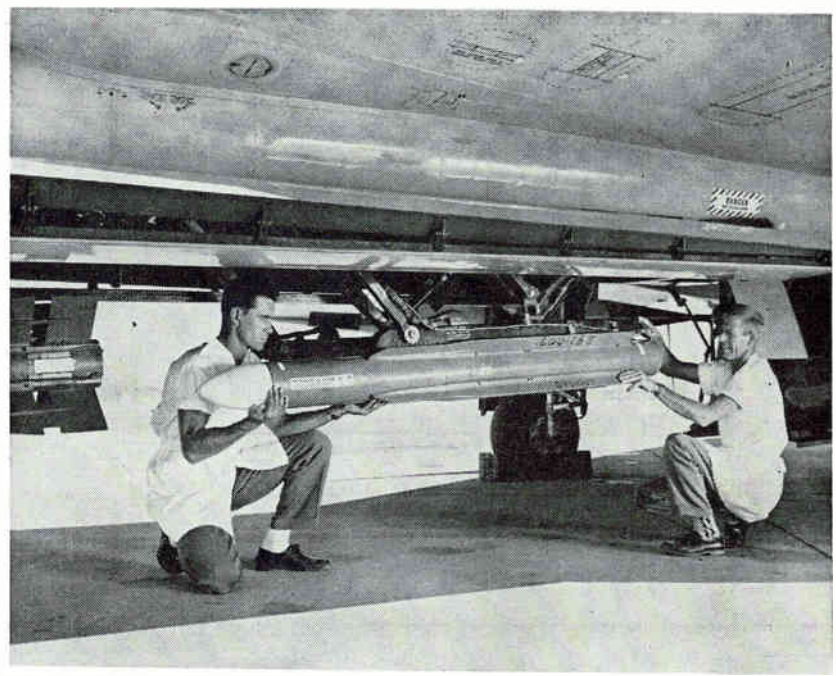
Tech Manpower Shortage To Continue for Decades

TECHNICAL MANPOWER will continue to be in short supply, perhaps for centuries, says J. R. Weir of California Institute Technology.

Speaking at a symposium on management planning at the Fall meeting of American Institute of Electrical Engineers in Chicago recently, Weir said "the demand for technical know-how must inevitably increase for many decades . . . probably at a geometric rate."

Worldwide living standards will depend on the number and quality of trained technologists. If populations continue to explode, only increased productivity and higher orders of production efficiency can keep pace—and the broadest possible application of all technologies will be necessary, Weir says.

Evaluator Missile Records Launches



Standard configuration of Falcon missile developed by Hughes contains signal recorder to check armament control and missile guidance systems

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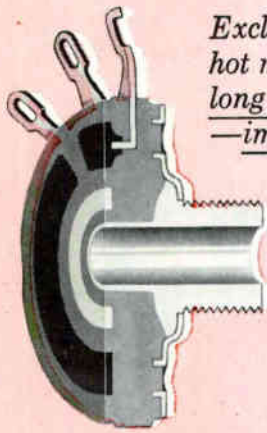
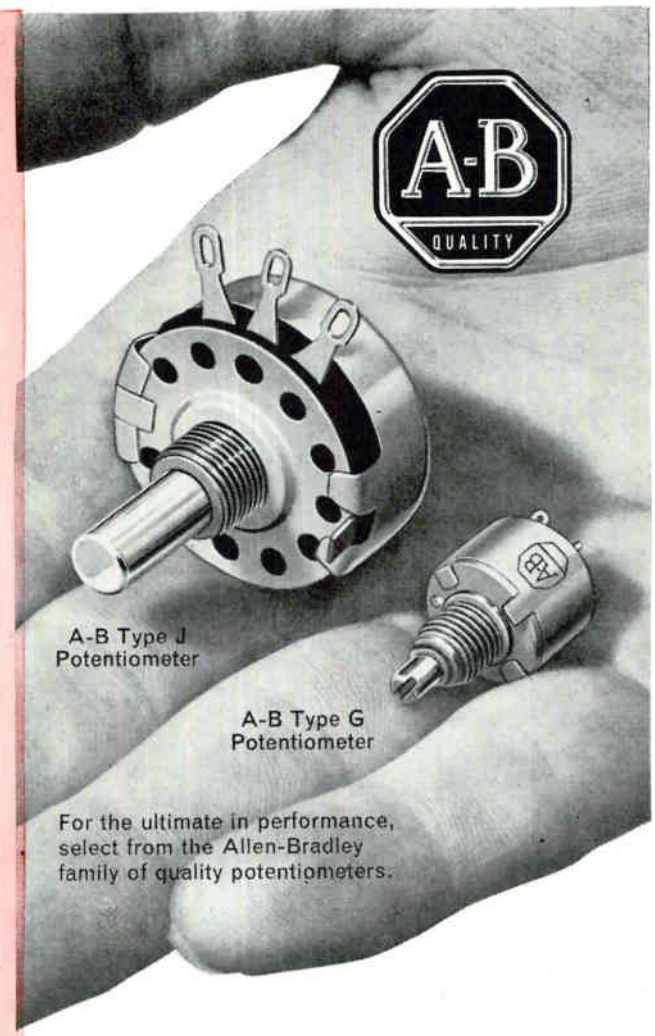


Exclusive one-piece hot molded element assures long life, quiet operation —improving with age!

With this solid molded resistance element, control is always smooth—there are never any abrupt changes. This also assures low "noise" even after long use. The sectional view of the Type "J" shows how the terminals, resistance element, faceplate, and threaded bushing are all molded together into *one* integral structure.



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TYPE J—rated 2 watts at 70°C. Total resistances to 5 megohms. Single, dual, and triple units. *Many RV-4 types in stock for overnight shipment of prototype quantities. Send for list.*

TYPE K—like Type J, but rated 1 watt at 125°C, 2 watts at 100°C, and 3 watts at 70°C. Can be used to 150°C under "no load."

TYPE G—rated ½ watt at 70°C. Total resistances to 5 megohms. Wide selection of styles and various optional features, including switch. *Many RV-6 types in stock for overnight shipment of prototype quantities. Send for list.*

TYPE L—similar to Type G, but rated at ½ watt at 100°C. Can be used to 150°C under "no load."

TYPE R—adjustable fixed resistor. Rated ¼ watt at 70°C. Total resistance ranges from 100 ohms to 2.5 megohms. Self-locking features hold settings under extremes of shock.

TYPE F—rated ¼ watt at 70°C. For printed wiring boards. Has screwdriver adjustment.

TYPE T—rated ½ watt at 70°C. Extremely thin; plastic cover serves as actuator.

TYPE H—rated 5 watts at 40°C, with a maximum continuous voltage of 750 volts. Designed for industrial applications. Total resistances to 2.5 megohms.

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AF Blueprints Key Role for

Mushrooming Hanscom Complex quickens regional growth; national pay rate ruling poses threat

BOSTON—The Northeast Electronics Research and Engineering Meeting (NEREM) will be held Tuesday through Thursday next week in an atmosphere charged with extraordinary promise—and a threat.

Focal point of the New England area's continued ascendancy in electronics is "The Hanscom Complex", the Air Force installation off Route 128 in Bedford, some 20 miles from Boston.

On the threshold of becoming the design-development management center for military automation, the Hanscom Complex will control allocation of $1.5 billion in fiscal '61, notably for the "L" systems. The grand design of aerospace command-control systems of the '60s and '70s will be blueprinted at Bedford, if a proposal now before the AF general staff is approved.

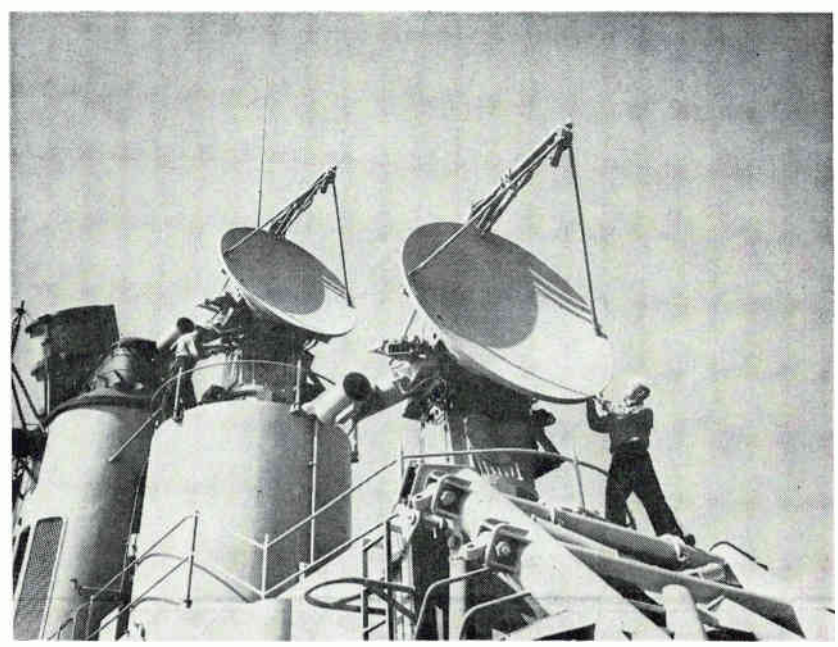
Impact of the mushrooming of the Hanscom Complex is being increasingly felt in Greater Boston and New England as electronics firms rooted in other sections of the U. S. set up research labs and technical offices close to Hanscom.

The threat aimed at the N. E. electronics industry flows from the U. S. Labor Department's tentative decision to set nationwide minimum-pay rates for electron tube and semiconductor workers under the Walsh-Healey Act (ELECTRONICS, p 14, Oct. 14).

With a traditionally skilled labor force and lower wage rates than on the West Coast and other sections, New England has some of the fastest-growing semiconductor plants in the U. S. And components production is counted on for a big share of the projected $2 billion factory sales for N. E. electronics by 1970 (ELECTRONICS, p 45, Apr. 22).

Individually and through the EIA, New England producers are

Radars Guide Tartar Missiles



Raytheon-produced radars on guided missile destroyer can also be used as part of ship's overall fire control system

New England

fighting for regional rather than national minimum rates.

On the brighter side of the regional picture, the Hanscom Complex now has a staff of 6,000, and this level rises monthly. Headquartered there are such electronic systems management organizations as ARDC's Command and Control Development Division, AMC's Electronic Systems Center and ADC's Command and Control Defense Systems Office which embraces user commands like SAC and TAC. The complex includes the Space Surveillance and Control Center, U. S. clearing house for identification and tracking of all orbiting objects.

Also members of the complex are AF Cambridge Research Laboratories, MIT Lincoln Laboratory and Mitre Corp., engineering systems adviser. In addition, Rome Air Development Center, although geographically removed, is part of the complex and is its primary development agency for sub-systems and components.

Rounding out the command-control team are representatives from industry, from the Army, Navy, FAA and other government agencies and from the Royal Canadian Air Force.

One of the new jobs being proposed for the complex is training the Air Force officers of the future in electronics, data processing and command-control technology, the tools of military automation.

A companion trend in N. E. electronics in recent years is an increasing emphasis on R&D in automatic controls—industrial automation. Two of the NEREM sessions next week will be devoted to electro-hydraulic and electro-pneumatic controls. "The mechanical engineers are more and more invading the electronics field," comments an MIT professor.

The N. E. which has seen abandoned textile plants refurbished for the new industrial giant of electronics is now witnessing another development: advent of jewelry pro-

(Continued on p 49)

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New England . . .

(Continued from p 47)

duction companies into electronics, particularly in southern Massachusetts and Rhode Island. And the growth of the industry continues to spread into northern N. E., especially New Hampshire.

NEREM 1960 has been planned as more of a national technical meeting than a show, although there will be nearly 400 exhibits at Commonwealth Armory in Boston.

The technical program at the armory will feature papers of an application nature. The research-type reports will be delivered at the Sheraton-Plaza Hotel, a short distance from the armory. The NEREM committee, comprising IRE members of the Boston, Connecticut and Western Massachusetts sections, has planned a bus shuttle service between the armory and the hotel.

"Sales promotion papers" have been excluded, says the committee, and the technical program has been shaped to reflect the research and advanced development emphasis of the industry in N. E.

Keynote address at the formal opening of NEREM Tuesday will be delivered by Jerome B. Wiesner, director of the MIT Research Laboratory for Electronics. Evening speaker will be Rear Adm. Rawson Bennett, chief of Naval research.

For the first time in the history of NEREM, a digest of papers will be available when the conference opens. The booklet will be less than a proceedings, but more than a collection of abstracts. Authors have submitted 800-word summaries which preserve technical content.

No employment recruitment will be permitted within the confines of NEREM, the committee says. "Help Wanted" ads will not be permitted on message boards, nor will solicitation be allowed at the booths —the committee thus hopefully restricting recruitment activity to hotel suites and advertising.

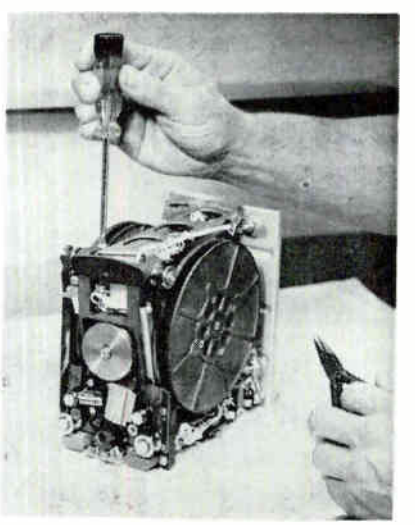
Report Breakthrough In Thermoelectricity

RESEARCH BREAKTHROUGH in the field of thermoelectric conversion was reported by Naval Research Laboratories last week at the IRE Electron Devices Meeting in Washington. Breakthrough was announced by NRL on behalf of its contractor Nuclear Corp., whose research chemical division developed the new device.

The thermoelectric converter uses gadolinium selenide elements for direct conversion of heat energy to electricity. Figure of merit for the new device is said to be 45×10^{-3} compared with conventional figure of merit of about 0.8×10^{-3}. The gadolinium selenide converter combines high voltage output with high conductivity. Although NRL spokesmen think that the ultimate figure of merit for production units will be less than that given for the laboratory device, they are strong in the belief that results so far indicate a significant breakthrough.

In a report on other developments in thermoelectricity, P. H. Egli of NRL told of experiments in the conversion of the excess heat of jet aircraft engines to electric power, for use with electronic equipment.

Courier Recorder



Device, developed by Consolidated Electrodynamics, uses 3-M's tape resistant to —40 to 250 F changes

Twin Cities Echoes Call for Research

ST. PAUL—Newest midwestern demand for additional investments in research came out of University of Minnesota's latest meeting of Institute of Radio Engineers.

Ronald McFarlan, IRE president, stressed need for dynamic leaders like Charles Kimball, director of Midwest Research Institute at Kansas City.

Pointing with pride to Twin Cities area's tremendous growth in technical fields during past 10 years, Byron Smith, president of St. Paul's Telex, Inc., said data processing is really about the only technical area where Twin Cities are in the lead.

"We have far too many small companies making power supplies," he said. "We are doing very little or nothing in microwave, cryogenics, masers and the solid-state fields."

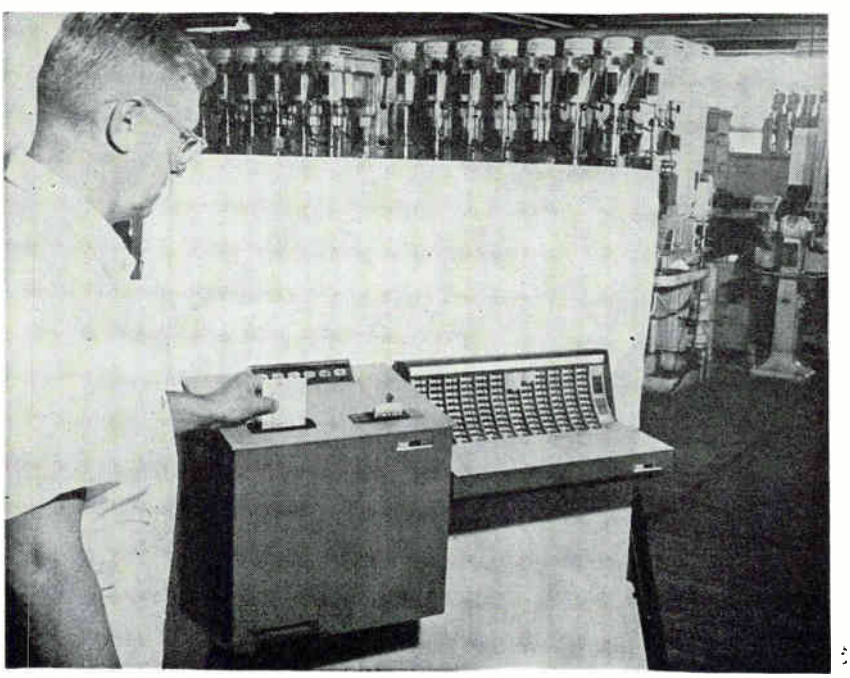
Smith concluded with hope that the governor's committee to expand the electronics industry, headed by the university's Neal Amundson, can provide leadership for setting up needed research facilities.

Setmaker Training Men For Transistor Television

TO GET READY for predicted increase in number of transistorized television sets reaching the market, some hundred tv service specialists are currently taking two-day courses in eight cities around the country.

Motorola field engineers are giving the courses. The Chicago firm introduced an all-transistor tv with large screen last May, is now predicting that "within four to five years" the majority of tv sets coming off U. S. assembly lines will be transistorized.

Reads Badges, Job-Data Cards



Factory data-collection system designed by IBM is used for reporting job location and status for centralized production control. This production-floor station reads regular punch card containing job data, also reads man's number, department number off badge into which these data are permanently punched. Keyless "keyboard" at right enters other variable data

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Here's a high-gain scope that makes your test equipment appropriation go farther. Vertical sensitivity, 6 mv RMS. Vertical calibration accuracy, ± 3%. Response (linear position): DC to 5.0 mc/sec, ± 0.5 db; DC to 8.0 mc/sec, ± 1.5 db. Response (transient position): DC to 3.5 mc/sec, −3 db, and −6 db at 5.0 mc/sec. Triggered and recurrent sweeps. Precalibrated sweep positions of 5, 50, 500, 5000 microseconds. Price **$575**

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Two terminal connections cover all 49 ranges for unusually fast operation. DC accuracy is ± 0.5% F.S.; AC, ± 0.75% F.S. (at 77°F, 25°C). Separate meters (*self shielded* movements) for DC and AC readings. Price **$1620**

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MEETINGS AHEAD

Nov. 14-17: Magnetism & Magnetic Materials, AIEE, AIP, ONR, IRE, AIME; Hotel New Yorker, New York City.

Nov. 15-16: Mid-American Elect. Convention, MAECON; Hotel Muehlebach, Kansas City, Mo.

Nov. 15: Product Engineering & Production, PGPEP of IRE; Contact D. Ehrenpreis, 325 Spring Street, New York City.

Nov. 15-17: Northeast Electronics Research & Engineering Meeting, (NEREM), IRE; and PGPT National Conference; Commonwealth Armory and Sheraton-Plaza Hotel, Boston.

Nov. 15-16: Engineering Application of Probability & Random Function Theory, PGIT of IRE; Purdue Univ., Lafayette, Ind.

Nov. 20-21: Electro-Optical & Radiation Devices, PGED of IRE, AIEE; Stanford Research Inst., Menlo Park, Calif.

Nov. 28-29: National Association of Broadcasters, Fall Conference; Biltmore Hotel, New York City.

Nov. 30-Dec. 2: Electronics Exposition, Long Island Electronics Manufacturers Council; Roosevelt Raceway Exhibit Hall, Westbury, Long Island, N. Y.

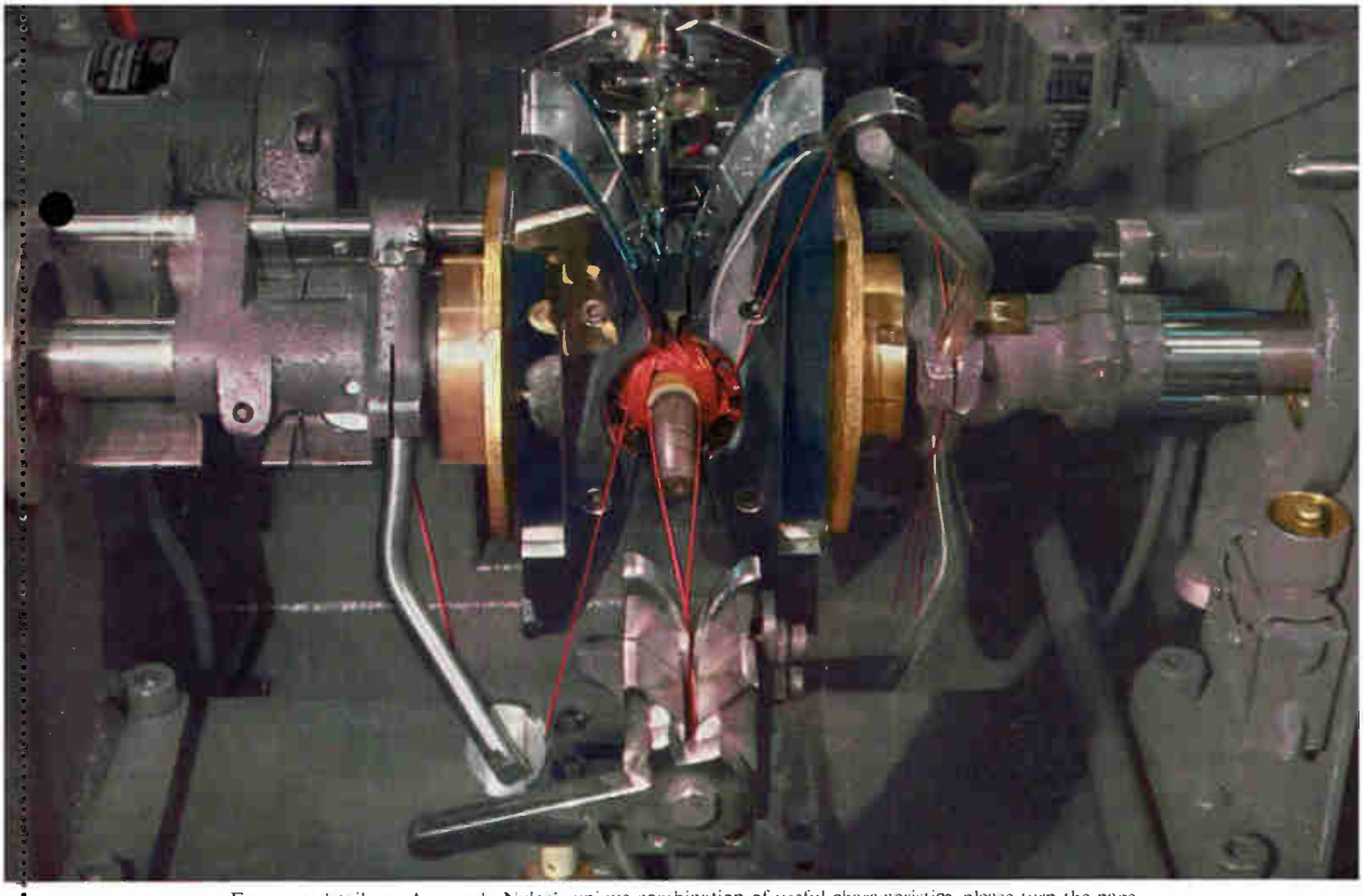
Dec. 1-2: Vehicular Communication, Annual Meeting, PGVC of IRE; Sheraton Hotel, Phila.

Dec. 5-7: Electronic Equipment Maintenance, EIA; Hilton Hotel, San Antonio, Texas.

Dec. 5-8: Electrical Insulation, National Conf., AIEE, NEMA; Conrad Hilton Hotel, Chicago.

Dec. 12-14: USA National Committee, URSI, Fall Meeting; National Bureau of Standards, Boulder, Colo.

Dec. 13-15: Eastern Joint Computer Conf., PGEC of IRE, AIEE, ACM; New Yorker Hotel, New York City.



For more details on Anaconda Nylac's unique combination of useful characteristics, please turn the page—

When you must wind fast, tight, and meet high temperatures, too, **SPECIFY NYLAC SOLDERABLE MAGNET WIRE**

The faster you wind and the tighter your space factor—the more you should consider the advantages offered you by Anaconda Nylac Magnet Wire.

For Nylac is Anaconda Analac with a tough, Nylon film outer covering. The Nylon provides outstanding slipperiness and abrasion resistance—these tight-winding characteristics enable you to make compact, easily shaped, uniform coils.

Yet Nylac incorporates many features of Analac. For example, it gives you easy, fast solderability without stripping. It also has excellent moisture resistance.

In addition, Nylac offers you high dielectric strength, high thermoplastic flow temperatures, excellent flexibility, resistance to hot varnishes and potting compounds. *And—it meets all 130°C (AIEE Class B) requirements.*

So by combining Nylon, an old and industry-accepted insulation, with a newer but thoroughly proven film covering—*Analac*—Anaconda's *Nylac* is a new solderable Class B Magnet Wire especially designed to overcome the strains of today's high-speed winding equipment and tight space factors.

The next time you face these and other winding problems, contact your nearest Anaconda Wire & Cable Sales Office. Our technical staff and Research and Development Laboratory facilities are available to give you every assistance possible. See the Man from Anaconda. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

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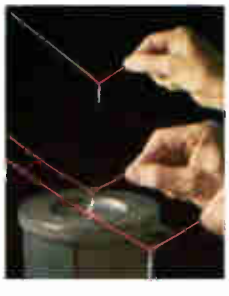
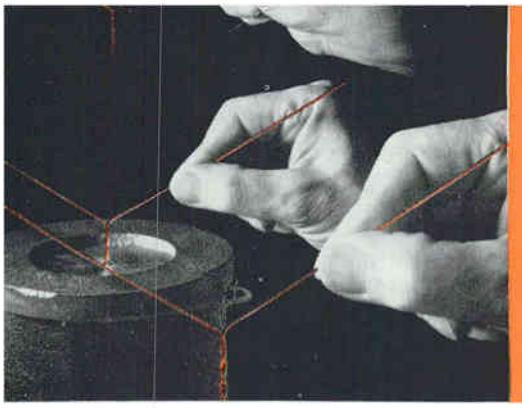
ANALAC 105°C (AIEE Class A)
solderable magnet wire





Important Facts about NYLAC MAGNET WIRE

Anaconda® Nylac film-coated magnet wire has a Nylon enamel outer surface over a film of Anaconda Analac (polyurethane) insulation. Nylac is a solderable wire that meets 130°C (AIEE Class B) thermal test requirements. It has outstanding windability and varnishability for severe process conditions, and exhibits excellent heat shock characteristics.

TECHNICAL PROPERTIES

ELECTRICAL PROPERTIES

Nylac has high dielectric strength. It has excellent electrical properties for all applications except high "Q" coils where dissipation factor should be as low as possible.

DIELECTRIC STRENGTH

Moisture environment of sample	Volts per mil of insulation
Dry	3580
Room Conditions	2560
Six hours at 100% relative humidity at 100°F	1310

DIELECTRIC CONSTANT AND DISSIPATION FACTOR

(Measured with capacitance bridge)

Frequency Cycles Per Second	Dielectric Constant		% Dissipation Factor	
	35°C	100°C	25°C	100°C
10^2	3.5	10.7	2.4	11.4
10^3	3.4	8.9	2.2	21
10^4	3.5	6.2	2.8	18
10^5	3.3	4.8	2.8	6

MECHANICAL PROPERTIES

Nylac is a strong flexible insulation. It adheres well to the conductor. Nylac wire survives severe abrasion, stretch and flexing in high-speed, high-tension winding operations due to the tough Nylon overcoat. The wire will take short radius corner bends without cracking.

CHEMICAL PROPERTIES

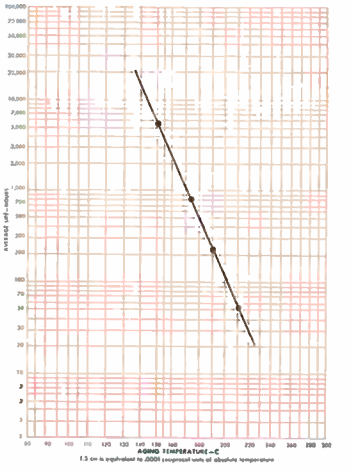
Nylac has outstanding resistance to chemical attack. It will withstand 24 hours' immersion at room temperature in solvents including naphtha, Xylol, ethyl alcohol, chlorothene, methanol, and in 5% sulfuric acid and 1% potassium hydroxide.

THERMAL PROPERTIES

THERMAL STABILITY

Nylac meets the 130°C (AIEE Class B) requirement. Graph 1 indicates 20,000 hours' life at 135°C for unvarnished samples. Varnished sample data, available on request, indicates over 30,000 hours at 130°C.

Nylac is not recommended for use where severe thermal overloads may be encountered.



NYLAC MAGNET WIRE UNVARNISHED AIEE 57 TEST

HEAT SHOCK
1 HR. AT 155°C

Prestretch	Mandrel Diameter (Multiple of Wire Diam.) 1x	3x	5x	10x
0%	pass	pass	pass	pass
10%	pass	pass	pass	pass
15%	pass	pass	pass	pass
20%	pass	pass	pass	pass
25%	pass	pass	pass	pass

Thermoplastic flow temperature

265°C using 5°C per minute rate of rise

SOLDERABILITY

Nylac wires solder without pre-stripping at practical solder temperatures.

Wire Size	Time-Seconds	Solder Temperature	Sample
15—18	15	360°C	Twisted Pair
19—25	10	360°C	
26—30	4	360°C	Wrap on 20 gage mandrel
31—46	4	360°C	

Measure transistor characteristics—

Alpha (h_{fb})
Beta (h_{fe})
Input Resistance (h_{ib})

—with the new BRC Type 275-A Transistor Test Set

Price: $935.00 F.O.B. Boonton, N. J.

The BRC Type 275-A is an exceedingly flexible and efficient instrument for the precise measurement of basic transistor parameters over an extended range of operating conditions. It can also be used to measure the characteristics of diodes and other semi-conductor devices. Direct readout of the following parameters—

- **Alpha (h_{fb})** • **Beta (h_{fe})**
- **Input Resistance (h_{ib})**

is presented on a large, easy-to-read dial without correction or interpolation. Two built-in, fully regulated, low ripple power supplies furnish completely variable emitter current and collector voltage.

Exclusive BRC features—

- Unique null-type measuring circuit completely unaffected by signal level fluctuations
- Reads Alpha to three significant figures
- Accurately measures at extremely low emitter currents

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- Permanent Calibration
- Direct Readout of Alpha, Beta, and Input Resistance on large easy-to-read dial
- Built-in adjustable, metered collector and emitter power supplies
- Handles up to 5 amperes emitter current
- Measures both NPN and PNP transistors
- Special test circuit guards against transistor burnout

SPECIFICATIONS

Alpha Measurement (h_{fb}):
RANGE: (a) 0.100 to 0.999 (b) 0.9001 to 0.9999
ACCURACY: (a) $\pm (0.1 + \frac{0.09}{h_{fb}})$ %* (b) ± 0.2%*
*when $f\alpha \geqslant 500$ Kc.

Beta Measurement (h_{fe}):
RANGE: 7 to 200
ACCURACY: $\pm (0.6 + \frac{30}{h_{fe}})$ %*
*when $f\alpha \geqslant 500$ Kc.

Input Resistance Measurement (h_{ib}):
RANGE: (a) 0.30 to 30 ohms (b) 3.0 to 300 ohms (c) 30.0 to 3000 ohms
ACCURACY: (a) ± 3%* (b) ± 3%* above 30 ohms (c) ± 3%*
* for linear impedances

Collector Voltage Supply:
RANGES: Internal: 0 to 100 V.D.C.
External: 0 to 100 V.D.C.
METERING: Range: 0 to 2, 5, 10, 20, 50, 100 volts
Accuracy: ± 1.5% full scale

Emitter Current Supply:
RANGE: Internal: 0 to 100 ma D.C.
External: 0 to 5 amp. D.C.*
*h_{fb} only; $I_b \geqslant 100$ ma D.C.
I_E and I_C metered externally
METERING: Ranges: 0 to 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100 ma.
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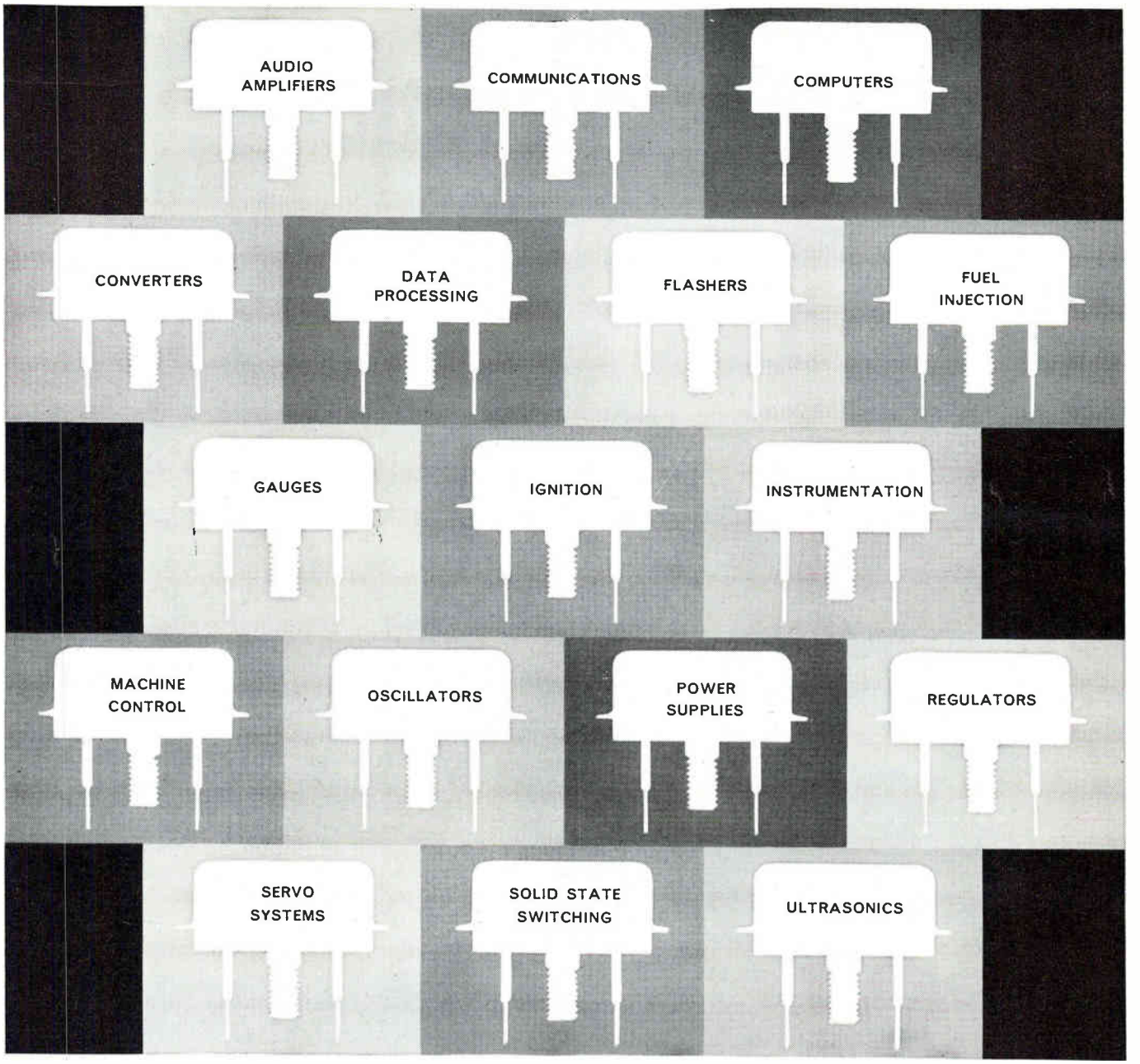
CIRCLE 55 ON READER SERVICE CARD



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RELIABILITY

Division of General Motors · Kokomo, Indiana

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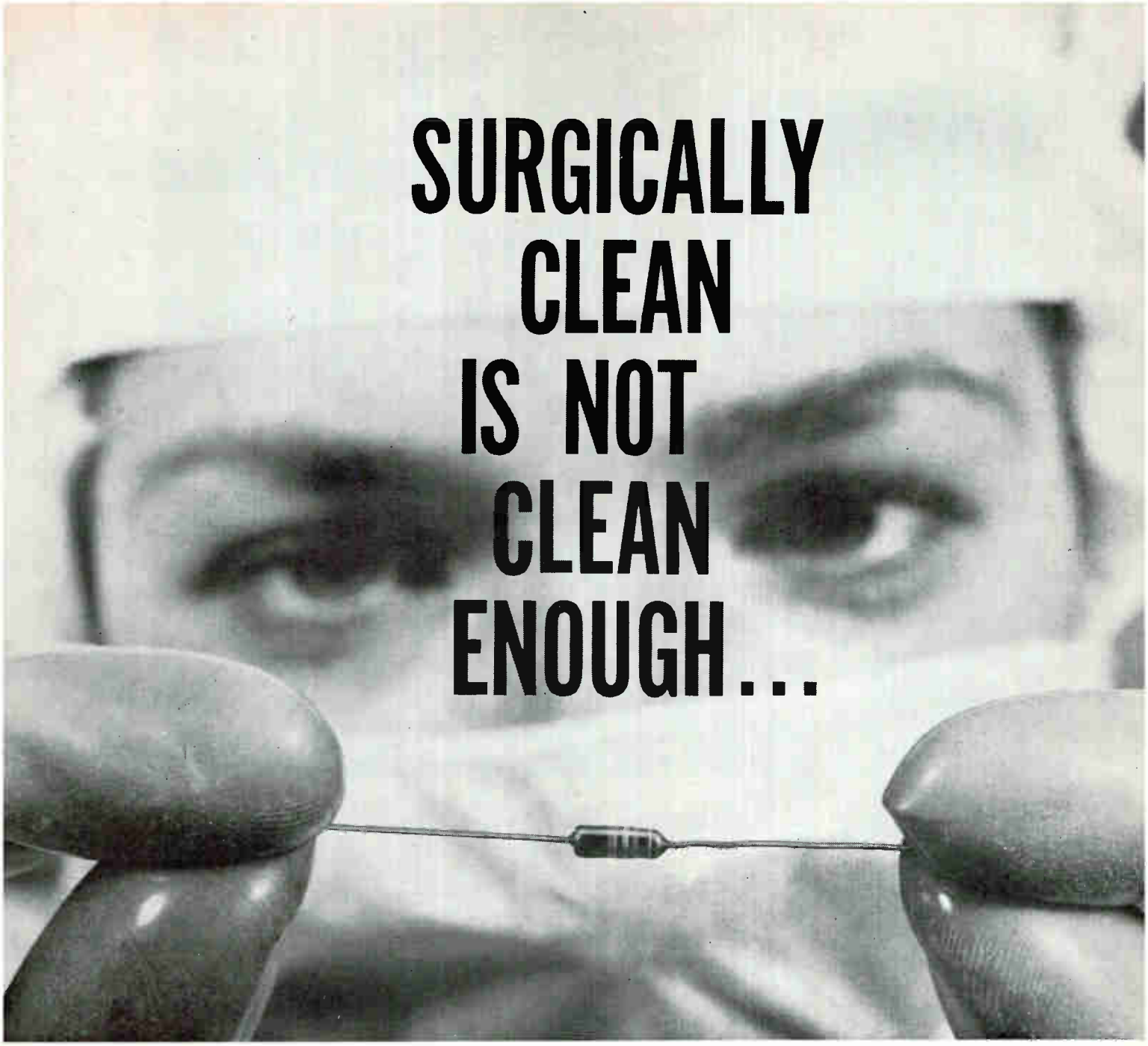

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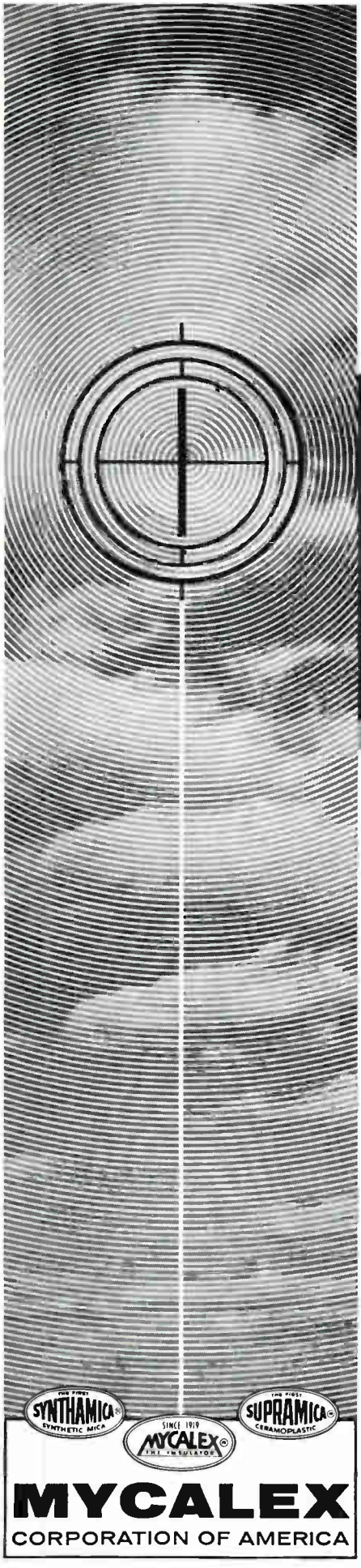

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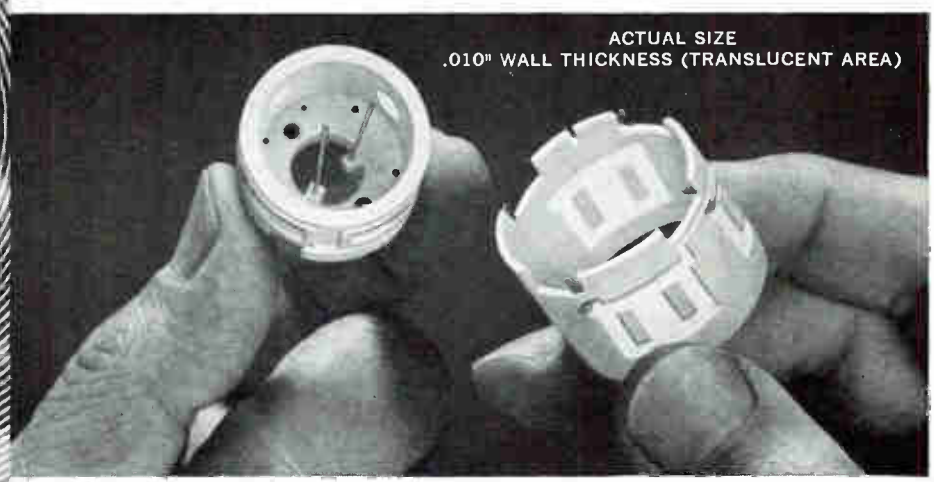

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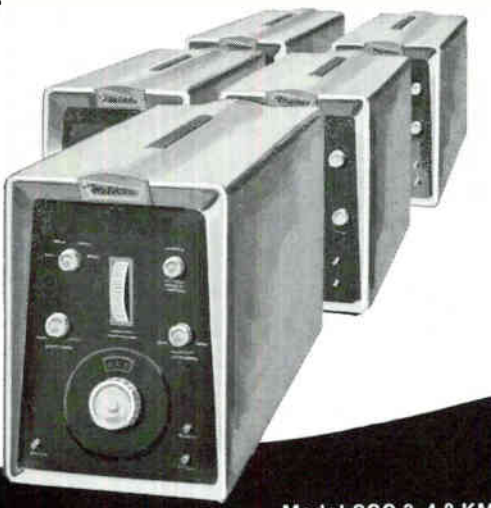

Model SGL-2, 1-2 KMC
Model SGS-2, 2-4 KMC
Model SGC-2, 4-8 KMC
Model SGX-2, 8-12 KMC
Model SGK-2, 12-18 KMC

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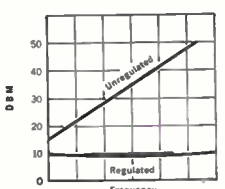
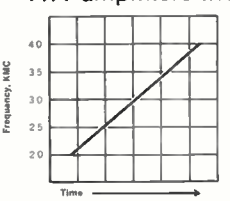


Power output



Linear time/frequency characteristic

SPECIFICATIONS

Model SGS-2, S Band, with SGO-2 Power Supply

Power output:	Regulated, 10 mw ± 1 db; unregulated, 10 mw at 2 KMC, rising to 300 mw at 4 KMC; manual adjustment range, 30 db.
Internal modulation:	For regulated power, pulse, 1-10 μsec; square wave. Rep rate, 100-5000 cps.
External modulation:	Any type, unregulated only.
Sweep:	0.3 to 30 cps; cw through 100% of band.
Price:	Model SGS-2, $2,300.00; Model SGO-2, $900.00;
Specifications similar	Model SGL-2, $2,600.00; Model SGC-2, $2,400.00; Model SGX-2, $2,600.00; Model SGK-2, $4,500.00.

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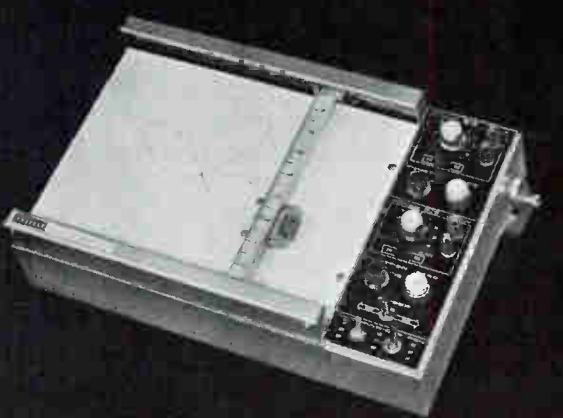

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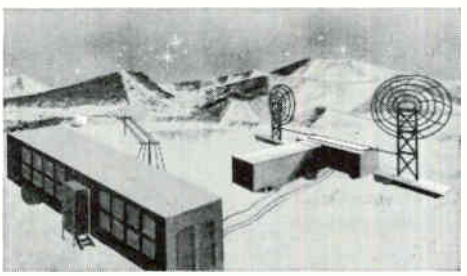

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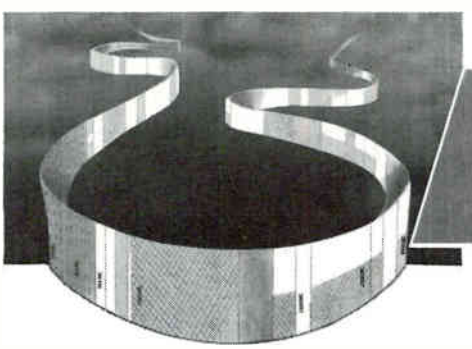

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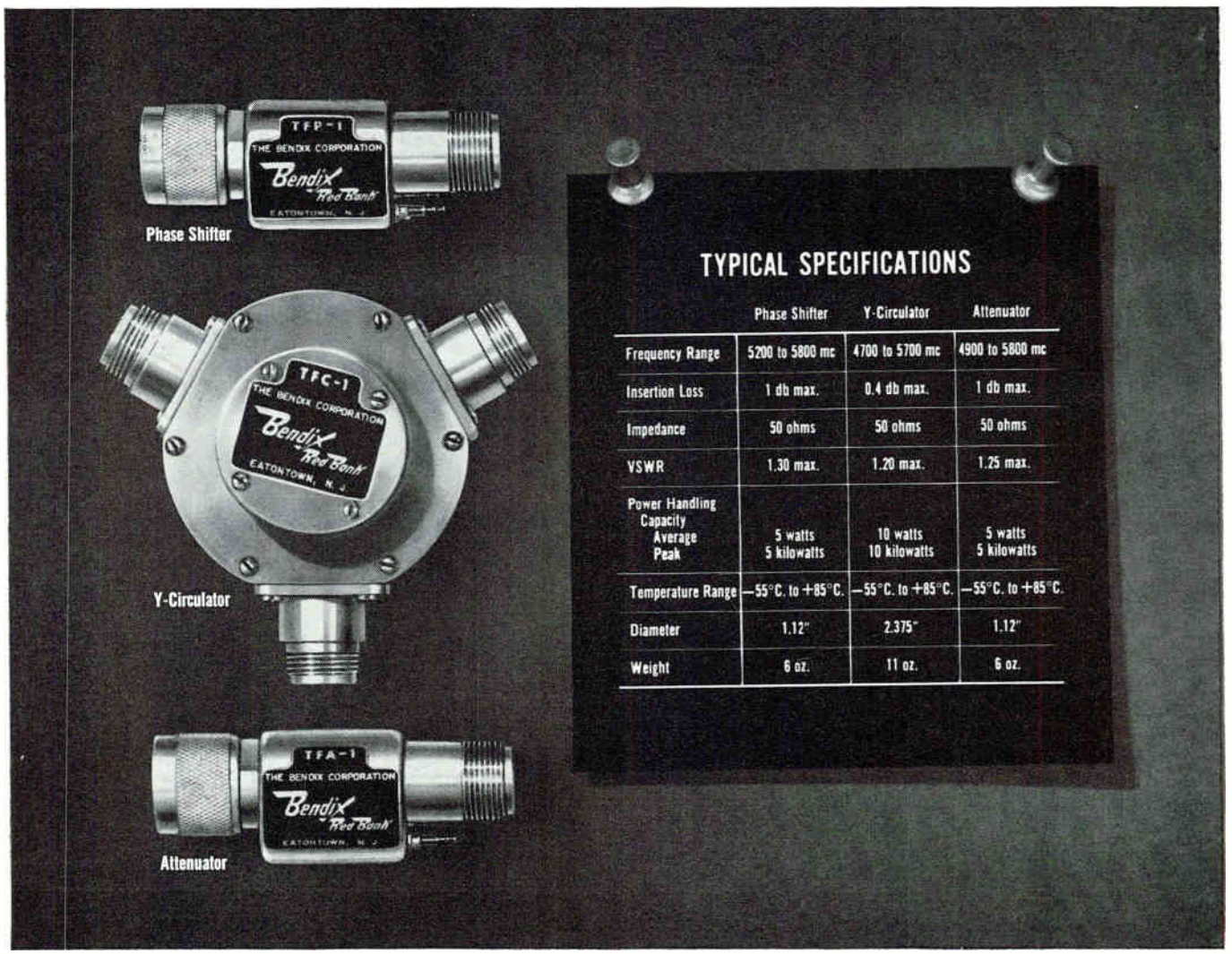

	Phase Shifter	Y-Circulator	Attenuator
Frequency Range	5200 to 5800 mc	4700 to 5700 mc	4900 to 5800 mc
Insertion Loss	1 db max.	0.4 db max.	1 db max.
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Power Handling Capacity Average Peak	5 watts 5 kilowatts	10 watts 10 kilowatts	5 watts 5 kilowatts
Temperature Range	−55°C. to +85°C.	−55°C. to +85°C.	−55°C. to +85°C.
Diameter	1.12"	2.375"	1.12"
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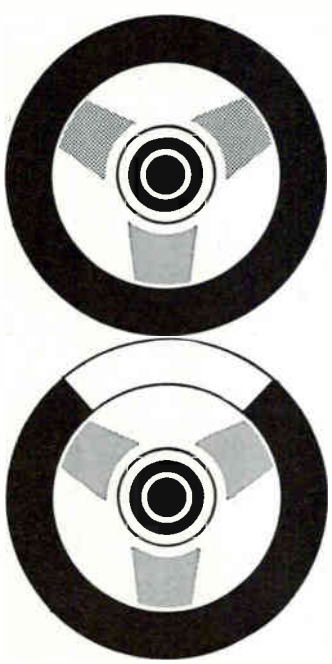

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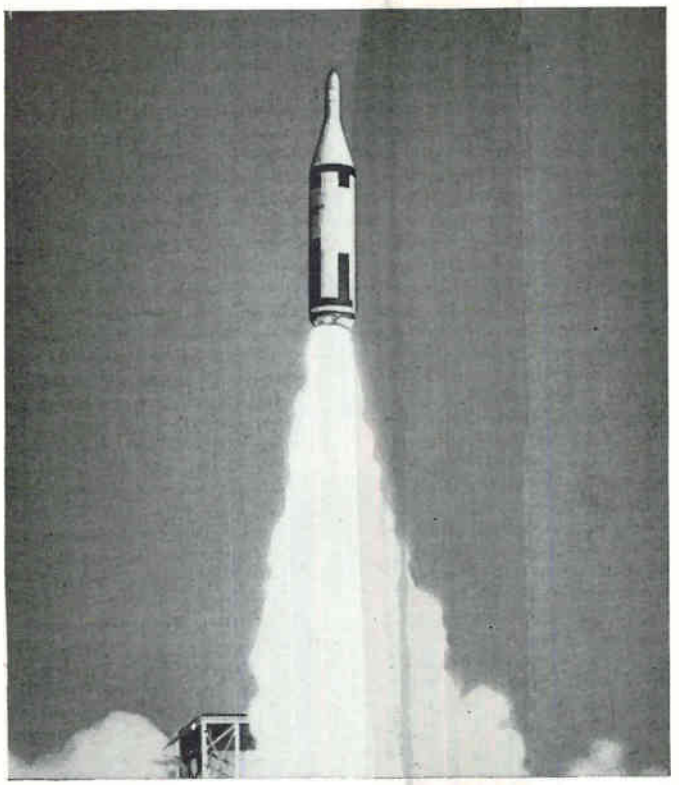

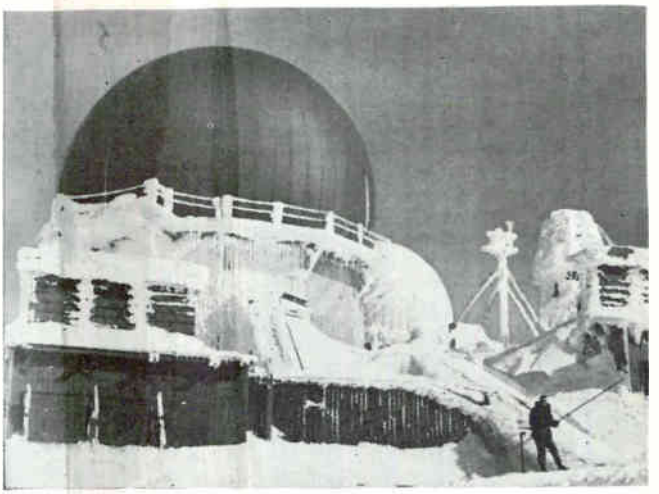

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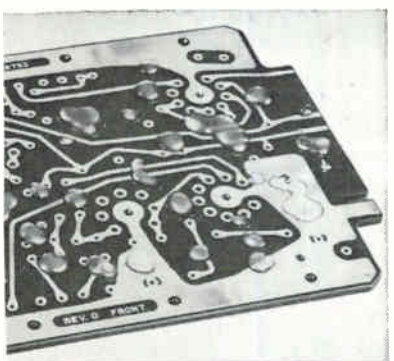

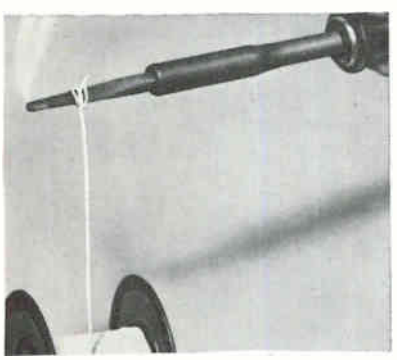

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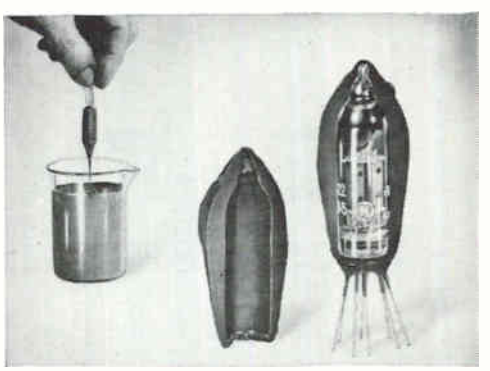

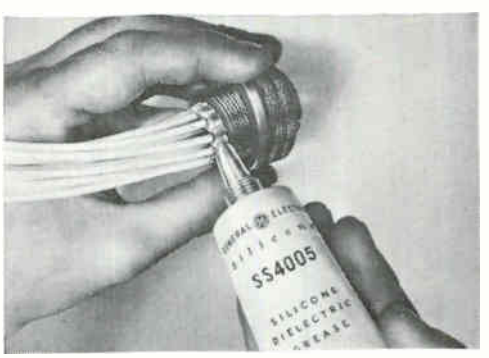

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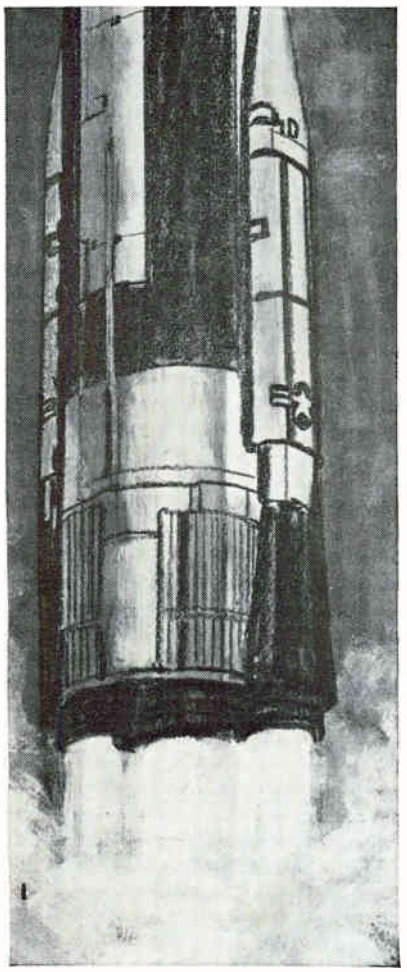

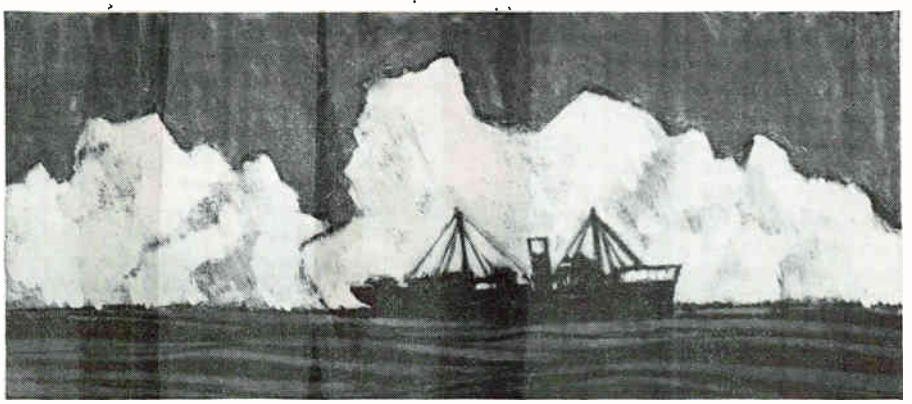

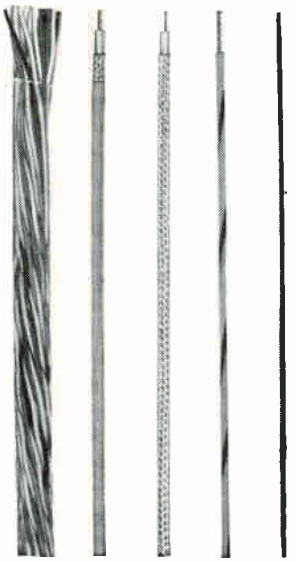

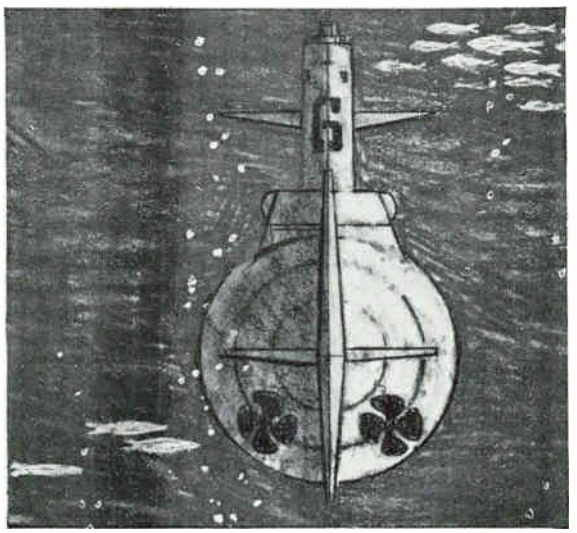

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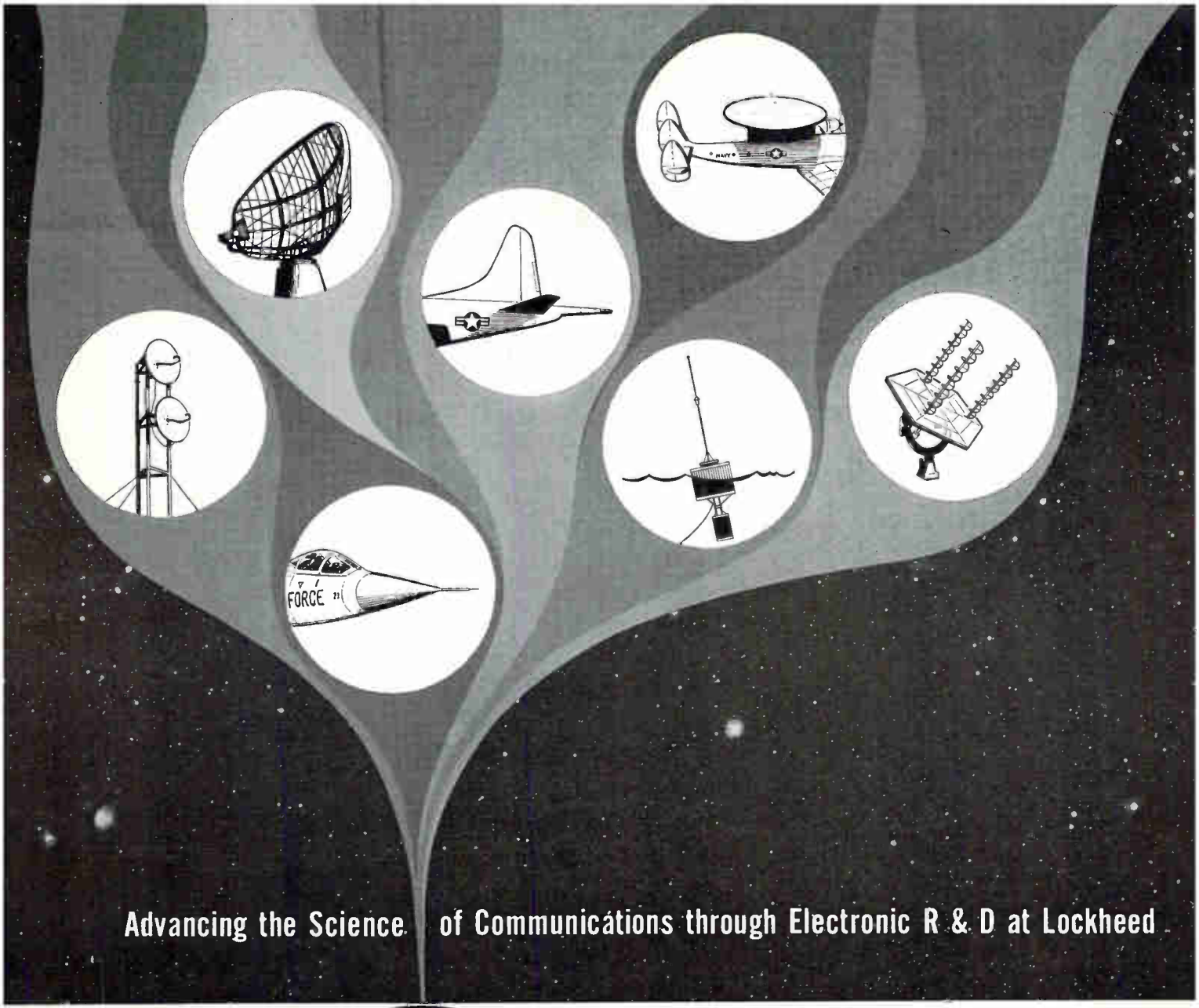

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The Avco TF-006 fixture is designed for use as an integral part of such environmental test equipment as vibration exciters, shock machines and centrifuges. It permits simultaneous testing of components in each of three mutually perpendicular planes. Relocation of the test specimen to change axes is easily accomplished.

Avco test fixture TF-006 offers these important advantages:

- **Insures flat vibration response in the 0-2000 frequency range.**
- **Eliminates need for fixture equalization runs and improves test efficiency as a result of its flat response.**
- **Saves valuable engineering time previously spent in designing new fixtures for conventional tests.**

Avco test fixtures are available in two sizes—the TF-006 and the larger TF-025—in both magnesium and beryllium. Avco offers you a 30-day free trial of the TF-006 fixture, with no obligation. For more information, contact your nearest representative. Offices are located throughout the continental United States and the world. Or write: *Industrial Products Subdivision, Research and Advanced Development Division, Avco Corporation, Wilmington, Mass.*

AVCO
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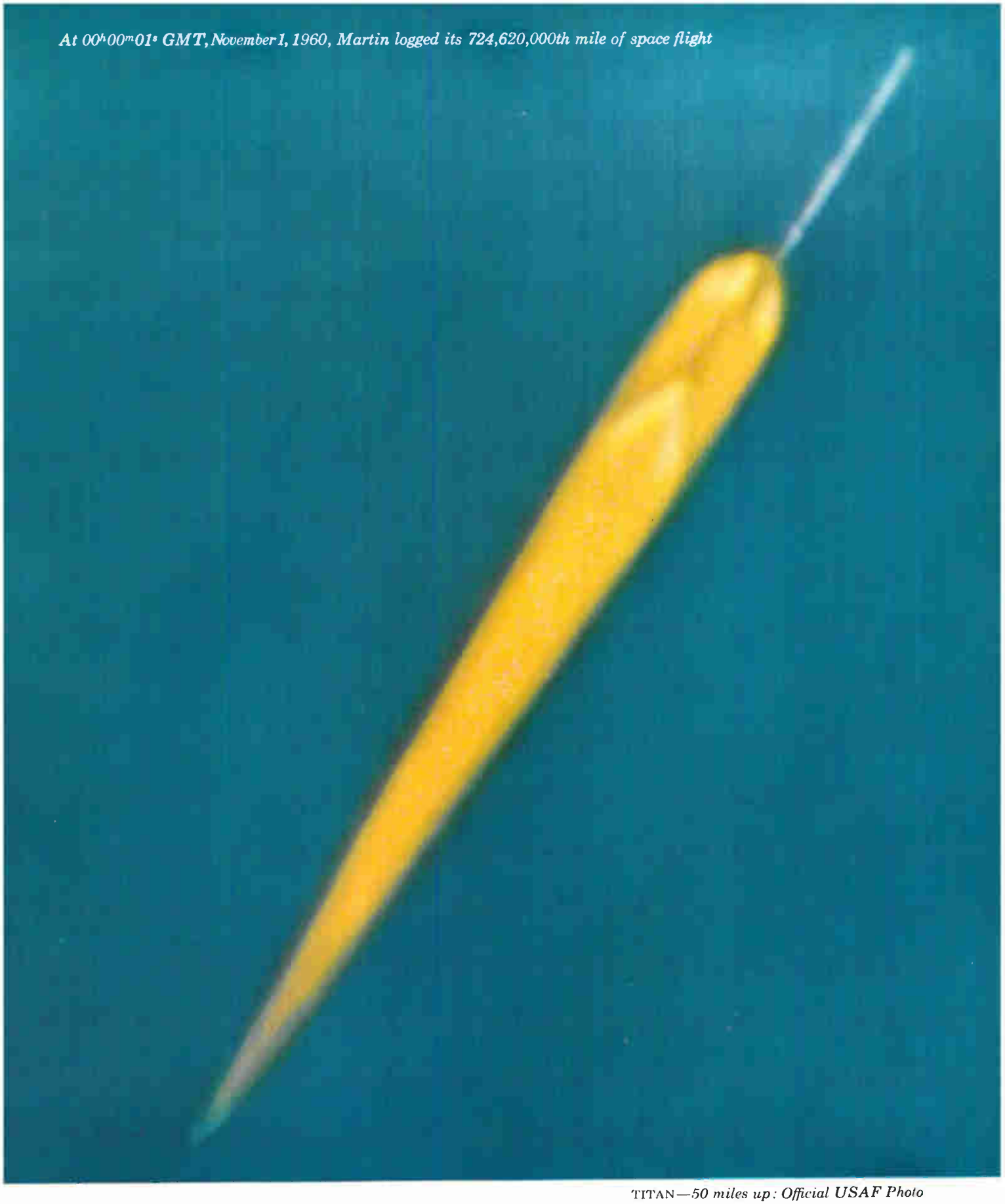
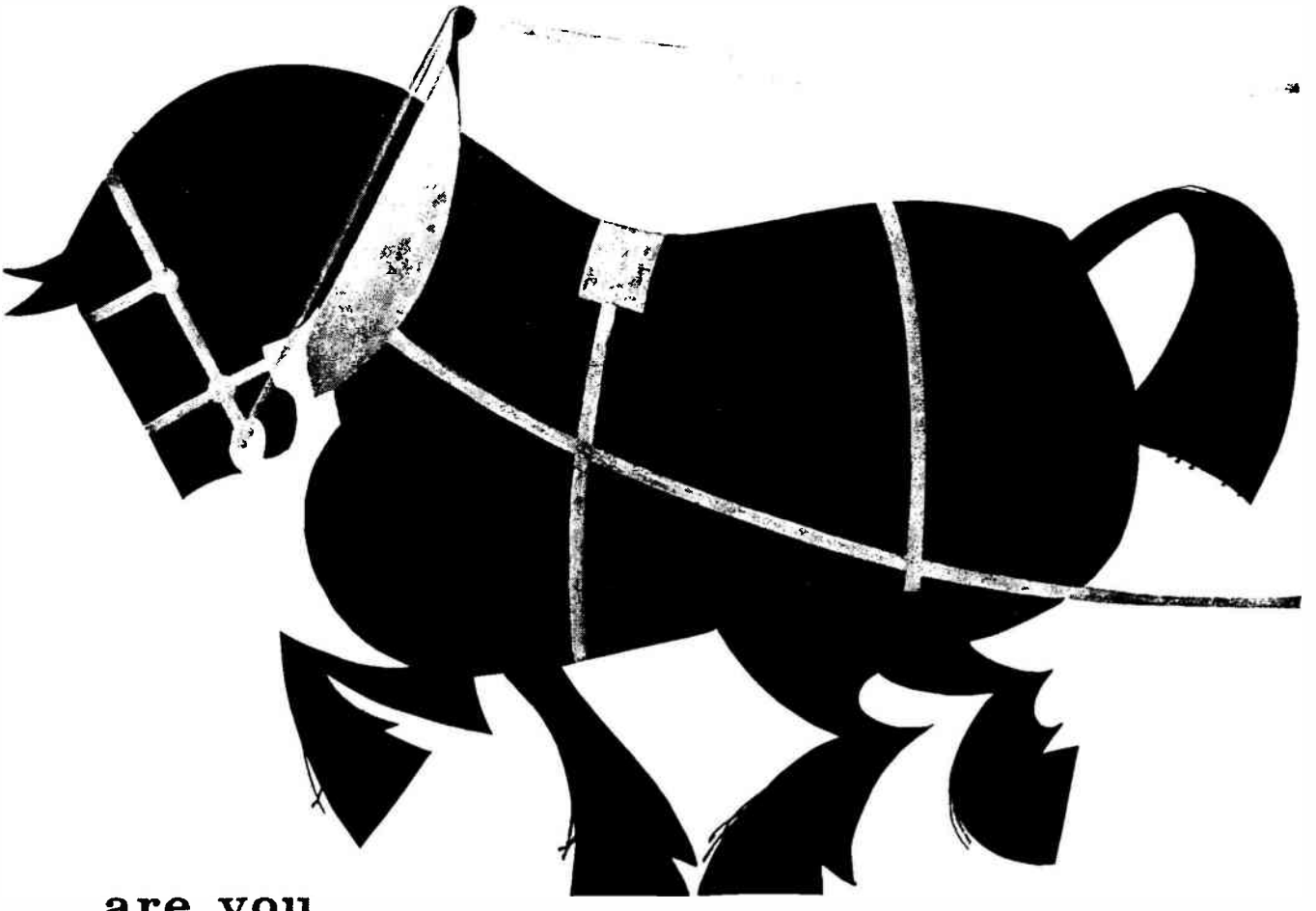


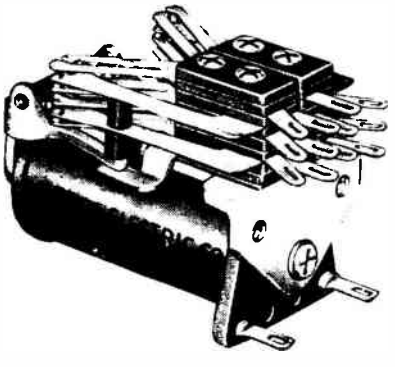
TITAN—*50 miles up: Official USAF Photo*

Air Force-Martin Titan, *giant American ICBM, has been chosen for a key role in space exploration. One of its first missions will be to launch USAF Dyna-Soar — manned aerospace craft.*

MARTIN



are you using North Electric's Workhorse "E" relay?



Expanded production facilities and increased efficiency in manufacturing methods have enabled North Electric to step up production of "E" relays to provide prompt delivery (at a new low cost, too) to an ever-growing list of steady customers.

If you need a relay that incorporates the inherent proven dependability of a telephone-type relay with minimal spatial requirements, this "little workhorse" from North can be your answer!

GENERAL CHARACTERISTICS:

Light Weight (2½ ozs.)
Compact (Length 2¼"; Width 1⅛"; Height 1¾" max. with 10 springs in either pile-up)
Long Life (over 100 million operations)

SPECIFICATIONS:

Coil Voltages: Up to 250V DC
Contacts: Independent action twin contact springs
Contact Materials: Palladium, Gold, Platinum
Forms: A to C
Speed: 3 ms. minimum
Residual: Lock Screw (adjustable)—Fixed (nylon flap type)
Time Delay: Available for both operate and release
Coil: Single or Double wound
Mountings: 2 #6-32 Screws on ¾" spacing
Accessories: Dust Cover and Hold Down Bracket

ELECTRONETICS DIVISION

NORTH ELECTRIC COMPANY

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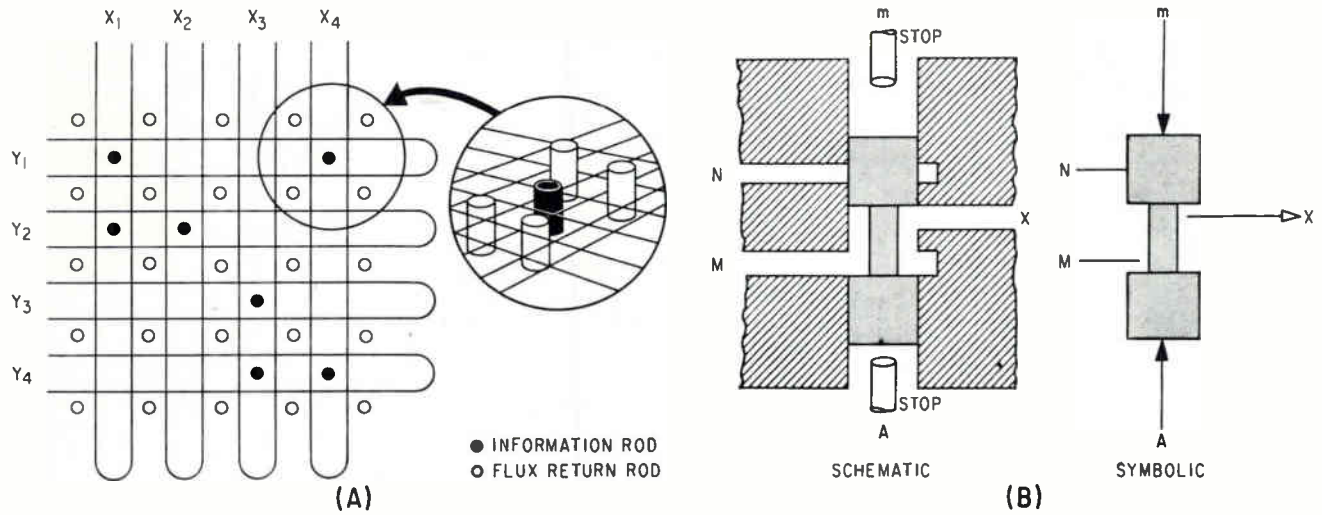


FIG. 1—Fixed-rod memory (A) and spool valve (B) are new steps in Western European information technology

New Memory Devices Highlight Research Trends

NEREM papers spotlight recent progress in space and ocean electronics, information technology and microminiaturization

By THOMAS MAGUIRE,
New England Editor

SOME 15,000 VISITORS to Boston next week will get a panoramic view of the vanguard of electronics industry transformations both here and in Western Europe.

The Northeast Electronics Research and Engineering Meeting (NEREM), third largest electronics show in the U. S., will highlight fast-evolving theories and techniques in information technology, new energy sources, exploration of the oceans and of space, military command and control systems, very high microwave power and the emergence of interdisciplinary technologies in: materials, microwave-optical phenomena, electro-hydraulic and electropneumatic developments.

Engineers visiting NEREM will hear a report on information technology in Western Europe today.[1]

At IBM in Zurich, for example, where metallurgical methods for depositing and heat-treating ferromagnetic thin films are being studied, experiments on nanosecond switching of film 1,000 angstroms thick and 1 cm² have yielded output signals of up to 1 volt.

In England, International Computers and Tabulators Ltd. uses a new alloy which can be deposited by vacuum evaporation onto an aluminum substrate, for improved signal-to-noise ratio and reduced drive impedance.

A fixed-rod memory developed by T. Kilburn of the University of Manchester in England has been laboratory-operated at 0.3-microsecond cycle time, is expected to operate in the MUSE computer with 0.4-microsecond cycle, 0.2-microsecond access time. The memory is constructed from a woven mesh of cop-

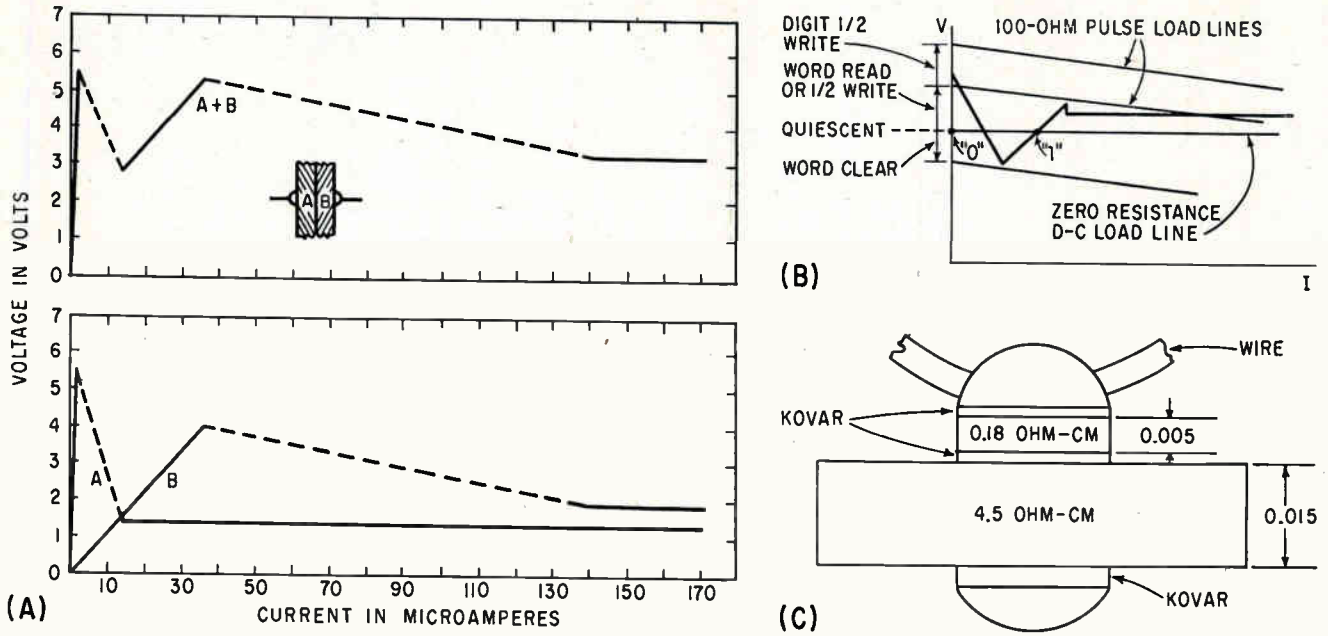


FIG. 2—Double-break cryosar is formed by placing two bistable cryosars with different prebreakdown conductivities in series (A); device can be used in a coincident-voltage memory (B) and is fabricated as shown in (C)

per wire mounted over a soft plastic, as shown in Fig. 1A.

Ferrite rods 1-mm in diameter and 5-mm long are placed in the interstices of the mesh wherever a ONE is to be stored. The mesh is formed into loops by cutting one horizontal and one vertical edge of the screen. A ferrite rod inserted within both a horizontal and vertical loop provides coupling to the loops for detection. To provide a flux return path for the magnetic field, identical rods are inserted in all non-coupled loops.

An acoustic memory developed by Elliott Brothers in England uses non-destructive nickel delay line storage. A bit is stored in the nickel wire by discharging a capacitor through the wire at a fixed point, applying a permanently stored circular magnetization to the wire. Passing a current pulse through the wire sets up an acoustic wave from each bit stored so that an acoustic coil transformer mounted on the wire past the current output receives the sequence of signals corresponding to stored discharges.

Also at IBM Zurich, hydraulic logic is under development. Laboratory models of hydraulic multivibrators have been operated at 300 cps. The devices use spool valves, shown in Fig. 1B. In this simple building block, three inputs (A, M and N) and one output (X) are provided. Logical signals in the form of high and low pressure are applied to the inputs. A static medium pressure is applied to M. Pressure at A determines the position of the valve which in turn defines, together with the input at M or N, the pressure at X. By providing a feedback path from X to A, a bistable element is created.

Among U.S. computer developments which will be discussed at NEREM is a random-access cryosar memory at MIT Lincoln Laboratory.[2] The device reportedly gives promise of good yields and ease of mass fabrication, competitive speed and relatively large, noise-free, non-destructive pulses. But work to date indicates the difficulty of circuit development with liquid helium temperatures.

The cryosar is a negative-resistance, two-terminal device using impact ionization of impurities (a bulk effect) in germanium at liquid helium temperatures. These elements have a large resistance until a critical field is reached, after which the current increases by many orders of magnitude. If compensated Ge is used, a negative resistance occurs between the high- and low-resistance states, permitting bistable operation.

For a coincident voltage memory, a resistor is provided in series with each cryosar to decrease sneak path noise. The desired V-I characteristic is obtained at present by adding two cryosars in series as shown schematically in Fig. 2A. The resultant "double-break" cryosar then may be used in a coincident-voltage memory as shown in Fig. 2B. This is a word-organized memory in which a negative pulse on a word line clears the entire word, then the coincidence of a positive pulse on the word line and positive pulses on the desired digit lines write "ones" into the desired digits. The entire word is read at once nondestructively by a positive pulse on the word line.

The complete system envisioned is shown in Fig. 3. The memory matrix is composed of double-break cryosars and the decoder matrix passes pulses of both polarities. Latter cryosars are of the simple, no-negative-resistance type with a one-volt breakdown voltage. All the word lines but two are clamped by cryosars leading to opposite polarities. One line is able to pass a positive pulse while the other (its address complement) is able to pass a negative pulse.

Present experimental double-break cryosars are made as indicated in Fig. 2C. The low-resistivity pillbox is cut from a wafer ultrasonically and soldered on. Figure 4 shows a matrix of 25 cryosars

made in this manner.

Progress on microminiaturization using thin film technology will be presented at NEREM. Fabrication of circuit networks by multi-layered vacuum evaporation has yielded significant size reductions, circuit performance comparable to existing methods and a high degree of reproducibility for individual circuit functions.[3]

Microminiaturization experiments using thin films in a three-dimensional structure encompass switching and communications applications. Six circuit types have been fabricated employing multi-layered films as the resistive, capacitive and inductive networks. Nichrome was chosen for resistors, silicon monoxide for insulation and dielectric use, aluminum for conductors. A thin glass plate serves as the substrate.

Experimentation showed that use of three evaporators, one for each material, is superior to other methods. The substrates are manually changed from one evaporator to the other. Eight substrates are handled in each evaporator, and only one evaporation is performed for each pumpdown.

For dynamic evaluation of the film network, unencapsulated transistors have been attached to the wafers by thermo-compression bonds. Future use of deposited active elements is envisioned, also multi-layered film interconnections.

Use of optical Doppler for navigation in the midcourse phase of space flight is under investigation at Franklin Institute and will be outlined at NEREM.[4] Researchers conclude that natural radiation in optical frequencies shows promise because of the excellent detectors available in this range and the relatively small size and weight of optical equipment. Major problem is low signal level.

In one method of velocity determination, two balanced detectors are placed on the sides of a spectrum line. A change in the position of the line such as would be caused by the Doppler effect results in an imbalance of the detectors. Use of template spectroscopy simultaneously would be required when light is very weak, as is the case for the majority of the stars. A template consisting of an appropriate negative placed in the focal plane of the spectrograph is matched with the spectrum of the star at zero velocity. Any shift of the lines due to motion of the observer is detected by a change in the light transmitted by the template.

Propagation phenomena induced by very high microwave radar power will be discussed at NEREM by a Cornell Aeronautical Laboratory researcher.[5] There is reason to believe that the signal-to-noise ratio of microwave radar systems cannot be indefinitely improved merely by increasing the power level. At some level, for a given receiver sensitivity, a point will be reached at which the energy backscattered from the ionosphere becomes the limiting noise.

The receiver used in the experiments employs a parametric amplifier input, and adjustable bandwidth to optimize the system for the ionospheric clutter—instead of for target return.

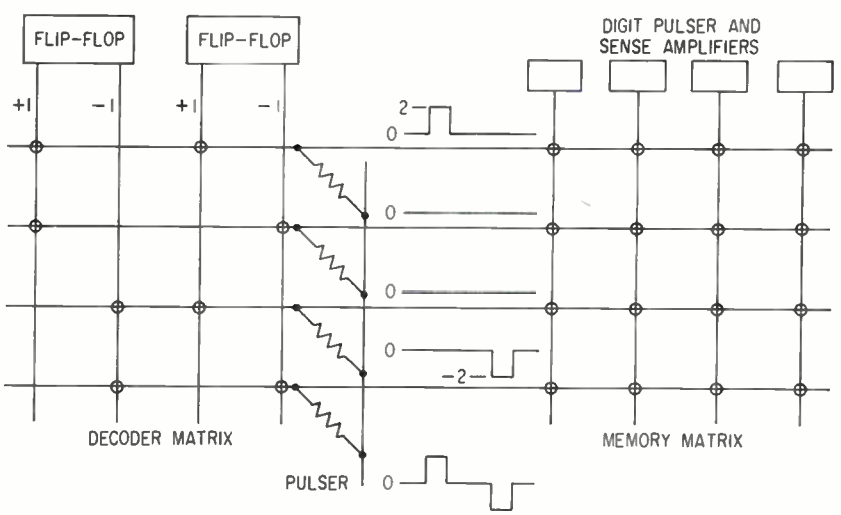


FIG. 3—Proposed memory system employs monostable cryosars in the decoder and double-break cryosars in the memory

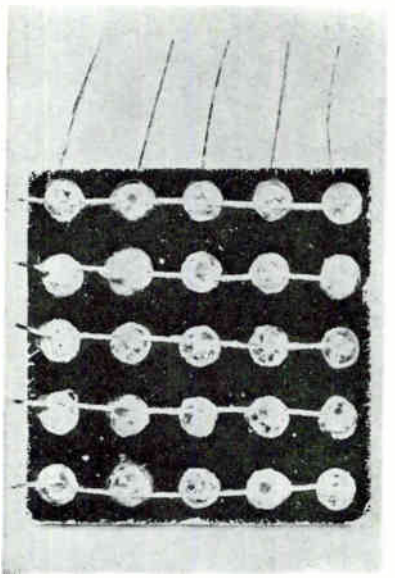


FIG. 4—Matrix of 25 experimental double-break cryosars fabricated by pillbox method

Project HIGH POWER is seeking techniques for radiating very high microwave radar power, in addition to investigating limits to the concept of amplitude discrimination of a target in or beyond the ionosphere.

Such limits may occur when the radar cross-section of the target approaches the background clutter of the medium. Two known sources of such clutter are: auroras, and incoherent backscattering from free electrons, both of which need to be taken into account for effective defense systems.

Auroral returns are important in the case of targets approaching from the polar regions. The absolute magnitude of backscatter at microwave frequencies remains to be determined. The HIGH POWER experiments are studying these effects for the radar case.

A new transmitter for the program is capable of 50 Mw peak power, 50 Kw average. Pulse repetition rate is adjustable from 50 to 250 pulses a second, pulse length from 1 to 8 microseconds. Transmitter operates at 2.850 ±10 Mc. Figure 5 shows radar site at Newstead, N. Y.

Eight parallel VA 820 klystrons

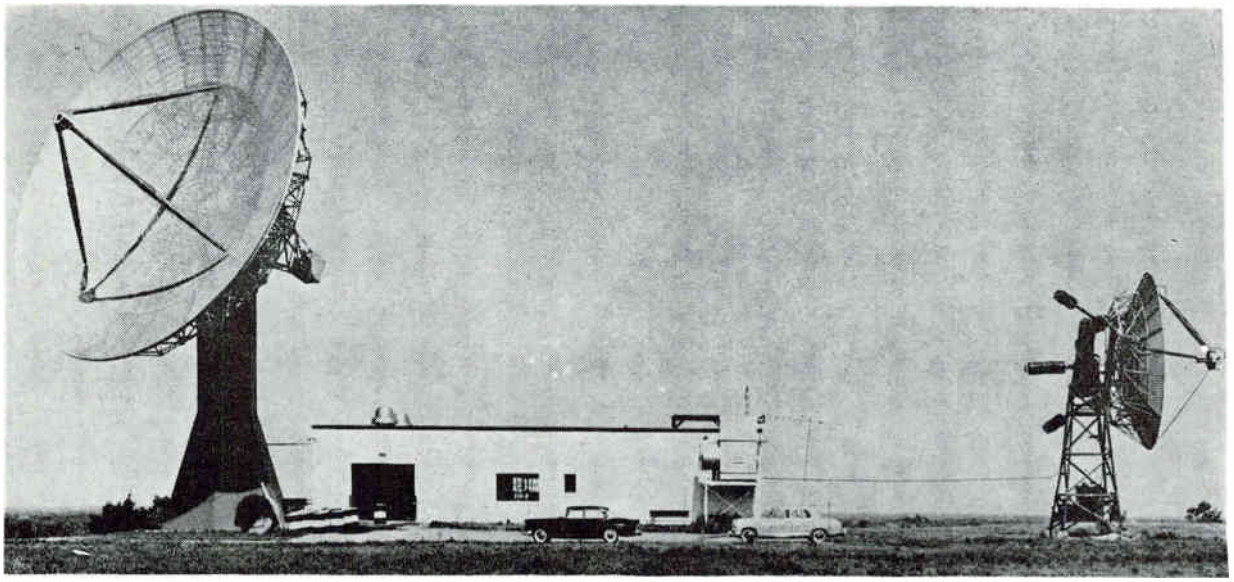


FIG. 5—Radar site at Newstead, N. Y. has 60-ft antenna on left and building housing 50-Mw S-band transmitting and receiving equipment

are used in the output amplifier. The inputs are fed in phase, and their outputs are combined by means of a special output combiner system so as to produce a single power output that is equivalent to the summation of the individual sources. Each VA 820 klystron is operated at 6.25 Mw peak power and 6.25 Kw average.

The transmitter is used in conjunction with a 60-foot parabolic antenna, which provides a ½-degree beam at the operating frequency.

Telemetering ocean buoys provide a relatively inexpensive tool for measuring currents, temperature at many depths and other parameters of the ocean.[6] Emphasis has been given to the precise measurement of temperature and salinity, since from these variables can be calculated density as a function of depth. And density is perhaps the most significant parameter for understanding oceanic circulation. Temperature must be measured to 0.01 C and salinity to 0.01 part of salt per 1,000, an accuracy which has been obtained in the laboratory and aboard ship.

Strides are being made toward measurement with this accuracy from unattended buoys. In one experiment, a thermistor 15 feet below the surface controlled the frequency of a resistance-controlled oscillator, modulating a buoy transmitter. Instrumental accuracy was ±0.2 C. Results better than 0.1 C have been obtained by using servo balancing methods and digitizing the data before transmission.

Telemetering buoys have been used as long-life anchored sonobuoys in a radio acoustic ranging system shown in Fig. 6. Detailed topography studies are possible using the buoys as navigational controls.

Buoys also measure ocean waves. One type uses an insulated mast, extending above and below the surface of the water. The aluminum mast acts as one plate of a capacitor while the sea water is the other. The resulting capacitance variation varies the frequency of a subcarrier oscillator modulating a transmitter.

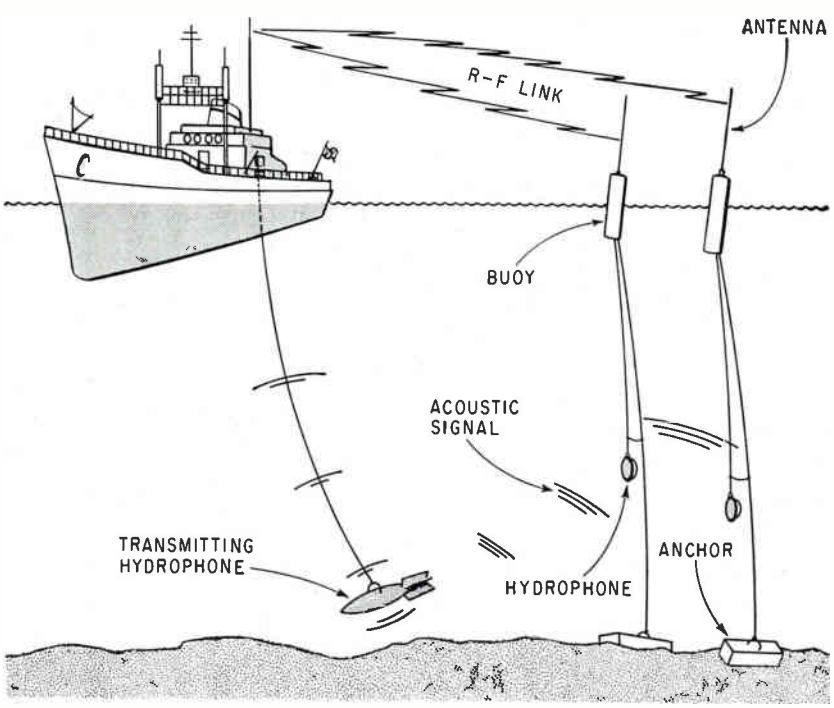


FIG. 6—In radio acoustic ranging system, sound impulses from hydrophone towed by the ship are received by the ship directly and by bottom reflection. In addition, sound energy is picked up by buoys and telemetered to ship

Another approach has been taken recently. A stainless steel wire is held in suspension vertically through the surface of the water. Waves rising and falling around the wire change its effective resistance due to the shunting effect of the sea water. The buoys are set adrift by ships and located by direction-finding techniques from long-range aircraft.

Retiming with a local clock has proven effective in removing virtually all jitter from pulse signals in a digital transmission system.[7]

Causes of jitter in digital systems include thermal noise, crosstalk, multipath transmission in radio links, and pattern effects in regenerative repeaters.

System is shown in Fig. 7A. The jitter may exceed one pulse interval, so a digital memory with a capacity of four bits is used as a buffer. As bits come in from the signal, they are written cyclically into the memory locations. The address of the write operation is controlled by a counter working from a timing signal derived from the input. The data is read out of the memory at demand of a local clock signal in the same order as it was written. The address of the read operation is controlled by another counter, driven by the clock signal.

The buffer memory circuit, with the write address selector, is shown in Fig. 7B. The outputs of the write counter control the resistor diode logic chain to hold all outputs of the selector at ground, except one. If the digital signal is ONE, the driver signal will go negative, causing the selected storage capacitor to be charged negatively. This capacitor will hold its charge until it is selected by the read circuit.

Read and write functions are independent, so the delay between input and output can be any value, as long as the same capacitor is not selected simultaneously by both. Range of the delay is between ½ and 3½ pulse intervals.

To avoid exceeding the memory capacity, it is necessary that the local clock be synchronous with the long time frequency of the input. Figure 7A indicates how the clock can be synchronized to the input signal by a phase controlled loop with a long response time.

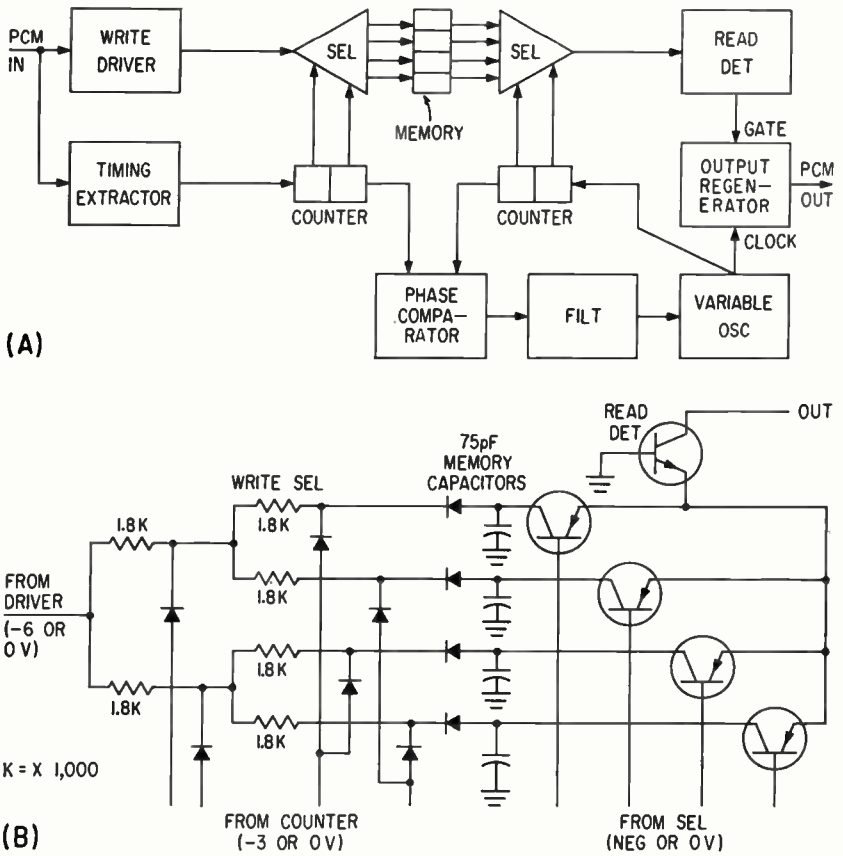


FIG. 7—System for retiming digital signals with a local clock (A) employs the buffer circuit shown in (B)

Automatic transistor tester developed in England carries out 18 checks in two seconds.[8] An additional second is allowed to carry the transistor into the test station, thus giving a rate of 20 transistors a minute.

Magazines, each holding 25 transistors, are fed into the input storage mechanism and then proceed through the machine automatically. At the first test station, noise measurements are carried out; at the second, all other d-c and a-c measurements are performed. The machine analyzes results obtained on each transistor, grades them and conveys them pneumatically through one of a number of electrically-operated flaps to the appropriate output bin.

Results of selected tests can be displayed on electromechanical counters, so that immediate information can be obtained regarding the spread of selected parameters. If necessary, information can be fed back to the production line to correct any adverse trends in the parameter values. Also, results can be recorded in digital form on punched paper tape.

Rapid switching necessary to set up and complete all tests within two seconds is carried out by dry-reed relays controlled by logic switching circuits.

REFERENCES

All papers prepared for the 1960 Northeast Electronics Research and Engineering Meeting in Boston.

(1) I. L. Auerbach, Auerbach Electronics Corp., The Current State of Western European Information Technology.

(2) R. C. Johnston, MIT Lincoln Laboratory, A Random-Access Cryosar Memory.

(3) W. N. Carroll and F. F. Jenny, IBM Microminiaturization Utilizing Thin Film Technology.

(4) R. G. Franklin and D. L. Birx, Franklin Institute Laboratories, Optical Doppler for Space Navigation.

(5) R. C. Beitz, Cornell Aeronautical Laboratory, High Power Microwave Radar Research.

(6) R. G. Walden, Woods Hole Oceanographic Institution, Data Acquisition from Unattended Buoys.

(7) C. J. Byrne, M. Karnaugh and J. V. Scattaglia, Bell Telephone Laboratories, Retiming of Digital Signals With A Local Clock.

(8) H. F. L. Cameron, British Telecommunications Research Ltd. and P. M. Tipple, Associated Transistors Ltd., An Automatic Transistor Tester.

Using Digital Techniques

Analyzer determines frequency spectrum of nonperiodic as well as periodic inputs. Digital circuits use speed-up process in modifying input wave for analysis

By
BERNARD GRAND
LEROY PACKER
JAMES L. WEST
General Applied Science Laboratories, Inc., Westbury, N. Y.

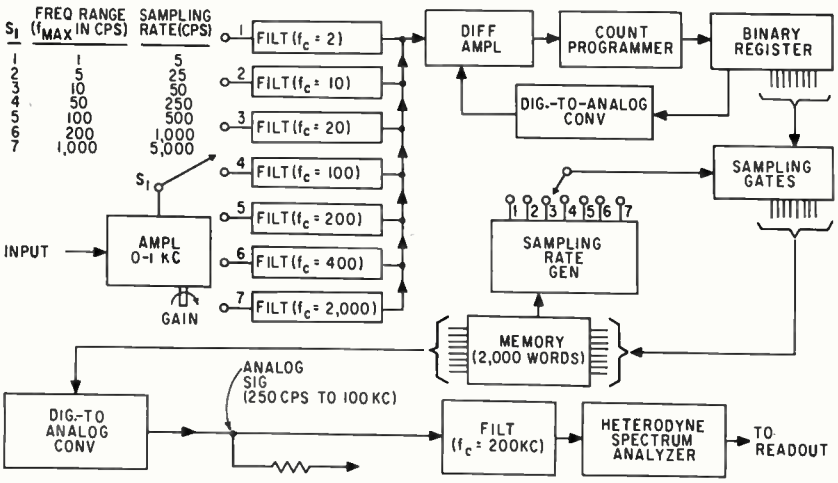


FIG. 1—Speed-up circuits of analyzer process the input wave, readying it for conventional analysis by the heterodyne-analyzer block

THE PRIMARY function of this instrument is to analyze spectra in the sub-audio and audio frequency region. Its readout method is fast and simple, unlike those of other l-f analysis instruments. Its ability to analyze l-f components of the transient as well as harmonic content of a waveform record should extend the use of spectrum analysis in the study of heart beats, brain waves and seismic waves.

The analyzer is shown in Fig. 1. Before the heterodyne-analyzer block determines the frequency spectra of the input signal, other circuit blocks convert the analog input to a ditigal signal, which is stepped up in frequency, reconverted to an analog signal, and delivered to the heterodyne analyzer block. The analyzer operates on a change-of-time-scale principle; at the lowest operating range (0.0025-cps to 1-cps) the input frequency is multiplied by 100,000. The multiplication process is accomplished with extreme accuracy both in amplitude and frequency. Spurious signals generated by the speed-up process are attenuated at least 60 db. The multiplied signal allows the use of conventional heterodyne frequency analysis methods, using scanning rates 1,000 times faster than those required without the speed-up process to obtain equivalent resolutions.

The system analyzes the spectrum of signals over the range 0.0025-cps to 1,000-cps in seven scales. Each scale has a resolving power of 0.25 percent of the full-scale frequency and the dynamic range in amplitude is 48 db.

The input signal is amplified in a variable-gain amplifier having a bandwidth from d-c to 1 Kc. Amplifier gain is adjusted to obtain a peak-to-peak signal of approximately 40 v. The amplified input is fed to the appropriate low-pass filter for each frequency range. These filters attenuate all frequencies above the frequency range of interest, reducing the amplitude of frequency components in the input signal in the vicinity of the sampling frequency. This procedure eliminates errors in the power spectrum which would otherwise be objectionable. The bandwidth-limited output of the low-pass filter is fed to a feedback-type analog-to-digital converter. The difference amplifier compares the input analog voltage to a feedback analog voltage which is proportional to the binary number in the binary register. The parallel binary number at the register output is sampled at a rate determined by the sampling-rate generator. The sampled binary number is fed to the main memory which consists of eight 4,000-μsec magnetostrictive delay lines. Timing of the sample rate pulses is such that digital data enters the magnetostrictive storage delay lines sequentially.

Output of the memory is read at a 500-Kc rate. The binary number is fed to a digital-to-analog converter which activates binary-weighted constant-current sources. The resulting currents are fed to a single resistor. The voltage developed across the resistor is an analog signal proportional to the digital numbers read out of the memory unit. This signal goes to a low-pass filter which attenuates the unwanted output sampling frequency of 500 Kc. Frequencies of interest vary from 250 cps to 100 Kc.

Figure 2A is the logic diagram of the analog-to-digital converter which converts the input signal to an 8-bit word. The analog input goes to a sample and hold circuit. During the sample time a capacitor in this circuit is charged; when a sample rate pulse occurs, the sample gate is turned off. The capacitor is now charged to a d-c voltage equal to the amplitude of the input signal at the sample time. Gating signal *SHG* controls the turn-on and turn-off time of the sample and hold circuit. The output d-c of the sample-and-hold amplifier goes to a decoder d-c amplifier which compares the sampled analog input voltage and the 8 binary-weighted bits (AD_1 to AD_8). The result of this comparison

in L-F Spectrum Analysis

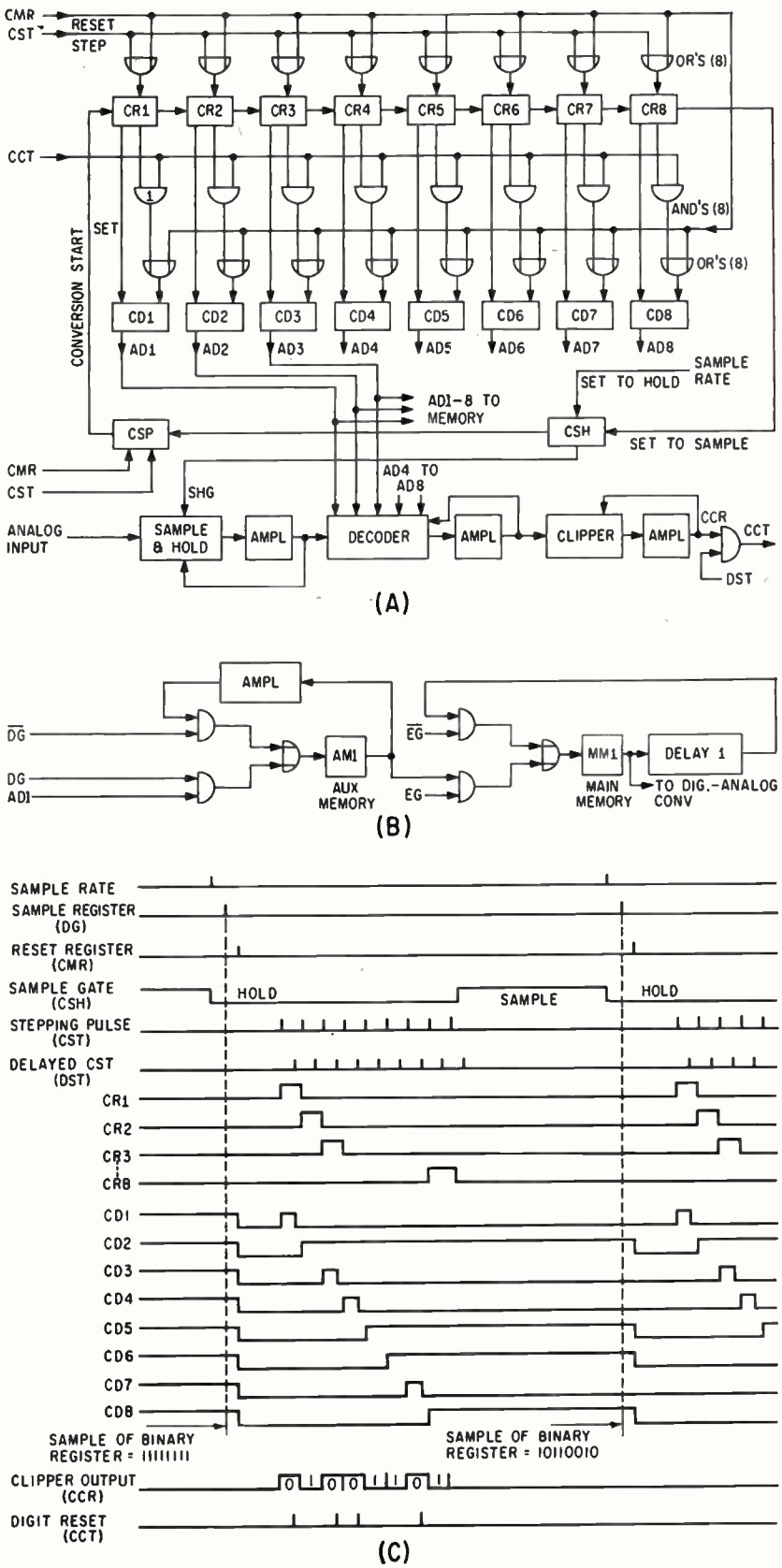


FIG. 2—Outputs AD1 to AD8 of analog-to-digital converter (A) go to memory (B). Timing diagram of operation is shown in (C)

is to set binary register CD_1 to CD_8 to a digital number which is accurate to ±0.4 percent of the input voltage at every sample time.

Immediately after the sampling-rate pulse is generated, the strobe pulses (*DG* of Fig. 2B) gate the 8-bit digital word (AD_1 to AD_8) of the previous analog-to-digital conversion into the main memory. Figure 2C, the timing diagram of Figs. 2A and 2B, indicates the operating sequence. The ring-counter (CR_1 to CR_8) and binary register (CD_1 to CD_8) are reset by *CMR*. The sample rate pulse sets sample-and-hold flip-flop *CSH* to the HOLD state. A delayed sample-rate pulse is fed to an AND gate (not shown) at a 25-Kc pulse rate to generate *CST*, the ring counter stepping pulses. The first *CST* pulse triggers *CSP* which in turn sets CR_1, the first stage of the ring counter, ON. The first stage of the binary register, CD_1, representing the most significant digit, is set by CR_1. At this time the actual conversion begins.

Output AD_1, which goes to the decoder, switches in the most-significant binary digit of the analog-to-digital conversion. This digit has a weight of one-half the total possible analog input signal. Depending upon the magnitude of the analog input signal, the output of the decoder d-c amplifier is above or below zero, signifying that the analog input signal is larger than or less than the first significant digit. The decoder output is fed to a clipper d-c amplifier whose output either inhibits or passes a delayed stepping pulse (DST), which forms *CCT*, the binary-register digit reset. If the analog input is less than the weight of the most significant digit, *CCT* resets CD_1 via AND gate No. 1. If the analog signal is greater than the first decoded digit, *CCT* fails to develop and digit-control flip-flop CD_1 remains ON.

Several microseconds after the first digit-control flip-flop is sampled for resetting, the ring counter is stepped to the next position, that is, CR_1 is turned OFF and CR_2 is turned ON. As CR_2 is turned ON,

CD_2 is turned ON. Output AD_2 turns on the second digit, which has a weight of one quarter the maximum analog voltage.

The process for resetting and stepping continues in the manner outlined above, thus determining the remaining digits. Each *DST* pulse samples the next least-significant digit of the digital conversion and either generates *CCT* to then reset the appropriate digit control flip-flop or allows it to remain in the ON state. As the last ring counter stage (CR_8) is turned OFF, an output of CR_8 is fed to *CSH*, resetting this flip-flop to the SAMPLE state. The sample and hold gate goes ON and remains ON until the next sample-rate pulse turns *CSH* OFF. Until the next register-reset pulse (*CMR*) is generated, the binary register holds the digital number representing the analog voltage of the last conversion.

The digital word held in the binary register is fed to the main memory in a parallel form synchronous with the generation of every sample pulse. Figure 2B shows one of the eight identical sections of the memory. The main memory contains eight magnetostrictive delay lines (D_1 to D_8) each of which is 4,000-μsec long. The bit rate is 500-Kc, yielding a storage capability of 2,000 eight-bit words. The main memory access at sample rates above 250 cps is made possible by the use of eight auxiliary memory storage units (AM_1 to AM_8), each with a storage capability of 20 bits.

Pulse *DG* strobes the binary register outputs (AD_1 to AD_8). Output AD_1, a d-c voltage defining the state of CD_1, and *DG* are fed to an AND gate. If CD_1 is ON, a ONE is entered in AM_1. At the time that a digit is being entered $\overline{DG}$ (NOT *DG*) is fed to the recirculation input of AM_1, thus erasing the oldest bit in storage. Since AM_1 has a 20-digit storage capacity, the enter and erase gating cause AM_1 to hold the last 20 most-significant digits. Auxiliary memories AM_2 through AM_8 successfully store the last 20 lesser-significant digits. The result of the last analog-to-digital conversion is represented by the last digits entered into AM_1 through AM_8. The main memory units MM_1 through MM_0 are gated by entry and erase gates *EG* and $\overline{EG}$. The logic applied here is similar to that employed in the auxiliary storage. Entry gate *EG* is generated once for every 20 *DG* pulses, at sample rates above 250 cps. Hence, for a sampling rate of 5,000 cps, the main memory receives new information every 4,000μsec. At sampling rates of 1,000 cps and 500cps, new data enters the main memory at a rate of 20 words every 20 and 40 millisec, respectively. At sample rates of 250 cps and lower, the auxiliary memory is not used; appropriate logic strobes the analog-to-digital binary register directly into the main memory storage.

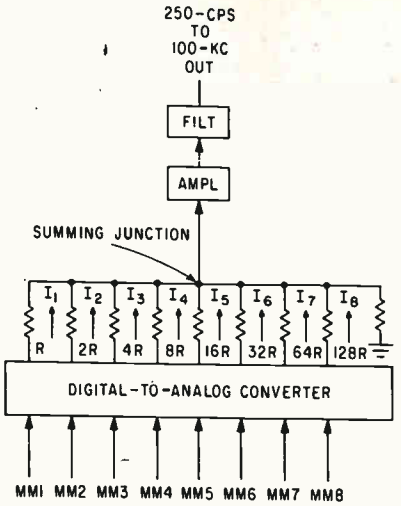


FIG. 3—Digital-to-analog converter output is amplified and filtered before going to heterodyne analyzer

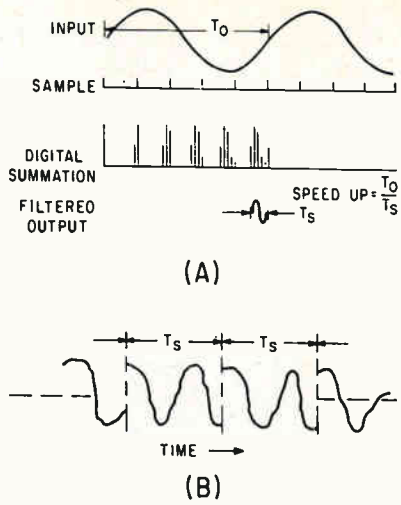


FIG. 4—Sampling and speed-up process (A) and waveshape at storage output (B)

The output of the main-memory storage is a parallel digital representation of the analog input signal. As an example, consider a 100-cps input c-w signal. Using the appropriate 500-cps sample rate (see table in Fig. 1) for the 0.25-cps to 100-cps range of spectrum components, five samples are taken of each cycle of the input 100-cps signal. These five samples occupy (5/2,000) x 4,000 or 10μsec in the main memory (word capacity of the storage is 2,000 and the storage line is 4,000-μsec long). This is equivalent to a 100-Kc signal, thereby effecting a speed-up of 100Kc/100cps = 1,000.

The parallel digital output of the main memory is fed to a digital-to-analog converter (Fig. 3). The converter feeds into a summing junction, current directly proportional to the digital word being converted. The envelope of voltage generated at the summing junction is the sped-up input signal. The summing junction feeds a low-pass filter which suppresses all frequencies above 200 Kc by at least 60 db, thereby eliminating the 500 Kc carrier of the storage. The 500-Kc carrier component is caused by the 2-μsec spacing between successive sample bits.

Figure 4A shows the sample process and resultant frequency multiplication. A sine wave of period T_o is sampled with a minimum of five samples for every cycle of the input. Referring to the example outlined above, the digital summation of the main-memory storage consists of sample voltages corresponding to the levels of the input wave at the sample time, and occurring at 2-μsec intervals. The output filter yields the sped-up envelope of the input with a period equal to T_s. The analog signal goes to the heterodyne spectrum analyzer, which is conventional.

In the speed-up process, signals are represented in the time interval determined by the magnetostrictive storage access time. The heterodyne-frequency analyzer receiving the decoded and demodulated output of the magnetostrictive storage perceives it to be a succession of samples of the signal in duration of time equal to the access time of the delay lines, as shown in Fig. 4B. Consequently, the spectrum of the transformed signal appears as a line spectrum, each line being a multiple of the frequency corresponding to the storage access time. Due to the 4,000-μsec delay line,

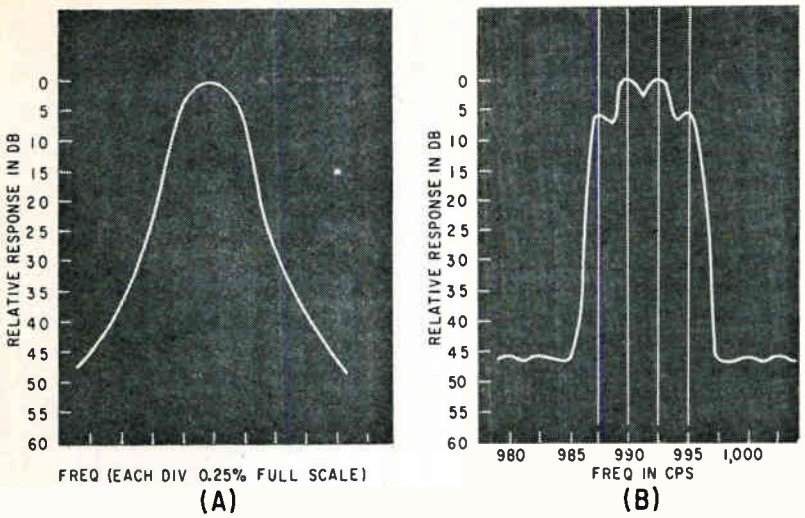


FIG. 5—Response with cosine weighting (A). Spectrum display of two sinusoidal signals at 990 and 998.5 cps which is shown in (B) is obtained with cosine weighting

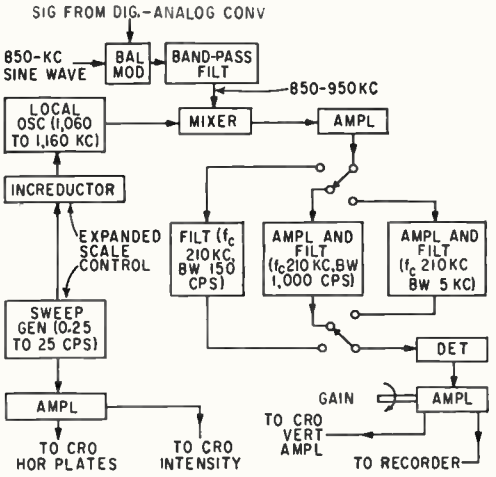


FIG. 6—Heterodyne spectrum analyzer receives input from digital-to-analog converter

this frequency is 250 cps. Since all transformed signals lie in the range 250 cps to 100,000cps, spectral lines are separated by 1/400 full scale.

It can be shown that an input sine wave (to the speed-up section) of a frequency, f_o, which lies exactly between spectral lines, produces an output from the frequency-multiplying section with a spectrum of the form $\sin x/x$. By weighting the samples in the magnetostrictive storage, these signals can cause the display shown in Fig. 5A. The latter weighting is a cosine function weighting, producing a selectivity curve such that adjacent spectral lines (0.25-percent of full scale) for a sine-wave input are down 6 db. As representative numbers, on the 1,000-cps scale the selectivity curve is 3.75-cps wide at the 3-db points and 19-cps wide at the 40-db points. The display of two signals 2.5-cps apart near 1,000 cps with cosine weighting is shown in Fig. 5B. Other types of weighting, including triangular, may be employed.

The selectivity discussed previously for the speed-up section is determined by the type of weighting used in the magnetostrictive storage and by the length of the information held in storage. The heterodyne spectrum analyzer (Fig. 6) which receives information from the speed-up section utilizes a filter bandwidth of 150 cps to obtain the maximum available resolving power. The 3-db bandwidth is 5 cps for the 1,000-cps maximum-frequency scale. Since the speed-up for the scale is 100, the 3-db bandwidth for the frequencies at the output of the speed-up device is 500 cps. Therefore, an i-f bandwidth in the spectrum analyzer portion of the system of 150 cps provides adequate resolution. The narrowest filter bandwidth is 150 cps at the 3-db points and the scan time for this i-f bandwidth can be set to a minimum time of 1.6 seconds. Other i-f filter bandwidths provided are 1,000 cps and 5,000 cps with respective scanning times of 0.1 sec and 0.05 sec for the full 100,000 cps band.

Incoming signals in the range 100 cps to 100,000 are mixed with a local oscillator and heterodyned to the frequency range 850 to 950 Kc. The band-pass filter eliminates unwanted side bands. The resulting signal is mixed with a sweep-frequency oscillator and filtered in the i-f strip at 210-Kc. Output of the i-f stage is detected and amplified. This output may be fed to a cro and/or recorder.

Sampling of a signal may be interrupted at any time and the contents of the storage repeatedly analyzed. The contents of the storage may also be emptied at any time for replacement by fresh data.

Figure 7A shows a complex test signal composed of a mixture of a 1.5-cps square wave and a 6-cps sine wave. In Fig. 8A a ½ cycle sample of a 5-cps c-w signal was gated into the analyzer. Figure 8B shows the spectrum resulting from a 4-cycle sample of a 5-cps c-w input. Here the scale was set to 5 cps; 3-db resolution was 1/80 cps.

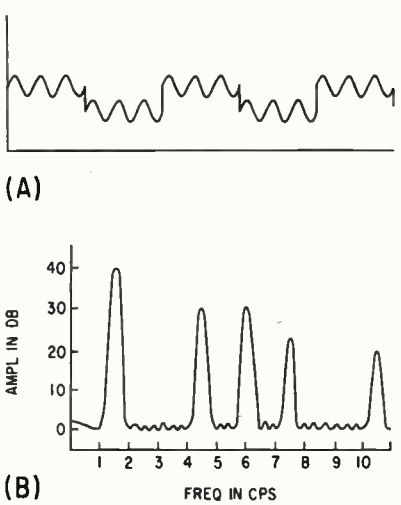


FIG. 7—Spectrum of complex-wave input (A) is shown in (B)

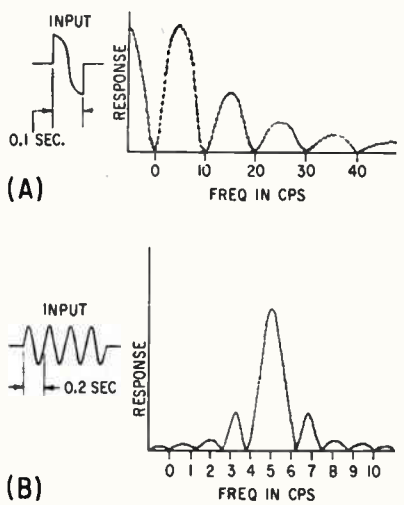
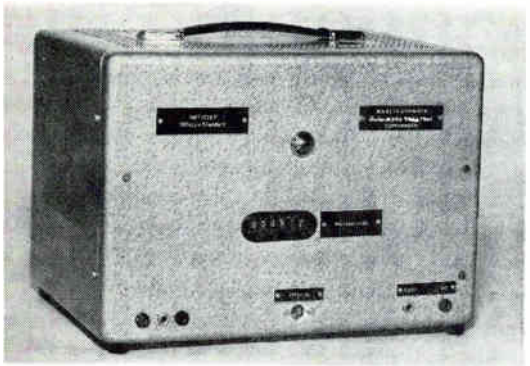


FIG. 8—Analyzer scale is set for 100 cps in (A), 5 cps in (B)



Crystal clock locked to atomic standard through radio signals produces accuracies of one part in 10^9 at moderate cost

Atomic Clock Accuracy

Crystal oscillators can be locked to atomic clock-controlled

ALTHOUGH the precisely controlled signals from transmitters such as WWV or WWVH are influenced by doppler variations and suffer interruptions, the transmissions can be used to control crystal clocks to obtain an accuracy almost as high as that of the transmitted signal. As at least one of these high-accuracy standard frequencies can be received any place in the world, a frequency standard controlled to one part in 10^9 is available at low cost to those who require it. The system can be applied to existing crystal clocks.

The principle of the system is simply explained if it is assumed that the frequency of the crystal oscillator being controlled is the same as the standard frequency being received, although in practice this assumption is not necessary.

A block diagram of the circuit is shown in the figure. Frequency f_c from the crystal oscillator is mixed with the received frequency f_r. The receiver has a narrow bandwidth so that only the standard frequency is received. The mixer, known as a Nygaard discriminator (Fig. 1B), delivers two outputs, each equal to the difference frequency $f_c - f_r$ but 90 degrees apart in phase. After amplification the signals drive a small synchronous motor. Motor speed is thus dependent on the difference frequency, including the sign. The motor drives the trimmer capacitor of the crystal oscillator in a typical servo loop to bring the difference frequency to zero. Time needed for error correction depends on the gear ratio. Short term errors, doppler variations, in the received frequency have only small influence on the oscillator frequency if error correction time is much longer than the time in which the errors occur. Interruptions in the received frequency have no influence on oscillator frequency because the motor is motionless without both signals present.

Let the received frequency be defined by

$$f_r = f_n + \Delta f_n \qquad (1)$$

where f_n is the nominal transmitted frequency and Δf_n is the error caused by doppler variation. Doppler effects depend chiefly on variations in the ionosphere, and mainly in the E-layer and F-layer, from which the radio wave is reflected. Magnitude of Doppler shift is given by

$$\Delta f_n = -(f_n/c)(ds/dt) \qquad (2)$$

where c is the velocity of light, s is distance signal has traveled and t is time. The difference between the longest and shortest possible signal path is termed S and thus

$$\left| \int_{t_1}^{t_2} \Delta f_n \, dt \right| \leqq \frac{f_n S}{c} \qquad (3)$$

for all values of t_1 and t_2. The quantity S/c, for high frequency signals close to the transmitter, can be as large as 10^{-3} sec.

The crystal is assumed to be resonant approximately at f_n, and to have an ageing rate $g(t)$. Oscillator frequency is varied with a trimmer capacitor and frequency deviation per turn of the trimmer axis is $-\alpha f_n$. The number of turns of the trimmer axis counted from zero is called m. Crystal frequency f_n then is determined by

$$df_c/dt = g(t) - \alpha f_n \, dm/dt \qquad (4)$$

Received frequency $f_n + \Delta f_n$ is mixed with crystal frequency f_c in the Nygaard discriminator. Both discriminator outputs deliver the same frequency, $f_c - f_n - \Delta f_n$, but the two voltages are 90 degrees out of phase. After amplification the two voltages are fed to a synchronous motor, the rotational speed of which is thus equal to the difference frequency providing the motor has only two poles. If the motor has more than 1 pair of poles, motor speed will be reduced accordingly. Motor speed is equal to the difference frequency for all frequencies lower than cutoff, since there is an upper limit for motor speed depending on electrical and mechanical details. The upper limit is usually not significant, since the motor operates at low speed. The motor drives the trimmer capacitor through step down gear ratio r, giving the equation

$$dm/dt = (f_c - f_n - \Delta f_n)\, r \qquad (5)$$

Equations 4 and 5 together give an equation for crystal frequency f_c

$$df_c/dt = g(t) - (f_c - f_n - \Delta f_n)\alpha f_n/r \qquad (6)$$

Defining the time constant as

$$T = r/\alpha f_n \qquad (7)$$

the solution of Eq. 6 becomes

$$(f_c - f_n)/f_n = A + B + C \qquad (8)$$

where A, B, and C are defined as

$$A = \frac{1}{Tf_n} \exp\left(-\frac{t}{T}\right) \int_o^t \Delta f_n \exp\left(\frac{t}{T}\right) dt \qquad (9)$$

$$B = \frac{1}{f_n} \exp\left(-\frac{t}{T}\right) \int_o^t g(t) \exp\left(\frac{t}{T}\right) dt \qquad (10)$$

$$C = k \exp(-t/T) \qquad (11)$$

where k is a constant equal to the initial error. The last term C, may be disregarded as it tends to zero.

Equation 3 together with 9 shows that $|A|$ cannot exceed S/cT. If G, without regard to its sign, is the highest aging rate within the time interval of interest, $|B|$ cannot exceed TG/f_n and thus

$$|(f_c - f_n)/f_n| \leqq TG/f_n + S/cT \qquad (12)$$

assuming C is zero. Equation 12 then gives the maximum value for the deviation between crystal frequency and nominal transmitted standard frequency. This maximum value is as small as possible if

$$T = \sqrt{f_n S/cG} \qquad (13)$$

Then Eq. 12 becomes

$$|(f_c - f_n)/f_n| = 2\sqrt{GS/cf_n} \qquad (14)$$

For Crystal Oscillators

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radio stations to produce high-accuracy, low-cost frequency standard

For a fairly good oscillator G/f_n may be 10^{-14}; assuming $S/c = 10^{-8}$ the worst conditions of doppler variations are covered. For the assumed values of G and S/c, maximum deviation of crystal frequency from nominal transmitted frequency is 6.3×10^{-9} and the time constant T is 3×10^5 sec or 3.7 days. The figures are computed under the assumption that there are no interruptions in reception. With reception only 50 percent of the time this system cannot ensure an accuracy higher than approximately one part in 10^8.

Frequency errors in the crystal depend only on short term accuracies, as can be seen by examining the quantities A and B, or rather, the maximum values S/cT and TG/f_n. By connecting the motor to the trimmer as shown in Fig. 1C, A can be set equal to zero; then a small time constant will keep TG/f_n small.

If crystal aging rate G is zero and $f_c = f_n$, only the Doppler effect is effective in causing motor rotation; motor speed is $-\Delta f_n$. Taking speed reduction into account,

$$dN/dt = -\Delta f_n/f_r \qquad (15)$$

where N is the number of turns of the output shaft of the motor-gear reducer combination. From Eq. 2 and 15

$$dN/dt = (f_n/cr)\, ds/dt \qquad (16)$$

Equation 16 is integrated to give

$$N = f_n s/cr + N_0 \qquad (17)$$

where N_0 is a constant. Since the maximum difference in transmission distance is S, N_0 can be selected to give

$$0 \leqq N \leqq f_n S/cr \qquad (18)$$

The arrangement shown keeps Doppler variations from affecting crystal frequency as long as other errors are not present. But if f_c shifts away from f_n, the motor will turn through the dead zone and make the correction. To make the correction time small, T is made small. To maintain stability, one revolution of the motor should not change crystal frequency by more than about 10^{-10}. Thus $a/r \leqq 10^{10}$; which gives $T \geqq 10^{10}/f_n$.

With $f_n = 10$ Mc, $S/c = 10^{-8}$ sec., $G/f_n = 10^{-11}$ sec. and $T = 10^3$ sec., the following figures, based on 50-percent reception, are obtained for $(f_c - f_n)/f_n$: one part in 10^7 is reached in 3 hours, one part in 10^8 in 1 day, one part in 10^9 in 10 days; with 80 percent reception, one part in 10^{10} is reached in three months.

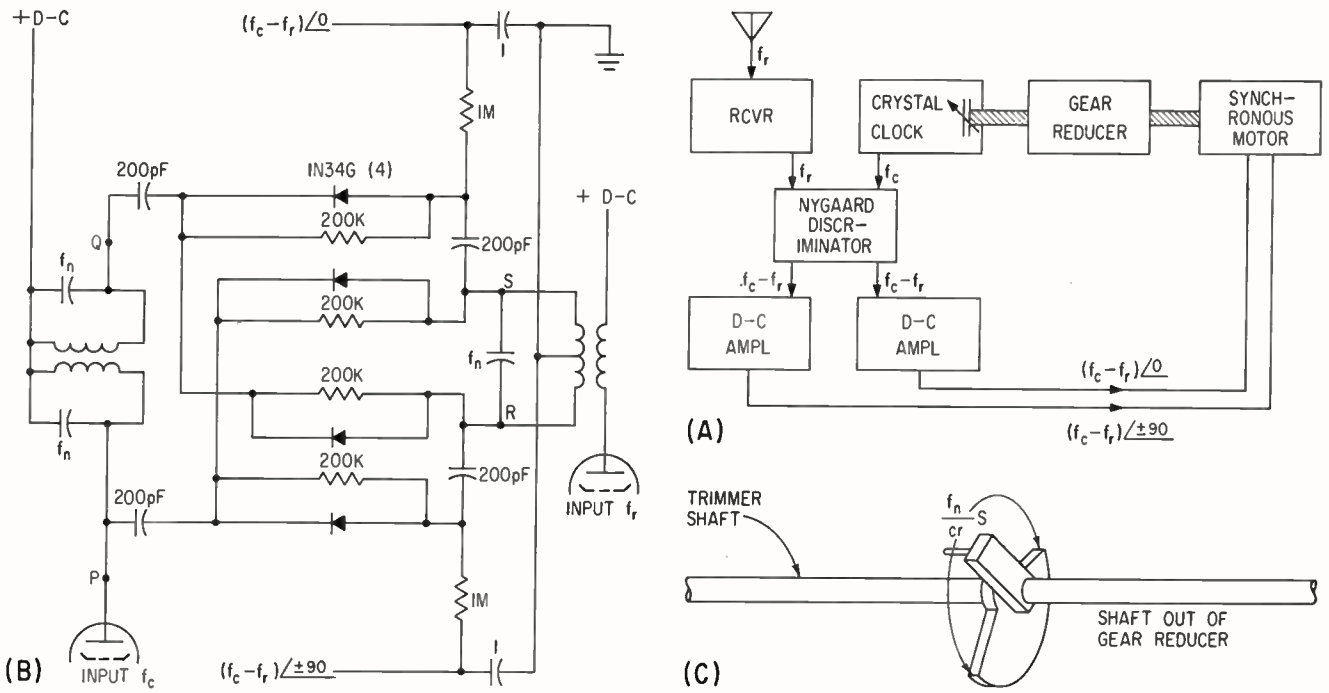
Accuracy of the crystal frequency is easily measured by a revolution counter connected to the motor shaft. Speed of the motor shaft dM/dt, is given by

$$dM/dt = f_c - f_n - \Delta f_n \qquad (21)$$

and

$$M = \left(\int_o^t \frac{f_c - f_n}{f_n}\, dt - \frac{s}{c} \right) f_n + \text{constant} \qquad (22)$$

From Eq. 22, time delay M/f_n can be calculated. For the example used, one revolution of the motor indicates that the time delay has changed 0.1 μsec, or that s has changed by 30 meters.



Synchronous motor in (A), driven by the error frequency, brings crystal clock into synchronism with f_r. Discriminator (B) produces difference frequencies that are 90 degrees out of phase, with the sign of the angle depending on whether f_c is lower or higher than f_r. Short-term Doppler variations can be filtered with mechanical connections (C)

Telemetering Radiation Data By

Three types of radiation monitor are discussed, with information about their relative

THE METHODS described have two major objectives: the first is detection of ionizing radiation, the second is the transmission of the resulting information by radio frequency to the monitoring station. Both requirements are satisfied by the same operation and equipment.

The first requirement can be fulfilled in many ways: with an electrometer, an ion chamber, extrapolation chamber, a Geiger counter or a crystal detector. These instruments when connected with the proper electronic, optical or acoustical instrumentation give information readout.

The methods described in the following pages use the ionization currents of ion chambers, or the pulses from Geiger counters, to vary the reactance of a frequency determining network of a high frequency oscillator. In accordance with signal strength the reactance variation will produce a frequency modulation.

If the oscillator is connected to an antenna, the information is transmitted directly.

At the receiver end, the information can be recovered by beating the incoming signal with a crystal controlled local oscillator, or alternatively, the transmitter itself can produce the reference and signal frequencies simultaneously. The last method is preferable, since the frequency difference between the center frequency and the reference can be kept nearly constant by suitable methods.

During the experiments described, the audio signal was detected as a beat frequency, using a quartz crystal oscillator, and was displayed on an oscilloscope by means of an interpolation oscillator. The following features are desirable for detection and telemetering of ionizing radiation:

The center frequency must not drift appreciably through temperature variations; the signal must be large enough to be easily observable; low power consumption is essential if located at remote positions or in space; stability against mechanical vibrations is required; minimum volume and weight is necessary for space applications.

The first detection method to be discussed is the reactance variation of a movable-vane electrometer; its readings are susceptible to vibration, whereas the following ones are not.

An ionization chamber (Fig. 1) includes an electrometer section with a movable vane suspended by a silverplated quartz fiber. The capacitance between the electrode pairs is maximum when the vane position is in the direction of the electrode pairs. The frequency is determined by the inductance L_1, the capacitances C_1 and C_2, and the capacitance of the electrometer system. If the vane is charged electrically and ionizing radiation enters the chamber, the vane loses its charge and turns out of the space between the two electrode pairs. (This is because the air between the plates becomes ionized and so loses its insulating properties.) Change of vane position decreases the effective vane capacitance and increases the frequency of the oscillator. When the ionization chamber is connected as shown in Fig. 1B the capacitances of the first electrode pair, vane and second electrode pair are in series for the rf circuit (see the r-f equivalent circuit) electrostatically, however, the two capacitances are in parallel since both electrodes are at ground potential. The resultant rf capacitance is about 1 pf, the electrostatic capacitance being 4 to 5 pf.

If the vane is just outside of the space between the electrode pairs, and a voltage is applied to it, while the electrodes are electrostatically grounded, the vane will resist the torsion of the quartz fiber and turn into the space between the two electrode pairs, thereby increasing the capacitance of the system. The maximum capacitances between the vane and each electrode pair is about 2 picofarad.

Figure 1B circuit provides high stability, since the parallel capacitance between grid and cathode is approximately 1,000 pf thus eliminating the effect of grid-cathode capacitance fluctuations.

The increase of capacitance through vane movement produces a frequency increase $\Delta F = \Delta C f_o/2\ C_T$, where f_o is the operating frequency and C_T the total frequency-controlling capacitance. For an optimum condition, C_T should remain as small as possible.

The total range of frequency variation at a center frequency of 2.3 Mc is about 10,000 to 20,000 cycles. By measuring the third harmonic this range can be tripled, but mechanical conditions impose a practical limit to the sensitivity.

In a test, the aluminum ion chamber contained about 100 cm^3 of air under normal pressure, a 25-cm^2 window of 0.001 inch copper-foil permitted practically all gamma radiation and hard beta particles to enter the chamber, and the vane system was charged to about 300 v. A radiation dose rate of 1.58 mr/hr produced a frequency variation of 35 cps during an exposure of one minute. Saturation current is about 1.75×10^{-14} amp for 100 cm^3 of air at this gamma ray dose rate.

The operation requires a minimum leakage of the charge when not exposed to radiation. The use of polyethylene or teflon for suspension of the quartz fiber and moving vane reduces the leakage so that the frequency drift amounts to only a few cycles/second an hour.

In a later model, a crystal-controlled oscillator was used for better frequency stabilization. The fundamental frequency was 5 Mc (Fig. 1C) but the frequency was multiplied to 15 Mc in the plate circuit of tube V_1. The frequency can be varied within a range determined by the ratio of the electromechanical equivalent capacitance C to the parallel capacitance C_o, both shown in the equivalent quartz

Frequency Variation

By HANS KOHN RICHARDS
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advantages and the way in which they are connected to the telemetry transmitters

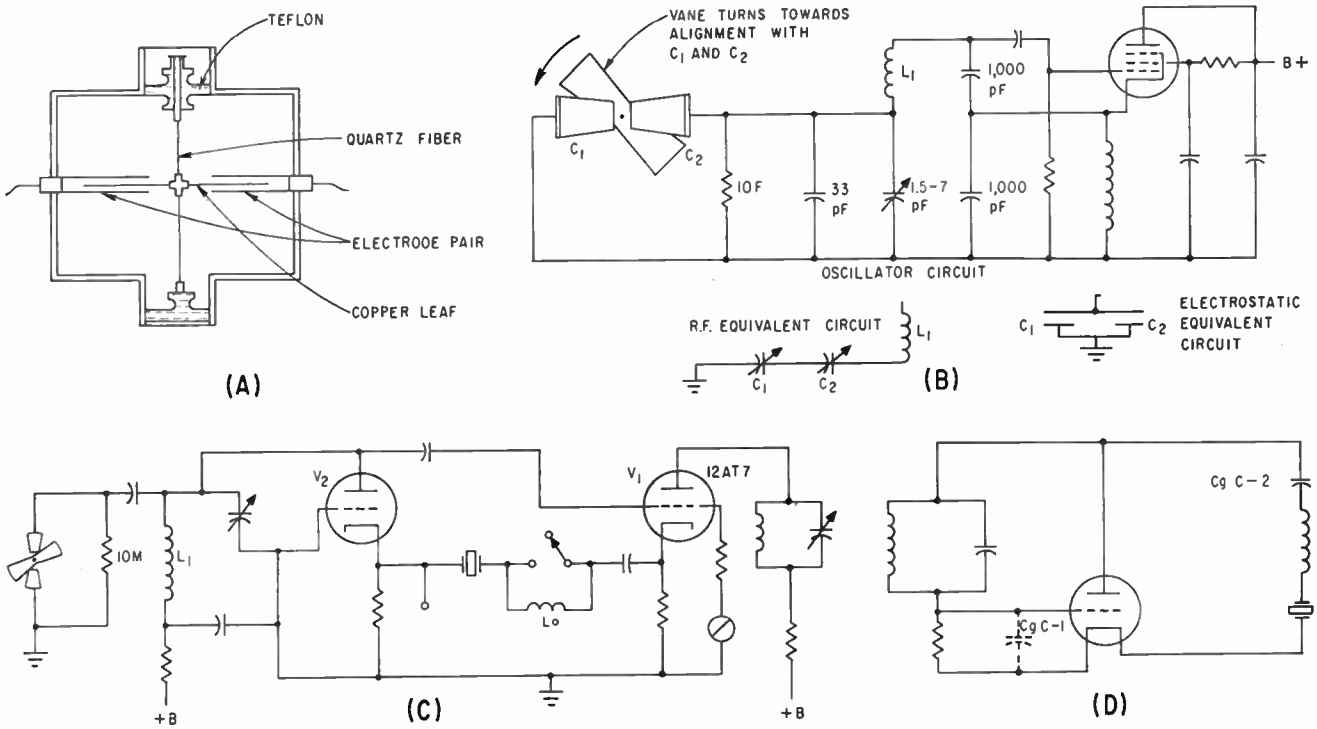

FIG. 1—Ion chamber with movable-vane electrometer (A) is coupled to the basic oscillator circuit (B) to vary its frequency in proportion to vane rotation and thus in proportion to the incident radiation. Circuit of (C) uses a crystal for oscillator stability and (D) is the equivalent circuit of (C)

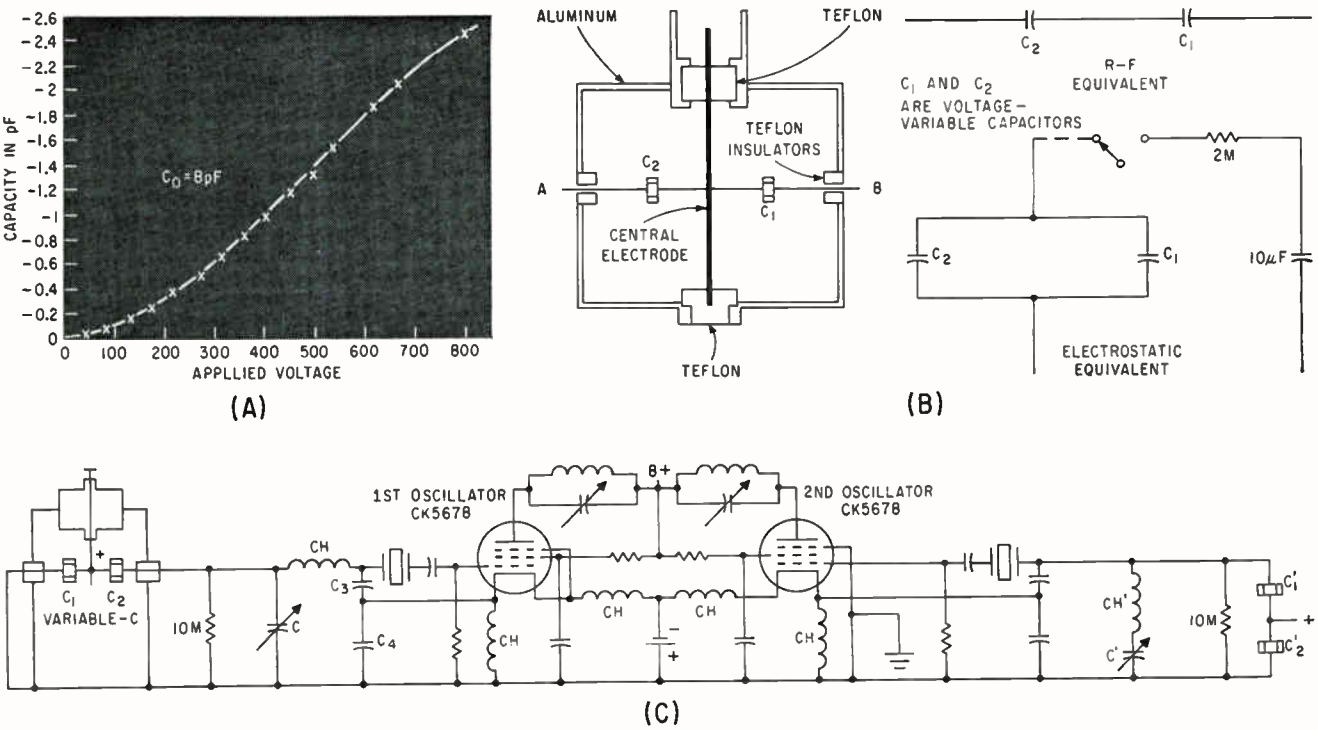

FIG. 2—Graph shows that linear range of voltage dependent capacitor lies in 300 to 600-v region (A); ion chamber construction using barium titanate capacitors (B), and the final circuit with wind drift compensating oscillators (C)

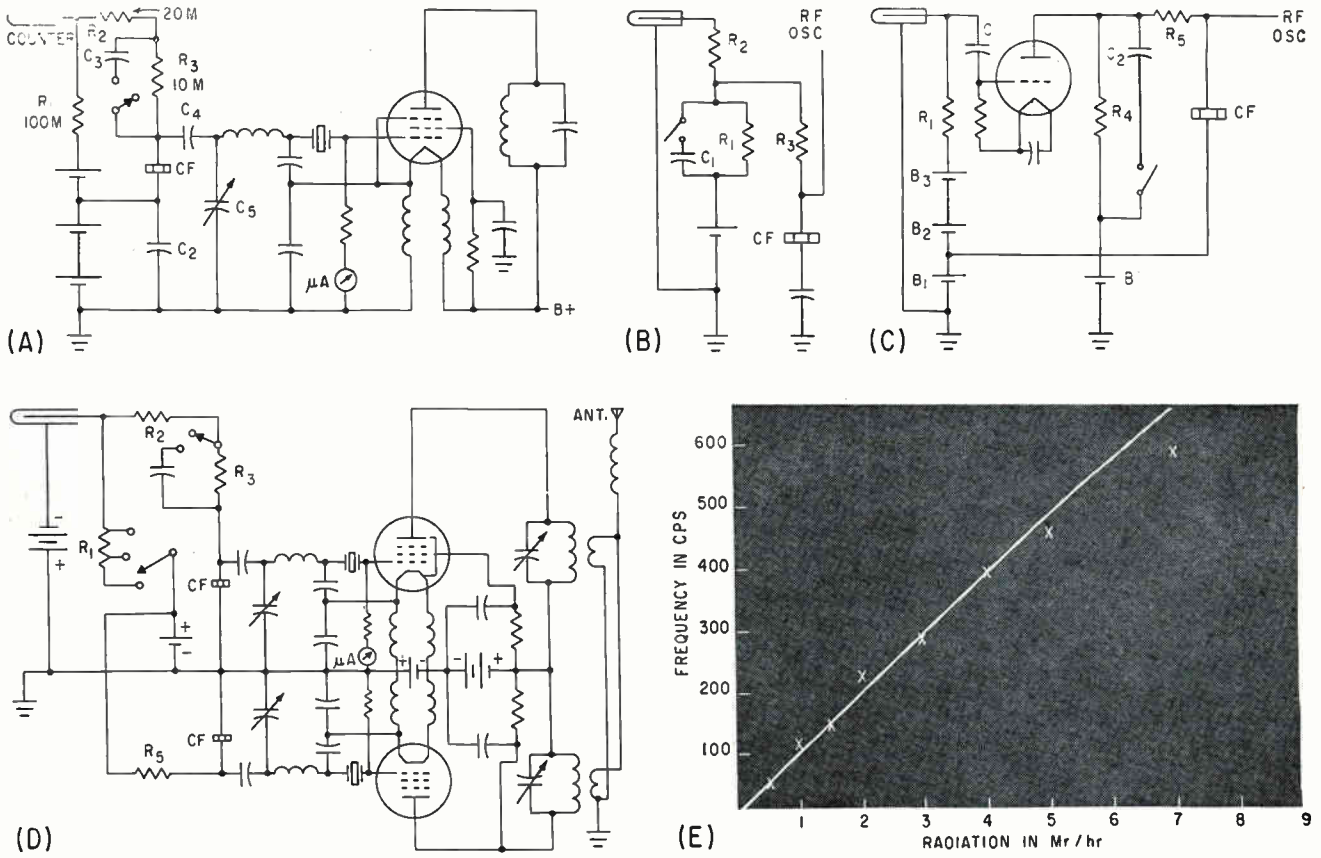

FIG. 3—Circuit (A) provides a pulsed change in transmitted frequency for every Geiger tube discharge; circuit (B) integrates the effects of the Geiger tube discharges to give reading proportional to dose-rate; circuit (C) uses a buffer amplifier between counter-tube and the oscillator; final circuit of (D) incorporates a second oscillator to compensate for frequency drift, while the graph (E) is the telemeter characteristic before drift compensation

crystal circuit, Fig. 1D. By adding an inductance in series with the quartz crystal, this range can be extended, but some control is sacrificed.

The second detection method uses voltage variable capacitors instead of the movable vanes.

Moving parts are eliminated by replacing the electrometer section with a nonlinear capacitance. Nonlinear capacitances can be made from ferroelectric materials having high dielectric constants that are functions of the applied electrical field. Barium titanate was used in all the designs described below. This material has a dielectric constant of about 6,000 at 25 degrees C. A major disadvantage is the dependence of the dielectric constant on temperature, necessitating a thermostatic control if the ambient temperature varies. Later developments have produced combinations of barium-titanate with calcium-titanate and other compounds that give nearly a zero temperature coefficient over certain temperature ranges. A compensation method to overcome the temperature variation of the material is discussed later. A disk barium titanate about 1.2 cm diameter and $\frac{1}{2}$ mm thickness was silverplated on both sides by evaporation in vacuum. The disk was afterwards broken into small pieces, and those pieces with freshly broken sides were used as ferroelectric capacitances after tests for leakage resistance. On removal of the test voltage source, the decay of capacitor voltage was observed with a low-capacitance electroscope. For capacitances of 15 to 20 pf, the voltage decay time was several hours. Leakage resistance is of major importance in this application since it determines the minimum dose-rate that can be measured.

The voltage-variable capacitors are mounted between metal springs and coated with ceresin wax.

The dielectric characteristic of the material was measured by applying voltages from zero to 900 v. As shown in Fig. 2A, there is a section of the curve from 300 to 600 v with an approximately linear voltage-capacitance characteristic.

The ferrolectric capacitance is placed in an ionization chamber as shown in Fig. 2B. Capacitor C_1 is the ferroelectric capacitance, C_2 is either a common capacitance of the same magnitude as C_1 or another ferroelectric capacitance. Together, C_1 and C_2 have capacitances of 15 to 20 pf and the resulting series r-f capacitance is therefore 7.5 to 10 pf.

One electrode of each capacitance (C_1 and C_2) is connected to the central electrode of the ion chamber, the remaining electrode of C_1 being grounded while that of the other capacitance C_2 is connected to an element of the oscillator circuit.

As Fig. 2B shows, C_1 and C_2 are electrostatically connected in parallel, since (Fig. 2C) the side connected to the r-f circuit is grounded through a 10-megohm resistance. The control electrode is charged during the operation to about 300 volts positive, resulting in a capacitance reduction of about 8 percent.

Fig. 2C shows the modified Clapp circuit with quartz crystal fre-

quency control. Tubes used are subminiature types.

Since C_3 and C_4 are about 100 pf each, and the series capacitance of C_1 and C_2 amounts to about 8-10 pf, the frequency is determined essentially by C_1 and C_2 as far as the crystal control permits. Capacitor C is in parallel with the resultant control capacitance and serves for the exact adjustment of frequency; it can be varied from about 3 to 20 pf.

A voltage applied to the center electrode of the ion chamber reduced the controlling capacitance and, therefore, increased the frequency. The quartz crystal frequency is about 2 Mc, and the resonant plate circuit is tuned to 6 Mc, the 3rd harmonic.

To eliminate or reduce the effect of temperature variation on the ferroelectric material, as well as the capacitance variation due to charge leakage, a second oscillator of the same design is added, as shown in Fig. 2C. The two oscillators have approximately the same drift through charge leakage or temperature variation and this drift can be made the same in each by adjustment of capacitance C. Since the second oscillator is not connected to any ionization chamber, its frequency is not affected by radiation.

Each oscillator transmits a frequency of approximately 2 Mc or 6 Mc. These two frequencies differ by some few hundred or thousand cycles sec depending upon the radiation received. The second oscillator serves as a reference. As long as no radiation enters the chamber, the difference of frequency between oscillators appears after detection as a constant audio tone or an ellipse on the screen of an oscilloscope. If ionizing radiation discharges the ferroelectric capacitances connected to the center electrode of the ionization chamber, the two oscillator frequencies drift apart in proportion to the radiation dose-rate. Use of this second oscillator eliminates need for a secondary standard at the receiver.

Temperature variations can be eliminated by thermostatic control of the ferroelectric material, the small volume of this material needing little power and space. A further improvement can be obtained by reduction of the ferroelectric capacitances. The sensitivity would be increased by using a large-volume chamber or a pressure chamber.

As pointed out, the chamber has to be recharged after some few hours. This is done automatically by a clock controlled relay.

The disadvantage of the methods so far discussed is the dependence on high grade insulation to combat electrostatic leakage. It should be emphasized, however, that at large dose rates, one r/hr and higher, this disadvantage disappears and an improvement of insulation will extend the usefulness to lower dose rates. There is no limit for high dose rates since the sensitivity can be reduced by capacitances electrostatically coupled to the ferroelectric capacitance.

A Geiger counter provides radiation detection in the third method.

The disadvantage of electrostatic leakage disappears completely by replacement of the ionization chamber by a Geiger counter. Insulation problems are eliminated even for ferroelectric materials with a resistance of 1,000 megohms and less. This improvement is due to the fact that the counter discharge produces a dynamic characteristic and the electrostatic charges required for the polarization of the ferroelectric capacitances become negligible quantities. It should be noted, however, that the Geiger counter serves as a detector of radiation only, and does not measure dose rate directly.

The design, shown in Fig. 3, can be separated into counter and oscillator circuits. These circuits are coupled electrostatically, but are separated for r-f.

A counter operated at about 900 v is connected by R_1 to the supply battery. Resistor R_2 decouples the counter from the r-f circuit. Capacitor C_F is the ferroelectric capacitance of about 30-60 pf. The rest of the oscillator is the modified Clapp circuit as described previously. As shown in Fig. 3A C_F is connected to C_2 and grounded for r-f by C_2. When no counter discharge occurs, the polarization voltage applied to C_F is 300 volts.

Any discharge through the counter and R_1 will lower the voltage across C_F. With C_3 disconnected, each current pulse will vary the capacitance of C_F and hence the frequency of the oscillator.

On the screen of an oscilloscope at the receiver end the ellipse will disappear with every pulse due to the frequency change. Thus, a count of the number of discharges of the Geiger tube is provided.

The time constant of the pulse circuit depends primarily on the resistance R_1 and the combined capacitance of C_F and those in parallel with it. This total capacitance is of the order of 100 pf. Time constant C_1R_1 is therefore about 10^{-2} seconds.

For high intensities the observation of single counts can be replaced by integration. A capacitance C_1 (Fig. 3B) is connected in parallel to R_1, and any frequency change represents the average of many counts.

Figure 3C shows the application of an intermediate amplifier stage between the counter and transmitter circuit. The low coupling capacitance C_1 reduces the time constant for the single counts and the amplified pulses may be integrated by the network R_4 and C_2. The voltage through R_3 will vary in accordance with the amplified pulses.

The transmitter circuit is identical with those described previously. Figure 3D shows the transmitter with drift compensation incorporated to establish the reference frequency. An antenna is coupled with the 3rd harmonic circuit as seen in Fig. 3D. Figure 3E shows the frequency deviation against incident radiation characteristic.

BIBLIOGRAPHY

H. K. Richards, Measurements of Ionizing Radiation by High Frequency Variation. *ORNL Health Physics Division*, Semiannual Report for Period Ending July 31, 1953.

H. K. Richards, Measurement of Ionizing Radiation by Frequency Variation Using Ferroelectric Effect. *ORNL Health Physics Division*, Semiannual Report for Period Ending Jan. 31, 1954.

H. K. Richards, Detection of Ionizing Radiation by Frequency Variation with the Use of the Ferroelectric Effect. *ORNL Health Physics Division*, Semiannual Report for Period Ending Jan. 31, 1955.

H. K. Richards, *Phys. Rev.*, **89**, 897 A, 1953.

E. D. Denmar, Radiation Measurements by Frequency Variation, M. S. Thesis, Vandebilt University, 1954-55.

H. K. Richards, Measurement of Ionizing Radiation by Frequency Variation Using Ferroelectric Material, *Am. Phys. Soc.* Chicago Nov. 25, 1954.

P. A. Bordon and W. M. Wells, "Telemetering Systems," Reinhold Publishing Co., New York, 1959.

H. K. Richards, Detection and Telemetering of Ionizing Radiation by Frequency Variation, ORNL CF-55-9-122.

H. K. Richards, Radiation Detection and Telemetering System, Pat No. 2,917,633, Dec. 15, 1959.

Tracking

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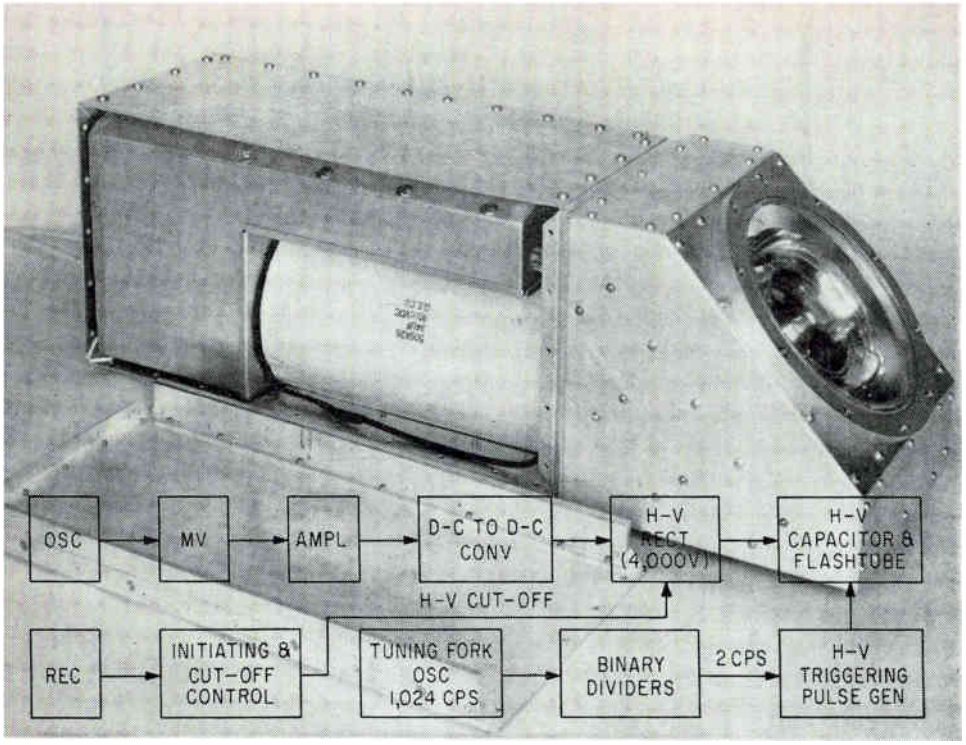


Prototype of airborne optical beacon (photo). When placed in a missile, the lens becomes an integral part of the missile surface

Block diagram of airborne optical beacon (overprint). The flashing light operates on command from a ground station, through the initiating circuit

OPTICAL TRACKING BEACONS can be used to track missiles launched at night. If a light of high intensity is flashed from a missile at a precisely controlled repetition rate, the flight of the missile can be recorded as a series of dots on a photographic plate. From the plate, the trajectory of the missile can be determined.

The stringent requirements for a compact, lightweight optical tracking beacon dictate the use of solid-state devices that can be assembled into a small unit.

The optical beacon flashes a high-intensity light twice a second for 25 seconds. The flash duration does not exceed 100 μsec as measured at the 30 percent power points. The required accuracy of the flash rate is ∓ 0.001 second. The radiated light emitted by the flash tube is produced by a minimum electrical input of 150 watt-seconds per flash to the flash tube. The unit is powered by a 28-volt battery. The battery is a three ampere-hour unit that has a terminal voltage ranging from 45 to 22 v from no-load to full-load conditions. This large variation in supply voltage is compensated for by Zener diodes that regulate the voltage applied to critical sections.

In addition to these operating requirements of the optical beacon, special test circuits are provided for measuring the operating parameters. These circuits include a photoelectric detector, flash-rate detector for telemetering, and flashtube ignition pulse test circuit.

High-intensity light is obtained by discharging instantaneously a high-voltage charge from a capacitor into a flashtube. In the design, as shown the figure, a 4,000-v charge from a 21-μf capacitor is delivered to a flashtube. The energy input to the lamp is represented by the equation $J = \frac{1}{2} CV^2$ wattseconds. At 4,000 v and 21 μf, $J = 168$ watt-seconds, which is the average energy delivered. The capacitor is charged through a 5,000-ohm resistor from a d-c to d-c converter. This converter changes the nominal 28-v from the battery to 4,000 by a static inverter and high-voltage rectifier. The inverter is driven by an amplifier controlled by a relaxation oscillator and multivibrator circuit. The multivibrator operates at 400 cps, the operating frequency of the inverter stage. The multivibrator is turned on by a low-level signal and does not require mechanical relays. The entire system is static in operation. All switching devices are semiconductors, which are necessary to keep radio interference at a low level and to assure high system reliability.

To control the point at which the capacitor stops charging, a voltage feedback system turns off the multivibrator when the capacitor is charged to 4,000 v. This stops the operation of the converter circuit and the charging of the capacitor. The flashtube timing circuit obtains its pulses from a tuning-fork oscillator. The oscillator circuit and countdown stages produce a two-pulse-per-second flash repetition rate.

The initiating stage turns on the optical beacon when energized with a radio-controlled d-c voltage of 4.5 to 5.5 v. The beacon operates continuously as long as the initiating signal is present.

The converter is driven by a low-power square-wave signal generator (bistable multivibrator), which controls the converter. The advantage of this method is that the initiating stage controls a low-power circuit, in this case about 600 mw.

A relaxation oscillator drives a standard bistable multivibrator, that feeds the amplifier; the amplifier in turn, drives the d-c to d-c power converter. This circuit assures symmetry in the signal driving the converter. Such symmetry is vital to insure proper transformer operation.

The amplifier circuit consists of two direct-connected push-pull stages. The first stage consists of two 2N656 *npn* silicon transistors, the bases of which are direct-coupled to the output of the multivibrator. Emitter resistors of 8.2 ohms provide a small amount of bias at the bases of the transistors to keep them cut off when no signal is present. Voltage dividers between the

Missiles at Night by Light Flashes

Precisely timed, high intensity light flashes from beacon in missile permit trajectories to be determined from distances to 400 miles

two stages of the amplifier permit the first stage to be saturated when the signal from the multivibrator is at its maximum value.

The second stage of the amplifier consists of two 2N1100 *pnp* germanium transistors, also in push-pull. The collectors are connected to the primary of a driver transformer, with d-c fed to the transistors through the centertap. In normal operation the transistors are alternately driven from cut-off to saturation, which effectively supplies a square wave to the driver transformer.

Two diodes are connected across each side of the output stage of the amplifier. One is a Zener diode to provide voltage limiting and the other is an ordinary diode for current blocking. These diodes suppress spikes in the transformer primary circuit to a voltage level that will not damage the 2N1100 transistors. The spikes appear on the trailing edge of the square wave when the transistor collector current is suddenly switched off. The magnitude of the spike will vary from one unit to another, depending largely on the amount of leakage reactance in the power transformer. The Zener diodes limit the peak of the spikes to approximately the same value in all units and well below the maximum permissible value for the transistors.

The converter stage changes d-c from the 28-v battery supply to a-c. The battery voltage can then be stepped up through a transformer to a much higher voltage. The basic circuit of the converter uses two transistors in push-pull so that they are alternately driven from saturation to cut-off. The operation of this circuit is similar to the operation of the second stage of the amplifier.

To control enough power to give the output, four push-pull stages are connected in parallel, so that a total of eight 2N1100 transistors is used in the converter stage. Series resistors of 0.1 ohm in the emitter circuit of each transistor equalize the currents in the transistors on each side of the converter. This is necessary because the collector-to-emitter voltage drop at saturation varies from transistor to transistor and there would be a tendency for the transistor with the lowest voltage drop to carry the largest current.

The output transformer provides a step-up from 20 to about 4,500 v. The d-c input to the converter at the start of each charging cycle is about 70 amp.

The high-voltage circuit consists of a full-wave bridge rectifier, a series resistor, and an energy storage capacitor. It rectifies the high-voltage output from the converter stage and stores the energy in the capacitor until enough is available to operate the fiashtube. The bridge rectifier consists of four sections, each of which contains 16 IN444B diodes. It will withstand inverse voltages greater than 7,000 v and will handle currents up to 500 ma.

The storage capacitor, special-constructed of laminated Mylar film, has a nominal capacitance of 21 μf, and an operating voltage of 4,000 v. Energy furnished by the converter and the rectifier is stored until it is desired to operate the photo flashtube, which is then connected directly across the capacitor. The 5,000-ohm charging resistor limits the current drawn by the converter stage when the capacitor is recharging.

A voltage divider consisting of a five megohm fixed resistor and a variable resistor having a maximum resistance of 50,000 ohms are connected across the energy storage capacitor. The divider provides a reference voltage that turns off the multivibrator and ultimately the converter when the capacitor has been charged to the desired voltage. The variable resistor is adjusted so that the multivibrator cuts off when the desired charging voltage is reached on the capacitor.

The flashtube used on the optical beacon is a specially designed tube similar to those used in photography. The flashtube, a highly efficient photographic light source, is a quartz arc-tube with an electrode sealed into each end. Quartz is used because high levels of energy are dissipated at each flash. The arc chamber is a flash coil about 3¼ inches in diameter. It is filled with xenon and has a trigger electrode on the external wall. The flashtube is triggered by applying a high-voltage pulse to the trigger electrode that ionizes the gas and makes it conductive. The main storage capacitor then discharges its energy into the flashtube. The energy levels at which the flashtube is operating are about 7,500 lumenseconds at a peak of 82 megalumens.

The overall system of the optical beacon meets an estimated reliability of 0.998. The static semiconductor elements insure accurate, stable operation. The high-powered d-c to d-c transistorized converter is larger than most developed to date. The precisely timed flash repetition rate is accurate to within several microseconds, which is far superior to that required for useful data. The unit is compact and relatively light; the production model weighs 33 pounds and measures 27 inches long by 8 inches square.

Smaller and more powerful systems will be feasible with transistors capable of handling higher power than those used in this design.

In a paper written in 1956 on a miniaturized airborne optical beacon, a system is envisioned that has characteristics similar to this unit. With the optical and electronic system developed during this program, it is believed that a satisfactory optical beacon is now available for tracking missiles.

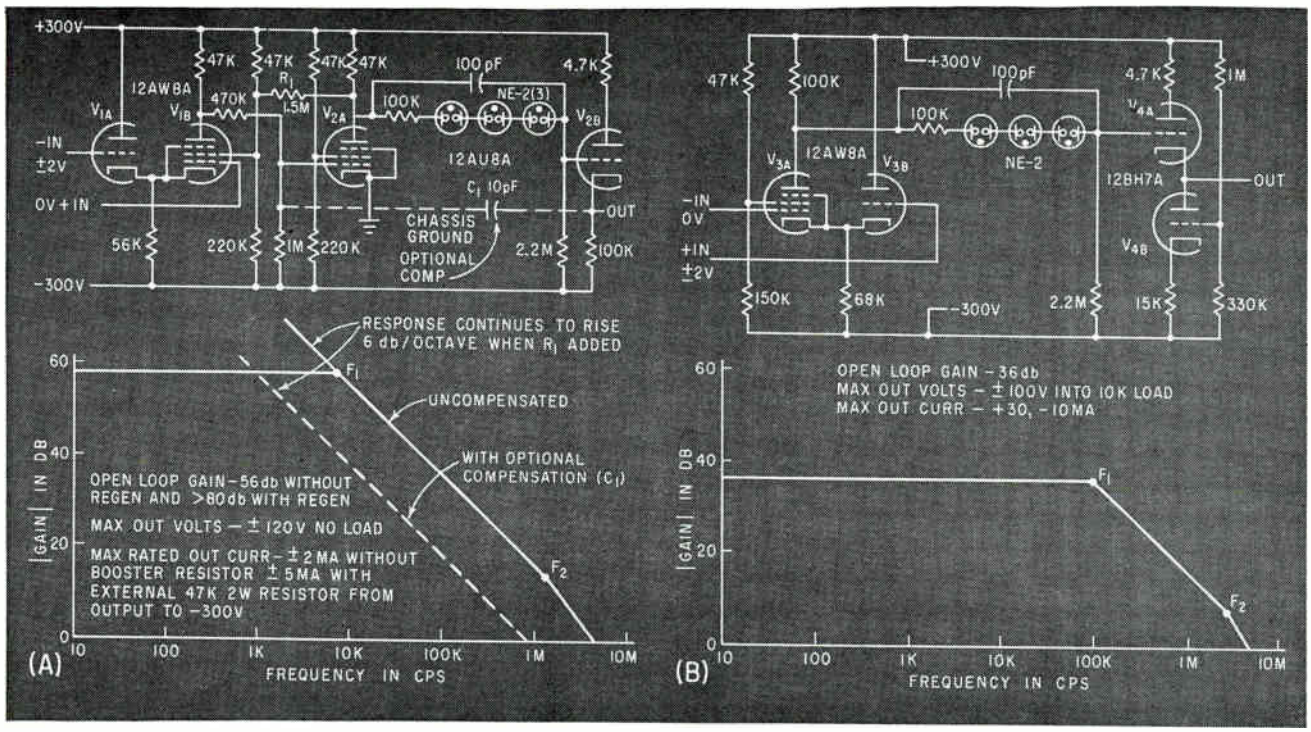


FIG. 1—Both model 1 (left) and model 2 (right) operational amplifiers use differential input circuits and may be used with external chopper-stabilizing amplifier. Gain-frequency response curves for each amplifier are also shown

How to Extend Operational

By HENRY KOERNER,

Department of Electrical Engineering, University of Arizona, Tucson, Arizona

THE DEVELOPMENT of a series of simple, plug-in operational amplifiers having extended high-frequency response and high output current capabilities was recently undertaken for use in high-speed switching circuits or as operational amplifiers in a repetitive computer installation. This development has resulted in the design of two amplifiers which may be used separately or operated in tandem combination to provide higher loop gain.

Both models feature differential inputs and may be used with an external chopper-stabilizing amplifier. In each case, two tubes are mounted on a turret structure which plugs into an octal socket through which all signal and power supply connections are made.

Circuit diagrams of the two amplifiers with their gain-frequency response characteristics are shown in Fig. 1. The two models differ both in their open-loop gain characteristics and in their output current capabilities.

Both amplifiers use a triode-pentode tube (V_1, V_3) as a dissimilar difference amplifier. For analysis purposes it is convenient to regard this stage as a triode cathode follower direct-coupled to a grounded-grid pentode amplifier. The gain from triode grid to pentode plate is approximately 30 db.

In model 1, the signal from the input stage is fed to V_{2A} through a resistance divider network which establishes the proper operating bias at the control grid of V_{2A}. This pentode is used as a voltage amplifier to provide up to 140 v peak signals at the grid of V_{2B} connected as an output cathode follower.

Coupling from the plate of V_{2A} to the grid of V_{2B} is through three neon lamps connected in series. The constant voltage drop across these lamps maintains the correct d-c operating voltages without loss of signal level.

The signal gain through the driver and output stages is approximately 30 db. A drop of radioactive paint ensures ionization.

An optional capacitor C_1 connected from the amplifier output to the control grid of pentode V_{2A} provides high-frequency attenuation so that the amplifier open-loop gain and phase characteristics yield stable operation at any closed-loop gain setting with resistive feedback ratios between zero and unity. For stability at unity gain this capacitor should be 10 pf, and for best recovery time in high-speed switching circuits it may be as low as 1.8 pf.

Regeneration from the plate of V_{2A} to the screen grid of V_{1B} increases the low-frequency gain without affecting high-frequency performance.

In model 2, signals from the plate

Simple plug-in units designed for fast time-scale analog computers, feature increased high-frequency response and higher output current capabilities

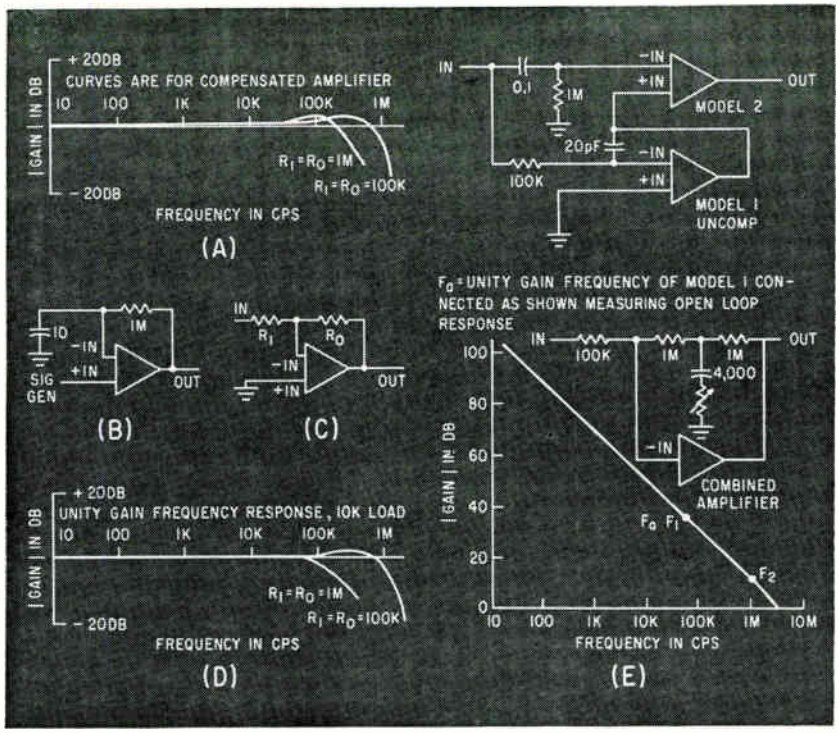


FIG. 2—Unity-gain frequency response (A) of model 1 amplifier connected as shown in (C). Open-loop amplifier is shown at (B). Unity-gain frequency response of model 2 amplifier (D) obtained when connected as shown in (C), tandem connection open-loop response and amplifier (E)

Amplifier Response

of V_{3A} are coupled to the control grid of V_4, connected as a dynamically-loaded cathode follower, through neon lamps that (as in model 1) maintain correct operating voltages without producing signal loss. Open-loop gain of this model is low enough that no additional phase correction is needed to assure stability under closed-loop conditions.

Maximum d-c output current is 5 ma with a 47 K booster resistor.

Maximum frequency of model 1 amplifier (Fig. 2B) at which ±100 v (no load) can be developel is 16 Kc with optional compensation and 50 Kc without compensation. The open-loop phase shift (without regeneration) reaches 5 degrees at 630 cps for the uncompensated amplifier.

The closed-loop characteristics of the circuit shown in Fig. 2C are shown in Fig. 2A. Here, maximum shunt capacitance from the output to ground (for stability) is 4,000 pf when $R_i = R_o = 1$ megohm, and 1,000 pf when $R_i = R_o = 100{,}000$ ohms. Square-wave response at unity gain with $R_i = R_o = 100{,}000$ ohms with a large signal (+80 v, 0 v) shows a positive rise time of 12 μsec and a negative rise time of 2 μsec. With a small signal (+20 v, 0 v), the positive rise time is 4 μsec and the negative rise time is 2 μsec. Maximum d-c output current is +30 and −10 ma.

The maximum frequency of the model 2 amplifier at which full rated output (±100 v) developed into rated load is 50 Kc. The open loop phase shift reaches 5 degrees at 10 Kc.

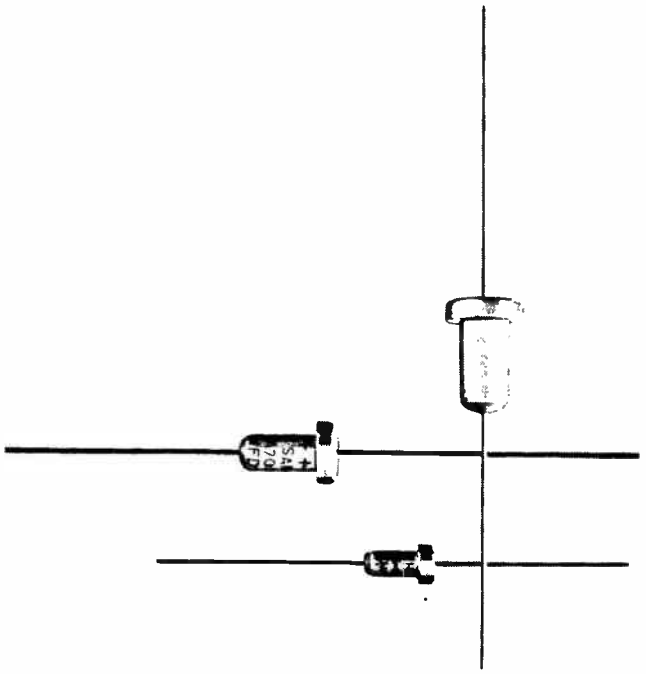
The closed-loop characteristics of the circuit shown in Fig. 2C are shown in Fig. 2D. Here, the maximum shunt capacitance from the output to ground (for stability) is > 0.01 pf when $R_i = R_o = 1$ megohm and 1,500 pf when $R_i = R_o = 100{,}000$ ohms. Square-wave response at unity gain with $R_i = R_o = 100{,}000$ ohms and a 10,000-ohm load with either a large signal (±80 v, 0 v) or a small signal (±20 v, 0 v) shows both positive and negative rise times of 2 μsec.

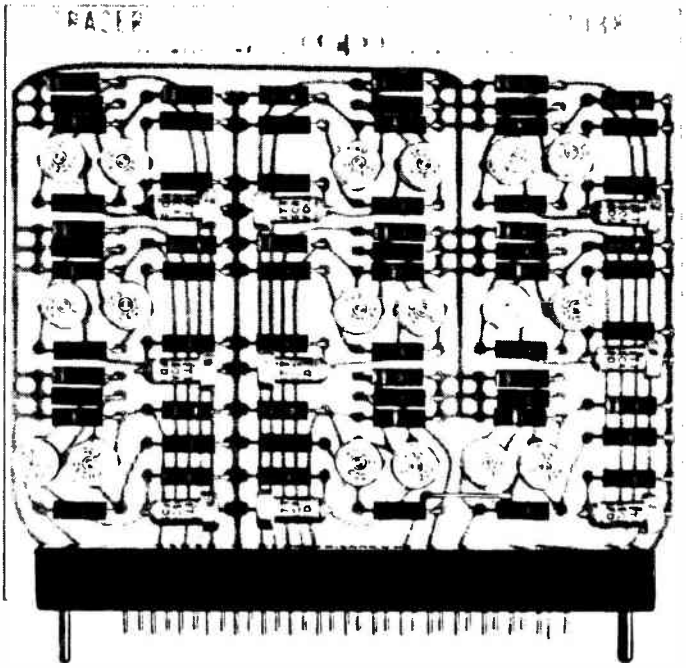
The performance characteristics of a tandem (feed forward) combination of these amplifiers (with no internal compensation in model 1) shows an open-loop gain > 100 db at d-c without chopper stabilization, maximum output voltage of ±100 v into a 10,000-ohm load and a maximum output current of +30 and −10 ma.

Open-loop response is shown in Fig. 2E.

The cascaded combination makes a very fast and reasonably powerful operational amplifier for modern multipurpose analog computers incorporating repetitive operation and storage.

The new amplifiers were developed in the course of a repetitive analog computer project directed by G. A. Korn. Acknowledgement is due the Electrical Engineering Dept. of the University of Arizona and Dr. P. E. Russell for continuing support of this work.





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Nomograph Gives Receiver Noise Figure

By MORRIS ENGELSON,
Polarad Electronics Corp., Long Island City, N. Y.

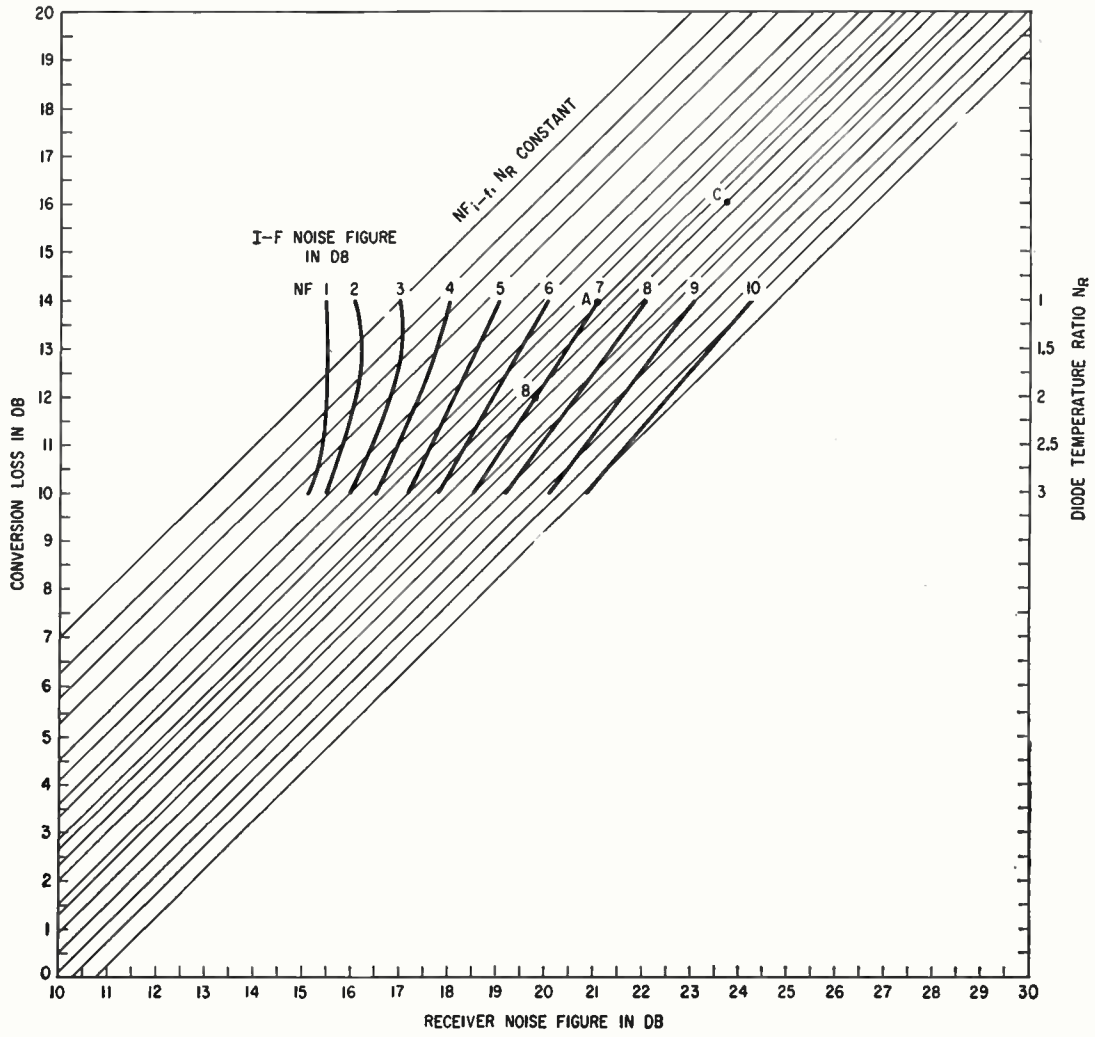
IN DESIGNING MICROWAVE RECEIVERS it is often necessary to determine front-end noise figure before a unit is available for measurement. Such a computation can be based on the expected i-f noise figure (NF_{i-f}) and the crystal parameters, temperature noise ratio N_r and conversion loss CL. The graph expedites calculations by presenting a graphical solution to the equation

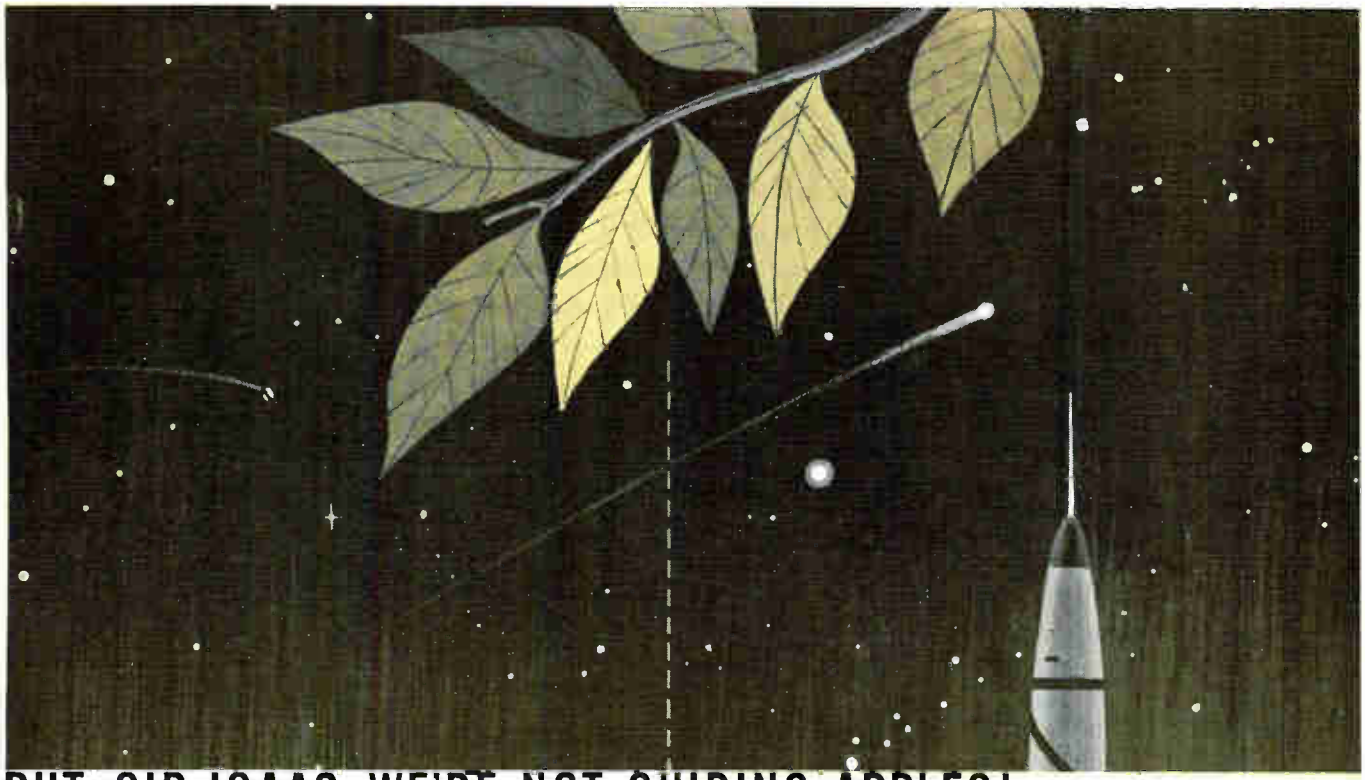
$$NF = CL\,[N_r + (NF_{i-f} - 1)]$$

First go to the proper I-F Noise Figure line (heavy lines) numbered 1 to 10. Move along this line to the given temperature noise ratio (vertical N_r axis). Here switch to a light line marked NF_{i-f}, N_r *constant*. Move along this line to the given conversion loss (vertical scale) and read receiver noise figure on horizontal scale.

Example: Given $CL = 16$ db, $N_r = 2$, $NF_{i-f} = 7$ db. Start at $NF_{i-f} = 7$ (point A), go to $N_r = 2$ (point B), then to $CL = 16$ (point C) and read NF as 23.8 db on the horizontal scale.

The quantities in the equation are ratios while noise figure and conversion loss are usually in db. Therefore, when using the equation, the conversion loss and i-f noise figure have to be converted from db to power ratios, then combined with the crystal noise temperature ratio, and the resulting receiver noise figure then must be reconverted to db. The graphical solution presented here saves time by eliminating these conversions.





BUT, SIR ISAAC, WE'RE NOT GUIDING APPLES!

Until a ballistic missile is in free fall, our inertial guidance systems must be able to account for both rocket thrust and gravity. Making them this smart is a tough job, but we hit the mark so well on Thor that all of this country's long range missiles will soon be guided inertially. If you would like to help us keep pioneering new guidance systems, and have a BS, MS or PhD in Physics or Math, or an ME or EE, please contact Mr. B. C. Allen, Director of Scientific and Professional Employment, 7929 S. Howell Ave., Milwaukee 1, Wisconsin.

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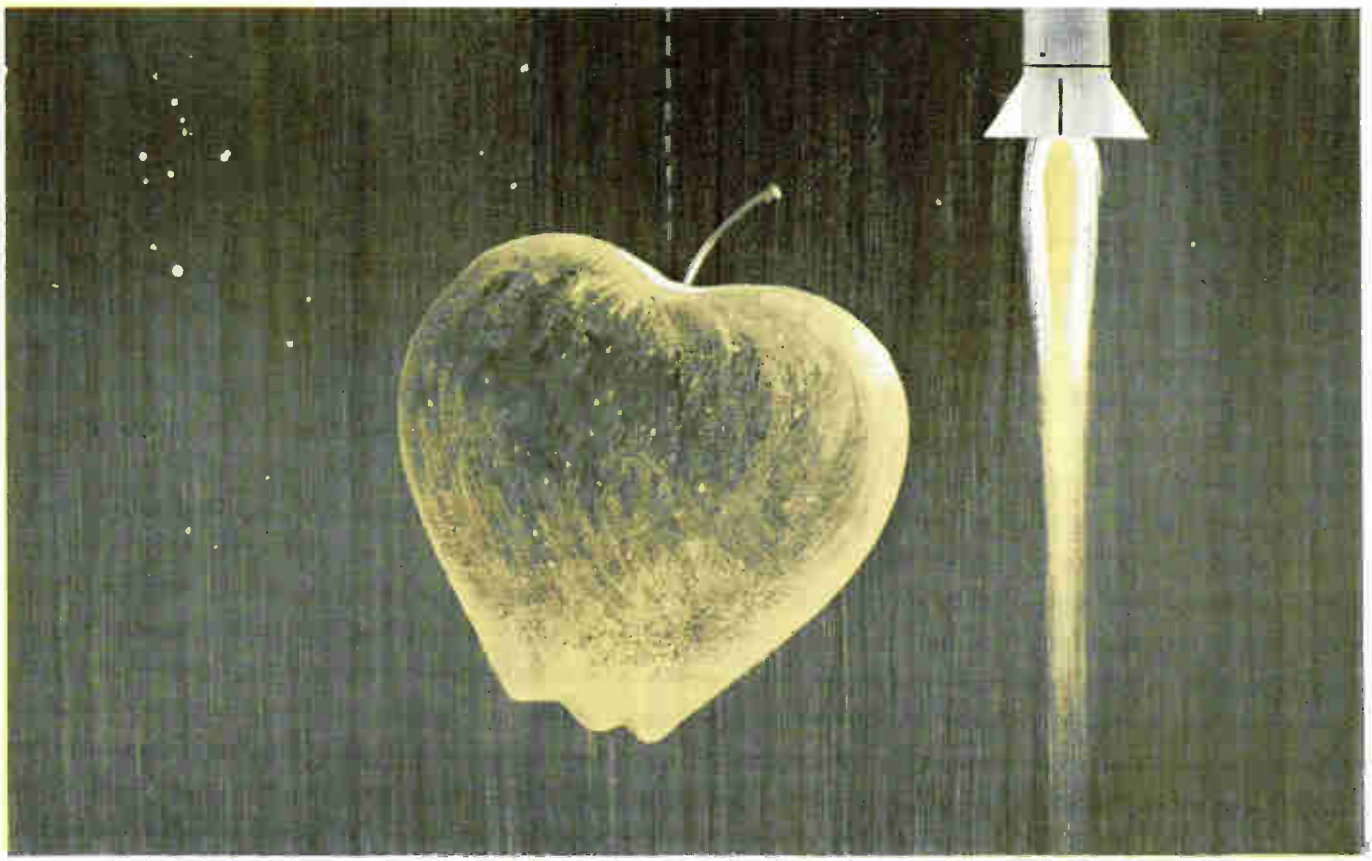


Rockets Study Night-to-Day D-Layer Density

DECREASE in ion density in the D layer of the ionosphere going from day to night is apparently much less than had been expected. The limited day-to-night difference is particularly noteworthy compared to that of the E and F regions. This condition was inferred from data gathered in two Nike-Asp rocket flights on June 7. Detailed analyses of the data are now being carried out. Information obtained in the flights is also being used to study recombination of charged particles at these altitudes.

Knowledge of upper atmospheric ionization has usually been obtained from propagation measurements, which provide integrated rather than local values. Techniques developed previously at the Photochemistry Laboratory, Air Force Office of Scientific Research, for investigation of ion densities at lower altitudes have now been adapted for the upper atmosphere.

A spherical ion counter similar to the Russian ion trap[1] has been developed and flown successfully in ICBM's and in-house research vehicles. It consists of two concentric spheres mounted on an arm that keeps the counter well outside the electrically charged sheath around the vehicle. The outer sphere is perforated so that the ratio of open to surface area is high. It is kept at vehicle potential except during periodic application of a sawtooth sweep voltage.

The highly insulated inner sphere is kept at a high negative potential with respect to the vehicle. Therefore all positive ions entering the outer sphere are collected by the inner sphere. The resulting current is measured using a highly stable logarithmic d-c amplifier operating through a current range of 10^{-11} to 10^{-5} amp.

To find ion densities from current, vehicle potential with respect to its surroundings must be known. This value was calculated by applying Langmuir probe theory to the current-voltage curves obtained when the sawtooth voltage was applied to the outer sphere. Ion temperatures and energy distribution are also determined by periodically sweeping potential of the inner-outer sphere with the sawtooth voltage and studying its Langmuir characteristics. Depending on instrument time constant in relation to vehicle velocity, the counter thus directly indicates positive ion density and indirectly indicates vehicle potential, ion temperature and energy distribution.

Purpose of the two rocket firings was to study day-to-night variations in these quantities at altitudes from 50 to 200 Km. The first shot made at ion density maximum reached 125 statute miles altitude; the second at ion density minimum attained 108 miles altitude.

Rough estimates made from the data gathered indicate a peak density on both day and night flights at an altitude of 65 Km, a reduction factor of only about 10 from day to night. Above this peak, daytime ion density decreased slightly to a minimum at 85 Km. It then increased steadily to 200 Km except for a sudden increase at 100 Km on entering the E region. Above this altitude, it decreased so that at 125 Km ion density was reduced by a factor of 20 to 30 from the peak value in this region.

REFERENCE

(1) V. I. Krassovsky, Exploration of the Upper Atmosphere with the Help of the Third Soviet Sputnik, *Proc IRE*, 47, Feb. 1959.

High-Speed Shock-Wave Collision

Impact of two shock waves, each traveling at Mach 80, illuminates Boeing hydromagnetic shock tube. High-temperature gas experiments may aid development of effective ion propulsion system

Induction Plasma Torch May Provide New Devices

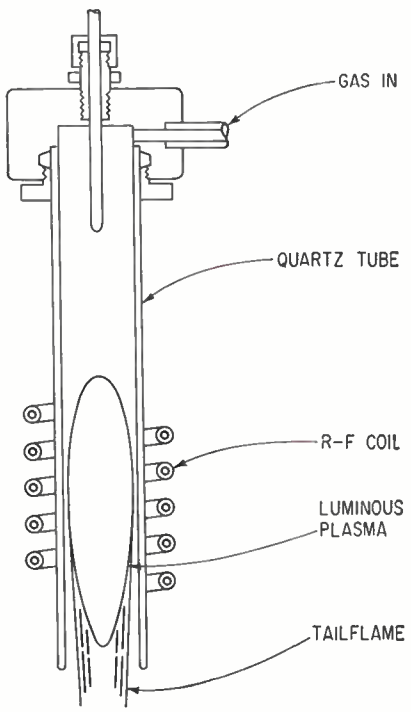
INDUCTION plasma torch that generates extremely high temperatures is expected to have a wide variety of applications in the production of electronic devices. It will also permit research in the area of solid-state materials that could result in new electronic components.

The new torch, invented at MIT Lincoln Laboratory by T. B. Reed, was described at the Gaseous Electronics Conference, Monterey, Calif., at the U. S. Navy Postgraduate School. The meeting was sponsored jointly by the school, the Division of Electronic Physics of the American Physical Society and

the Office of Naval Research.

Temperatures up to 19,000 K have been produced by the torch using only 3 Kw of electrical power. As much as 57 percent of the total energy was transferred to the plasma. Generation of temperatures approaching 100,000 K seems feasible without excessive power requirements if a method can be developed for containing the plasma.

The basic plasma torch in the diagram is a quartz tube open at one end with gas supplied to the other end. An r-f coil of a few turns around the tube provides power. A commercially available 4-Mc power supply of the type used for r-f heating was used. Although maximum rated output is 10 Kw, temperatures produced by more than 3 Kw melt the quartz tube. As little power as 500 watts can maintain the plasma. The more recent model of the plasma torch shown in the photograph uses a flat pancake coil.



Developmental model induction plasma torch is simply constructed and produces no combustion products to contaminate materials

No combustion occurs in the inductively coupled plasma torch. A variety of gases and gas mixtures can be used, and the high-temperature region is not contaminated by combustion products. This high-temperature region is not just a

Artificial sapphire is produced by melting end of aluminum oxide rod

point focus but extends throughout an appreciable working space. It is completely accessible for introduction or manipulation of materials to be heated.

The primary value of generating and maintaining high temperatures to electronics is in research and production of solid state materials. Crystals of germanium and silicon can be produced economically in crucibles at temperatures below 2,000 K, which is one reason for their widespread use.

Artificially grown sapphire or ruby for phonograph styli and masers, rutile and other crystals cannot be produced in crucibles. The crucibles would melt or contaminate the crystal material. Crystals of some of these materials can be produced with the Verneuil method in which the material itself acts as the crucible. A torch melts a puddle at the center of a large piece of the material or a drop at the end of the material.

Even with this method, few combinations of combustible gases exist that do not contaminate the material. Also, gas flow velocity must be rather high to maintain the high temperature, which can stir up or splatter the material. Electric arcs and d-c plasma torches are free from some of these limitations but the electrodes produce contamination. The induction plasma torch does not have these disadvantages, is simple in construction and requires only a reasonable amount of power for high temperatures.

Report on Dendritic Growth Techniques

USED FOR FABRICATION OF MADT TRANSISTORS

By C. G. THORNTON, Director of Semiconductor Research & Development, and
R. C. MUSA, Manager, Chemistry & Metallurgy Departments, Philco Corporation, Lansdale, Pa.

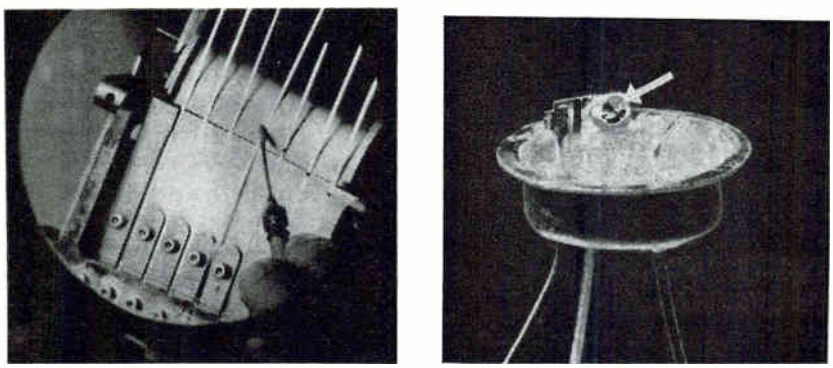


FIG. 2—Rows of dendrites are fed through a scribing machine, (left), each strip being cut into tiny germanium dice approx. 50/1,000-in. long. Each wafer forms a single transistor (right)

GERMANIUM MICRO ALLOY Diffused-Base Transistors (MADT's) prepared by special dendritic growth techniques developed at Philco's Lansdale Division demonstrate performance comparable with conventionally manufactured military-type devices. This performance level has been achieved despite the inherent defects in dendritic material, as a result of a simple and economical precision-etch fabrication process.

In conventional manufacture, semiconductor material is prepared in the form of a monocrystalline bar, or ingot, approximately one-inch diam. and 12-in. long. The ingot is sliced into 0.015-in thick wafers. The wafers are lapped and etched to a thickness of 0.008 in., and scribed into dice measuring 0.072 × 0.005 in. The material is then ready for diffusion, if required, and transistor fabrication. Philco's dendritic growth process eliminates most of the operations associated with this conventional crystal growth.

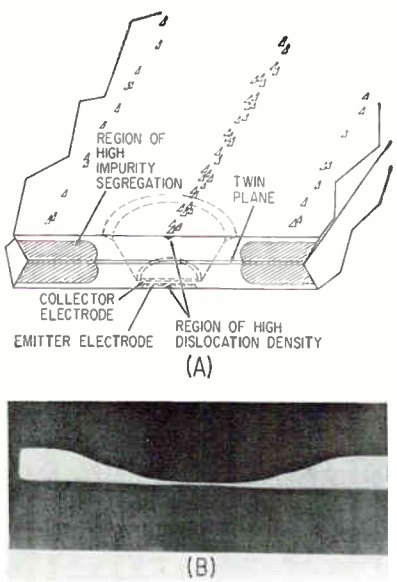


FIG. 1—Cross section of germanium dendrite with MADT geometry superimposed (vertical scale exaggerated), (A), shows that imperfections commonly associated with dendrites can be etched away (B) leaving relatively perfect areas (pits) where collector and emitter electrodes can be precisely positioned. Regions of high crystal dislocations, twinning and high impurity segregations are avoided.

Essentially, dendritic growth is a method of preparing a continuous ribbon of semiconductor material to a thickness required for device fabrication. As in standard crystal growth, lumps of high purity, polycrystalline material are melted, and dopant added in controlled amounts.

However, in dendritic growth, the temperature of the melt is reduced until it is considerably supercooled. A seed crystal is introduced, then withdrawn at an extremely rapid rate. The supercooled liquid surrounding the seed solidifies, and as the seed is removed, a thin dendrite of semiconductor is formed.

Using this technique, dendrite ribbons 0.060-in. wide, 0.005-in. thick, and up to 12-ft long have been grown. Lengths are limited only by height of the pulling apparatus.

Recently, improved growth techniques have made possible smooth dendrites without surface irregularities or edge facets. This has been achieved by having the growth process more nearly approach a true steady state equilibrium process.

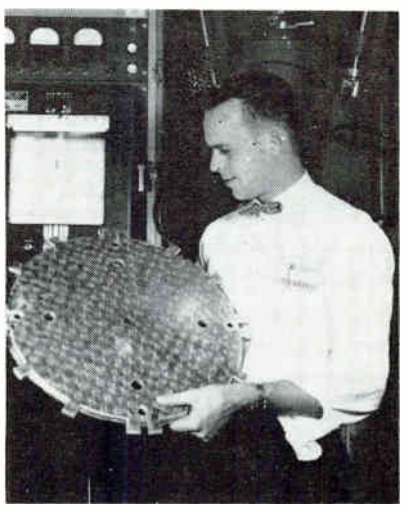
A significant aspect of Philco's production technique is that the dendrites grown do not need modification before being employed for transistor fabrication. The dendritic growth technique has two advantages over conventional growth processes: speed and economy.

The over-all process of dendritic growth is many times faster than the standard pull furnace technique. Dendritic withdrawal, measured in inches per minute, eliminates the elaborate sawing, slicing, lapping, etching, and scrubbing operations necessary when conventional growth techniques are used. It is simply necessary to scribe the 0.005-in. wide dendrite into dice of desired lengths, and briefly etch the dice to the desired thickness. Great wastes of material are obviated as the dendritic process makes possible 100 per cent usage of the original germanium ingot.

Unfortunately, defects in the quality of dendritic material are sufficient to make the material impractical for many uses. In cross-section, undiffused conventionally-prepared dice are homogenous; dopant is distributed evenly throughout the single-crystal mate-

rial. In contrast, a cross section of dendritic dice reveals considerabe inhomogeneity.

Figure 1A shows the kinds of imperfections which can occur in germanium dendrites making the material unsuitable for many transistor types. Twin planes exist at the center of the dendritic dice, thus a differentiation in crystal orientation may exist between upper and lower halves. In addition, severe crystal dislocations exist in localized regions at the surface of the dendrite, and considerable impurity segregation occurs at the edges. Difficulty in obtaining reproducible device properties occurs whenever the impurity segregation regions are incorporated in the transistor.



Engineer holds spool of 200 feet of germanium dendritic ribbon used to make MADT's

However, fabrication of MADT transistors can circumvent this situation. A precision etch technique is used to etch depressions into specific carefully chosen areas in the semiconductor materials.

Electrodes are deposited in depression (Fig. 1B) to form emitter and collector. This surface region generally comprises high-quality material. The regions of high crystal dislocation, twinning, and high impurity are avoided. The remaining material that forms the base region of the transistor is located close to one surface so that uniformity in the semiconductor material is required only in the one area.

The result of the large-scale use of dendritic material can easily be

Dendritic MADT's show performance characteristics similar to those made by standard growth techniques: i. e.

TYPICAL	
Collector voltage, V_{CB}	10 v
Emitter voltage, V_{EB}	2 v
Collector current, I_{CBO}	<4 μa
Cutoff frequency, F_T	>500 mc
Power gain (200 mc)	11 db

predicted. Because of the relative simplicity of the etching technique, semiconductor devices can be made and sold more cheaply. In addition, the technique is well suited to automatic production. Dendrites can be fed into a high-speed automatic production line, and emerge as completed transistors.

Introduction of these preparation techniques is expected to result in a major contribution in the form of economy and productivity.

Zener Diodes for Voltage Regulation

"DEVELOPMENTS in the semiconductor art have made the reverse breakdown characteristic of silicon diodes extremely useful for close tolerance voltage regulation," according to J. S. McGee, vice president in charge of Hoffman's Zener diode production facilities, Evanston, Illinois. "In particular, the techniques employed in solid state diffusion have enabled these Zener devices to provide stable voltage over wide variations in current and temperature. This makes possible, simplified, reliable circuitry."

Hoffman Electronics now has added nine EIA types to its 250-milliwatt regulator series, 36 types each to the 500-mw and 1-w series, and 37 types to the 10-w regulator line. The company has also extended its line of 400-mw subminiature "glass" Zener reference diodes by the addition of two types—1N823 and 1N824—to the recently introduced types 1N821 and 1N822. Addition of the 120 new types brings to 2137 the total number of Zener diodes offered by Hoffman.

All of the new regular types have a standard voltage tolerance of plus or minus 10 percent with plus or minus 5 percent types available. Operating temperature is from minus 65 C to plus 175 C.

Turntable Motor Grinds Its Own Pulley

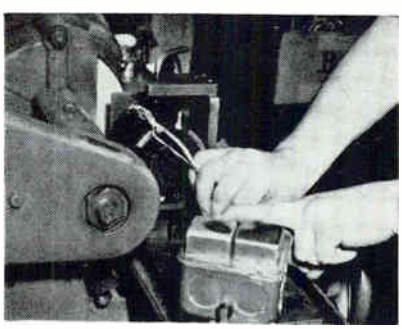
REVOLVING TURNTABLE parts must be round and concentric to avoid rumble and wow in the record player. The effect of slight eccentricities is magnified when the parts revolve against each other in the operating assembly.

A basic solution is precision machining to insure that parts have the same centerlines as their shafts. Several machining techniques following this principle are employed by Rek-O-Kut Company, Inc., Corona, N. Y., in preparing motor drive pulleys, idler wheels and turntables used in their record players.

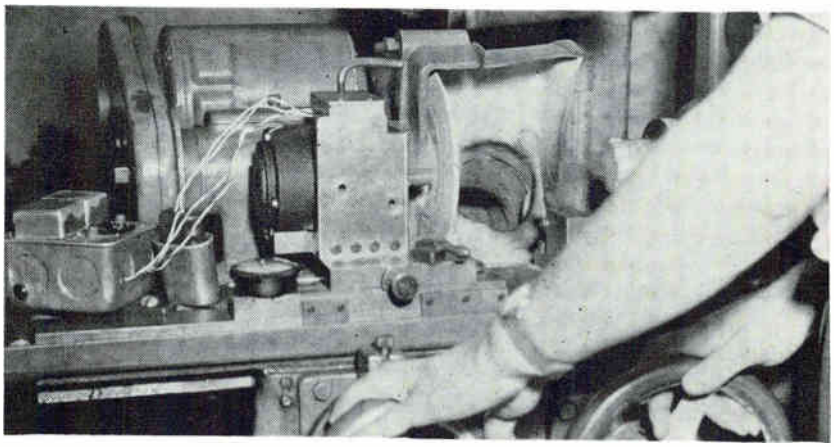
Drive pulleys are mated to motor shaft bearings by using each motor as an individual pulley lathe. Motors with an original shaft eccentricity within 0.0005 inch are selected, run-in and balanced. Pulleys with oversized outside diameters are press-fitted onto the shafts.

Each motor is fastened in a fixture which allows the shaft to turn under its own power. The fixture is on a cylindrical grinder. The motor is turned on and the grinder used to make a cut on a portion of the pulley not used as a bearing surface. The cut portion is measured at each end with a micrometer. A taper would cause a speed variation in the drive (tapered pulleys are used in one of the firm's variable speed record players, but are not desirable in single-, two- and three-speed models).

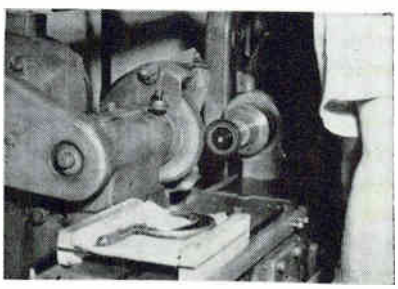
Taper is corrected by pivoting the fixture. A pin type feeler gage fixed on the bed of the grinder so it contacts the fixture guides the machinist in making this adjustment. When the cuts are no longer producing a taper, the bearing surfaces are ground to size. This method assures concentricity of the pulley surfaces with the motor shaft bearings despite any slight eccentricity or bow in the shaft. The same method is used for pulleys of belt-driven turntables.



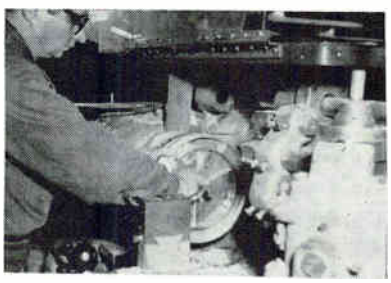
Motor leads are connected to power supply next to fixture



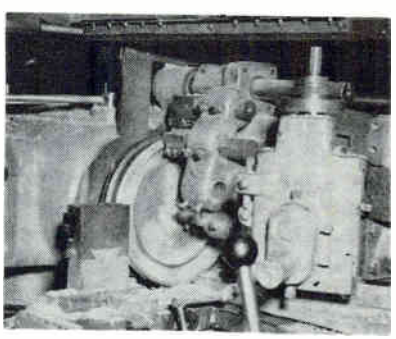
Pulleys are mated to motors by using each motor as individual grinder after pulleys are placed on motor shaft



Idler wheels are trued on grinding machine



Turntable blanks are bolted to turret lathe



Mounting hole and rim are machined simultaneously

Idler wheels of rim-driven turntables are also trued by grinding, using their center hole as a reference. The wheel is placed on a pin which is held in the grinder. The pin is precision ground on the same grinder at the start of a production run. It is discarded at the end of the run, since rechucking the pin could be a cause of eccentricity.

Turntables are machined from aluminum castings. Finish machining follows normalizing after rough machining. The turntables are fastened to the headstock of a turret lathe with several bolts placed halfway between the shaft hole and rim. Cuts are made simultaneously on the rim and in the hole. Light cuts are used since tool "give" caused by heavy cuts could produce out-of-roundness.

The turntable bearing shaft is a hardened and ground rod with a spiral oil groove. The shaft well is prepared with an inside diameter about 0.0005 inch undersize. The

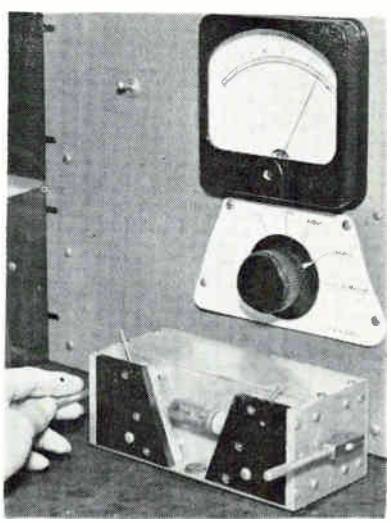
i.d. is peened to size, smoothed and hardened with a roller-peener on a drill press.

To assemble the turntable, the shaft is press-fitted into the turntable hole. When the shaft is placed in a level well, it should revolve freely without wobble or play. Flatness of the turntable is checked by a feeler gage mounted on an optical flat. Squareness to shaft is checked by indicators. After the player has been assembled and run-in for about 36 hours, its operation is checked again.

Leakage Tester Range Is 0.1 to 10^{12} Ohms

LEAKAGE TESTS on oil and paper capacitors can be made at very high resistance levels with a voltmeter by the test set pictured in Fig. 1. The test set is used by Ballantine Laboratories, Inc., Boonton, N. J., to test components for high resistance circuit performance.

The indicating instrument is a Ballantine Model 300 vacuum tube voltmeter. The meter scale, which is logarithmic, is inverted so that it will read in ohms from right to left



Voltmeter scale is inverted to read in megohms

Bench setup includes capacitance meter at right

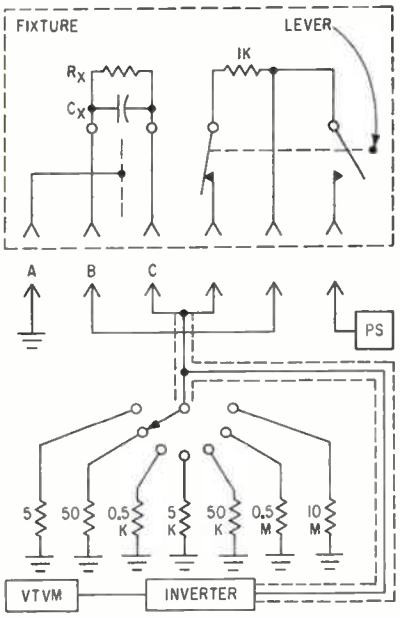


FIG. 1—Megohm measuring range is determined by resistor selected

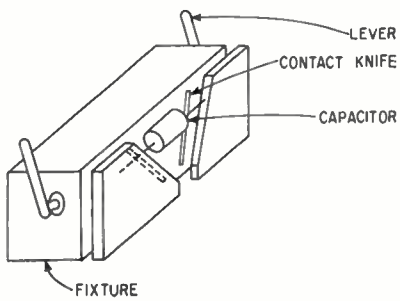


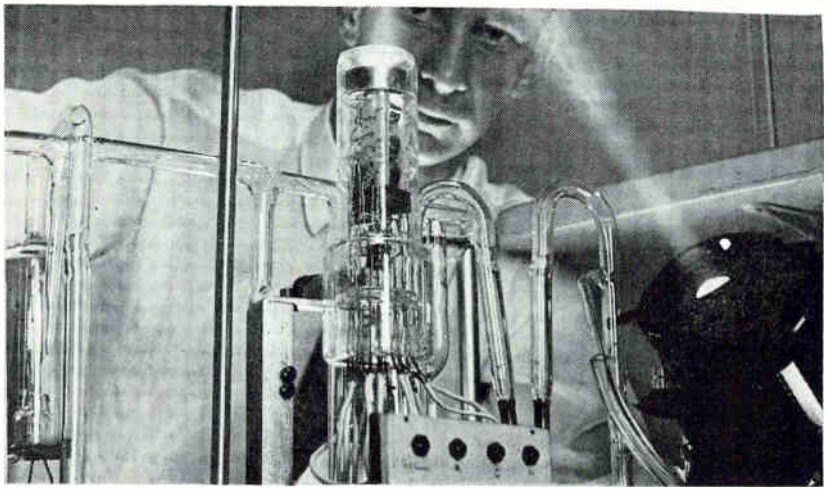
FIG. 2—Fixture is plugged into test set

instead of volts from left to right. The range of the scale is 1 to 10 megohms. Through the selector switch, resistances of 0.1 to a million megohms may be made.

The power supply provides 200 v d-c, ± 1 percent. A Ballantine Model 700 inverter with a 1:100 range is placed in front of the vtvm. A 10-megohm resistor rather than a 5-megohm resistor is used in the higher range since the parallel input resistance of the inverter is also 10 megohms.

The test fixture is designed so it can be rapidly loaded and unloaded by hand. The operator holds the capacitor by its body and places the leads as shown in Fig. 2. The hand levers are pulled to close the contacts, placing the capacitor in the measuring circuit. When the levers are in the unlocked position indicated in Fig. 1, the capacitor is discharged through a kilohm resistor. In Fig. 1, A is a guard which prevents leakage current in the jig from flowing between terminals B and C.

New On The Market



Laboratory Tool

MEASURES ULTRA-LOW PRESSURES

A LABORATORY TOOL for measurement of pressures less than one-thousandth of one-billionth of atmospheric pressure at the earth's surface has been announced by Westinghouse research laboratories, Pittsburgh, Pa. The device, known as a photomultiplier ion gage, was developed for the U. S. Atomic Energy Commission's Project Sherwood, a long-range research program aimed at controlled nuclear fusion.

Conventionally, the instruments which measure extremely low pressures do so by placing electrical charges upon the gas particles remaining in a vacuum system and counting the rate at which these charged particles, or ions, form. Usually, these charges come from electrons that are boiled off the surface of a hot tungsten filament located inside the vacuum system and in contact with the gas being measured.

However, gas interactions with the hot filament surface contaminate the gas and upset such experiments.

The new pressure-measuring device does away with the heated filament. To produce the required ionization of the gas, it uses a beam of ultraviolet light. The light is beamed onto a metal surface which releases electrons under ultraviolet. These electrons are guided onto a series of similar surfaces (photomultiplier) which multiply the electrons in speed and number. These electrons then are used to form the ions that are collected and counted in the usual fashion.

The photomultiplier ion gage will be useful in key ultrahigh vacuum research experiments, being ideally suited to low-pressure studies of hot filament-gas interactions such as those encountered in ordinary fluorescent lamps, in electronic tubes and in thermionic energy converters. The gage is linear with pressure over the range from one-thousandth (10^{-3}) to one-tenth of one-billionth (10^{-10}) millimeter of mercury, equivalent to distances between 50 and 650 miles above the surface of the earth.

CIRCLE 301 ON READER SERVICE CARD

Airborne Oscillator

ELIMINATES SEPARATE AMPLIFIER

A NEW APPROACH to the transmission of research data from an aircraft or missile (or any other remote location) to the control point is represented by an airborne voltage-controlled oscillator, Model AOV-10, which has been introduced by Data-Control Systems, Inc., 39 Rose St., Danbury, Conn. Low level output of strain gages, thermocouples, or other low level transducers is directly converted to a frequency-modulated subcarrier signal (standard approach is to amplify the signal derived from the strain gages or thermocouples, then use it to modulate the carrier frequency). A true floating input is provided, which makes it possible to use a common bridge supply for many strain gage channels, eliminating the effects of potential differences that may exist in an airframe. The AOV-10 can be used with a low level mechanical commutator. It is a rugged transistorized unit (silicon transistors) which can be used at ambient temperatures up to 100 deg C.

Circuits in the AOV-10 include a multivibrator controlled by a square-loop core, and a feedback amplifier-modulator.

Performance specifications: For modulation index of 5 or greater, the intelligence frequency response is within 0.2 db of the d-c response, and is down less than 1 db at a modulation index of 1. Input voltage is plus or minus 10 millivolts for full deviation. Common mode rejection is 100 db at d-c and 94 db at 400 cps. Grounding one side of open input produces a frequency change of less than 2 percent of full bandwidth. Linearity is plus or minus 0.25 maximum deviation from best straight line. Continuous operation may be obtained in ambient temperatures up to 100 deg C. Power requirements are plus 18 or plus 28 volts d-c plus or minus 10 percent for stated specifications at 25 ma.

The unit measures 1.87 x 1.44 x 1.63 inches high, and weighs 5.5 ounces.

CIRCLE 302 ON READER SERVICE CARD

Ka-Band Mixer Diodes

FOR HIGH ALTITUDE

A MATCHED PAIR of high altitude silicon microwave mixer diodes designed for ultrasonic aircraft and

missile applications is available from Sylvania Electric Products,

64-IN-1
ELECTROMETER

You can measure dc voltage, current, and resistance over 64 ranges with the Keithley 610A Electrometer. Some examples of its extreme versatility are voltage measurements of piezo-electric crystals and charged capacitors; currents in ion chambers, photocells, and semi-conductors; and resistance measurements of insulation.

The input resistance of the 610A can be selected from one ohm to over 10^{14} ohms; it checks its own resistance standards and is a stable dc preamplifier. Brief specifications are:

- **9 voltage ranges** from 0.01 to 100 v full scale, 2% accuracy all ranges.
- **current ranges** from 3 amperes to 1×10^{-13} ampere full scale with 2 ranges per decade.
- **resistance ranges** from 10 ohms to 10^{14} ohms full scale on linear scales.
- **gains to 1000** as a preamplifier, dc to 500 cps bandwidth, 10 volts and one milliampere outputs.
- **accessory probes** and test shield facilitate measurements and extend upper voltage range to 30 kv.
- **price,** $480.00.

Write for complete details

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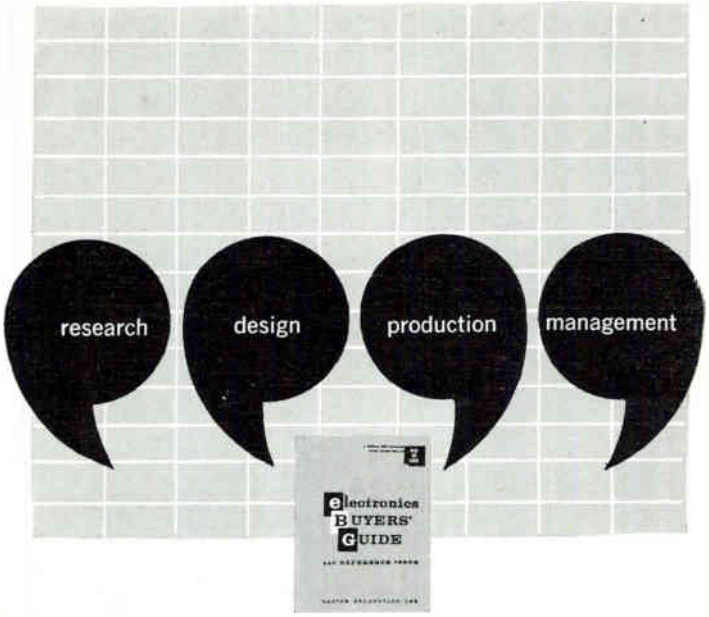

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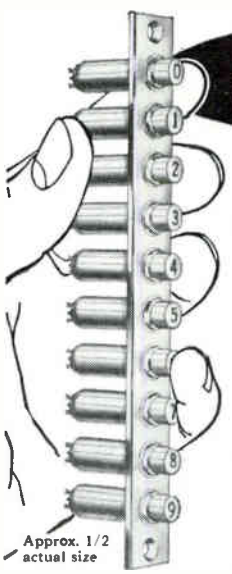

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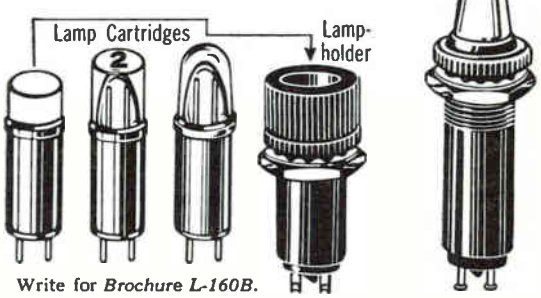

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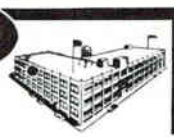

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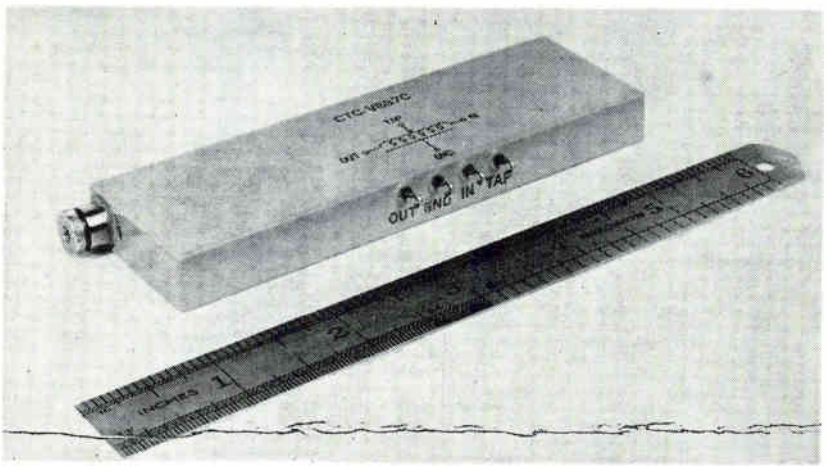
CIRCLE 107 ON READER SERVICE CARD

Inc., a subsidiary of General Telephone & Electronics Corp., Woburn, Mass.

These hermetically sealed diodes (Type 1N53D and its reversed polarity version 1N53RD) are Ka-band (34,000 Mc) units with maximum operating temperature of 150 C, overall noise figure of 9 db, and an amplifier noise figure of 1.5 db. Both feature vswr maximum (to a 65 ohm holder) of 1.5 at 34,860 Mc, and 2.5 maximum at ±6 percent. Use of the matched pair is said to eliminate local oscillator noise.

In quantities of 1-99, Type 1N53D is priced at $75, Type 1N53RD at $110. Sample and production quantities are available.

CIRCLE 303 ON READER SERVICE CARD



Miniaturized Delay Line

FOR PRINTED CIRCUITS

A MINIATURIZED compact delay line with a special locking device for printed circuit applications has been developed by Columbia Technical Corporation, 24-30 Brooklyn-Queens Expressway West, Woodside 77, N. Y. The unit is continuously variable from 0 to 0.5 microsecond.

Designated type V887, the delay line is hermetically sealed, and has a specially designed locking device that prevents delay changes under vibration without affecting the initially set delay.

It has a characteristic impedance of 1,000 ohms. Rise time is 0.08 microsecond, attenuation 0.3 db, resolution of 0.001, and a temperature coefficient of better than 150 ppm.

CIRCLE 304 ON READER SERVICE CARD

Frequency-Shift Converter

TELEPRINTER SERVICE

A FREQUENCY-SHIFT converter introduced by the Western Division of Collins Radio Company, Burbank, Calif., makes possible teletype service from radio-equipped aircraft, ships, submarines, trains, motor vehicles or fixed stations.

The unit (designated the 700B-1) provides a single channel of half-duplex teletype communications at speeds up to 100 words-per-minute via any single sideband or a-m radio circuit. The converter can be used in airborne data systems for transmitting digital information at up to 75 bits-per-second.

For airborne applications, the converter accommodates a doppler shift for speeds up to 600 knots. In fixed station operation, the teletypewriter can be located up to one mile from the converter.

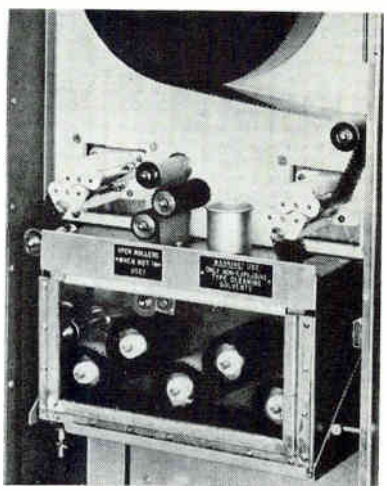
The all-solid-state 700B-1 is a commercial version of a unit now in production for a military jeep-transportable communications system. Features include electronic keyer and built-in loop-current power supply.

CIRCLE 305 ON READER SERVICE CARD

Magnetic Tape Cleaner

AUTOMATIC TYPE

AN AUTOMATIC TYPE cleaner of magnetic recording tape has been introduced by Computer-Measurements Company, 12970 Bradley Ave., Sylmar, California. Operation is completely automatic. Once the tape is in place and the solvent tank filled, the cleaner completes all operations. Dirt, lint, oil, fingerprints and wax are removed without disturbing information on the tape. Cleaners are available for ¾ inch, 1 in. and 2 in. tape.



Speed is adjustable from 0-300 feet per minute, with automatic shut-off that leaves the machine threaded with leader for continuous operation. The unit uses non-inflammable, non-explosive solvents.

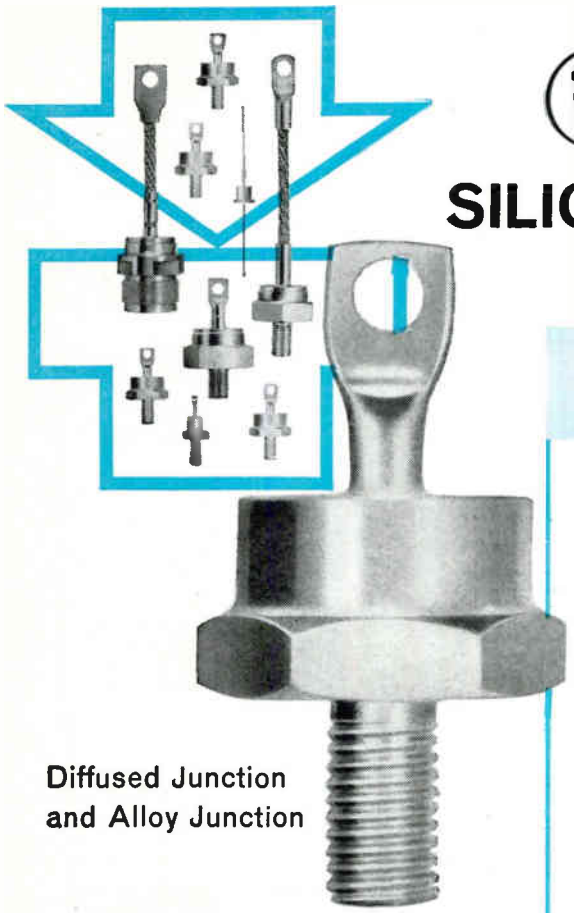
Model T-7070 for 2 in. tape is priced at $6,575.

CIRCLE 306 ON READER SERVICE CARD

Pulse-Control Relay

FOR CLOSE-PULSE WORK

A NEW ratchet relay provides the designer of pulse-operated control circuits with a device for counting, absorbing, or controlling the pulses



Diffused Junction and Alloy Junction

TUNG-SOL®

SILICON POWER RECTIFIERS

250 ma to 100 amps

	Type	Peak Reverse Voltage (Volts)	Average Forward Current	Maximum Reverse Current *	Max. Full Load Voltage Drop (Volts)	Surge Current† (Amps)
250- mA 150°C Ambient Temperature	1N538	200	750 mAdc @ 50°C 250 mAdc @ 150°C	250 μAdc	0.5	
	1N540	400	750 mAdc @ 50°C 250 mAdc @ 150°C	250 μAdc	0.5	
	1N547	600	750 mAdc @ 50°C 250 mAdc @ 150°C	250 μAdc	0.5	
1 Amp 150°C Case Temperature	1N253	100	1.0 Adc	100 μAdc	—	
	1N254	200	0.4 Adc	100 μAdc	—	
	1N255	400	0.4 Adc	150 μAdc	1.0 ▲	
	1N256	600	0.2 Adc	250 μAdc	—	
20 Amp 140°C Case Temperature	1N1191	50	20 Adc	5 mAdc	.55 Full cycle avg. @ 150°C case temp.	250
	1N1192	100	20 Adc	5 mAdc	.55	250
	1N1193	150	20 Adc	5 mAdc	.55	250
	1N1194	200	20 Adc	5 mAdc	.55	250
	1N1195	300	20 Adc	5 mAdc	.55	250
	1N1196	400	20 Adc	5 mAdc	.55	250
	1N1197	500	20 Adc	5 mAdc	.55	250
	1N1198	600	20 Adc	5 mAdc	.55	250
25 Amp 150°C Case Temperature	CS-120Z	50	25 Adc	5 mAdc	.55 Full cycle avg. @ 150°C case temp.	350
	CS-120A	100	25 Adc	5 mAdc	.55	350
	CS-120B	200	25 Adc	5 mAdc	.55	350
	CS-120C	300	25 Adc	5 mAdc	.55	350
	CS-120D	400	25 Adc	5 mAdc	.55	350
	CS-120E	500	25 Adc	5 mAdc	.55	350
	CS-120F	600	25 Adc	5 mAdc	.55	350
35 Amp 140°C Case Temperature	1N1183	50	35 Adc	10 mAdc	0.6 full cycle avg. @ 140°C case temp.	500
	1N1184	100	35 Anc	10 mAdc	0.6	500
	1N1185	150	35 Adc	10 mAdc	0.6	500
	1N1186	200	35 Adc	10 mAdc	0.6	500
	1N1187	300	35 Adc	10 mAdc	0.6	500
	1N1188	400	35 Adc	10 mAdc	0.6	500
	1N1189	500	35 Adc	10 mAdc	0.6	500
	1N1190	600	35 Adc	10 mAdc	0.6	500

	Type	Peak Reverse Voltage (Volts)	Average Forward Current	Maximum Reverse Current*	Fwd. Voltage Drop** (Volts)	Surge Current† (Amps)
50 Amp 150°C Case Temperature	CH116Z	50	50 Adc	20 mAdc	1.1	500
	CH116A	100	50 Adc	20 mAdc	1.1	500
	CH116B	200	50 Adc	20 mAdc	1.1	500
	CH116D	400	50 Adc	20 mAdc	1.1	500
	CH116F	600	50 Adc	20 mAdc	1.1	500
70 Amp 150°C Case Temperature	1N1396	50	70 Adc	15 mAdc	1.3	1500
	1N1397	100	70 Adc	15 mAdc	1.3	1500
	1N1398	150	70 Adc	15 mAdc	1.3	1500
	1N1399	200	70 Adc	15 mAdc	1.3	1500
	1N1400	300	70 Adc	15 mAdc	1.3	1500
	1N1401	400	70 Adc	15 mAdc	1.3	1500
	1N1402	500	70 Adc	15 mAdc	1.3	1500
70 Amp 150°C Case Temperature	CH109Z	50	70 Adc	30 mAdc	1.3	1500
	CH109A	100	70 Adc	30 mAdc	1.3	1500
	CH109B	200	70 Adc	30 mAdc	1.3	1500
	CH109C	300	70 Adc	30 mAdc	1.3	1500
	CH109D	400	70 Adc	30 mAdc	1.3	1500
	CH109E	500	70 Adc	30 mAdc	1.3	1500
80 Amp 150°C Case Temperature	1N1291	50	80 Adc	30 mAdc	1.3	1500
	1N1292	100	80 Adc	30 mAdc	1.3	1500
	1N1293	200	80 Adc	30 mAdc	1.3	1500
	1N1294	400	80 Adc	30 mAdc	1.3	1500

▲ Max. fwd. voltage drop @ 0.5 amp., 25°C case temperature
* Full cycle average for rectifier operating into inductive or resistive load at rated current and voltage
** 50 amp units @ 100 amps D.C. and 25°C;
70 and 80 amp units @ 150 amps D.C. and 25°C
† Max. half sine wave peak current for one cycle @ 60 cps
Storage temperature range for all types . . .-65° to 200°C

This select line fits the broadest variety of applications. Each unit delivers across-the-board versatility and directly replaces many existing types.

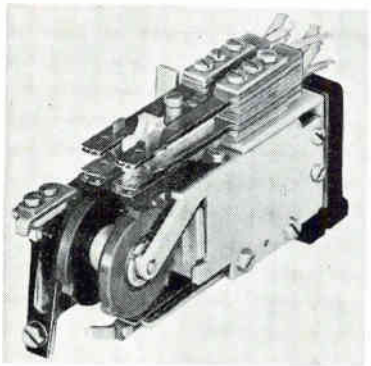
Tung-Sol silicon rectifiers were designed to serve with unqualified dependability in the most exacting military and commercial applications. They're precision engineered to assure the utmost in top-performance uniformity and stability . . . and to function at maximum capacity even under the most severe environmental and electrical overload conditions. Write for the new Tung-Sol silicon rectifier interchangeability chart and complete technical information. Tung-Sol Electric Inc., Newark 4, New Jersey.

Standard JEDEC configurations and with Tung-Sol's unsurpassed Standard and reliability.

Technical assistance is available through the following sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Toronto, Ont.

TUNG-SOL®

as required. Called Genalex ratchet relay, the unit is made by General Electric Co., Ltd. of England, is available in the U. S. from IMTRA



Corp., 11 University Rd., Cambridge 38, Mass. Designed for application in automatic telephone systems, recording of aircraft instruments, control components in data processing systems, and the like, the relay is about 4¼ in. x 2¼ in. x 1⅞ in. and weighs 10½ ounces.

The relay is a cam-and-ratchet type with an operating coil consumption ranging from 150-200 milliamperes at 50 volts depending on the springset loads. Magnet coil power is restricted to 10 watts to avoid overheating.

The relay contains two separate springsets (operated by separate cams), each accommodating up to six contact springs in any combination of makes, breaks, or changeovers. Auxiliary armature springs are fitted to allow the relay to return to its home position by self-interruption or self-cycling. Most service adjustments are possible without removing the relay from its mounting.

CIRCLE 307 ON READER SERVICE CARD

Inertia Switch

ONE MOVING PART

A MINIATURE inertia switch that is accurately preset to respond to acceleration forces up to 250 g within a tolerance of plus or minus 15 percent of setting is now available from Inertia Switch, Inc., 311 West 43 Street, New York 36, N. Y. The switch, designated 6UO-200 (Milli-Mite), is designed with only one moving part, a precision-ground steel ball held against a solid base by a uniform magnetic field. When the opposing force of acceleration exceeds the magnetic force, the ball moves to close a normally open electrical contact. The switch automatically resets itself when acceleration is removed. Response time is 0.015 sec; electrical rating is 2

amps at 28 v d-c resistive. Switch is 0.75 in. in length, 0.25 in. in diameter.

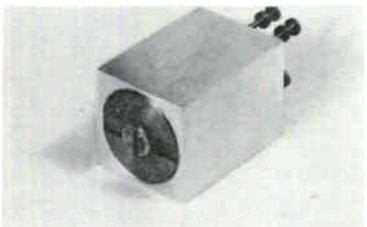
The switch meets all environmental specifications of MIL-E-5272, including an operation range of minus 65 deg F to plus 200 deg F. Miniature switches of this type can be used for control or limiting applications when actuated by acceleration, deceleration, impact and/or shock.

CIRCLE 308 ON READER SERVICE CARD

D-C Blower
VANEAXIAL

GLOBE INDUSTRIES, INC., 1784 Stanley Ave., Dayton 4, Ohio. New VAX-3-BD vaneaxial blowers operate from direct current to produce an optimum output of 90 cfm at 1 in. H_2O back pressure. A 28-v d-c maximum current is 1.7 amperes at free air delivery; motor windings may be provided for 4 to 115 v d-c operation. Precision aluminum castings are black anodized and designed to provide adequate environmental protection to meet pertinent MIL specifications. Mounting is made by clamping to servo flange on either end. Life exceeds 500 hours. Dimensions: 3 in. diameter by 3¾ in. maximum length. Weight: 16 oz.

CIRCLE 309 ON READER SERVICE CARD



Acceleration Switch
SMALL AND LIGHT

EASTERN TECHNICAL ASSOCIATES, INC., Main St., North Acton, Mass. Model AS-4 switch is responsive to acceleration in one direction along a single axis. Resetting is by means of high acceleration in the opposite direction or manual reset. The design is rugged and simple consisting of only one moving unit within the switch housing. The housing is constructed of aluminum and interior construction can be of nonmagnetic materials resulting in a completely nonmagnetic component. Accuracy of the switch is under 0.2 g; response time less than 50 milliseconds; range, 0.2 g to 1000+ g. Unit is suited for commercial, industrial and military applications where acceleration sensitive switching is desired.

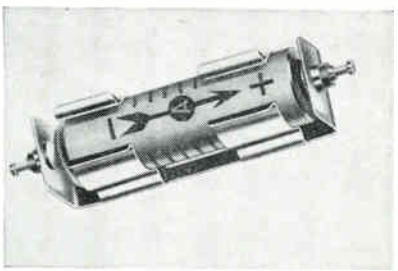
CIRCLE 310 ON READER SERVICE CARD

Power Supply
ULTRA-PRECISION

VIDEO INSTRUMENTS CO., INC., 3002 Pennsylvania Ave., Santa Monica, Calif. Model SR-200EP features 0.01 percent regulation for line volt-

age fluctuations from 95 to 135 v, and 0.01 percent regulation for load changes from no-load to full-load. The d-c output voltage is variable from 0 to 15 v. Maximum output current is 200 ma. Special consideration has been given to isolation from the power line in order to obtain minimum noise from possible ground loops. The effect of this isolation is that the noise measured with a grounded 350 ohm bridge is only 1 μv, peak to peak. Six of these units mount side by side in a 19-in. rack module, requiring 3½ in. of panel height. Also available in the same configuration is model SR-200EHP, with an adjustable voltage range from 0 to 24 v.

CIRCLE 316 ON READER SERVICE CARD



Battery Holder

COMPACT DEVICE

AUGAT BROS., INC., 33 Perry Ave., Attleboro, Mass. New battery holder, designed for use with Eveready E91, Mallory RM-502, and Burgess CD-6 size batteries, fills the need for a compact, dependable holder in portable equipment. Made of either cadmium plated steel, or beryllium copper, the holder features silver plated contacts pressed into nylon insulators. With both contacts insulated, the battery is completely insulated from the holder and chassis.

CIRCLE 317 ON READER SERVICE CARD

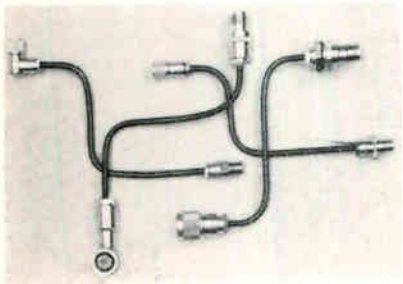
Vibration Calibrator

BATTERY-OPERATED

GENERAL RADIO CO., West Concord, Mass. Type 1557-A vibration calibrator is a small compact instrument for the calibration of a variety of accelerometers, from the small 3-4 gram high-frequency type to linear, limited-response, 300-gram models. It is also possible to obtain 1 g at 100 cps with this calibrator, via a pair of pill-boxed-shaped 50-

gram disks, that are at opposite sides of the instrument. Both velocity and displacement-type pickups can be calibrated, as well as the acceleration types. Mercury cells, with 100-hr life, are used.

CIRCLE 318 ON READER SERVICE CARD



Coax Connectors
POSITIVE CLAMPING

GENERAL RF FITTINGS, INC., 702 Beacon St., Boston 15, Mass., announces a new series of TNC Coaxitube (semi-rigid) connectors. They feature Collett clamp construction—an extremely reliable method of positive cable clamping so cables cannot turn or pull out. The connectors are also available in TM series—miniaturized versions of TNC—for use where size and weight are critical considerations. Weatherproof, the metal parts of all Coaxitube connectors are silver plated; contacts have gold plate over silver plate. All are immediately available from stock. Specifications include impedance matched, 50 ohms; operating temperatures — 65 F to + 260 F; voltage: 1500 v rms, 60 cycles (TNC), and 500 v rms, 60 cycles (TM).

CIRCLE 319 ON READER SERVICE CARD

Scatter Antenna
MEETS MIL SPECS

ANTENNA SYSTEMS, INC., Hingham Industrial Center, Hingham, Mass., has designed a new 60-ft scatter antenna which features low cost. It is fabricated out of galvanized steel to minimize maintenance and the overall design stresses maximum interchangeability and standardization of the various members. It is easy to erect, is an all-bolted construction, and meets the necessary military specifications. A complete line of r-f components is available for the antenna.

CIRCLE 320 ON READER SERVICE CARD

Mixer-Preamplifier
LOW NOISE

LEL, INC., Akron St., Copiague, N. Y. This latest addition to the series of matched microwave-mixer amplifier units further extends the range of the company's microwave receiver front ends to include coverage of the 34,000 to 36,000 Mc band. The MMK-2 combines a K_a band waveguide mixer with a matched preamplifier and provides an overall gain of 25 db, an i-f bandwidth of 8 Mc and a noise figure of 10 db maximum.

CIRCLE 333 ON READER SERVICE CARD

Subcarrier Oscillator
FOR F-M TELEMETERING

DORSETT ELECTRONICS LABORATORIES INC., 119 West Boyd, Norman, Okla. Excellent data stability for f-m telemetering applications ranging from −55 C to +125 C is possible with the model 0-20 voltage controlled subcarrier oscillator. Utilizing silicon semiconductors, it is packaged in a die cast aluminum configuration that features a unique captive screw hold down and removal device. The package measures 2.25 in. high by 1.875 in. wide by 0.875 in. deep. The 0-20 is designed to meet a wide range of missile, satellite, aircraft, land line and industrial applications. Adjustment controls for centering, deviation sensitivity, and output, are utilized, with accessibility provided at the top of the unit. Model 0-20 is available in all standard

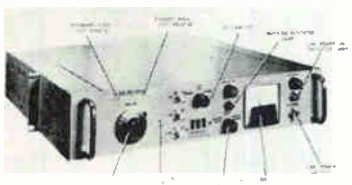
IRIG channels with inputs of either 0 to 5 v, or $-2\frac{1}{2}$ v to $+2\frac{1}{2}$ v. Priced at less than $300 in quantity, normal delivery is 30 to 60 days.

CIRCLE 334 ON READER SERVICE CARD

Vibration Exciter
HIGH FORCE OUTPUT

VIBRASONICS INC., 10 High St., Boston, Mass. The VS-10 vibration exciter has been used extensively for the production vibration testing of vacuum tubes and other small components. Unit is supplied with a permanent magnet which makes it convenient for portable use, or can be supplied with an electro-magnet on special order where precision of repeatability is desired. The unique spider suspension virtually eliminates all motions other than the axis of excitation. The armature eliminates multiple resonances and supplies virtually a point source of vibration. A specially designed h-f accelerometer can be built into the vibration platform on special order which, when used with a feedback controlling system, will give a constant (± 1 db) frequency response from 20 cps in excess of 20,000 cps.

CIRCLE 335 ON READER SERVICE CARD



Frequency Standard
TRANSISTORIZED

MANSON LABORATORIES, INC., 375 Fairfield Ave., Stamford, Conn., has introduced a transistorized, low-cost frequency standard, model RD-180, which provides highly stable output frequencies of 5 Mc, 1 Mc and 100 Kc for use in frequency control systems. The design objective in this new, ultrastable timing device was to construct a precision-engineered unit with uncompromised reliability and performance. It offers a stability of ±5 parts in 10^{10} per day. Included is an emergency battery source to provide continuous operation with automatic switchover in the event of line failure.

CIRCLE 336 ON READER SERVICE CARD

Literature of the Week

TUNING FORK OSCILLATOR Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y. Description and specifications for the model JF400 tuning fork oscillator are given in a recent bulletin. Unit described consists of an electronically driven tuning fork and output filter.

CIRCLE 321 ON READER SERVICE CARD

MICROWAVE TEST INSTRUMENTS PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y. Four-page, two-color bulletin 400 categorizes hundreds of PRD products by frequency range, waveguide size, and price.

CIRCLE 322 ON READER SERVICE CARD

VIBRATION TESTING MB Electronics, 781 Whalley Ave., New Haven 8, Conn. A new 16-page brochure describing the complete line of products manufactured by the company to excite, measure and control vibration is now available.

CIRCLE 323 ON READER SERVICE CARD

P-C BOARD Elgin Laboratories, Inc., Waterford, Pa. "Econo-Grid", a stock, paper base epoxy, printed circuit board is discussed in a newly published catalog sheet. Applications, technical description, stock sizes available, and prices are given.

CIRCLE 324 ON READER SERVICE CARD

R-F CHOKES Cinema Engineering, division of Aerovox Corp., 1100 Chestnut St., Burbank, Calif., has released a new data sheet, catalog 22CA, on custom quality encapsulated radio-frequency chokes.

CIRCLE 325 ON READER SERVICE CARD

MASS SPECTROMETER Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. An eight-page, illustrated bulletin describes in detail the specifications and applications of the type 21-110 mass spectrometer.

CIRCLE 326 ON READER SERVICE CARD

INDUSTRIAL DIGITAL VOLTMETER Non-Linear Systems, Inc., Del Mar, Calif. A two-color, four page bulletin explains how the model 484 industrial digital voltmeter can be used with plug-in accessories to build low cost, reliable and highly accurate measuring and data logging systems.

CIRCLE 327 ON READER SERVICE CARD

BASIC SWITCH Micro Switch, Freeport, Ill. Data sheet No. 181 contains two pages of information on the type E basic switch which feature a steady state current rating of 25 amperes without sacrificing accurate repeatability and precision performance.

CIRCLE 328 ON READER SERVICE CARD

DELAY LINE COIL FORMS Corning Electronic Components, Bradford, Pa. Delay line coil forms made of low expansion, low loss glass are described in Engineering Reference File CE-7.00. The sheet should be requested under company letterhead.

SINUSOIDAL OSCILLATOR Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif., has published a bulletin describing the model S-200 silicon transistor sinusoidal oscillator, an epoxy encapsulated unit designed to create a sine wave signal source.

CIRCLE 329 ON READER SERVICE CARD

CAPACITORS Marshall Industries, 430 North Halstead St., Pasadena, Calif., has available two new engineering data sheets giving complete performance characteristics, specifications, illustrations and order information about metallized Mylar capacitors.

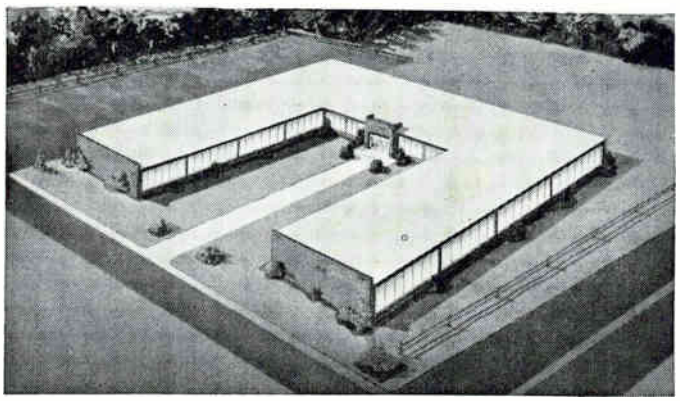
CIRCLE 330 ON READER SERVICE CARD

TRIODE OSCILLATOR John Gombos Co., Inc., Webro Road, Clifton, N. J. A technical data sheet illustrates and describes model 151C miniature C-band triode oscillator which covers from 4,200 Mc to 6,000 Mc in 50 Mc steps.

CIRCLE 331 ON READER SERVICE CARD

SPECIAL PURPOSE COMPUTERS Lockheed Electronics Co., U. S. Highway 1, Metuchen, N. J. Advantages of special purpose computers in terms of low initial investment and minimum upkeep are described in a 4-page brochure.

CIRCLE 332 ON READER SERVICE CARD



Bomac Erecting New Laboratory

BOMAC LABORATORIES, INC., Beverly, Mass., has under construction a new building to house the research division, which will be under the direction of Wellesley J. Dodds, vice president, engineering.

This new addition, the seventh for Bomac since 1951, will be situated on Route 128, adjacent to the present facilities. It will be a 20,000 sq ft, U-shaped, one story, brick building, and is scheduled for completion late in the fall. With this addition, Bomac's facilities will total over 135,000 sq ft.

Bomac became a subsidiary of Varian Associates of Palo Alto, Calif., in March, 1959. Besides Bomac, Varian's present corporate structure includes Varian of Canada Ltd. in Georgetown, Ontario; S-F-D Laboratories, Union, N. J.; Semicon Associates, Inc. in Lexington, Ky., and Watsonville, Calif.; and Varian A. G. in Zurich and Zug, Switzerland.

Harold C. Booth, Bomac's executive vice president and board member of Varian Associates, says: "Under Varian's policy of broadening and strengthening its product lines and fields of interest by sponsoring research programs, Bomac will also enter into programs of basic research. Research has been the most important factor in putting Varian where it is today, and this addition at Bomac is only part of the overall company research program. Plans were recently approved by Varian's board of directors for 225,000 sq ft of new space to be constructed in the next year at the Palo Alto facilities. S-F-D Laboratories is also expanding to undertake further research programs."

Edward L. Ginzton, board chairman of Varian, had the following to say on the new Bomac division: "It has always been Varian's policy to carry on an R&D program far more extensive than necessary for immediate manufacturing purposes. The value of this policy has been demonstrated by the company's rapid growth during the 12 years since its founding. We believe that this policy must be applied at each of Varian's affiliated companies. Bomac's location in the Boston electronics community should facilitate rapid expansion in research and development."

Stewart-Warner Corp. Elects Vice President

DONALD A. POTTER, general manager of the electronics division of Stewart-Warner Corp., Chicago, Ill., was recently elected a vice president. He has been with Stewart-Warner since 1947.

Prior to becoming head of Stewart-Warner Electronics in January, 1959, Potter was an executive of S-W's South Wind division at Indianapolis, Ind.

Raytheon Opens New Canada Plant

RAYTHEON CANADA LTD., Waterloo, Ontario, which started business there in 1956 with three employees and now has 190, has opened a new $400,000 plant.

John R. Cann, executive vice president and general manager, said the 25-acre site on which the new plant is built provides room for substantial expansion. By 1963 the firm plans to have 270 employees and a $1 million annual payroll.

Dunbar Will Direct Electronic Research

THE CONVAIR (SAN DIEGO) DIVISION of General Dynamics Corp. recently named A. S. Dunbar chief of electronic research. He formerly was manager of electromagnetics research at Lockheed missile and space division.

EIA Renames Borth Committee Chairman

REAPPOINTMENT of Robert T. Borth, General Electric Co., Washington, as chairman of the Electronic Industries Association's Congressional Information Committee has been announced.

The committee is responsible for

SQUARE-LOOP TAPE CORES TO MEET YOUR *TOUGHEST* SPECIFICATIONS

Speed your specs to Dynacor when you want square-loop tape cores *to exact requirements—fast!* Here you'll find a dependable combination of personnel, experience and facilities—the know-how to deliver parameters to your very tightest tolerance requirements for switching time, flux, and noise.

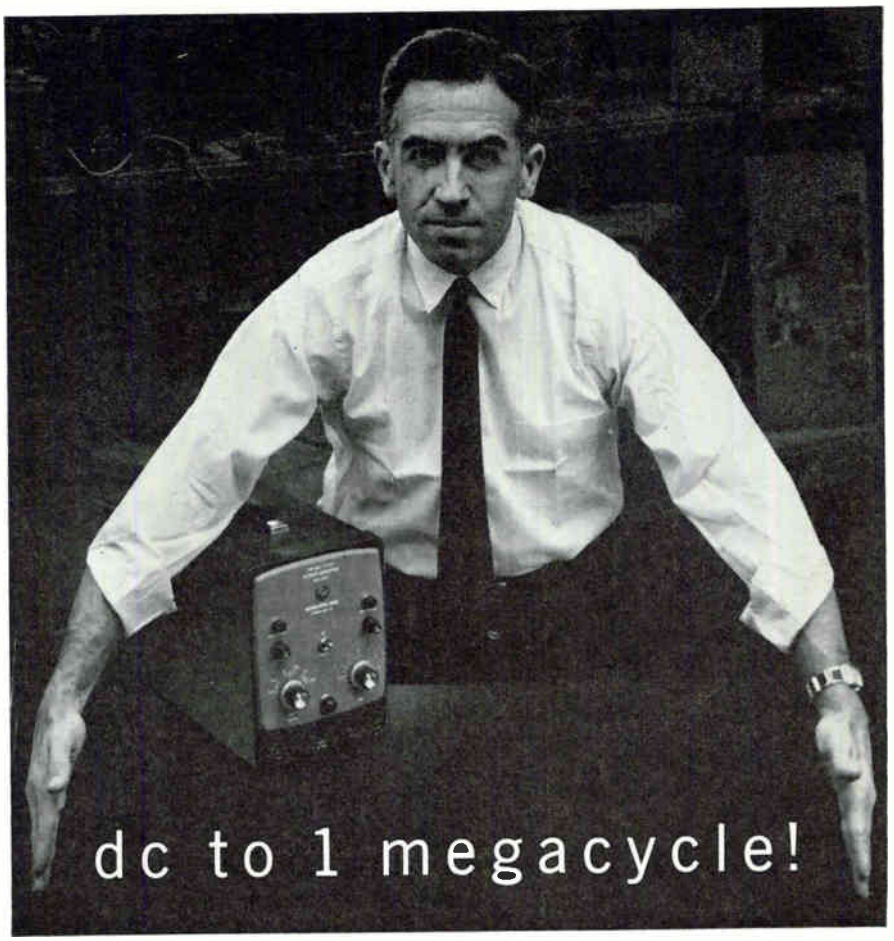
Dynacor Square-Loop Tape Cores are manufactured with the high permeability alloys—Grain-Oriented 50-50 Nickel Iron, 4-79 Molybdenum Permalloy, and Grain-Oriented 3% Silicon Iron . . . with fully guaranteed uniformity . . . under rigid standards of control and inspection.

Look to Dynacor for reliable production and swift delivery of your tape core requirements. For your convenience a full line of standard units are stocked for immediate off-the-shelf delivery—Send for bulletins DN 2000, DN 2001, DN 2002.

DYNACOR

DYNACOR, INC.
A SUBSIDIARY OF SPRAGUE ELECTRIC CO.
1006 Westmore Ave.
Rockville, Maryland

CIRCLE 213 ON READER SERVICE CARD



. . . and 10 watts of power with this direct-coupled amplifier!

New from Krohn-Hite: this unique combination of power and bandwidth! The Model DCA-10 direct-coupled amplifier allows you to increase power of all sources from dc to one megacycle, without the bother of changing amplifiers or bandswitching!

The DCA-10's low distortion (0.1%) makes it the perfect complement for low-distortion, quality oscillators — for unexcelled performance over the entire frequency range.

Output — to 300 volts peak to peak, to 600 milliamperes peak to peak. Frequency response is flat, within one db, from dc to 1 mc. Stability is excellent for both output DC level and gain.

The Model DCA-10 direct-coupled amplifier provides high, distortion-free power over the entire range, from sub-sonic into radio-frequencies. 20 watts of push-pull power can be obtained from two DCA-10's cascaded. If this high-quality, flexible amplifier can fill a need for you, write for full information.

Other Krohn-Hite amplifiers include the direct-coupled 50 watt DCA-50, and the ultra-low distortion (0.005%) 50 watt UF-101A. Also, Krohn-Hite Oscillators, Filters and Power Supplies.

KROHN-HITE CORPORATION
580 Massachusetts Avenue • Cambridge 39, Mass.
Pioneering in Quality Electronic Instruments

CIRCLE 121 ON READER SERVICE CARD

keeping EIA members informed on major questions before Congress affecting the electronics industry.

Lagerstrom Joins Eitel-McCullough

RICHARD P. LAGERSTROM has joined Eitel-McCullough, Inc., San Carlos, Calif., as a senior scientist in the company's research division.

As a research assistant and associate with Stanford University's Electronics Research Laboratories since 1951, and with Hughes Aircraft Co. from 1946 to 1951, Lagerstrom has worked on the development of various new techniques and methods in the field of twt's and microwave devices.

Adler Electronics Adds New Plant

ADLER ELECTRONICS, INC., New Rochelle, N. Y., has more than doubled its production capacity with the addition of a new 55,000 sq ft plant in Pelham, N. Y. This facility, which recently opened with a pilot force of 150 employees, houses a major portion of the company's manufacturing operations.

Adler produces transportable communications systems, missile ground support systems, and low power tv transmitters and repeaters.

Holtzman Takes Post Of R&D Director

APPOINTMENT of Sidny M. Holtzman to director of research and development for Fidelity Electronic Corp., Riverside, N. J., is announced. He has been directing research and development activities for the firm since July, and will now

take part also in production and marketing activities.

Holtzman has been associated with Trylon Radio Labs, Inc., and RCA in product engineering.

Industro Transistor Appoints E. S. Davis

EDWIN S. DAVIS was recently named device design engineer by Industro Transistor Corp., Long Island City, N. Y. Previous to joining Industro, he was supervisor of pilot engineering for CBS Electronics, Lowell, Mass., supervising project engineers in germanium power transistor device design.

CMC Names Manager Of Manufacturing

JAY SCHWALBE has been appointed manager of manufacturing of Computer Measurements Co., Sylmar, Calif.

Prior to joining CMC, he was plant and production manager of Electric Cords and Supply Co., a division of ITT.

Frederick Joins Epsco, Inc.

ARDEN H. FREDERICK has recently joined the instruments division of Epsco, Inc., Cambridge, Mass. He was formerly director of engineering at Production Research Corp., subsidiary of Radio Condenser Co.

Sperry Products Appoints Main

ROBERT C. MAIN has joined Sperry Products Co., a division of Howe Sound Co., Danbury, Conn., to assume the duties and responsibilities

of manager of engineering, a newly created position. He was formerly with United Aircraft as engineering manager of the missiles and space systems division.

Wise Becomes ITA Board Chairman

BERNARD WISE has been elected to the chairmanship of the board of directors of Industrial Transmitters & Antennas, Inc., Lansdown, Pa. He will also continue in his capacity as president.

Wise has been associated with RCA in its broadcast marketing and engineering divisions.

Aero Geo Astro Hires Peeler

GEORGE D. M. PEELER has been named senior laboratory director of the Aero Geo Astro Corp., Alexandria, Va.

Prior to this appointment he had been manager of the microwave development department, missile systems division of the Raytheon Company in Bedford, Mass.

Shockley Adds Ewing To Research Staff

RICHARD E. EWING recently joined the senior research staff of Shockley Transistor Unit of Clevite Transistor, Palo Alto, Calif.

Before joining this research team, Ewing was working in the field of nuclear fuels with General Electric in Richland, Wash.

Pacific Scientific Changes Division Name

THE AERONAUTICAL DIVISION of Pacific Scientific Co., Los Angeles, Calif., will now be known as the "aerospace" division. This division manufactures cable control systems, pilot safety equipment, electrical rotary couplings, 6 pdt relays and a variety of electromechanical components.

Rogers Takes Over Newly-Created Post

APPOINTMENT of Gordon F. Rogers as manager of advanced development for RCA communications equipment is announced.

In the newly-created position, he will head an advanced development group at RCA's David Sarnoff Research Center at Princeton, N. J.

Rogers, who joined RCA thirteen years ago, has served in RCA activities at New York, Hollywood, Chicago and Camden.

Hartman Moves Up At Philco Corp.

LAWTON M. HARTMAN was recently appointed associate director of research—operations at Philco Corp., Philadelphia, Pa.

With the research division since 1958 when he joined Philco as a consultant and member of the technical systems planning group, Hartman has recently been responsible for directing one of Philco's important space communications programs.

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First, fill out the coupon below and check off the tests which apply to your training and professional experience. Forward the completed coupon to us and in a few days you will receive the tests, a sealed answer sheet and explanatory material.

During a convenient hour at home, take the test and score it with the answer sheet provided. Then, compare your performance with the criterion group composed of Light Military engineers at all levels who took the same test. In most cases you will be able to relate your score to years of experience, from 2 to more than 10.

What it measures:

If your adjusted score is equal to, or more than the years of experience you possess, the probability is excellent that a significant community of technical interest exists between you and The Light Military Department. In addition, a valid assumption can be made that a high probability for success awaits you here. And remember, your score need not be divulged to us at any time; it is for your own guidance exclusively!

. . . . . .

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SPACE COMMUNICATIONS & TELEMETRY • MISSILE & SATELLITE COMPUTERS • SPACE VEHICLE GUIDANCE • UNDERSEA WARFARE SYSTEMS • THERMOPLASTIC DATA STORAGE • SPACE DETECTION & SURVEILLANCE • COMMAND GUIDANCE & INSTRUMENTATION • INFRARED MISSILE APPLICATIONS

. . . . . .

Facts about the tests

1 Each technical test is composed of 40 multiple choice questions.

2 To find answers for some questions, mathematics is involved – but only to the degree normally associated with the work.

3 The "mix" of questions includes some easy ones, some bordering on the state of the art.

4 None of our engineers achieved a perfect score.

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General Electric Company, French Road, Utica, New York

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☐ COMMUNICATIONS ☐ ADMINISTRATIVE ENGINEERING

NAME _____

HOME ADDRESS _____ HOME PHONE _____

CITY _____ ZONE ____ STATE _____

DEGREE(S) _____ YEAR(S) RECEIVED _____

69-WS

LMED
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GENERAL ELECTRIC

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Positions Vacant
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Civil Service Opportunities
Selling Opportunities Wanted
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Republic Aviation has an exceptional opening for an Electronics Reliability Engineer. He will be responsible for analyzing electronic circuits and predicting the theoretical reliability of electronic equipment. He will also perform failure effect analysis, review proper parts application, and recommend piece part utilization.

An EE degree and 5-10 years experience in electronics, with at least 2-3 years in reliability required.

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Technical Employment Supervisor

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Salary to be commensurate with qualifications.

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Analysis, Research and Development
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If you have a solid background in technical electronics, at least 2 years of experience in advertising and writing, and a deep ambition to advance yourself, this is an opportunity you should investigate immediately.

Write P. R. SMITH, *Personnel Director*

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Representatives desired by manufacturer of Industrial Electronic Instruments and Controls. P.O. Box 8246, Tulsa 15, Oklahoma.

Manufacturers Representative Wanted. New low cost epoxy resin processing unit. Unique equipment for metering, mixing, and dispensing reactive resins. All territories open. CPM Special Machinery Corp., 324 Butler Street, Brooklyn 17, N. Y.

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MR. EMPLOYER, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.
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Maker	Type	Contact Arrangement	Resistance	Voltage	Price
Advance	#A8769-ly	3A	39 Ohm	6VDC	1.50
		2A2C	39 Ohm	6VDC	1.50
Sigma	52JOCA-80110	1A1C	16,000 Ohm	28VDC	3.00
Sigma	7-JOZ-80030 None Pile Up Cont.	SPDT	5000 Ohm	28VDC	2.50
		3A3B	144 Ohm	12VDC	1.00
		3B	144 Ohm	12VDC	1.00
		1A1B2C	39 Ohm	6VDC	1.00
Phillips Control	2QA316A	1C1A	200 Ohm	12VDC	1.50
		SPST	300 Ohm	24VDC	1.50
Clare	B65369	1A1B	125 Ohm	12VDC	1.50
RBM	RB22300-14	1A1B	280 Ohm	28VDC	1.50
Potter-Bromfield	KF-1012-4	SP5T	200 Ohm	12VDC	1.50

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The advertising is $24.75 per inch for all advertising other than on a contract basis. AN ADVERTISING INCH is measured 7/8" vert. on a column, 3 cols.—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line. BOX NUMBERS count as one line additional.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions.

Send NEW ADVERTISEMENTS or Inquiries to Classified Adv. Div. of Electronics, P. O. Box 12, N. Y. 36. N. Y.

The publisher cannot accept advertising in the Searchlight Section, which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

SPECIAL PURPOSE TUBES

OA2	.80	4X150A	12.50	348A	2.50	5545	12.50	5896	1.50
OA3	.85	4X250B	30.00	349A	2.00	5550	30.00	5899A	2.50
OB2	.50	5BP1A	9.50	350A	3.50	5552/FG-235	40.00	5902	2.35
OB3	.70	5C22	15.00	350B	3.50	5557/FG-17	4.25	5903	4.00
OC3	.50	5CP1A	9.50	352A	6.50	5558/FG-32	7.50	5932/6L6WGA	5.00
OD3	.30	5LP1A	17.50	354A	10.00	5559/FG-57	10.00	5948/1754	150.00
1AD4	1.25	5R4GY	.90	355A	10.00	5560/FG-95	12.50	5963	.85
1B24A	10.00	5R4WGB	5.00	393A	3.50	5586	100.00	5964	.75
1B35A	3.00	5R4WGY	2.50	394A	2.50	5632/C3J	8.50	5965	1.00
1B58	35.00	5RP1A	10.00	396A/2C51	2.50	5636	1.00	5975	2.00
1B59/R1130B	9.00	5Y3WGT	1.15	398A/5603	4.00	5639	2.00	5977/6K4A	1.25
1B63A	12.50	6AC7W	.35	401A/5590	1.50	5641	2.25	5981/5650	25.00
C1K	6.00	6AG7Y	.75	403A/6AK5	1.00	5642	1.25	5992	2.00
1P21	25.00	6AK5W	1.00	403B/5591	3.00	5643	4.50	5993	4.00
1P25	10.00	6AN5WA	3.00	404A/5847	10.00	5644	2.50	6005/6AQ5W	1.25
2-O1C	12.50	6AS7G	2.35	407A	3.50	5646	2.00	6012	3.75
2AP1A	3.50	6B4G	2.50	408A/6028	2.00	5647	2.25	6021	2.00
2BP1	6.00	6BL6	30.00	409A/6AS6	2.00	5651	.70	6032	25.00
2C39	2.50	6BM6	30.00	412A	4.00	5654/6AK5W	1.00	6037/QK-243	25.00
2C39A	7.50	6BM6A	30.00	415A	3.00	5656	3.50	6045	1.25
2C40	6.50	6C21	10.00	416B/6280	30.00	5665/C16J	25.00	6072	1.75
2C43	6.50	C6J	12.50	417A/5842	10.00	5670WA	1.35	6073	.80
2C50	4.00	6J4WA	1.25	418A	15.00	5675	7.50	6080	3.00
2C51	1.50	6J6W	.60	420A/5755	5.00	5676	1.25	6080WA	4.00
2C52	1.50	6L6GAY	.75	421A/5998	7.50	5678	1.25	6080WB	10.00
2D21	.50	6L6WGB	1.75	422A	10.00	5684/C3J/A	11.80	6082	3.00
2D21W	1.00	6Q5G	2.50	423A/6140	5.00	5686	1.85	6087/5Y3WGTB	3.00
2E24	2.50	6SJ7WGT	1.00	429A	9.00	5687WA	2.50	6099	.75
2E26	2.50	6SL7WGT	.75	450TH	30.00	5691	5.00	6100/6C4WA	1.25
2E30	1.85	6SN7WGT	.50	450TL	30.00	5692	2.00	6101/6J6WA	1.00
2J42	35.00	6V6GTY	.75	575A	12.50	5693	4.00	6111A	2.00
2J51	75.00	6X4W	.75	631-P1	5.00	5702WA	2.75	6112	2.50
2K25	8.50	6X5WGT	1.00	673	12.50	5703WA	3.00	6115/QK-351	40.00
2K26	25.00	7MP7	17.50	676	27.50	5704	1.00	6130/3C45	8.50
2K29	25.00	10KP7	20.00	677	27.50	5718	1.00	6136/6AU6WA	1.25
2K30	75.00	12AT7WA	1.40	714AY	10.00	5719A	1.50	6137/6SK7WA	1.50
2K34	100.00	HK-24	1.00	715C	10.00	5720/FG-33	17.00	6146	3.50
2K35	250.00	25T	7.50	719A	7.50	5721	125.00	6252	4.50
2K41	25.00	26Z5W	1.25	721B	3.00	5725/6AS6W	1.00	6186/6AG5WA	1.50
2K42	125.00	35T	7.50	723A/B	2.50	5726/6AL5W	.60	6189/12AU7WA	1.50
2K43	125.00	35TG	2.50	725A	7.50	5727/2D21W	1.00	6197	1.75
2K44	125.00	FG-105	17.50	726B	3.25	5728/FG-67	7.50	6199	35.00
2K47	125.00	FG-172	17.50	750TL	87.50	5740/FP-54	50.00	6201/12AT7WA	1.75
2K50	65.00	212E	25.00	BL-800A	50.00	5744WA	2.75	6202/6X4WA	1.50
2X2A	1.00	244A	2.50	802	4.50	5749/6BA6W	.75	6211	.65
3AP1A	7.50	245A	3.50	804	15.00	5750/6BE6W	1.35	6216	2.50
3B24W	3.50	249B	10.00	805	3.00	5751/12AX7W	1.35	6236	150.00
3B25	3.00	249C	5.00	807	1.25	5763	1.50	6263	9.00
3B28	4.00	250R	7.50	810	12.50	5777	100.00	6264	9.00
3BP1A	7.50	252A	6.00	811A	4.75	5778	125.00	6265	2.25
3C22	30.00	254A	2.00	813	8.50	5783	2.00	6293	4.50
3C23	5.00	257A	3.50	814	1.50	5784WA	3.50	6299	37.50
3C24/24G	2.50	259A	3.50	815	1.50	5787	2.50	6336	9.50
3C45	3.00	262B	3.50	816	1.75	5799/VX-21	3.00	6352	8.50
3D22	8.00	267B	7.50	828	7.00	5800/VX-41	3.50	6364	150.00
3E29	3.50	271A	10.00	829B	7.25	5801/VX-33A	3.00	6390	150.00
3J21	35.00	272A	4.00	832A	6.00	5802/VX-32B	3.50	6438	4.00
3J31	50.00	274A	2.50	833A	33.00	5803/VX-55	1.50	6463	1.25
3K21	125.00	275A	4.00	836	1.00	5814A	1.25	6517/QK358	500.00
3K22	125.00	283A	3.50	837	.90	5819	45.00	6533	6.50
3K23	250.00	287A	2.50	845	7.50	5824	2.50	6544	250.00
3K27	150.00	293A	4.50	866A	1.85	5828	3.00	6550	4.25
3K30	50.00	300B	5.00	872A	1.65	5829WA	1.50	6626/OA2WA	2.00
3KP1	8.85	304TH	30.00	884	1.00	5836	60.00	6627/OB2WA	2.00
3X2500A3	148.00	304TL	30.00	913	8.50	5837	60.00	6655	40.00
4-65A	9.50	310A	3.50	927	1.00	5839	2.50	6754	10.00
4-125A	20.00	311A	2.50	931A	3.00	5840	2.00	6784	250.00
4-250A	30.00	313C	1.00	959	.50	5845	4.85	6897	18.75
4-400A	32.50	323A	6.50	1000T	97.50	5852	2.50	6901	10.00
4-1000A	90.00	328A	2.50	1500T	150.00	5854	1.50	8005	5.00
4AP10	10.00	329A	3.50	1614	2.50	5876	7.50	8013A	3.00
4B31	15.00	336A	2.50	1620	3.50	5879	1.00	8020	1.50
4C35	15.00	337A	3.50	1624	.75	5881/6L6WGB	1.75	8025	3.00
4E27	7.50	339A	4.00	2050	1.00	5886	3.00	9002	.35
4J52	25.00	347A	1.50	2051	.50	5894	15.00	9005	3.00

ALL TUBES ARE NEW, INDIVIDUALLY CARTONED, FULLY GUARANTEED

Prices are FOB shipping point

western engineers

ELK GROVE, CALIFORNIA

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Orders for less than $10 cannot be processed

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SEARCHLIGHT Equipment Locating Service

NO COST OR OBLIGATION

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used electronic equipment and components *not currently advertised.* (This service is for USER-BUYERS only).

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment Locating Service
Classified Advertising
c/o ELECTRONICS
P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
Classified Advertising
c/o ELECTRONICS
P. O. Box 12, N. Y. 36, N. Y.
Please help us locate the following equipment components.

.....
.....
.....

NAME .....
TITLE .....
COMPANY .....
STREET .....
CITY 11/11/60

electronics

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BRUCE A. WINNER,
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So Little Time to Read It

NO LONGER is it sufficient for a business magazine to demonstrate editorial superiority. To that superiority must be added the ingredient of readability. Toward that end, ELECTRONICS began early this year a series of typography and format changes.

Improvement is a continuing program with us, not an experiment or an all-at-once change to another static dimension. We're making the magazine faster and easier to read—no mean chore, considering the scope and depth of the editorial content. Your reading habits must be selective. That's why we intend not only to warrant your reading time, but to conserve it as far as possible.

After all, we have little choice. ELECTRONICS is bringing you more than twice the number of feature articles, and 73 percent more editorial pages than you received in 1956, a short four years ago. This increase was necessary to keep you fully informed concerning our rapidly expanding electronics technology.

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James Gilwood

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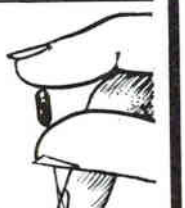

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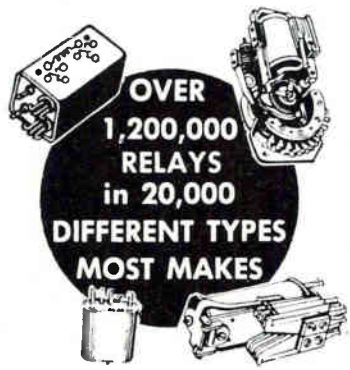

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• 1,500 BODINE MOTORS •
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• 200 G. E. STEPDOWN TRANSFORMERS •
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Model No. 9T 91Y1033G2
KVA. 1.36 EPS CY-60 Ph. 1
HV. 115, 208, 230 V Input
LV. 47.5, 48, 50 V—25A.
Resonant capacitor permanently attached to coil and core. Transf. leads connected to term'l board. Sh. Wt. 60 lbs. App. dim. 10x8x8:MTG Holes 6x4. Brand new—200 available. Single units $25.00 FOB-NYC.

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From the largest facility and stock in the country at lowest prices. Delivery on first class NEW special purpose tubes and transistors from stock in production quantities.

SPECIALS

500 Eimac 4-65A $15.50 ea.

1200 Transitron SV-3141A voltage reference 1.5V ± 2% at $1.75 ea. lot price.

250 Texas 2N338 $7.50 ea.

Astronetics, Inc.
Red Bank, N. J.
AT 1-2700

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GET IT FROM GOODHEART!

0.1% SORENSEN Line Voltage Regulator

#50005. Brand new at low surplus price! Input 95-130 V, 1 ph., with taps for 50 or 60 cy. Use for any power up to 5000 watts. Output adjustable 110-120 V and holds to ±0.1% at line frequency, or to ±0.25% if line frequency drifts 5%. Regulates against line changes of 95-130 V and against load changes from 0 to 5 KVA. Maximum harmonics less than 3%! Recovery time 0.15 seconds. Input to the control section can be moved to the point where you will use the power, thus compensating for line drop. In rack cabinet 28" h, 22" wd, 15" dp. Net wt 190 lbs. Shpg wt 285 lbs FOB Utica, N. Y. In original factory pack suitable for export, including SPARE PARTS group. Sorensen catalog net price is $695.00 less spares. Our price, WITH SPARES... **$349.50**

It is smart planning to buy this 5 KVA capability even if your present need is for lower power, because: 1. It works just as well at lower power. 2. Price is as low as a 1 KVA unit! (Sorensen's prices, LESS SPARES, are $320.00 for 1 KVA, $460.00 for 2 KVA, $520.00 for 3 KVA, and $695.00 for 5 KVA.)

WRITE for DETAILS on OTHER C-V UNITS

Raytheon unit has harm. filter, output 115 V ± ½% at 7.1 A and 1 other fixed load, $49.50. Following units regulate for any load within ratings: Superior servo-driven Powerstat. 1.2 KVA, $125.00, and 2.5 KVA $150.00; no harmonics in either. Sola 1 KVA at $79.50, 2 KVA w/dual input $147.50. 3 KVA w/dual input and output $167.50. G.E. 2.3 KVA $49.50.

130 DC AMPS at LESS THAN $1.00/AMP

Complete DC power supply ready to plug in and use. Outputs 15 and 30 volts DC at 130 and 60 amps continuous, or 600 and 300 amps intermittent for 100 seconds with 16 such int. operations per hour permissible. Metered for V and A. Input 220 V, 3 ph, 60 cy. Brand new! 550 lbs fob Topeka, Kansas.. **$129.50**

SURPLUS BARGAINS in TEST EQUIPMENT

Gen. Radio 715-AM combination DC Amplifier and VTVM with 1% accuracy. Output 5 ma into 1000 ohms with inputs 8-100 mv and X2, X5, X10. Has 9 calibrated input res. so can be used as mv, uA, or power meter. Input current less than .002 uA. Brand new w/instr. book. G.R. Price $340.00. Our low price only... **$97.50**

Brush BL-905, -913, -932 DC Amplifiers, your choice, certified... **$79.50**

Brush Piezo-Electric-drive 2-pen recorder complete with two tailor-made DC amplifiers, certified and ready to use, the set... **$375.00**

Brush BL-206 6-pen recorder is part of Fairchild REAC Mod. R-101, mounted eye-high on rack cabinet on roller dolly, with all power supplies and differential DC amplifiers, gain-control switches, etc. Certified as new. Fairchild price is $7350.00 Our low price only... **$1500.00**

Gen. Elect. 0-100 Microamp Recorder uses self-contained optical servo amplifier, certified perfect, 1/5 G.E. price... **$295.00**

Write for bargains in other G.E., West., Est. Angus recording DC and AC volt and current meters.

Hewlett-Packard 100-D Low Freq. Standard gives sine waves at 10, 100, 1 K, 10 K, & 100 K cy; rect. waves at 10, 100, 1 K & 10 K cy, w/harm. to 5 mc; and marker pips spaced 100, 1 K, and 10 K u-secs. Accuracy 2 millionths/week. Built in scope, see Lissajous to check count from the 100 KC crystal in oven. Certified. H.P. price $750.00 Our low price only... **$349.50**

Meas. Corp. Mod. 79-B Pulse Generator 60-100,000 cy pulses ½-40 usecs wd, and +sync pulses delayed ½ period. Can pulse-modulate an ext. RF source and can be synced by an ext. sine source. This is the model preceding the current catalog model which sells for $495.00. Good used, Navy reconditioned, fob Seattle... **$49.50**

New in orig. pack, w/instr. book, 40 lbs. fob Harrisburg, Pa... **$97.50**

Meas. Corp. Mod. 80 microvolter, 2-400 mc, as made by the Armed Forces is TS-497A/U. Guaranteed 100% OK, fob Los Angeles... **$349.50**

Meas. Corp. Mod. 84, 300-1000 mc microvolter, certified OK fob Los Angeles... **$179.50**

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Gen. Radio 651-AE oscilloscope recorder, like new, fob Los Ang... **$199.50**

Gen. Rad. 620-A Het. Freq. Meter. W/Harmonics range is 300 kc—300 mc, +.01%. Old cat. price $625.00. Our price, certified... **$199.50**

Gen. Rad. S61-D Vacuum-tube Bridge measures every tube and transistor parameter. G.R. price $850.00. Our price, like new, but less cords and small accessories is only... **$199.50**

Meas. Corp. Mod. 31 Intermodulation Analyzer, excellent cond. only... **$99.50**

Stoddart NMA-5A (TS-587/U) Radio Interference and Field Intensity Meter, 15-420 mc, with tripod, 2 diploles, cords, coupler, 2 cases, and 2 RF heads, in apparently excellent condition, complete... **$499.50**

Test Oscilloscope OS 4B/USM-258 has freq. response ±3 db. 10 cy-8 cm! Pulse rise time less than 0.1 us. 2 sync marker crystals, 10 us or counted to 50 us; and 12.2 us (2 K yards) or counted to 61 us (10 K yds), w accuracy ±.03%. Calibrated range step. Internal sweep 82-820,000 cy, or sync w/ext. sine source 20 cy to 1 mc. Certified, w/Maint instr. book... **$349.50**

DuMont 256B is commercial version of above w/5" CRT, certified, fob Los Ang... **$199.50**

DuMont 294A, w/pwr supply, certified 100% OK, fob Los Angeles... **$249.50**

TS-34/AP combination test and synchroscope, in exc. cond., w/case and 16-page instr. book reprint, fob Los Ang... **$39.50**

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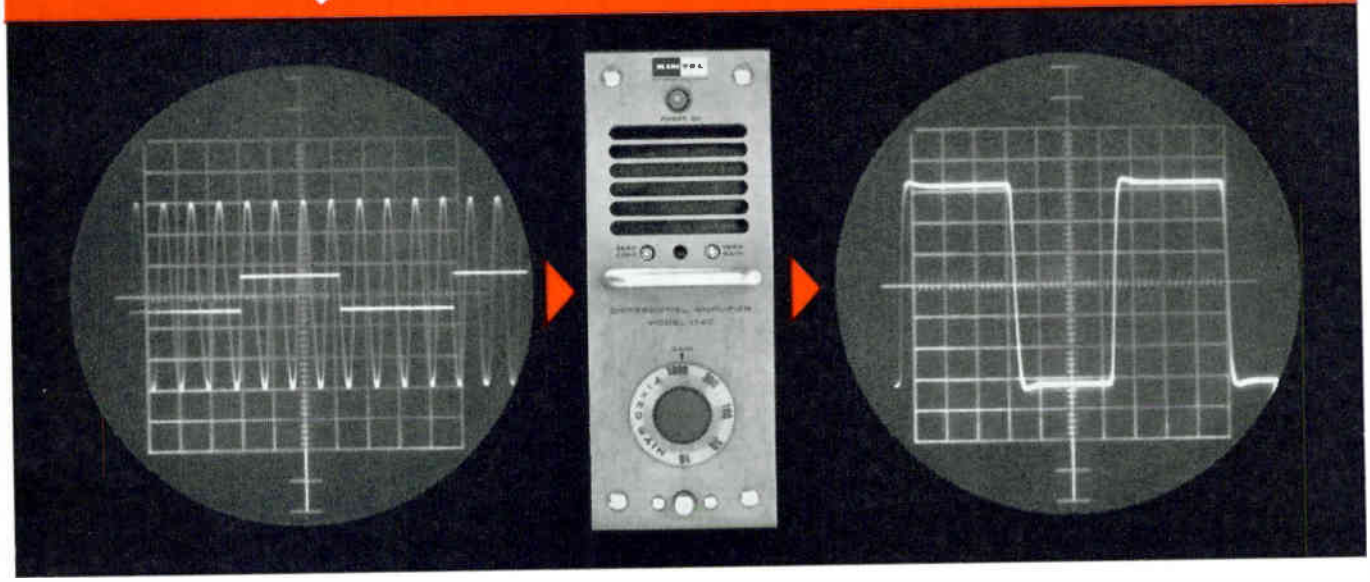
(picture of a KIN TEL differential amplifier at work)

6 volts of 60∿ common-mode noise and
6 millivolts of signal in here

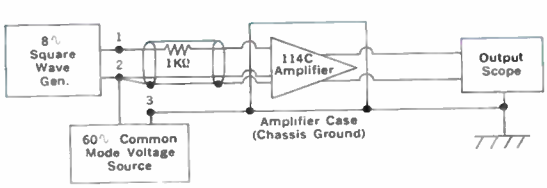
2 microvolts of 60∿ noise (equivalent input)
and 6 volts of signal out here



If you measure the output of thermocouples, and the thermocouples are bonded to a rocket engine or almost any other grounded object, and the distance between thermocouples and amplifiers is more than a few feet, you should consider the above illustration carefully. While we'll admit your thermocouples probably aren't producing square waves, nine chances out of ten you *do* have a problem with 60-cycle common-mode noise. Nearly everybody does.

What can be done about it? Well, KIN TEL differential amplifiers reject ruinous 60-cycle common-mode hum and noise by a factor of 3,000,000 to 1 with any unbalance up to 1000 ohms in series with either side of the input, 1,000,000 to 1 with 10,000 ohms unbalance. Rejection for DC is practically infinite and both input and output can be floated up to ±300 volts DC or peak AC. The secret of this exceptionally high common-mode rejection in the presence of high input unbalance is isolation. Input signal terminals are isolated from chassis ground by 10,000,000 megohms and 0.6 micromicrofarads. Input and output signal terminals are completely isolated from each other. Output signal terminals are isolated from ground to almost the same extent as the input. With this virtually perfect isolation, you can rescue microvolt level signals from volts of common-mode noise, regardless of whether load and transducer are floating or grounded, balanced or unbalanced.

Before you send us that letter... the input scope photo is a double exposure. The square wave input signal was taken with the scope connected across points 1 and 2 (see drawing below) with 5 mv/division sensitivity. To show the noise, the scope was connected between points 2 and 3, and sensitivity was 1 v/division. The scope on the output was set for 1 v/division sensitivity and, of course, no noise is evident.



Specifications other than common-mode rejection are equally impressive. Linearity is 0.01% of full scale (10 volt) output for either polarity, 0.02% of full scale for plus-to-minus or minus-to-plus polarities. Equivalent input drift is less than 2μv; noise at full amplifier bandwidth is less than 6μv. Input impedance is 30 megohms, output impedance less than 0.25 ohms. Standard bandwidth is less than 3 db down at 80 cps, and the amplifier settles to within 99.9% of final value within 50 milliseconds for an output change of 5 volts. Plug-in input and output filters allow bandwidth options from 3 cps to 120 cps, transient response as good as 25 milliseconds. Gain is 10 to 1000 in 5 steps. A front panel vernier control provides 1 to greater than 3.3 times continuous adjustment of each gain step. Gain stability is ±0.05%. Output capability is 10 volts at 10 milliamps. Amplifiers have integral power supplies. Enclosures include six-amplifier and single-amplifier 19-inch rack modules, and portable single amplifier cabinets.

To meet your exact requirements at minimum cost, two models are now available: the 114A at $775, and the 114C (described) at $875. Delivery on both models is currently from stock. Write for detailed technical data or a demonstration. Engineering representatives in all major cities.

KIN TEL
A DIVISION OF
COHU
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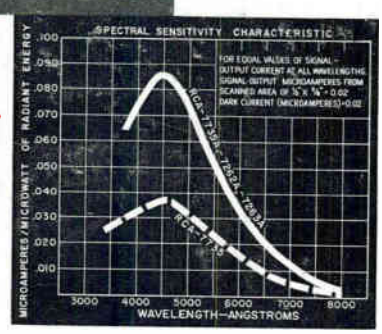
5725 Kearny Villa Road, San Diego 11, California
Phone: BRowning 7-6700

Unequalled Light Sensitivity and Low Lag

New RCA photoconductor utilized in world's most sensitive vidicons



Now, an RCA exceptionally sensitive photosurface ushers in a new family of advanced vidicons unequaled anywhere for their light sensitivity and closely-controlled characteristics.

The RCA-7735-A—double the sensitivity of the 7735—provides good pictures at lower light levels with less lag than previously possible! This sensitivity and the tube's lower "lag" make the 7735-A ideal for industrial use.

Two short-length vidicon types featuring the same sensitivity as the 7735-A are offered for use in compact transistorized cameras. RCA-7262-A is intended for normal outdoor-indoor environments. RCA-7263-A is especially designed for military or other applications involving shock, vibration, humidity, and altitude. Both types operate at 30% less heater power than any other commercially available type of vidicon.

All three of these advanced camera tubes feature a resolution capability of 600 to 900 lines, broad spectral response, and the high tube-to-tube uniformity that has become identified with RCA vidicons.

For complete information about these RCA vidicons—the most sensitive in the world—get in touch with: Marketing Manager, Industrial Tube Products, RCA, Lancaster, Pa. For a technical bulletin on any of these types, write Commercial Engineering, Section K-19-Q-2, RCA, Harrison, N.J.

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