

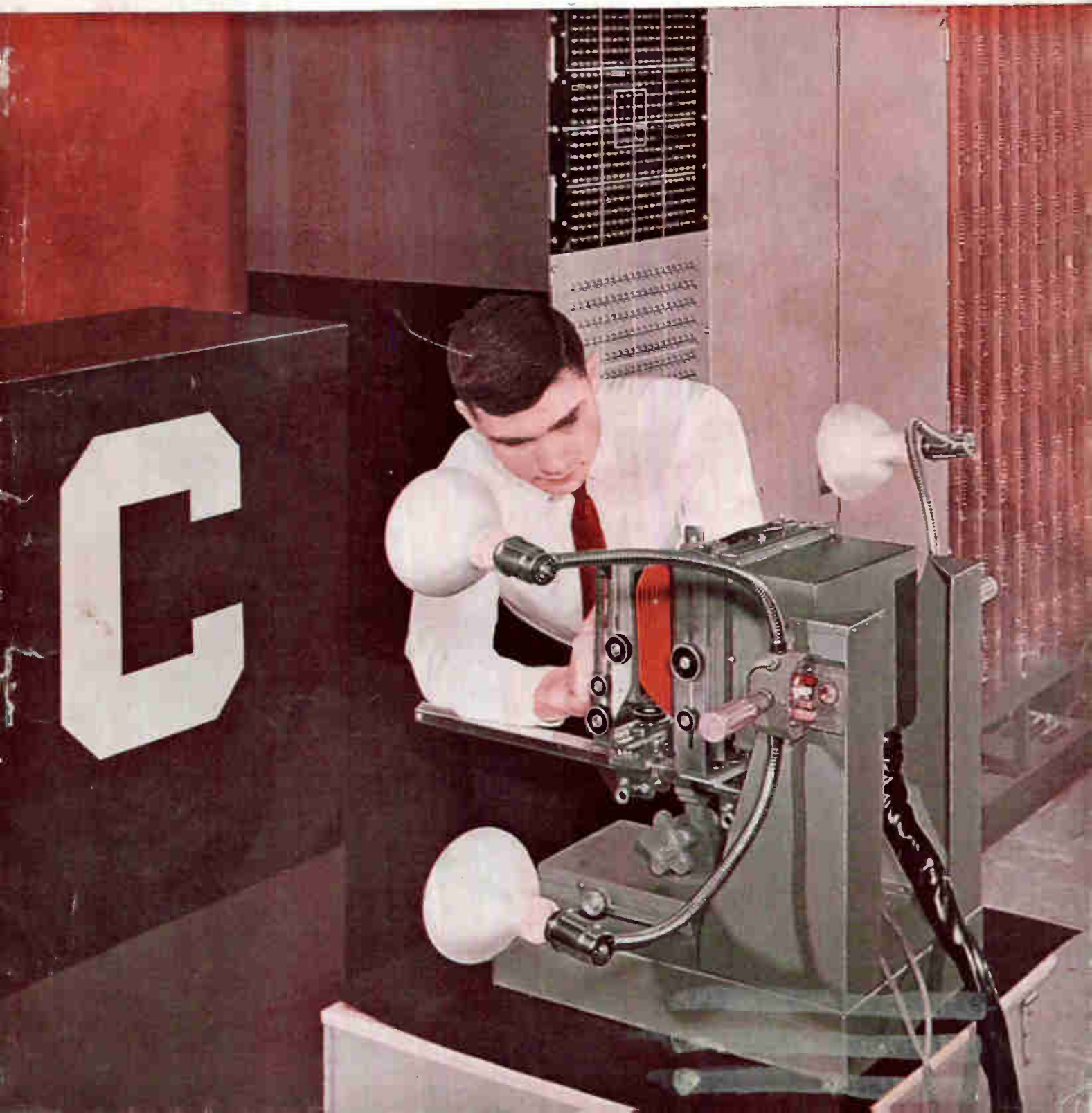
July 22, 1960

# electronics

*The perceptron is helping man understand how his brain works.*

*Thought processes are simulated electronically as the machine is taught to recognize letters of the alphabet. See p 56*

A McGraw-Hill Publication 75 Cents



Call your  rep today for a demonstration of one of these

# 3

## POPULAR






# OSCILLOSCOPES






Production or lab instruments—Simple to use, even for non-technical personnel—Moderately priced—Full 10 cm x 10 cm display—Automatic calibration waveforms—Low phase shift—Automatic triggering for optimum presentation—"Times-5" sweep expander magnifies trace, improves resolution.



## DC to 200 KC

Models 120A/AR combine minimum controls with  automatic triggering for utmost speed, convenience. Horizontal amplifier dc to 200 KC; phase shift only  $\pm 2\%$  to 100 KC. More X-axis information due to horizontal amplifier sensitivity control, with vernier, 5% accuracy. Balanced input on most sensitive ranges for low level work. Times-5 sweep expander, all ranges. 15 calibrated sweep speeds, 5  $\mu\text{sec}/\text{cm}$  to 0.2 sec/cm. Vernier, expander extend speed range 1  $\mu\text{sec}/\text{cm}$  to 0.5 sec/cm. 10 mv/cm sensitivity calibrated vertical amplifier, drift-free trace.  120A (cabinet) or  120AR (rack), \$435.


## DC to 200 KC—DUAL TRACE

Models 122A/AR provide simultaneous two-phenomena presentation, are ideal for direct comparison of filter, amplifier output/input phenomena; vibration testing. Unique  front-panel automatic calibrator waveform switch. Twin vertical amplifiers operate independently, simultaneously, differentially. Automatic triggering, automatic synchronization, single trace operation when desired. Sensitivity 10 mv/cm to 100 v/cm, 15 calibrated sweeps, vernier extension. Horizontal amplifier dc to 200 KC.  122A (cabinet) or  122AR (rack), \$625.

## DC to 300 KC—"BIG SCOPE" PERFORMANCE

Models 130B/BR provide wide usefulness, simple operation and rugged dependability. 21 calibrated sweep times, 1  $\mu\text{sec}/\text{cm}$  to 5 sec/cm. Vernier, expander extend range 0.2  $\mu\text{sec}/\text{cm}$  to 12.5 sec/cm. Twin horizontal and vertical amplifiers, phase shift  $\pm 1^\circ$  to 50 KC; sensitivity 1 mv/cm to 125 v/cm. Balanced input on 6 most sensitive ranges. Common mode rejection 40 db. Stability 1 mv/hour after warmup. Triggering automatic, internally, line power, externally, 0.5 v or greater.  130B (cabinet) or  130BR (rack), \$650.

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

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 oscilloscopes,  
dc to 1,000 MC



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# electronics

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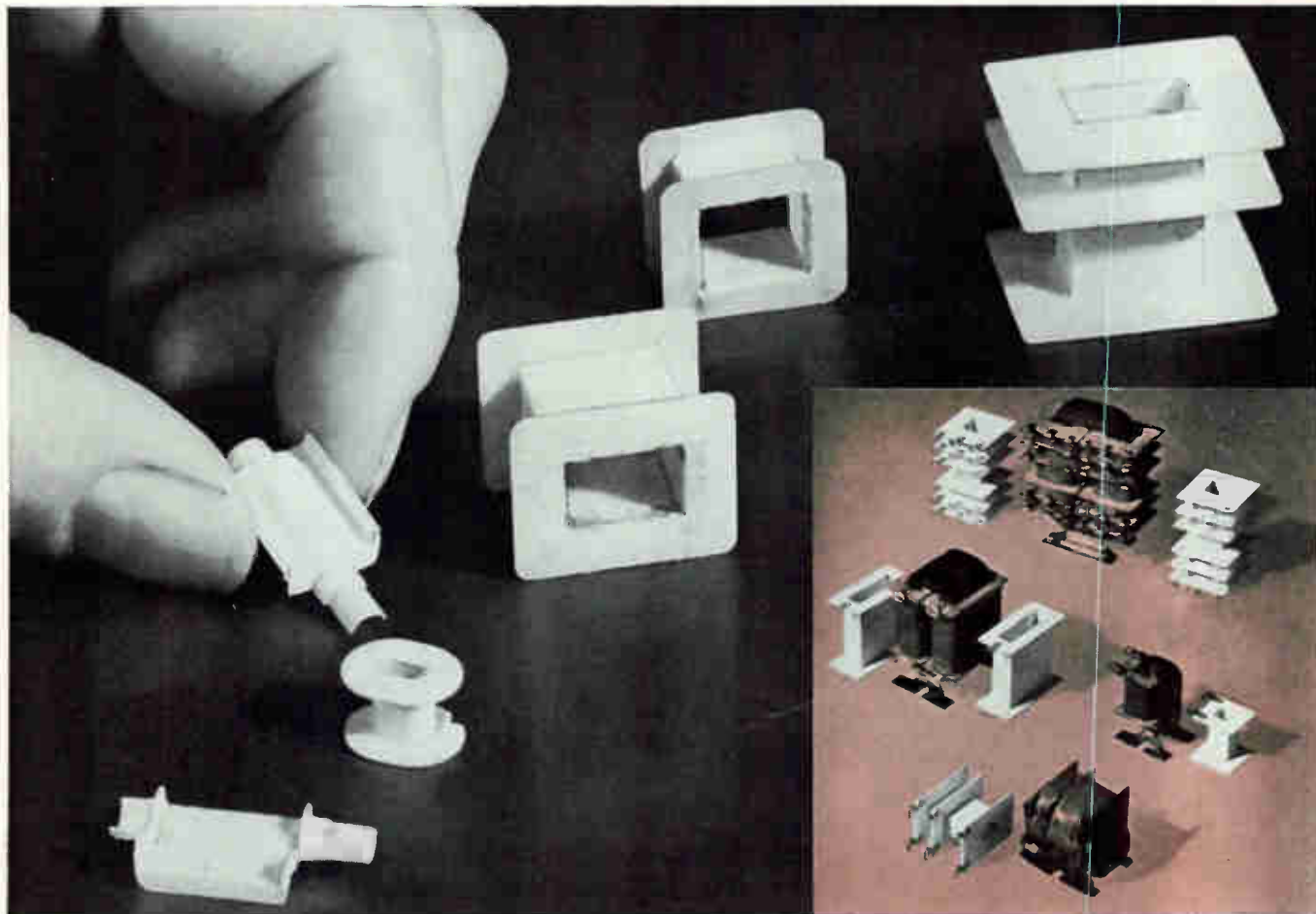
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# When Miniaturizing



## Design Problems Are Simplified With Silicone-Glass Laminates

Miniaturization means heat. Heat that has to be dissipated from smaller surface areas. Temperatures go up — and materials like Dow Corning Silicones come into their own!

Take silicone-glass laminates, for example. At high temperatures they have dielectric properties that are superior to those of other laminated materials. In addition, silicone-glass laminates have excellent resistance to ozone, arcing, corona, and fungus attack . . . even the formidable combination of high humidity and high voltage.

Mechanical strength is good — permitting thin, rigid coil bobbin walls, more winding space and better resistance to winding pressure. One-piece laminated coil bobbins, like those shown, are used in continuous operation at 250 C, have been tested at 400 C for 1,000 hours. This high temperature resistance means soldering heat doesn't loosen terminals.

These are reasons why the Foster Transformer Company, Cincinnati, Ohio, specifies coil bobbins of silicone-glass laminates for transformers they manufacture. Multi-flange coil bobbins simplify manufacture of computer power transformers. Used in airborne guidance control systems (top of insert), they weigh only .85 pounds each. This transformer, the filter chokes (center) and output transformer (bottom) all have coil bobbins made from silicone-glass laminates . . . are impregnated with Dow Corning silicone varnish to assure reliability of lightweight miniaturized designs.

Glass laminates made with Dow Corning Silicones are available from leading laminators. Write for a list!

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For "Silicones for the Electronic Engineer", Write Dept. 3507.



**Dow Corning**



# ... Specify Silicones

## For Constant Capacitance

Dow Corning silicone fluids are, in themselves, excellent dielectrics. In capacitors and RF filters, silicone fluids boost the performance of the paper dielectric . . . substantially increase permissible operating temperatures, decrease electrical losses. Highly stable to changing environments, silicones show little drift in electrical or physical properties over a broad range of temperature and frequency conditions . . . often eliminate costly compensating circuit. To assure an almost constant capacitance vs. temperature relationship for their specialty capacitors . . . and the lowest possible power factor for their RF interference filters . . . The Filtron Co., Inc., of Flushing, N. Y., impregnates their RF interference filters and capacitors with Dow Corning silicone fluid.



CIRCLE 290 ON READER SERVICE CARD

## Silastic RTV Packages . . . Protects

Built by Vitro Laboratories, Silver Spring, Md., this pre-amplifier consists of a vacuum tube and three transistor stages containing a total of twenty-five parts. Design specifications called for a package no larger than 1-7/16" diameter by 5" . . . plus operating requirements of high insulation strength, heat stability, resistance to shock, vibration and moisture. These were met conveniently and easily by mounting the components on a printed circuit board, encapsulating the unit with Silastic® RTV, the Dow Corning room-temperature vulcanizing silicone rubber.

Silastic RTV is poured over the unit until the mold is completely filled. It exerts a firm grip on components, eliminating clamps and brackets . . . soaks up shock and vibration, dissipates heat, locks out moisture.



CIRCLE 291 ON READER SERVICE CARD

## To Save Space . . . Cut Weight

Airborne Accessories Corporation, Hillside, N. J., uses a variety of miniaturization techniques in designing power drives for actuators and other devices. One of their most important tools in making smaller, more reliable drive motors is silicone insulation, including Dow Corning Silicone Varnish impregnation. Its use on these high performance motors assures utmost reliability under almost continuous on-off-reverse operation . . . helped designers provide up to 50% more power per pound.

This 400-cycle silicone insulated actuator motor has a 4.25 inch frame, weighs only 13.2 pounds with brake, is rated 2.5 hp, 11,000 rpm continuous duty; to 6 hp, 9,000 rpm intermittent duty.



CIRCLE 292 ON READER SERVICE CARD

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## CROSSTALK



**ELECTRONICS AT SEA.** A schoonerborne artificial lightning generator for vlf propagation studies is the subject of an article in this issue by M. M. Newman, J. R. Stahmann and J. D. Robb of the Lightning & Transients Research Institute, and E. A. Lewis of the Air Force Cambridge Research Center. The generator is carried on the schooner *Azara*, which is shown in the accompanying photograph as it appeared before modification for research. The center mast was removed (see p 53) to make room for the generator amidships.

**NUCLEAR MISCHIEF.** For a while, it seemed that all the electronics industry had to do was keep its equipment out of the blast and heat of nuclear explosions, or the intense flux dosages of nuclear piles, and everything would be all right. But recent experiments have demonstrated that even outside the permanent-damage area, transient values of gamma and neutron radiation can cause intermittent and perhaps permanent malfunction in electronic gear. The high peak values of gamma radiation that emerge in the first microsecond of a nuclear explosion, for instance, could upset the electronic controls in radars, computers, missiles and navigation gear miles farther out than we used to think possible.

It's a sobering thought, with serious ramifications in the technology of computers, missile controls and defense electronics. Several of the research reports in this area have recently come our way, and we've boiled them down in the story on p 40.

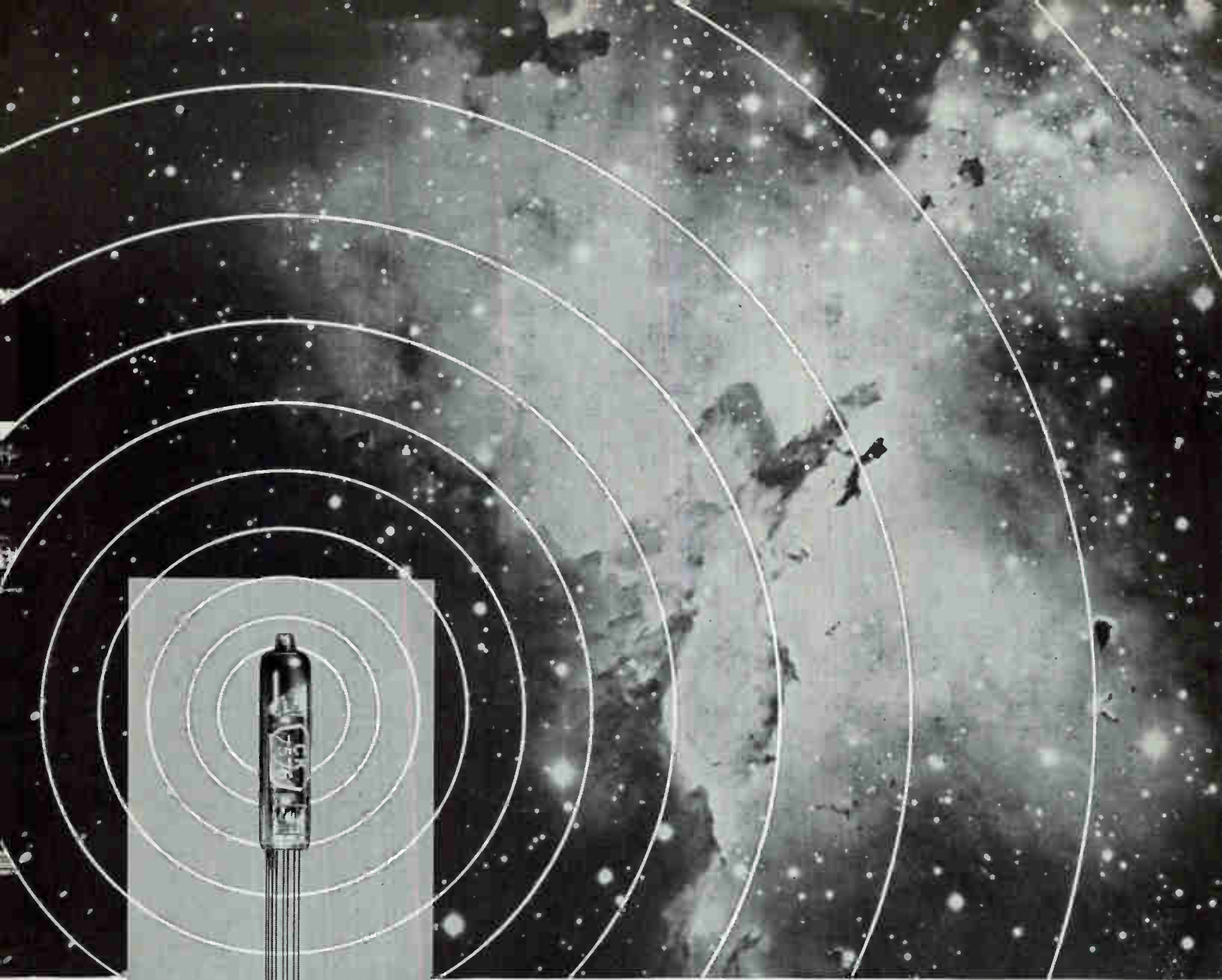
### Coming In Our July 29 Issue

**SPECIAL REPORT.** In recent years, more and more electronic engineers have found themselves drawn into areas of scientific research once regarded as the province of specialists such as astronomers, meteorologists and oceanographers. The increasing complexity of experiments being performed to study our environment has led to a need for advanced electronic equipment. Some recent examples in **ELECTRONICS** are Television System for Stratoscope I (p 49, June 17), Uses of Sonar in Oceanography (p 93, June 24) and Remote Preamplifiers for Under Ocean Work (p 60, July 8).

Next week's issue contains a Special Report designed to acquaint you with some of the problems facing science today and the manner in which our industry is being called upon to help solve them. To bring you this report, Associate Editor Bushor and Assistant Editor Wolff contacted government agencies, scientific and academic institutions, and industry to find out how electronic equipment is being used to probe nature. As a result, you'll read about the techniques for probing space, our atmosphere, the earth, the oceans, and living matter.

A center foldout tabulates the instrumentation for the successful space probes and satellites. A world map locates 90 radio astronomy facilities, as well as the major U. S. oceanographic facilities and seagoing research ships. We believe this useful and informative survey successfully captures the scope and excitement of man's growing quest to learn more about his environment. You won't want to miss it.





**CK7576 CHARACTERISTICS  
AND TYPICAL OPERATION:  
235Mc GROUNDED GRID  
RF AMPLIFIER**

Filament Voltage . . .  $6.3 \pm 5\%$  volts  
Plate Voltage . . . . . 200 volts  
Cathode Resistance . . . 150 ohms  
Peak RF Grid  
to Cathode Voltage . . 14 volts  
Grid Current . . . . . 10 mAdc  
Plate Current . . . . . 37 mAdc  
RF Driving Power  
(Approx.) . . . . . 0.5 watts  
Useful Power Output . . 3.25 watts



## Raytheon CK7576 Helps Keep Space Probes Sharp

Effective missile operation depends on compact, reliable telemetering made possible by components such as the CK7576.

The Raytheon CK7576 is a subminiature triode providing over 3 watts output at 235Mc in grounded grid RF power amplifier service. It offers designers of spaceborne telemetering equipment the advantages of excellent isolation between input and output circuits, high transconductance, high amplification factor, and impressive power-handling capabilities.

If your area of design interests includes airborne communication and navigation applications make it a point to investigate the CK7576 as well as the other versatile types in Raytheon's full line of subminiature tubes. For technical information, please write to: Raytheon, Industrial Components Division, 55 Chapel St., Newton 58, Massachusetts.

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# RAYTHEON COMPANY

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in compact  
unified cooling  
packages*



**Dean & Benson**, through their Project X-5000, have researched and developed advanced techniques in packaged cooling with compatible system designs. This new D & B approach means single source with single responsibility so that all units in the package work together for highest efficiency and performance.

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Division of Benson Manufacturing Co., Kansas City 1, Mo.

• Blowers • Heat Exchangers • Cooling Systems

## COMMENT

### Cableless Power

Recently read in a Russian publication called *Technical Practice* a report that by 1985 (significant date), power will be delivered to homes in all large towns and cities in Russia through a transmission network that will employ neither cables nor wire. Starting in 1965, the magazine says, special reception transformers about the size of a watt-hour meter will start going into new housing in the Moscow suburbs.

The Russians are apparently going to hang onto conventional interior wiring for the time being, with the so-called reception transformer picking up the power for a house or a whole building. Later on, the plan seems to be to dispense with wiring and fit out sockets with miniature receiver units.

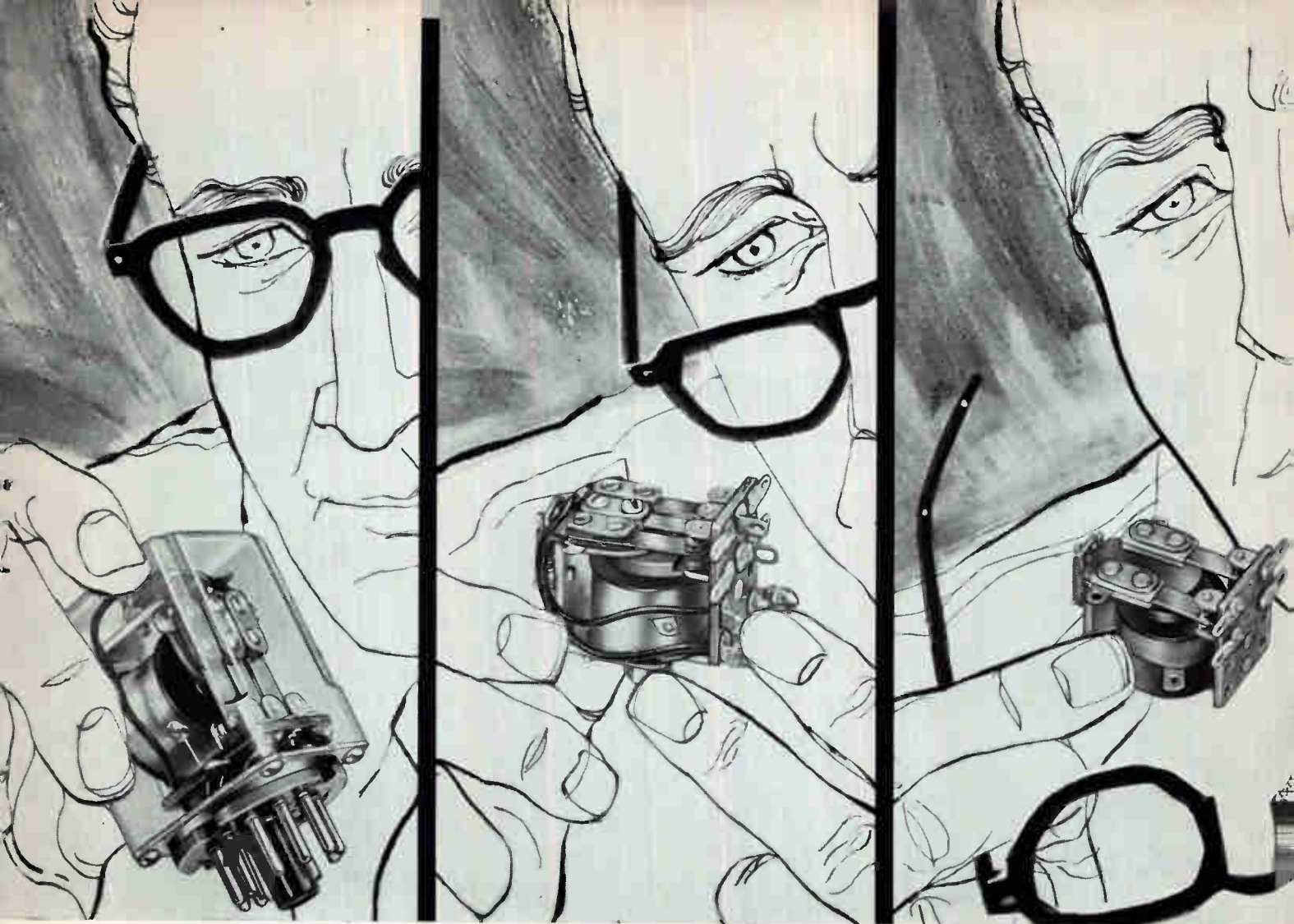
This development has apparently been going on for about six years in the Soviet Union. Significance seems to me that millions of tons of copper will be saved by setting up such a central transmission system for utility power, and that the electronics industry will get a boost into an area not hitherto explored.

Do you know of any similar work being done in the U. S.? I should think the electric utilities would be busy developing such a system.

E. O. FEENEY

HATFIELD, HERTS.  
ENGLAND

Our World News service has kept us informed about this Soviet engineering development, which was apparently first disclosed in 1955. At that time, the Russians themselves washed the experiment out as a failure, according to Swedish observers. The idea has been bandied about in the U. S. ever since Tesla, but there are several points to be weighed. At frequencies best suited for efficient power transmission, antenna systems are tremendous and expensive. Efficient antennas in the vlf and l-f portions of the spectrum, for instance, could hardly be put inside a conventional watt-hour meter, although recent advances in the ferrite technology make it



KCP SERIES

KT SERIES

KR SERIES

## three for dependability at low cost

### MEET P&B's FAMILY OF "K SERIES" RELAYS

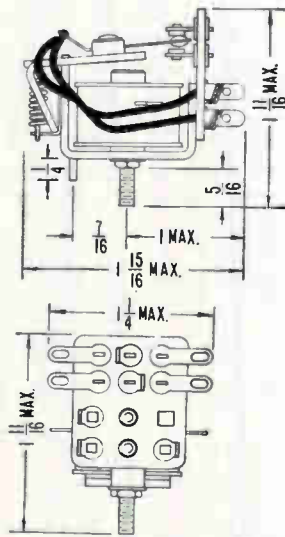
Here are only three of a large family of "K Series" relays by P&B. Blood brothers all, they are distinguished by fine craftsmanship and design maturity. Together they will handle a multitude of switching requirements.

Many design engineers find it saves time, saves money to integrate their circuits with related P&B relays. Makes sense, doesn't it?

**KR**—A small, lightweight relay used widely in communications and automation. Engineered for long life and dependability. 3PDT max. AC or DC. (See engineering data.)

**KT**—Designed for antenna switching. Capacitance: 0.5 mmfds between contacts. Terminal board is glass melamine and stack insulation is glass silicone for minimum RF losses to switch 300 ohm antenna line. 3 PDT max. AC or DC.

**KC**—Low cost plate circuit relay with sensitivity of 125 mw per pole. Factory adjusted to pull-in on specific current values. Available open, hermetically sealed or in clear plastic dust cover with standard octal-type plug. 3 PDT max. DC.



#### KR ENGINEERING DATA

**GENERAL:**  
Breakdown Voltage: 500 volts rms minimum between all elements.

**Temperature Range:**  
DC Coils—45°C to 85°C.  
AC Coils—45°C to 70°C.

**Terminals:**  
Pierced solder lugs standard. Octal 8 and 11 pin plug-in headers available.

**Enclosures:** Type K—Hermetically sealed.  
Type P clear cellulose acetate dust cover.

**CONTACTS:**  
Arrangements: 3 Form C (3PDT) max.  
Material: 1/4" dia. fine silver (gold plated).  
Other materials available to increase contact capacity.  
Load: 5 amperes 115V 60 cycle resistive.

**COILS:**  
Resistance: 16,500 ohms max. AC or DC.  
Power: 1.1 watts minimum to 4 watts maximum for DC at 25°C ambient.

**Duty:** Continuous.  
**Insulation:** Centrally impregnated with insulating varnish.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



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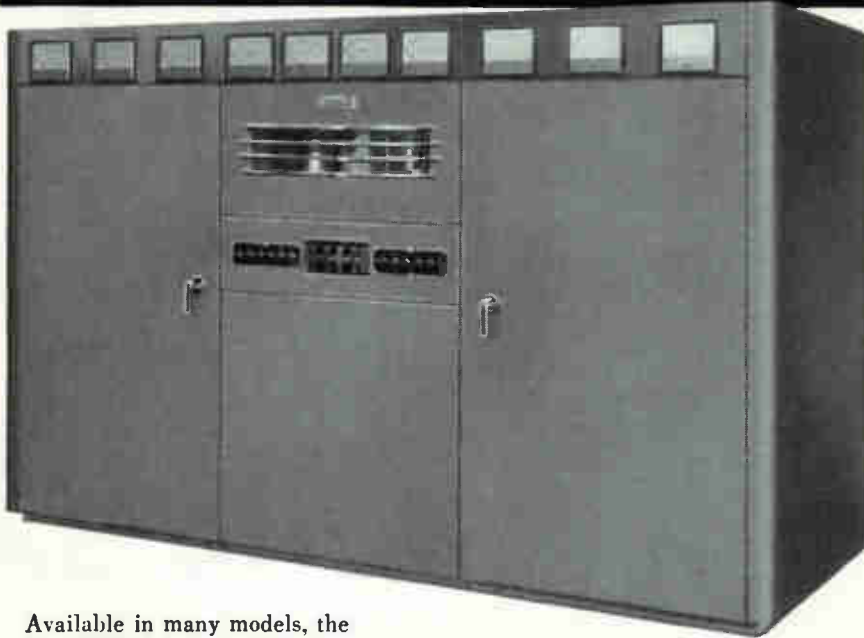
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# dependability

**GATES**

## 10,000 watt High Frequency Transmitter



Available in many models, the Gates HF-10 series of 10,000 watt transmitters are designed for true commercial application and where the key note is *dependability*. They have passed maximum government environment tests of high temperature and humidity without a single modification even though this specification was not considered in the initial design.

Whether for 50 or 60 cycle use, all power components are conservatively designed for 50 cycles. With 20% excess safety factor at 50 cycles, this offers a 38% excess safety factor at 60 cycles.

There are so many *engineer appealing* features in this famous Gates series of transmitters, and such an illustrious list of world-wide industrial and government users, that we feel those not yet acquainted with them will wish our latest catalog. This catalog (available without cost where requested on your letterhead) also lists other transmitters from 50 watts to 100,000 watts.

### Models

- ... 10,000 watt high speed telegraph with or without FSK.
- ... 10,000 watt high level modulated telephone (200-3500 cycles) and with or without telegraph feature.
- ... 10,000 watt short wave broadcast (30-10,000 cycles) and with or without telegraph feature.
- ... All models available with oil-filled or dry type power components, as desired.
- ... Three frequency range models: (a) 2-22 mc, (b) 4-30 mc, and (c) specified frequencies.

*Most models are usually available from stock to fill emergency needs.*

**GATES**

**GATES RADIO COMPANY**

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more feasible to design smaller low-frequency antennas.

At higher frequencies—in the h-f, vhf, uhf, shf or microwave regions—cheap and efficient antenna systems are more readily engineered, but other considerations intervene. Absorption in the atmosphere becomes a problem. And the biological hazards of large r-f fields become serious whenever the human body is a significant portion of the wavelength.

### Mass Recruitment

Let us hope the trend spotted in your June 3 issue in the article on recruitment ("Mass Engineer Recruitment Declines," p 40) will continue. It's time this industry began practicing more conservative personnel standards. One benefit that could come from this may be a change in the purpose of some of the big industry conventions, where the extravagant promises aimed at getting engineers away from their employers serve only to detract from the serious matters that should occupy these occasions.

C. J. REUBER

CHICAGO, ILL.

### A Lot of Difference

We were very pleased to see our article "Measuring Switching Speed of Magnetic Films" (p 79, June 3) in *ELECTRONICS*, and to see a picture of our equipment on the cover.

Unfortunately, our Research and Engineering Information department in New York obviously overlooked correcting a few technical faults in the galley proofs. In the text, all switching times, delay times and resolution times should be given in nanoseconds, and not in microseconds as printed. In the figure captions, these time dimensions are all correct, apart from Fig. 4C, where the indication on the vertical axis should be corrected to

$$1/T \text{ for } T \text{ in sec}^{-1}$$

We should be extremely obliged if you could possibly insert an errata note in a forthcoming edition of *ELECTRONICS*, as a scale factor of 1,000 certainly makes a lot of difference!

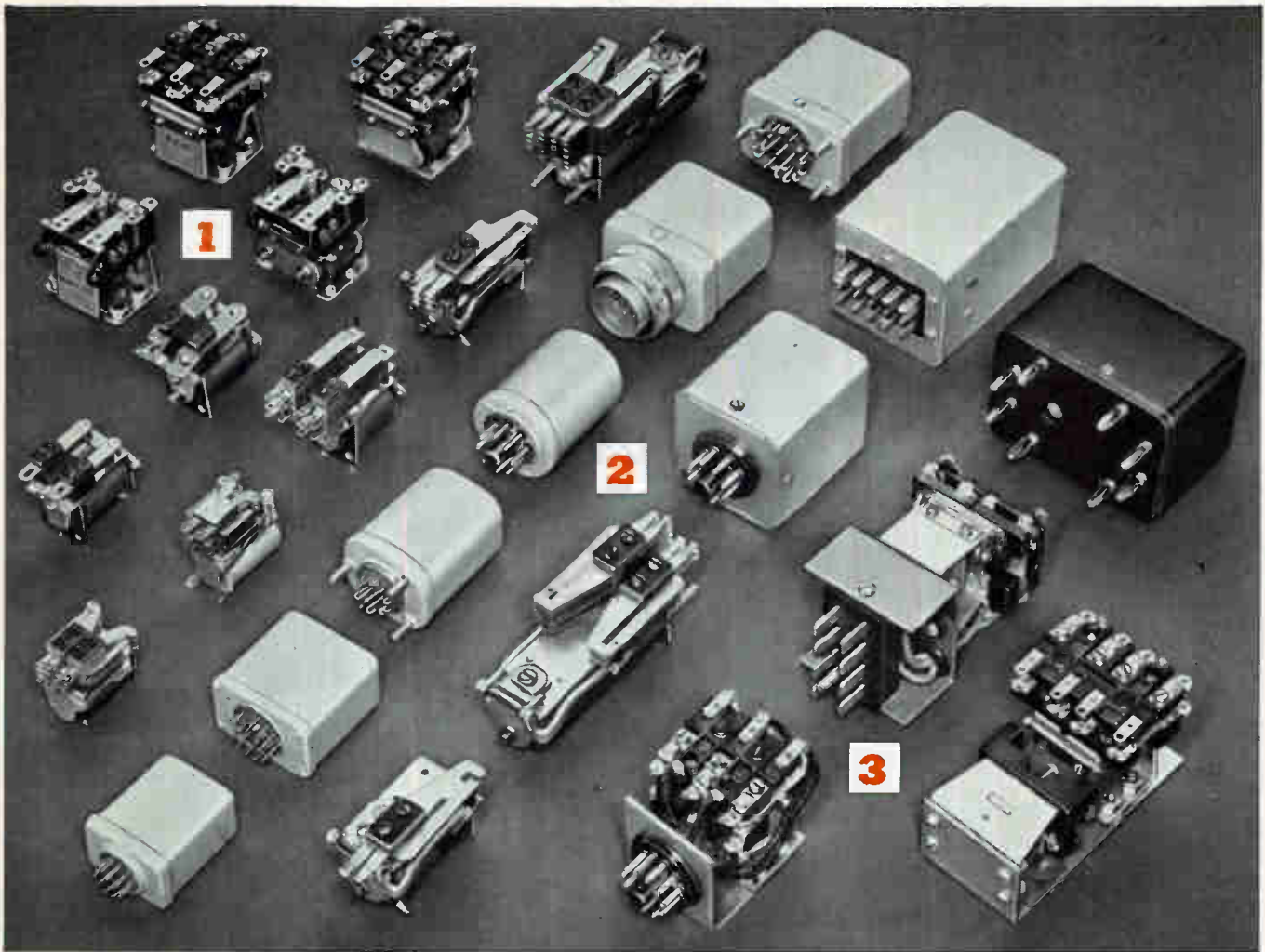
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# specify **OHMITE** Relays for Reliability



1. Eleven Standard Models

2. Typical Relay Enclosures

3. Relays with Special Construction

## EXCLUSIVE! Contact Combinations on New Ohmite Relays Are MOLDED\*

Permanence and ease of adjustment of the individual contact springs are the result of a revolutionary, new innovation found in two new Ohmite Relays—Models TT and TS. This innovation is the unique "Molded Module" contact spring construction. The "module" is a standard, single-pole, double-throw spring combination molded into a single compact assembly. As many as six modules can be incorporated into a relay.

*\*(Pat. Applied For)*

**QUALITY CONSTRUCTION**—All Ohmite relays embody the same meticulous engineering, strict quality control, and generous use of high quality materials which have made Ohmite components the standard of the industry. Parts are plated where necessary for corrosion resistance. Springs are of nickel-silver or phosphor-bronze. Contacts are fine silver. Special contact materials, such as silver, tungsten, palladium, or gold alloy, can be supplied. Protection against humidity and moisture is paramount and is accomplished in layer-wound coils, through complete sealing with cellulose-acetate. Relays are available in a wide range of coil operating voltages and contact combinations in both AC and DC types.

**65 TYPES IN FOUR STOCK MODELS**—For fast service, four

models in the Ohmite relay line are carried in stock in 65 types at the factory, and by Ohmite Distributors from coast to coast.

**HERMETICALLY SEALED AND DUST-TIGHT RELAYS**—You can specify many of the basic Ohmite relays in nonremovable, hermetically sealed enclosures for applications requiring complete relay protection. These high-quality relays are sealed in seamless steel enclosures which are exhausted and filled with dry, inert gas under control of Ohmite engineers. Ohmite hermetically sealed relays are available with either plug-in or solder terminals. Relays are also made with nonremovable dust-tight covers and removable dust covers.

**RELAYS WITH SPECIAL CONSTRUCTION**—Ohmite relays are available with special terminals or special construction, such as relays with push-on or screw terminals, relays with binding-post terminals. Where quantities warrant, Ohmite will manufacture relays made to your specifications. Ohmite can furnish not only special terminals, special contact combinations, contact materials, and coils but also special enclosures, connectors, impregnation, or frames. Ohmite relays can be engineered to meet your special pull-in, drop-out, or time-delay requirements.

*For your special or unusual relay applications, let Ohmite's experienced engineers help you work out the best solution.*

Write on company letterhead for Catalog and Engineering Manual 58.



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DIODES

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Sierra offers you now



**Model 160 50-ohm Coaxial Loads**

Now including Models operating to 11 KMC, Sierra 160 Series low VSWR terminations may be used when stable 50 ohm loads are required. Featuring rugged design, high stability at full rated power, the loads have a typical VSWR of 1.2. All models are air-cooled and complete shielding insures personnel safety. Models with power capacities of 1, 5, and 20 watts are available with N, C and BNC connectors. 100 and 500 watt models are provided with Type N connectors. \$20.00 to \$170.00.



**Model 185A Average-Reading Termination Wattmeters**

Sierra 185A series are particularly useful in terminating rf coaxial transmission systems, measuring average powers between 20 and 1,000 MC, and as dummy loads for testing and adjusting CW and FM transmitters and oscillators. Three models with maximum power dissipation of 15, 100 and 500 watts, and power ranges of 0 to 5/15, 0 to 30/100 and 0 to 150/500 watts, respectively. Accuracy is  $\pm 5\%$  and VSWR is 1.2. Female Type N connectors. Model 185A-15FN, \$170.00; 185A-100FN, \$260.00; 185A-500FN, \$315.00.



**Model 164A Average Power Monitors**

Sierra 164A Series Bi-Directional Power Monitors are now available with plug-ins down to 2 MC. Four plug-ins provide full scale ranges of 1, 5, 10 and 50 watts through frequencies 25 to 1000 MC. Two medium-power units provide full scale ranges 10, 50, 100 and 500 watts, 25 to 1000 MC. Two high-power units provide full scale ranges of 50, 100, 500, 1000 watts, 2 through 75 MC. Model 164 is now available with Type N, C, HN, UHF and LC connectors. Model 164, \$115.00; plug-ins, \$70.00 to \$170.00.

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



**Model 194A-A Bi-Directional Peak Power Monitor**

Covering the range 200 to 1,215 MC, Sierra 194A-A Peak Power Monitor offers two important, time-saving features—peak power is read directly without computation and a reversible directional coupler permits incident or reflected power readings simply by turning one knob. Peak powers to 30 Kw are covered in 4 ranges. Measurement accuracy is  $\pm 10\%$  full scale at pulse widths down to 0.1  $\mu\text{sec}$  or repetition rates as low as 10 pps. Minimum duty cycle 0.04% for specified accuracy. \$460.

The Sierra logo, featuring a stylized orange 'S' with a white outline, followed by the word 'Sierra' in a bold, black, sans-serif font.

For complete details, see your Sierra Representative or write direct.

**SIERRA ELECTRONIC CORPORATION**

*A Division of Philco Corporation*

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6561



# ELECTRONICS NEWSLETTER

## Seek Ray to Disarm Nuclear Warheads

MICROWAVES, infrared, atomic particles and X-rays are under consideration as energy media for a "death-ray" to destroy incoming missiles. Varo Mfg., Garland, Tex., is one firm working on the secret project for Department of Defense, has reportedly proved the feasibility of using microwave energy to abort missile missions.

Defense scientists say they don't want to burn the missile up, but merely to create a chemical or physical change to render atomic warheads harmless (see **ELECTRONICS**, p 36, May 13).

In other developments:

Boeing copped a \$247-million contract for R&D on Minuteman solid-fueled ICBM, making definite an earlier letter contract.

ITT's Federal Electric Corp. takes over operation and maintenance of the 60 Dew-line radar warning stations under \$40.8-million USAF contract.

RCA Service Co. will take over management of the USAF Alaskan long lines system (White Alice) under a \$5.3-million contract.

Magnavox will develop new radars and radar indicators for Bureau of Naval Weapons. Classified contracts total \$32.5 million.

## Survey Suggests Research Is Key to Growth

RECENT SURVEY of small and middle-sized electronics firms indicates the need to develop new products and processes to maintain growth.

The survey was taken by an investment firm, covered 25 companies responsible for about a third of total electronics industry sales in 1958. It was conducted with the idea of obtaining, for a series of years, R&D statistics for purely electronics companies comparable to standard indices of capital expenditures and sales.

Sales of the 25 companies increased 36 percent between 1955 and 1958, as compared with an 11-percent rise for the electronics industry as a whole during the same

period. Research and development spending consistently exceeded outlays for capital equipment by about 50 percent.

Capital expenditures were practically the same in 1958 as in 1957 (averaging 6 percent of sales); the percentage is rising slowly. Expenditures for research and development increased yearly and topped 9 percent of sales in 1958. Estimated R&D spending level for 1960 is over 10 percent of sales.

## Journeyman Test Will Use Miniature Telemeter

MINIATURE TELEMETERING SYSTEM designed by Space Electronics Corp., Glendale, Calif., will be used by Air Force in forthcoming flight of the Journeyman sounding rocket.

The system, called Digilock, will telemeter data on radiation and other phenomena during the entire 15-hour flight, coming into operation three minutes after the nose cone separates.

Circuits occupy a total volume of 54 cu in., consist of a 250-mw transmitter weighing half a pound, coding unit weighing one and a half pounds. Total power drain from the 1½-lb power pack is 3½ w.

System is designed to handle multiple-signal analog or digital data electronically commutated by the encoder. Rate of data transmission will be either 64 or 256 bits a second, depending on requirements.

## System Gives Commanders Precise Position Data

BATTLEFIELD POSITION-fixing and navigation system that will enable a field commander to keep track of all his units, including aircraft, ground vehicles and foot soldiers, will be built for Army by Bendix.

The system comprises a chain of four ground-based transmitting stations, mobile receivers, and a chart construction and reproduction unit. Transmitting chain comprises a master and three slave stations, all on different frequencies.

Lightweight, accurate system operates in the l-f portion of the spec-

trum, can be set up and in operation within five hours. Using hyperbolic techniques, the equipment can cover a 150,000-sq-mi area, operates day or night in all weather. Receivers are designed for use by foot soldiers, vehicles on either ground or water, and fixed or rotary-wing aircraft plus any number of receivers.

## European Tv Sets Use U.S.-Made Picture Tubes

SEVERAL EUROPEAN tv-setmakers are putting Sylvania 23-in. bonded-shield tv picture tubes on their new equipment. Companies involved in the deal are located in Germany, Italy, France, England and Scandinavia. In the past, European companies have mostly manufactured their own tubes, or used European makes, for reasons of economy and ease of replacement.

Sylvania exported 25,000 tubes last month for a dollar value of \$970,000. Company reports indicate that a similar number will be shipped this month, with dollar value expected to exceed \$1 million. One company puts Sylvania picture tubes on a Japanese chassis.

## Airport Radars Use Coherent MTIs

AIRPORT SURVEILLANCE radars designed by Texas Instruments will be installed at 34 airports during the next year and a half. The radars have a range of 60 miles, can reach an altitude of 25,000 ft at maximum range, will help Federal Aviation Agency keep abreast of the jet age.

TI's ASR-4 can operate either normally or with a coherent moving-target indicator system, as the controller chooses. Coherent oscillator serves as reference against which returns are compared; identical returns cancel out. Staggered pulse-repetition frequency prevents the cancellation of targets flying at blind speed (the speed at which a target, between successive pulses, moves a distance corresponding to a multiple of the transmitter wavelength). On conventional mti's, a target moving at blind speed reflects an in-phase pulse which is cancelled.



# Oscilloscopes

**Brilliant Picture**  
**Calibrated Deflection**  
**Stable Triggering**



**GM 5602**

## Three oscilloscopes

offering the following features:

- 10 cm flat-faced cathode-ray tube
- calibrated vertical deflection
- built-in calibration voltage for adjustment of the amplifier
- calibrated sweep speeds and magnification
- exceptionally stable and sensitive triggering
- modern design, printed wiring, good accessibility
- suitable for all normal mains supplies (110 V- 245 V, 40 c/s - 100 c/s)

# PHILIPS *electronic measuring*

*Sold and serviced by Philips Organizations all over the world*

Further information will gladly be supplied by:

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

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

GM 5601

## High-Frequency Oscilloscope, type GM 5601

### Vertical Amplifier

Bandwidth: DC - 5 Mc/s (-3 dB).

Sensitivity: 100 mVp-p/cm to 5 Vp-p/cm in 6 steps, accurate within 3%, in a 1 · 2 · 5 sequence; vernier 3 : 1 permits continuous adjustment to at least 15 Vp-p/cm. An attenuator probe 10 : 1 is delivered with the instrument.

Input impedance: 0.5 MΩ in parallel with 35 μF.

(Probe 5 MΩ in parallel with 9 μF).

### Sweep range

0.5 μsec/cm · 200 msec/cm in 18 calibrated steps, accurate within 3% in a 1 · 2 · 5 sequence, x5 magnifier expands fastest sweep

speed to 0.1 μsec/cm (accuracy 5%).

### Trigger facilities

Internal, external, or line frequency with adjustable trigger level and stability control.

Accelerating voltage: 2 kV



## High-Frequency Oscilloscope, type GM 5602

### Vertical Amplifier

Bandwidth: 3 c/s · 14 Mc/s, (-3 dB), risetime 25 μsec.

Sensitivity: 75 mVp-p/cm to 10 Vp-p/cm in 7 calibrated steps, accurate within 3%, in a 1 · 2 · 5 sequence; vernier 3 : 1 permits additional attenuation to 30 V p-p/cm. An attenuator probe 10 : 1 is delivered with the instrument.

Input impedance: 0.5 MΩ in parallel with 12 μF.

(Probe 5 MΩ in parallel with 8 μF).

Signal delay permits viewing of the leading edge of the displayed signal in the linear portion of the time base.

### Sweep range

0.2 μsec/cm · 10 msec/cm in 15 calibrated steps, accurate within 3% in a 1 · 2 · 5 sequence, x2 and x5 magnification expands fastest sweep speed to max. 40 μsec/cm (accuracy 5%).

### Trigger facilities

Internal, external or line frequency with adjustable trigger level and preset stability control.

High frequency synchronization up to at least 15 Mc/s.

Accelerating voltage: 4 kV

## Low-Frequency Oscilloscope, type GM 5606

### Vertical Amplifier

Bandwidth: DC · 200 kc/s (-3 dB).

Sensitivity: 10 mVp-p/cm to 50 Vp-p/cm in 12 calibrated steps, accurate within 3%, in a 1 · 2 · 5 sequence; vernier 3 : 1 permits continuous adjustment to at least 150 Vp-p/cm.

Input impedance: 1 MΩ in parallel with 40 μF.

### Sweep range

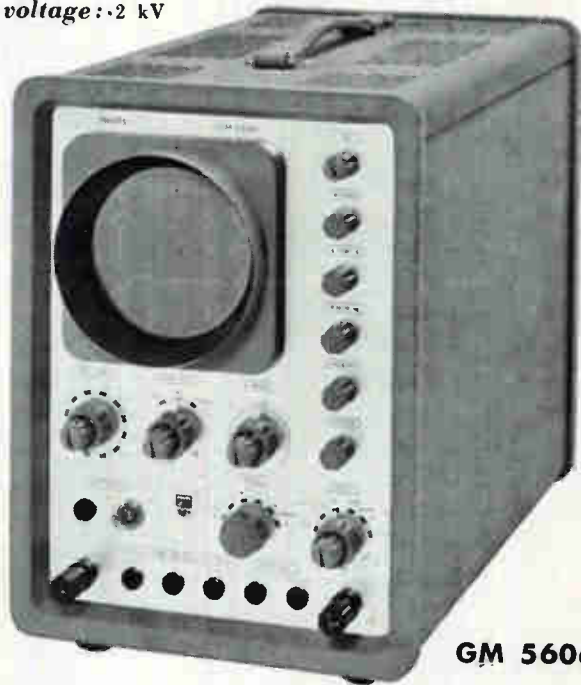
2.5 μsec/cm · 1 sec/cm in 18 calibrated steps, accurate within 3% in a 1 · 2 · 5 sequence, x5 magnifier expands fastest sweep speed to

0.5 μsec/cm (accuracy 5%).

### Trigger facilities

Internal, external or line frequency with adjustable trigger level.

Accelerating voltage: 2 kV

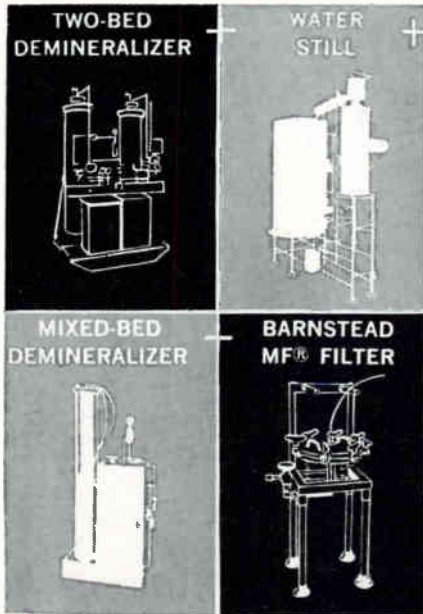


GM 5606

**instruments: quality tools for industry and research**



**DEMINERALIZATION  
ALONE  
IS NOT ENOUGH  
TO PRODUCE  
ULTRA-PURE WATER**



**THIS BARNSTEAD EQUIPMENT  
PRODUCES PUREST WATER  
IN PRODUCTION QUANTITIES  
FREE OF MINERALS, ORGANICS,  
BACTERIA AND  
SUBMICROSCOPIC PARTICLES**

**ENTIRELY NEW PRINCIPLE . . .** By combining different types of Pure Water Equipment in series, Barnstead makes possible a new high standard of water purification for greater advances in Chemical, Electronic, and Nuclear fields — where water of the highest purity is needed.

**VERSATILE EQUIPMENT . . .** The above combination of Barnstead equipment consisting of Water Demineralizers, Water Still, and MF® Submicron Filter, operating in series, produces 18,000,000 ohm water . . . free of organics, bacteria and submicroscopic particulate matter down to 0.45 microns . . . in production quantities . . . at temperature of 25° C. Whatever your Pure Water Problem . . . come to Barnstead first . . . Pure Water Specialists Since 1878.

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| <b>CHICAGO</b><br>Rogers Park<br>1-5173 | <b>PHILADELPHIA</b><br>Locust<br>8-1796     | <b>WASHINGTON, D.C.</b><br>District<br>7-1142 |
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# WASHINGTON OUTLOOK

AMONG ISSUES awaiting legislative action when Congress reconvenes briefly next month is the controversial question of defense procurement policy. The issue figured in seven Congressional investigations this session.

*Congressional sniping at military buying policy has resulted in passage of the Vinson bill by the House. This legislation is aimed to increase formal advertised procurement and cut the volume of negotiated contracting by the Pentagon. The bill would also put the lid on excessive cost estimates and profit allowances in incentive type contracts.*

Outlook for Senate passage of the bill is uncertain. Although there is little opposition to the measure, there isn't enough push behind it to ensure that the Senate will get a chance to vote on it.

Major provision is a requirement that target prices on incentive-type fixed-price contracts be readjusted before final settlement between the contractor and the military. Purpose: "So that the incentive profit over the normal profit will be the product of the contractor's action in performance rather than artificial pricing in negotiations for the target prices." Other provisions of the bill knock out certain legislative authority for negotiated procurement, and require contractors to "certify" cost estimates.

AIR FORCE's new contractor for scientific planning and management of missile and space projects, Aerospace Corp., has opened up shop. Ivan A. Getting has resigned as Raytheon's vice president for research and engineering to become president of the nonprofit corporation.

The new organization will be housed in facilities now used by Thompson Ramo Wooldridge's Space Technology Laboratories at El Segundo, Calif. Aerospace will take over from STL the managerial and technical planning of all Air Force projects excepting the Atlas, Titan, and Minuteman missiles.

*Aerospace will be in charge of initial systems engineering and technical direction. Detailed engineering and technical direction of developed systems, from here on out, will be farmed out to prime production contractors.*

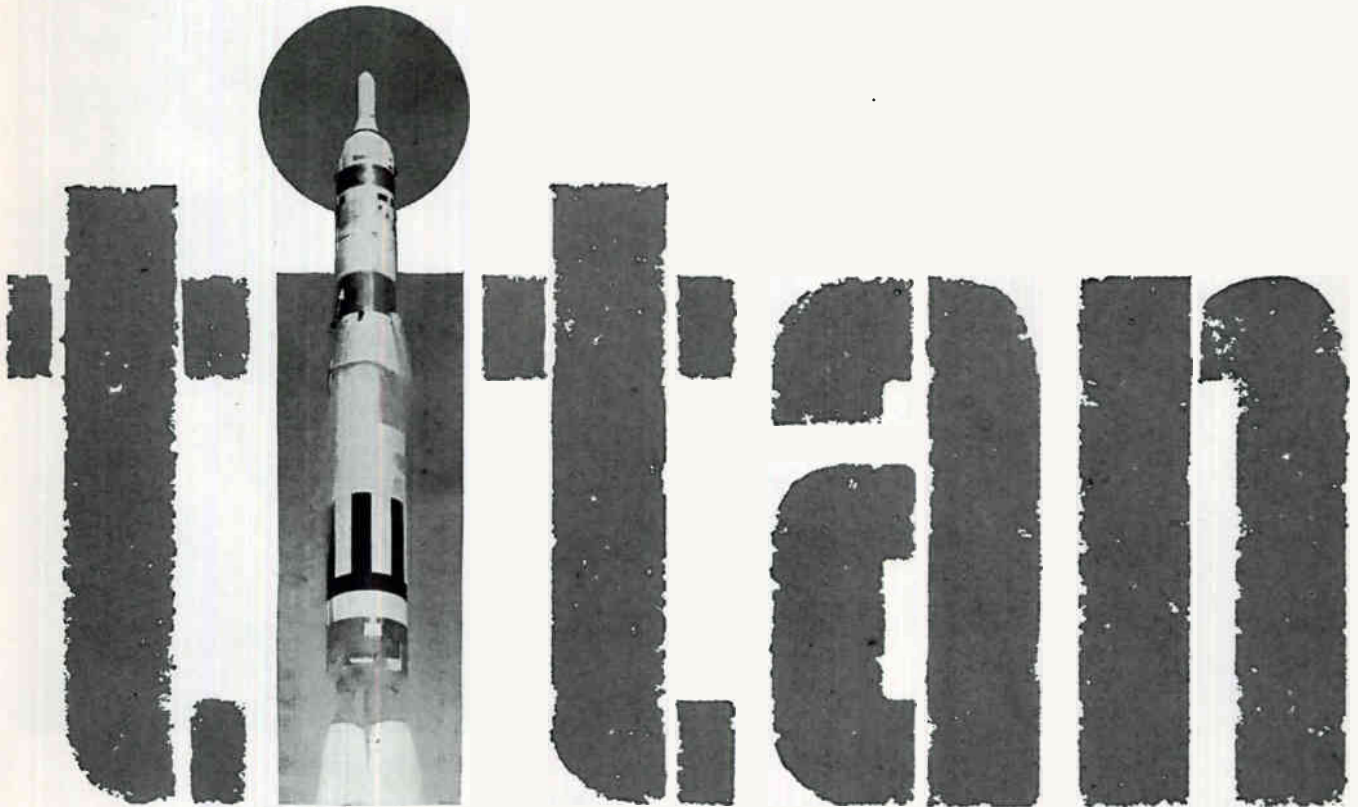
Aerospace's role will stress advanced systems analysis and planning, research, and experimentation in new guidance, satellite communications, satellite inspection systems, manned military space systems, and related fields. The new organization will play a key role in evaluating contractor proposals to the Air Force.

PENTAGON'S LATEST LISTING of top contractors shows electronics producers in a greater position of dominance than ever in defense research, development, and procurement. Sixty-four of the 100 leading companies in calendar 1959 held contracts for electronics, aircraft, and missiles. The roster shows a net increase of two electronics companies.

General Dynamics heads the 1959 contracting list with \$1.5-billion worth of new orders, 6.9 percent of the total. Boeing, Lockheed, and North American Aviation follow in that order. Other companies predominantly in electronics among the top 50: General Electric, 5th, \$915.7 million; AT&T, 9th, \$501.4 million; Raytheon, 11th, \$369.5 million; Sperry Rand, 14th, \$318.7 million; RCA, 15th, \$303.2 million; Bendix, 16th, \$279.9 million; IBM, 17th, \$262.5 million; Westinghouse, 18th, \$220.5 million; ITT, 24th, \$156.9 million; Thompson Ramo Wooldridge, 29th, \$133 million; Burroughs, 30th, \$117.9 million; Collins Radio, 32nd, \$116.4 million; Philco, 35th, \$102 million; American Bosch Arma, 36th, \$98.2 million; Minneapolis-Honeywell, 37th, \$94.8 million; General Precision Equipment, 44th, \$77.6 million.



Another USAF missile  
develops from a program  
which is in itself a...



Titan, America's two-stage intercontinental ballistic missile, is making giant strides—attaining new goals in U.S. missile technology. It has repeatedly demonstrated its ability to accomplish stage separation and altitude start of the sustainer engine. Equally outstanding successes in guidance and nose cone ejection-recovery are making Titan a significant contribution to our national space potential; a highly sophisticated missile system powerful enough to deliver a warhead accurately at more than 5,500-mile range.

As Titan continues to develop toward a state of operational capability, it provides another demonstration of the remarkable successes of the U.S. Air Force's ballistic missile program. This program, conceived only six years ago, has produced progress beyond expectation in an undertaking never before equalled in complexity.

Space Technology Laboratories is responsible for over-all systems engineering and technical direction for Titan, as it has been for Thor, Atlas, Minuteman and related space programs. Principal associate contractors for Titan include: The Martin Company for airframe and system integration, Avco Manufacturing Corporation for nose cone, Bell Telephone Laboratories and Remington-Rand for guidance, Aerojet-General Corporation for propulsion.

**Important positions in connection with these activities are now available at STL for scientists and engineers with outstanding capabilities. Inquiries and resumes are invited.**

**SPACE TECHNOLOGY LABORATORIES, INC.**



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

Los Angeles • Santa Maria • Edwards Rocket Base • Cheyenne • Cape Canaveral • Manchester, England • Singapore • Hawaii

July 22, 1960

15



## Premium temperature rating . . . in a low cost silicon rectifier

RATINGS AND SPECIFICATIONS	(60 CPS Resistive Loading)	
	1N2094/ T400	1N2095/ T500
Maximum allowable PIV	400V	500V
Maximum allowable RMS voltage	280V	350V
Maximum allowable continuous reverse DC voltage	400V	500V
Maximum allowable DC output current — (at 85°C ambient)	500ma	500ma
(at 50°C ambient)	750ma	750ma
Maximum allowable one-cycle surge current	15 amps	15 amps
Maximum peak recurrent forward current	5 amps	5 amps
Maximum surge current (4 ms)	35 amps	35 amps
Maximum full-load forward drop (full cycle avg. at 85°C)	.5V	.5V
Maximum leakage current (full cycle avg. at 85°C)	250µa	250µa
Ambient operating temperature	-55° to +100°C	
Storage temperature	-55° to +100 C	

First premium quality silicon rectifier at economical prices, the Mallory Type T is rated for full output at 85°C, can be operated continuously at higher ambients. Test-proved performance . . . ideal for the higher temperatures created by squeezing circuitry into smaller spaces.

Other outstanding service features of the Type T are:

- High resistance to humidity—passes 500-hour boiling water test, takes four times the humidity cycling required for hermetically sealed units by MIL-202A, method 106.
- Low reverse leakage current.
- Low forward voltage drop.
- Long service life—pass 4000-hour tests under load without failure.
- High reliability—100% inspection protects against premature failure.

*Write or call for literature and a quotation.*

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P. R. MALLORY & CO. Inc  
**MALLORY**



this is  
the Brush  
Mark II . . .  
anyone  
can  
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it in  
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in writing  
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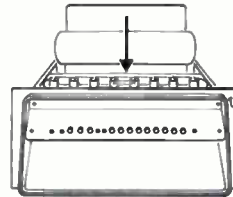
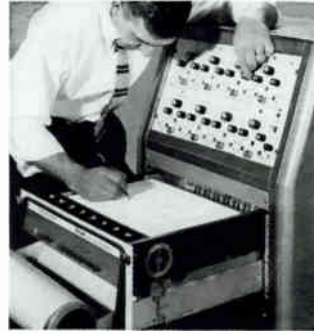


There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Immediate shipment from stock. Call, write or wire for complete details.

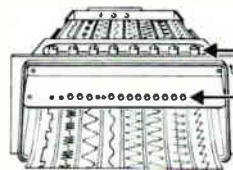
**brush** INSTRUMENTS  
DIVISION OF  
37TH AND PERKINS **CLEVITE** CLEVELAND 14, OHIO  
CORPORATION

# for direct writing recording systems

# no one is as qualified as Brush

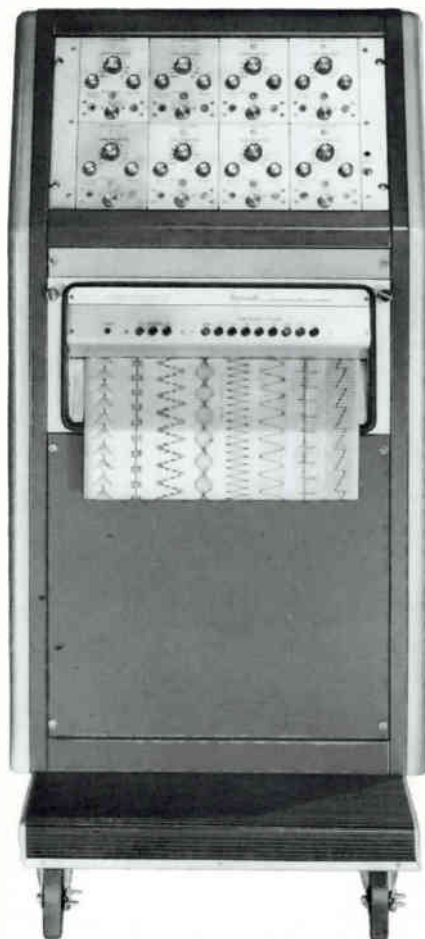


*Chart paper loads from top*



*Trace contrast control*

*Simple pushbutton speed selection*



Why? Simply because Brush recording systems such as this 6-8 channel unit incorporate all of the known refinements in the art of recording by direct writing. No comparable system in existence today is as compact . . . as simplified . . . as reliable . . . as versatile. Note slide-mounted oscillograph and interchangeable "plug-in" signal conditioners that provide four vital functions in addition to amplification: high input impedance, zero suppression, attenuation and calibration.

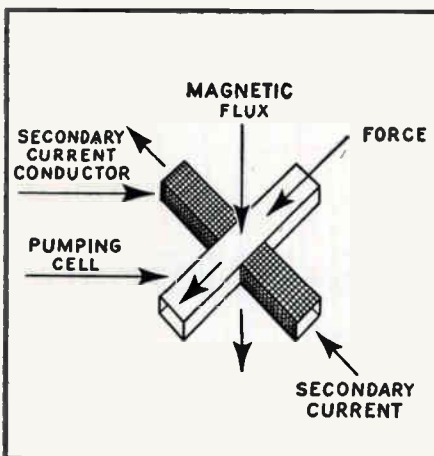
Instantaneous rectilinear presentation gives clear, uniform and reproducible traces for precise readout of telemetry, computer, ground control and other data gathering operations. Further, this functionally designed system has a "pull-out" horizontal writing table for convenient annotation and reading . . . without turning off the recorder! Check these and many other advanced features for yourself and you'll see why *no one* is as qualified as Brush. Call, write or wire for complete details.

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37TH AND PERKINS **CLEVITE** CORPORATION CLEVELAND 14, OHIO



## Grade "A" Nickel bus bar keeps molten metals flowing at 1000°-1600° F

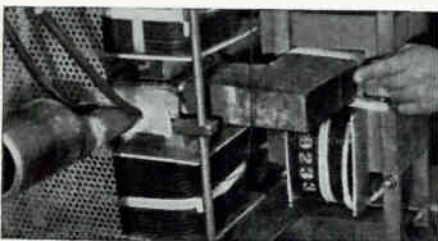
CALLERY, PA.—In nuclear reactor systems, molten metal coolants must be pumped safely and effectively. To do this, the MSA Research Corporation has developed an interesting ac conduction-type electromagnetic pump. It has no moving parts, packing glands, or throttling valves. This pump can handle molten sodium, potassium, NaK, lithium, and mercury at temperatures up to 1600°F.



WHEN A CURRENT is passed through the molten metal, perpendicular to a magnetic field, a force is produced on the liquid metal that results in motion within the pumping section. This motion is at right angles to the current and flux. (See diagram above.)

Current is conducted into the liquid metal by connecting the secondary of a current transformer in the pumping section. In the 1000°-1600°F range Grade "A" Nickel is used for the bus bar secondary because it is corrosion-resistant, and has satisfactory electrical conductivity.

A pump of this type will effectively pump fluids having a lower electrical



## TRANSFORMERS OPERATE AT 600°C ...ENCLOSED IN LOW CARBON NICKEL

WALTHAM, MASS. — Missiles and rockets have created environmental conditions which can destroy or seriously impair the operation of presently available electronic parts. There are two approaches to the solution of this problem. The first is to create an artificial atmosphere to support the *present* type component. The second is to create *new* components that will give reliable operation under high temperature environments.

Raytheon Company has designed and tested transformers of four basic types — plate, radar pulse, audio and high-voltage plate and filament — for operation at temperatures in the vicinity of 600°C for 1000 hours.

To eliminate effects of oxidation and other environmental factors, hermetic sealing in inert dielectric gas is used. Extensive evaluation tests were undertaken on various types of materials. Included in these tests were magnet and lead wires, layer and barrier insulation, sleeving and core materials, ceramic terminals, high temperature brazing materials and container metals.

Winner of the container metal test was Low Carbon Nickel because of 1) resistance to oxidation, 2) high temperature creep strength, 3) ease of degassing, 4) general strength and 5) ease of brazing and welding.

Softer than pure Nickel, Low Carbon Nickel does not work harden as rapidly, and for this reason finds wide use in the fabrication of articles and in coining operations. Low Carbon Nickel is somewhat more ductile than

resistance than that of the pumping section wall.

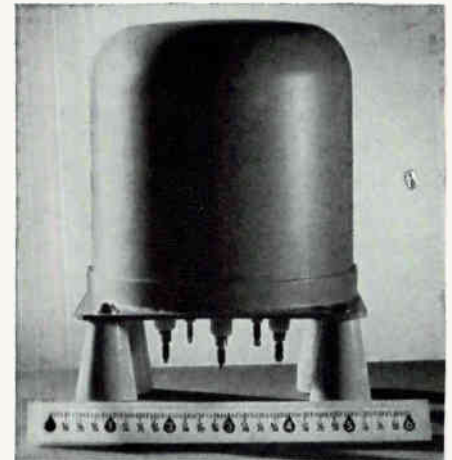
The flow rate of all MSA Research Corporation conduction type EM pumps is positively controlled from zero to maximum flow by an adjustable autotransformer. A capacitor is used for power factor correction due to the high magnetization current required.

Conduction type EM pumps may be used to pump any liquid metal which will wet the pumping section and which has a high conductivity.

Pertinent Literature: Booklet, *Nickel Alloys for Electronic Uses*.

Nickel, and its mechanical properties, particularly the yield strength and the elastic limit of annealed material, are lower.

Pertinent Literature: Electronic grades of Nickel and Nickel Alloys — with their applications — are fully described in our booklet, *Nickel Alloys for Electronic Uses*. Write us for a copy.

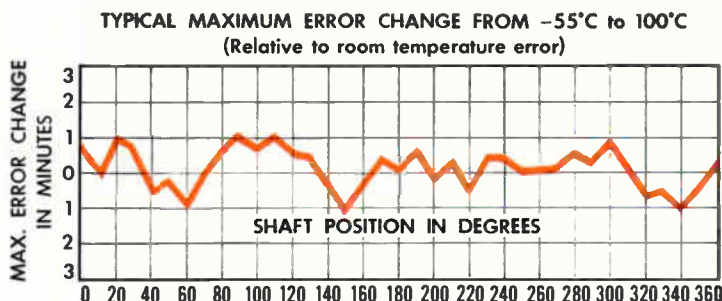


STANDS HEAT. Some military applications call for a transformer that can operate at temperatures as high as 600°C. Raytheon's approach to this problem was to create an artificial atmosphere (such as nitrogen or argon) to support the unit. Transformer and atmosphere are then enclosed in a container of Low Carbon Nickel. This material was selected because of its resistance to oxidation, its high temperature creep strength, its general strength and ease of degassing, and the readiness with which it is brazed and welded.

HUNTINGTON ALLOY PRODUCTS DIVISION  
The International Nickel Company, Inc.  
Huntington 17, West Virginia



# ALLOY PRODUCTS



## Ketay size 11 synchros use MIL-S-20708 as the minimum standard

KETAY, a name synonymous with synchros, now offers immediate delivery on a complete line of size 11 synchros that meet or surpass MIL-S-20708.

### Units are stable over the entire temperature range

Ketay has developed a special potting compound that now makes possible operating stability over the entire temperature range of minus  $55^{\circ}$  to plus  $85^{\circ}\text{C}$ . (see graph.) Higher temperature range units with these same characteristics, ( $-55^{\circ}\text{C}$  to  $+200^{\circ}\text{C}$ ) are available on special request. In addition metallic parts have the same coefficient of expansion.

Synchro units feature thru-bore construction and precision design which assure higher accuracy and longer life.

- Increased strength and resistance to shock, vibra-

tion and moisture is achieved because stator is potted in housing. Bearing bores and stator are machined simultaneously to accept rotor.

- High accuracy because of mechanical and electrical symmetry.
- Increased accuracy is achieved by the improved positioning of rotor and stator, with fully controlled rotor O. D. and air gap. Units available in accuracy of  $3'$  of arc.
- Ketay techniques of manufacturing, assembling and precise testing with highly accurate equipment assure product reliability of the highest quality available.

For more information about the size 11 line or other synchros from size 5 through size 31 please write to



KETAY DEPARTMENT  
**NORDEN DIVISION**  
UNITED AIRCRAFT CORPORATION  
COMMACK, LONG ISLAND, NEW YORK



## Varian Sales Up 27% in First Half

SALES INCREASE of 27 percent and earnings rise of 25 percent are reported by Varian Associates, Palo Alto, Calif., for first half of fiscal 1960 as compared with the similar period of 1959. Sales for the period were \$22,022,715, up from \$17,378,142. Net income was \$1,398,605 or 45 cents a share on 3,134,204 shares outstanding. This compares with \$1,112,530, or 36 cents a share on 3,134,204 shares outstanding in the same period of 1959. Order backlog for the period ended April 2, 1960, was in excess of \$23 million.

Fischer & Porter Co., Warminster, Pa., reports highest sales and shipments in company history and earnings double those of the past year for the fiscal period ended April 30, 1960. Sales this year were \$17,120,000, as compared with 1959's \$15,353,000. Net profit for 1960 was \$306,250, and for 1959, \$165,876. Per-share earnings for the 1959 total were 37 cents, as compared with 85 cents this year.

Taylor Instrument Co., Rochester, N. Y., in making its nine-month report for the period ended April 30, 1960, discloses net income of \$1,240,642, per-share earnings of \$3.13, working capital of \$11,303,605. For the comparable period of 1959, the figures are net income of \$408,360, per-share earnings of \$1.03, working capital of \$10,754,000. Orders for 1960 period increased 9.4 percent over last year and sales rose 13.1 percent.

Collins Radio, Cedar Rapids, Ia., for the nine months ended April 30, 1960, reports earnings of \$5,901,605 on consolidated sales of \$138,991,830 stated without audit and subject to year-end adjustments. This represents \$2.96 per share on 1,983,194 shares outstanding. A total of 169,847 common shares were issued during the period, largely from conversion of preferred stock and debentures.

Figures for the comparable 1959 period: Earnings of \$2,050,509 on sales of \$78,069,658 representing per-share earnings of 95 cents.

Lindly & Co., Mineola, N. Y., manufacturer of electronic automatic control equipment for the textile industry, announces net sales for the first quarter of 1960 rose 29 percent over those of 1959's first quarter. Total sales for 1960 are expected to reach about \$600,000, as compared with the 1959 total of \$459,000.

Specialty Electronics, Syosset, N. Y., reveals sales of \$3,578,946 for the nine-month period ended April 30, 1960, resulting in per-tax income of \$323,734 and net of \$151,334. In the fiscal year ended July 31, 1959, net sales were \$1,567,000, income before taxes was \$114,000 and net income was \$102,000. The company was formed in May of 1959, so nine-month figures are not available for last year.

### 25 MOST ACTIVE STOCKS

	WEEK ENDING JULY 8			
	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Tel & Elec	1,548	30¼	28½	29¾
RCA	1,199	66	63	64½
Int'l Tel & Tel	1,179	42¾	39¾	42¾
Sperry Rand	1,146	25¼	24½	24¼
Sterling Precision	1,061	3¾	3¾	3¾
Bulova Watch	821	20¾	18¼	19¾
Victoreen Inst	797	15½	13¾	14½
Standard Kollsman	737	26¾	22¾	23¾
Amer Tel & Tel	716	90¾	89½	90¾
Avco Corp	620	15¼	14¼	14¼
Ampex Corp	617	40½	38¼	38¼
Univ Controls	616	18¾	17½	17½
Gen Inst	605	49¼	43	45
Teletro Ind	589	16¾	13¼	16
Hoffman Electronics	554	30¼	26¾	27½
Philco Corp	459	29½	27¾	28½
Westinghouse	458	59¼	57½	59
Loral Electronics	439	98½	75¾	77½
Collins Radio	407	73¼	66½	67¾
Litton Ind	407	96	85	86¾
Amer Mach & Fdry	399	67¼	63	64¾
Burroughs Corp	396	37¼	34¾	36
Edo Corp	381	24¾	21½	21¾
Varian Assoc	311	64	57	59¾
Emerson Radio	280	17¾	15¾	16¾

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.

## MINIATURE AND SUB-MINIATURE CAPACITORS

# iei

### TANTALUM CAPACITORS

# iei

### ALUMINUM CAPACITORS

# iei



**iei**, originator of miniature aluminum foil electrolytic capacitors, now offers a full range of miniature and sub-miniature types and sizes:

Polar and non-polar

Plain foil and etched foil tantalums

Multi-section aluminum types

Reliable over a wide temperature range

Tantalum capacitors are made in accordance with Military Specs. High capacities, low DC leakage ideal for transistorized circuits. Write for bulletins 81558 and 2625.

International Electronic Industries, Inc.  
Box 9036-Q Nashville, Tennessee.

# iei

AN **SPS** COMPANY

where reliability replaces probability

## SARKES TARZIAN SILICON RECTIFIERS

# NEW J



CHOICE OF  
BASE POLARITY

### ...new 12-amp J3 Series

We've added a new group of four rectifiers with option of positive or negative base polarity. The new J3's offer exceptionally large capacity for their compact design, with the reliability and long operating life that is characteristic of all Sarkes Tarzian silicon rectifiers. They are stud mounted, with an insulated flexible lead for ease of connection.

Tarzian Type	Amps DC (100°C)	PIV	Max. RMS Volts	Max. Amps Recurrent Peak	Surge (4MS)
10J3N	12	100	70	60	150
10J3P					
20J3N	12	200	140	60	150
20J3P					
30J3N	12	300	210	60	150
30J3P					
40J3N	12	400	280	60	150
40J3P					

### The 1.5-amp J1 SERIES

has axial leads



Tarzian Type	Amps DC (100°C)	PIV	Max. RMS Volts	Max. Amps Recurrent Peak	Surge (4MS)
10J1	1.5	100	70	10	100
20J1	1.5	200	140	10	100
30J1	1.5	300	210	10	100
40J1	1.5	400	280	10	100

### The 10-amp J2 SERIES

is stud mounted (Stud is negative) with wire lead (cathode) Negative Base Only



Tarzian Type	Amps DC (100°C)	PIV	Max. RMS Volts	Max. Amps Recurrent Peak	Surge (4MS)
10J2	10.0	100	70	50	150
20J2	10.0	200	140	50	150
30J2	10.0	300	210	50	150
40J2	10.0	400	280	50	150

The three J Series rectifiers described above are part of the Sarkes Tarzian line of more than 200 distinct types, all available from stock in production quantities. Application assistance is always available.

For more information about J Series rectifiers, call the Sarkes Tarzian sales representative or write Section 5176A.



## SARKES TARZIAN, INC.

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices  
**SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA**  
 In Canada: 700 Weston Rd., Toronto 9 • Export: Ad Aurlema, Inc., New York

# USE THE BUYERS' GUIDE AS A MARKETING TOOL

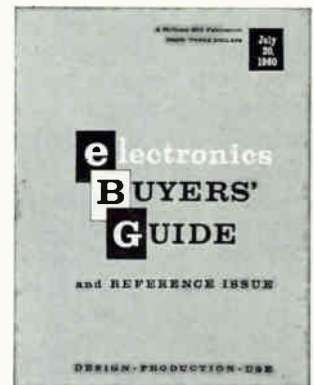
You'll find key information from the marketing viewpoint in the **electronics BUYERS' GUIDE**. It will help you to see the *whole* picture of industry activity *clearly*.

You'll find facts about the markets... materials... design—available nowhere else.

You'll find *who* makes which products and *where* they are located.

You'll find a reflection of the size, interests and stature of more than 4,000 companies.

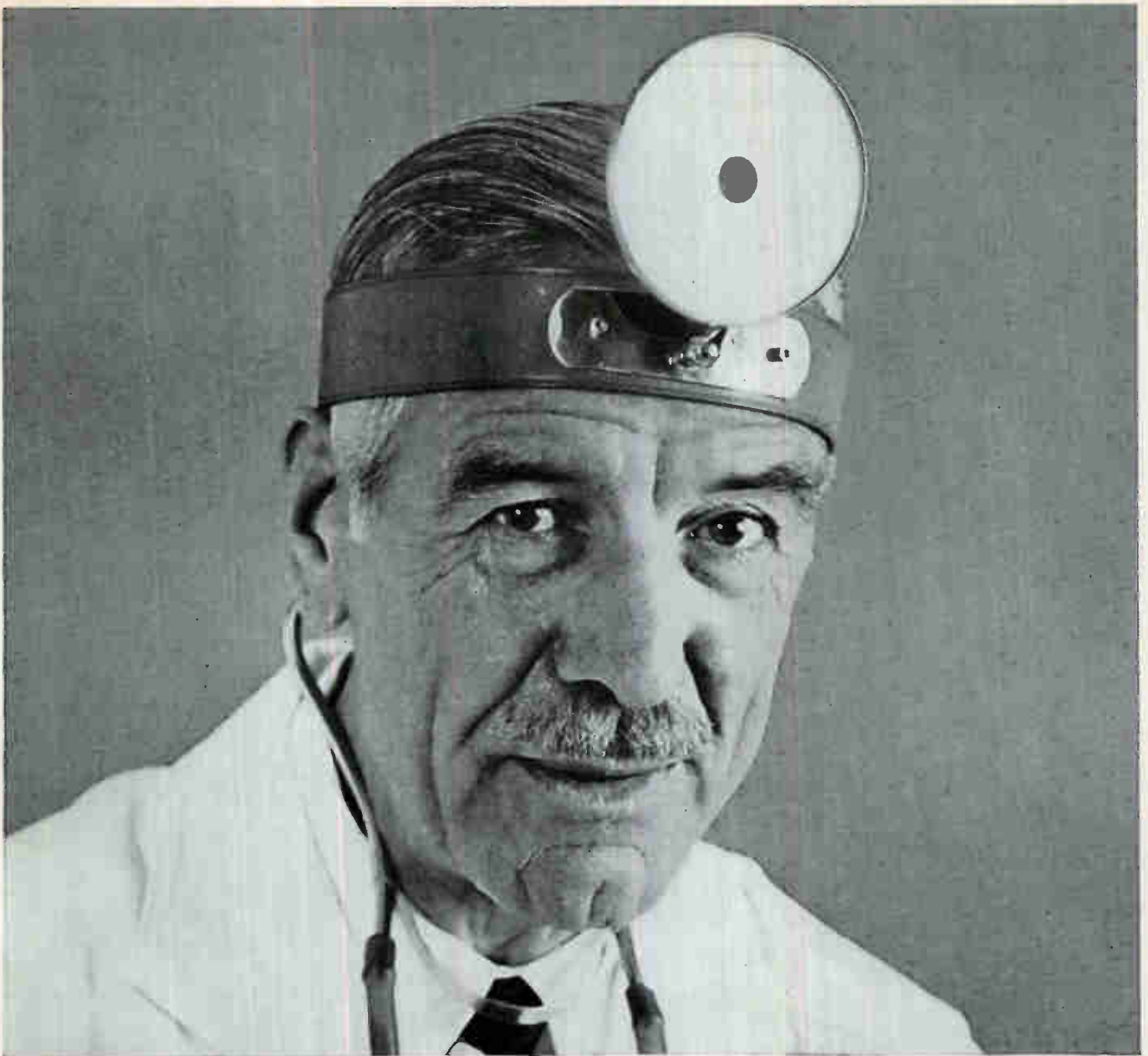
Best of all, the **BUYERS' GUIDE** and Reference Issue is accurate, complete and authoritative. You can *act* on the information it gives you. O.E.B.



FIND  
WHAT  
YOU  
NEED  
IN  
THE

**electronics  
BUYERS' GUIDE**





## The Extreme Case of Shipmentitis

The most extreme case of Shipmentitis on record dates back to the General who lost the War because during the crucial Battle he couldn't locate the nail for his horse's shoe.

Today, Shipmentitis is a disease that afflicts many electronic component users. Its symptoms are occasional shipments arriving late, or in the wrong place, or incomplete, or with the wrong specifications. Some Companies have a slight case of Shipmentitis without realizing it. In serious cases, Shipmentitis can delay vital defense projects, cause expensive setbacks.

Avnet developed a Cure. Simply, Avnet maintains a network of Sales Engineers traveling throughout the U.S. They are on call anytime to assist in selecting components designed to solve tough problems. Each engineer has his counterpart in a Service Center Expediter. Tremendous Stocking Facilities are maintained strategically throughout the country.

Add to that key Avnet Assembly Facilities for Connector Prototype Requirements, plus immediate access to the fastest known forms of commercial transportation, plus internal Ware-

house speed so highly developed that 75% of the orders received by Avnet are processed, assembled, inspected, packed, shipped, and received by customers before their confirmations reach Avnet.

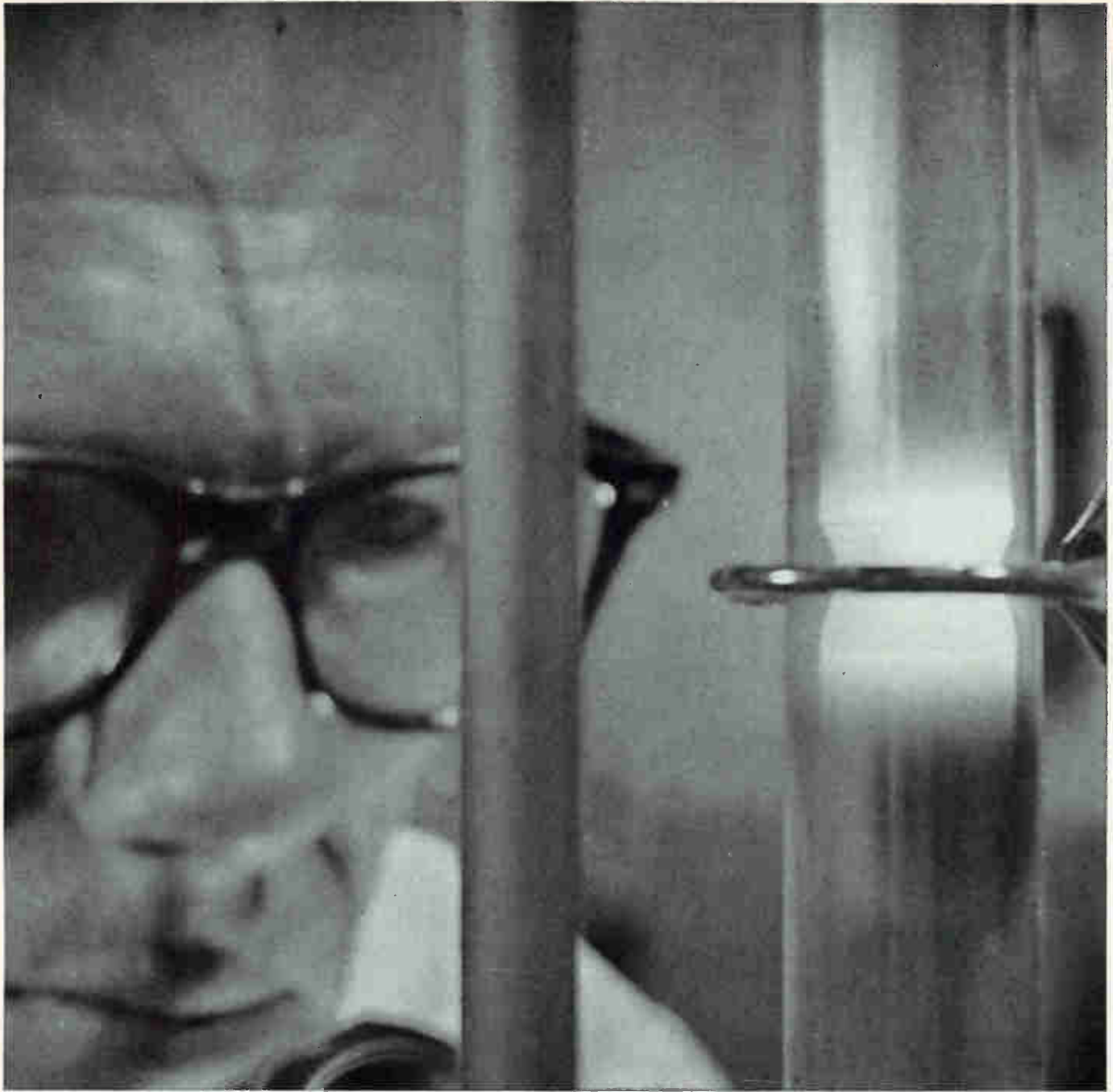
*Avnet Service Centers and Stocking Facilities are in*

LOS ANGELES, CAL.	CHICAGO, ILL.
SUNNYVALE, CAL.	DAYTON, OHIO
BURLINGTON, MASS.	WESTBURY, L. I.



**AVNET**  
AVNET ELECTRONICS CORP.

Avnet distributes from its stocking facilities: BENDIX SCINTILLA CONNECTORS, SPERRY SEMICONDUCTORS, RHEEM SEMICONDUCTORS, ELECTROSNAP AND HETHERINGTON SWITCHES, GREMAR CONNECTORS, CLARE RELAYS, ROBERTSON SPLICE & CONNECTOR CASES, BABCOCK RELAYS, KING SUBMINIATURE HI-TEMP CERAMIC CAPACITORS, TIC PRECISION TRIMMERS, VIBREX FASTENERS by GENERAL TIRE & RUBBER CO., U. S. SEMCOR SEMICONDUCTORS, SANGAMO CAPACITORS, SPRAGUE CAPACITORS



Now . . . Du Pont doubles capacity of floating-zone crystal-growing facilities at Brevard, North Carolina plant. You'll have a lower production cost per device when you purchase

single crystals from this dependable source, rather than growing them in your own plant.

## Now...Du Pont progress in the quantities...diameters...

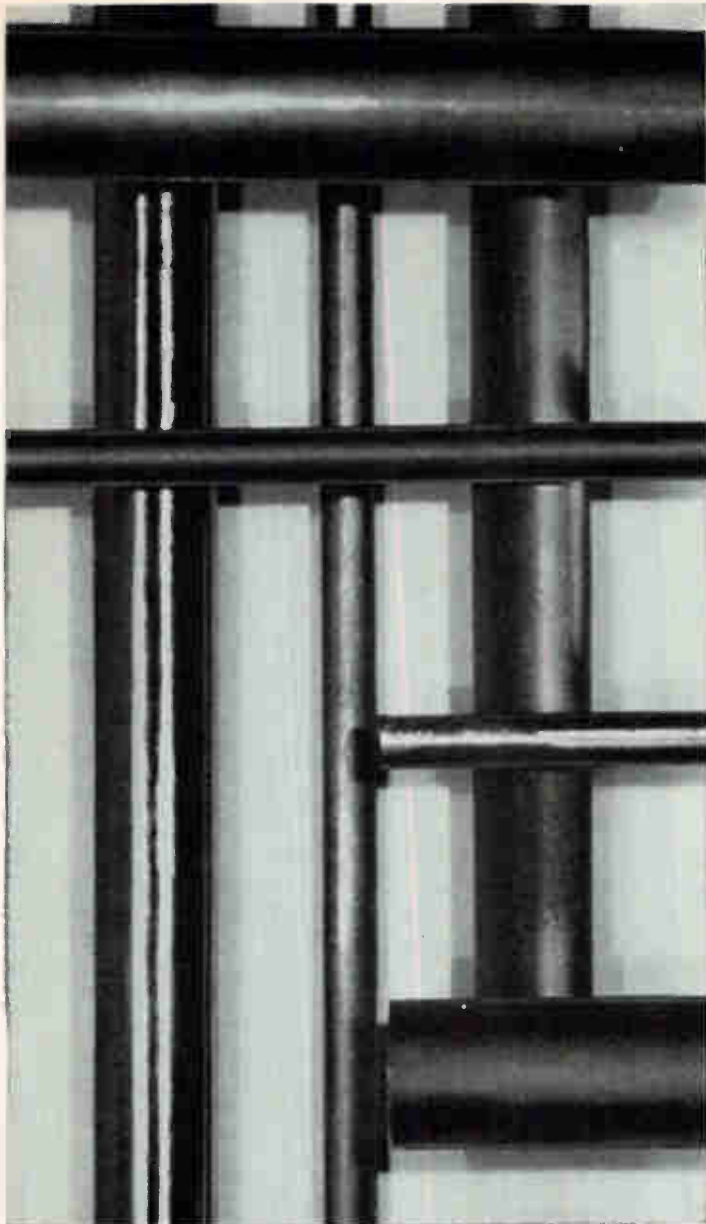
Du Pont has made great progress with recent and continuing research in silicon development for the growing semiconductor industry. It has expanded production facilities, increased the number of grades available and set up to perform a variety of special services.

These developments are results of Du Pont's continuing silicon research and attention to the specific needs of device

manufacturers. For example, now for the first time, Du Pont offers gold-doped single crystals in commercial quantities for high-speed switching devices.

Whatever type silicon you need for production or development, it will pay to consult Du Pont. We have the facilities to produce "special" grades and will be glad to work with you to meet your exact requirements. Du Pont





Now . . . single crystals are available in a wide range of diameters—even greater than one inch. You can specify the diameter crystal that is most efficient and economical for your cutting and dicing operations. Each diameter is available in a wide range of resistivities. Both 1:1:1 and 1:0:0 orientations are available.

### SILANE PROCESS

Single Crystal

“N” type 100 to > 1,000 ohm. cm.

“P” type 300 to > 2,000 ohm cm.

plus polycrystalline rod

---

### ZINC PROCESS

Single Crystal

“N” type .1 to > 250 ohm cm.

“P” type .1 to > 300 ohm cm.

Also grades 1, 2 and 3  
in both densified and standard  
rod form; solar grade  
in densified form.

Now . . . a Du Pont silane plant is on stream, producing single crystals of high resistivity. This new plant also produces polycrystalline rod for floating-zone crystal growing. Du Pont silane and zinc process plants offer you a complete line of silicon grades and physical forms.

# Hyperpure silicon assures and grades you need

is a specialist in the production of silicon—not devices—and will continue in its role of a raw material supplier to the electronics industry.

SEND FOR NEW BOOKLET which gives specifications and prices of all grades of Du Pont hyperpure silicon. Write for your copy to E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, 2533 Nemours Building, Wilmington 98, Delaware.



REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING... THROUGH CHEMISTRY

## HYPERPURE SILICON

## MARKET RESEARCH

# Static Relay Sales to Rise Fast

## GREEN PANTOGRAPH ENGRAVERS

● ELIMINATE DELAYS!

● KEEP YOUR OPERATING COSTS WHERE THEY SHOULD BE!



**PORTABLE 40-POUND BENCH MODEL 106**

*You Make Your Own Engraved Nameplates!*

Here is a speedy, economical 2 or 3-dimensional engraver used by thousands of dollar-conscious companies. It features 5 positive, accurate pantographic ratios; ball bearing spindle with 3 speeds up to 14,000 rpm. Is supplied with one copy carrier that accepts all standard master type sizes. Will actually work up to 10" by any width. Height of pantograph and position of cutter are continuously adjustable.



**MODEL D-2 HEAVY-DUTY 2-DIMENSIONAL**

Pantograph for milling, drilling and engraving.

Vertical adjustment of copy table automatic with Pantograph. Features: unobstructed on 3 sides to take large work; micrometer adjustment for depth of cut; ball bearing construction throughout; spindle speeds up to 26,000 rpm for engraving or machining; vertical range over 10"; ratios 2 to 1 to infinity — master copy area 26" x 10"

**NEW**

**MODEL D2-201 PNEUMATIC ATTACHMENT**



for use with Model D2 Pantograph Engraver to rapidly drill holes in printed circuits by tracing templates. Drills as many as 100 holes per minute. Equipped with foot switch; spindle air cylinder; regulating valve and pressure gauge; filter and oiler. It's ready to use as soon as it's attached to an air compressor

Write or call for full details and prices.

**GREEN INSTRUMENT COMPANY, INC.**

Dept. 363, 295 Vassar St., Cambridge 39, Mass. Tel. Eliot 4-2989

THERE IS much talk in the industry today that static relay sales will loom large at some indefinite date in the future.

To help clarify this fuzzy picture of future sales, ELECTRONICS recently interviewed Richard F. Blake, manager of the Walter Kidde electronics department. Kidde, a leading manufacturer of static relays, holds development contracts from all three services and makes a line of packaged relays.

At present the annual market is small, says Blake, about \$1 million, practically all military R&D. However, sales will rise rapidly in the next two years and should total \$15 to \$20 million in 1963, he adds. At that time, R&D work will be only a small part of the total and sales to military and industrial-commercial customers will be about equal.

Meaning of these estimates is limited unless you define static relays, says Blake. They use semiconductor components to achieve relay operations with fast response, long life and high reliability under severe environmental conditions.

However, they differ from static switching, gating and amplifying circuits because of three exclusive characteristics: 1. Snap action on and off. 2. Electrical isolation between actuating and load circuits. 3. No interaction between actuating and load signals.

About 50 percent of projected static relay sales will be for types using silicon controlled rectifiers, 40 percent for transistor types. Diode and photoconductor types will account for remaining 10 percent, according to Blake.

They are already finding applications in premium performance areas, such as missiles, aircraft, computer, teletypes and controls. It is expected they will be used in the near future for signal control and power switching.

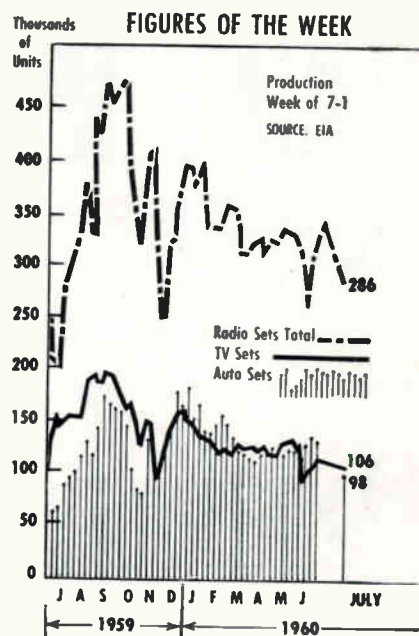
Substantial price reductions are expected in the next few years. Present minimum price is slightly under \$100; median price is \$200 and maximum is \$500 to \$600. By

1963, Blake looks for minimum price to drop to \$25 and median to between \$50 and \$70. Maximum price is not expected to change materially.

Size of static relays today is generally larger than equivalent mechanical relays. But future use of micromodular techniques should reduce size to same or smaller than equivalent mechanical types.

Big question in the minds of many is the effect static relays will have on mechanical relay sales. Only a minor effect, says Blake.

He estimates that about one-third of the \$15 to \$20 million of static relay sales expected in 1963 will come from replacement of mechanical relays, and he adds that these replacement sales represent only about five percent of noncaptive mechanical relay sales. Remaining two-thirds of projected static relay sales will come from new applications, he says.



### LATEST MONTHLY SALES TOTALS

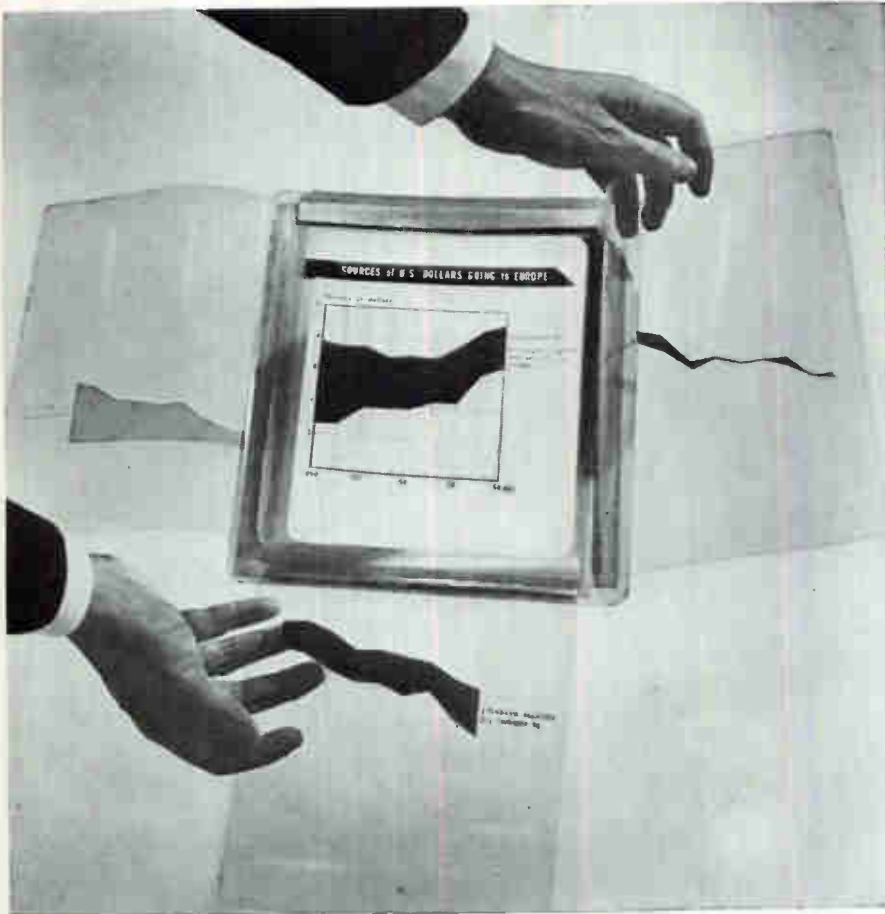
(Source: EIA)  
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	April 1960	March 1960	Change From One Year Ago
Rec. Tubes, Value	\$25,759	\$31,751	- 1.1%
Rec. Tubes, Units	29,737	36,382	- 0.2%
Pic. Tubes, Value	\$13,783	\$15,654	+ 3.8%
Pic. Tubes, Units	707	794	+ 1.4%
Transistors, Value	\$23,199	\$28,700	+ 37.6%
Transistors, Units	9,891	12,022	+ 67.4%



# OZALID NEWSLETTER

NEW IDEAS TO HELP YOU WITH ENGINEERING REPRODUCTION AND DRAFTING



Ozalid Viewfilms produce color images in seconds . . . and at lower cost than conventional methods.

## Need low-cost color in a hurry?

Four-color, three-color, or even two-color for that matter . . . no problem; Ozalid's Viewfilms provide the perfect low-cost answer.

Suppose we want to produce a performance chart in which each factor is a different color.

It's a snap. Just take translucent paper and draw the desired curve or dotted line (as the case may be) on the sheet.

Next, run the master through your Ozalid machine together with an Ozalid Viewfilm of the proper color. Want to add more material in a different color? Just prepare another

master, select a different colored film, and run them as you did the first pair. When you're all through, overlay the films in sequence and tape them into register. Your result is a composite color chart that's very dramatic . . . very convincing!

This is just one illustration to start your mental salivary glands working. We are sure that you can find uses we haven't even dreamed of, once you get going. And if you discover any new applications for this best of all possible color worlds, tell us about them so we can spread the good news to others.

## When it comes to cost estimating . . .

. . . there's nothing like a handy white-printer to cut preparation time of cost estimates, according to the Stackpole Carbon Company, St. Mary's, Pa. The company's Supervisor of Cost Estimating has just written us a letter on the subject which we pass on to you verbatim. "Our estimates are made in pencil on printed translucent vellum in pad form. These are reproduced on specially cut and punched Ozalid copy paper. Originals carry only basic information that has to remain constant. And from the originals we produce duplicate originals on Ozalid sepia line intermediate paper (#402 IT) as required, and these are used until the basic information is obsolete. To revise a cost, it is only necessary to add current rates and extend. With this simple Ozalid method we have eliminated typing, proof-reading, and copying errors."

The Supervisor goes on to say that Stackpole uses Ozalid copying in many other areas of its business because of convenience and economy. Perhaps we'll be able to tell you about these uses in a future *Newsletter*.

## Here's what 100 usable feet per minute can do for you

Speed up your production? Of course! But that's only the beginning. Look at it this way. One Printmaster 1000® working at a usable 100 feet per minute matches the output of several smaller, slower machines *but takes up less valuable floor space while handling widths up to 54 inches!* You save on production time and costs due to higher working speeds! And the Printmaster 1000 is probably the toughest, most durable unit ever produced. This means even greater savings in downtime and service charges. Our first recommendation for any shop having heavy work loads is this 100-foot champ . . . the Printmaster 1000.

**Ozalid**—Division of General Aniline & Film Corp. • In Canada: Hughes-Owens Co., Ltd., Montreal

**if you need compact cooling devices  
...you need**





# WESTINGHOUSE THERMOELECTRIC COOLERS

NOW AVAILABLE AT REDUCED PRICES

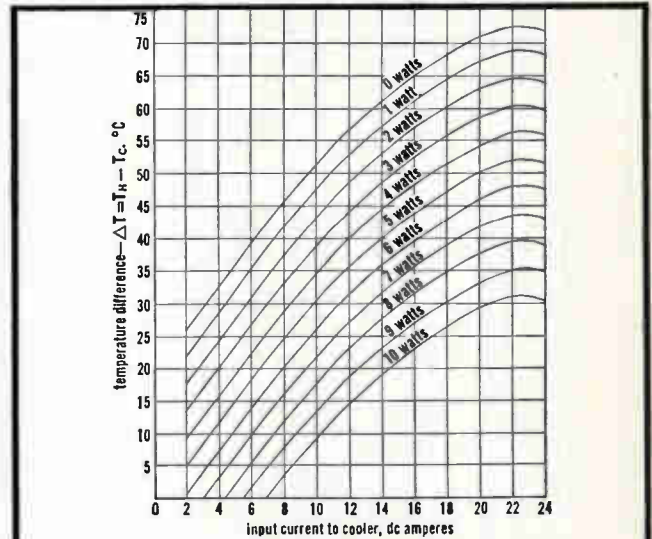
Now you can have the space and weight savings of Westinghouse "Component-Matched" thermoelectric coolers—with new cost savings, too. Prices are reduced on standard units, up to 50%!

**Exclusive Westinghouse "Component-Matched" configurations!** With no moving parts, Westinghouse Thermoelectric coolers provide dependable, compact, lightweight cooling where it is necessary to reduce component temperature below ambient. These unique "Component-Matched" coolers feature exterior cooling surfaces or inner-cooled chambers with tailor-made dimensions to fit specific requirements. As a result of new production facilities, a wide range of configurations can be offered to electronic equipment designers.

**Only Westinghouse guarantees minimum  $\Delta T$  ratings!** Recent Westinghouse improvements in thermoelectric materials and assembly techniques have made it possible to guarantee minimum  $\Delta T$  ratings for each cooling unit. Thus, a designer can select the unit he needs knowing in advance what the temperature drop will be from the hot to the cold side of the cooler.

**Immediate military and industrial applications include:** Photocells, photomultiplier tubes / Germanium transistors / Infrared detectors / Mechanical and electrical instruments / Laboratory and portable medical equipment / Controlling temperatures of solids, liquids and gases.

Westinghouse engineers who developed these new thermoelectric coolers will be glad to provide engineering assistance in your applications. For full information, contact your local Westinghouse representative, or write: Westinghouse Electric Corporation, Semiconductor Dept., Youngwood, Pennsylvania. SC-1000,



Typical  $\Delta T^{\circ}C$  versus input current—  
Types WX814-H, WX816-H

**"Buy and Try"—from Westinghouse distributors  
—standard WX814 and WX816 Coolers for  
immediate delivery at new reduced prices.**

#### EASTERN

CAMERADIO Pittsburgh, Pa./EX 1-4000  
CRAMER ELECTRONICS, INC. Boston, Mass./CO 7-4700  
ELECTRONIC SUPPLY Melbourne, Florida/PA 3-1441  
GENERAL RADIO SUPPLY CO., INC. Camden, N.J./WO 4-8560  
KANN-ELLERT ELECTRONICS, INC. Baltimore, Md./TU 9-4242  
MILGRAY ELECTRONICS New York, N.Y./RE 2-4400  
RADIO & ELECTRONIC PARTS CORP. Cleveland, Ohio/UT 1-6060  
SCHWEBER ELECTRONICS Long Island, N.Y./PI 6-6520

#### MIDWESTERN

ELECTRONIC COMPONENTS FOR INDUSTRY CO. St. Louis, Mo./WO 2-9917  
INTER-STATE RADIO & SUPPLY CO. Denver 4, Colo./TA 5-8257  
LENERT CO. Houston, Texas/CA 4-2663  
RADIO DISTRIBUTING CO. Indianapolis, Ind./ME 5-8311  
SEMICONDUCTOR SPECIALISTS, INC. Chicago, Ill./NA 2-8860  
UNITED RADIO, INC. Cincinnati, Ohio/MA 1-6530

#### WESTERN

ELMAR ELECTRONICS Oakland, Calif./TE 4-3311  
HAMILTON ELECTRO SALES Los Angeles, Calif./BR 2-8453  
NEWARK ELECTRONICS CO. Inglewood, Calif./OR 4-8440

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

CIRCLE 29 ON READER SERVICE CARD

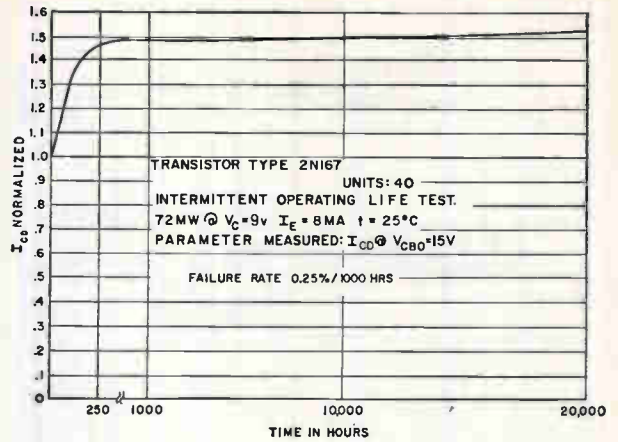
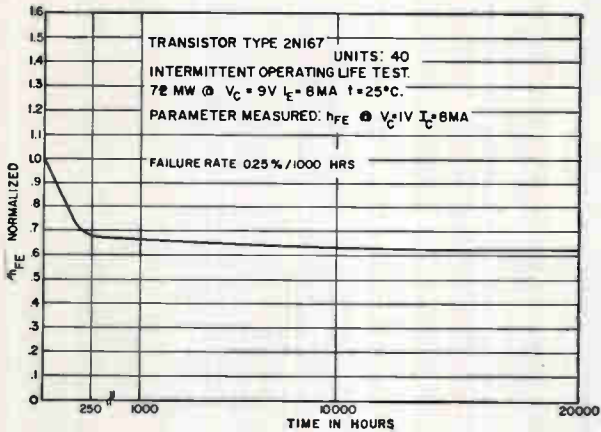
**General Electric takes the tubulation**





## General Electric transistors hold the record in rate-grown reliability

General Electric has manufactured millions of rate-grown transistors in the past seven years. As a result of this experience, G.E.'s parameters are exceptionally stable and a vast amount of reliability data has been accumulated, some of which is shown here. These curves cover 29 lots of General Electric 2N167, tested to MIL-T-19500/11.



The rate-grown process produces a small, clean junction which exhibits almost no drift or deterioration at high voltages and offers the user low  $I_{CO}$  and  $I_{BO}$ . Two new types, the 2N1510 and 2N1217, will be useful for low-level switch and neon indicator applications. Both the 2N1217 and 2N167 operate at extremely low current and leakage levels, making them ideal for starvation circuits of 2 ma or less.

## off rate-grown NPN transistors!

**Remove the tubulation (pinch-off) from rate-grown transistors without sacrificing reliability? General Electric has done just that and even improved reliability with stabilized beta and collector cutoff current. Prices have been reduced on some types up to 20%.**

Removal of the tubulation was made possible by adding a sieve or getter. Improved beta and collector cutoff current results from a 125-hour 85°C bake, which also improves the paint's resistance to solvents and chipping. Pellet, pellet mount and processing are identical to the previous process before encapsulation. Then a sieve is added rather than evacuation and subsequent pinch-off. The sieve is the same used and proved for years on G.E.'s PNP low-frequency 2N525 and PNP high-frequency 2N396 lines.

The high-reliability 2N78A and 2N167A have guaranteed 71°C  $I_{CO}$  and tight AQL's. The 2N78A also features a 20 volt  $BV_{CEO}$  rating compared with the 2N78's 15 volts. The 2N167A, in addition to 71°C  $I_{CO}$ , has a lower  $I_{EO}$ . For more information, see your G-E Semiconductor Sales Representative or Authorized Distributor. General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

ADVANTAGES TO YOU: 40% lower height • Reduced prices • Stabilized $I_{CO}$ and $h_{FE}$ . All units baked 125 hours at 85°C • Greater resistance of paint to solvents, chipping, and salt spray • Improved low-temperature performance and reliability.	Type No.	Maximum Ratings				Electrical Parameters					
		$P_{cmw}$ @ 25°C	$BV_{CE}$ $BV_{CB}$	$I_c$ ma	$T_J$ °C	$h_{FE}$	MIN @ $I_c$ ma	MIN $f_{abmc}$	MIN $G_{odb}$	MAX $I_{co}$ @ $V_{CB}$ ( $\mu a$ )	MAX @ $V_{CB}$
	2N78	65	15	20	85	45	1	5	27	3	15
	2N78A	65	20	20	85	45	1	5	29	3	15
	2N78A (Cert)	65	20	20	85	45	1	5	29	3	15
	2N167	65	30	75	85	17	8	5	—	1.5	15
	2N167A	65	30	75	85	17	8	5	—	1.5	15
	USAF2N167A (per MIL-S-19500/11)	65	30	75	85	17	8	5	—	1.5	15
	2N169A	65	15	20	85	34	1	—	27	5	15
	2N1198	65	25	75	85	17	8	5	—	1.5	15
	2N1217	65	20	20	85	40	2	5	—	1.5	15
	2N1510	75	75	20	85	8	1	—	—	5	75

IN STOCK FOR FAST DELIVERY FROM YOUR AUTHORIZED GENERAL ELECTRIC DISTRIBUTOR

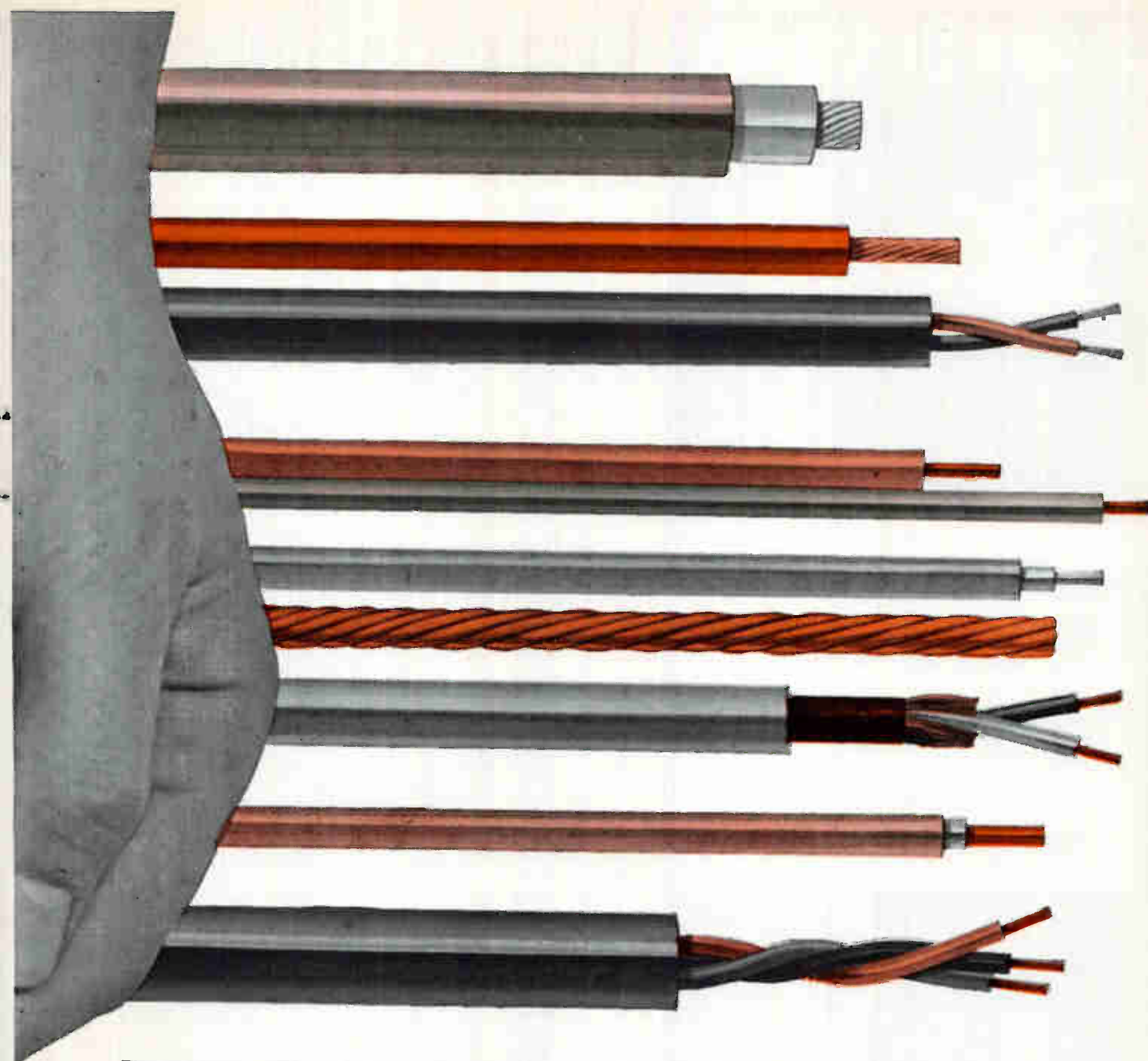
**GENERAL ELECTRIC**



**PUT  
YOUR  
WIRE  
&  
CABLE  
PROBLEMS  
IN  
OUR  
HANDS  
!**

*To help conquer extremes... from known to*





Electronic Cable, Military-Specification Wire and Cable, Special Defense Products, Instrumentation Cable, High-Frequency Cable, Shipboard Cable, Communication Wire and Cable, Control Cable, Power Cable, Cable Accessories

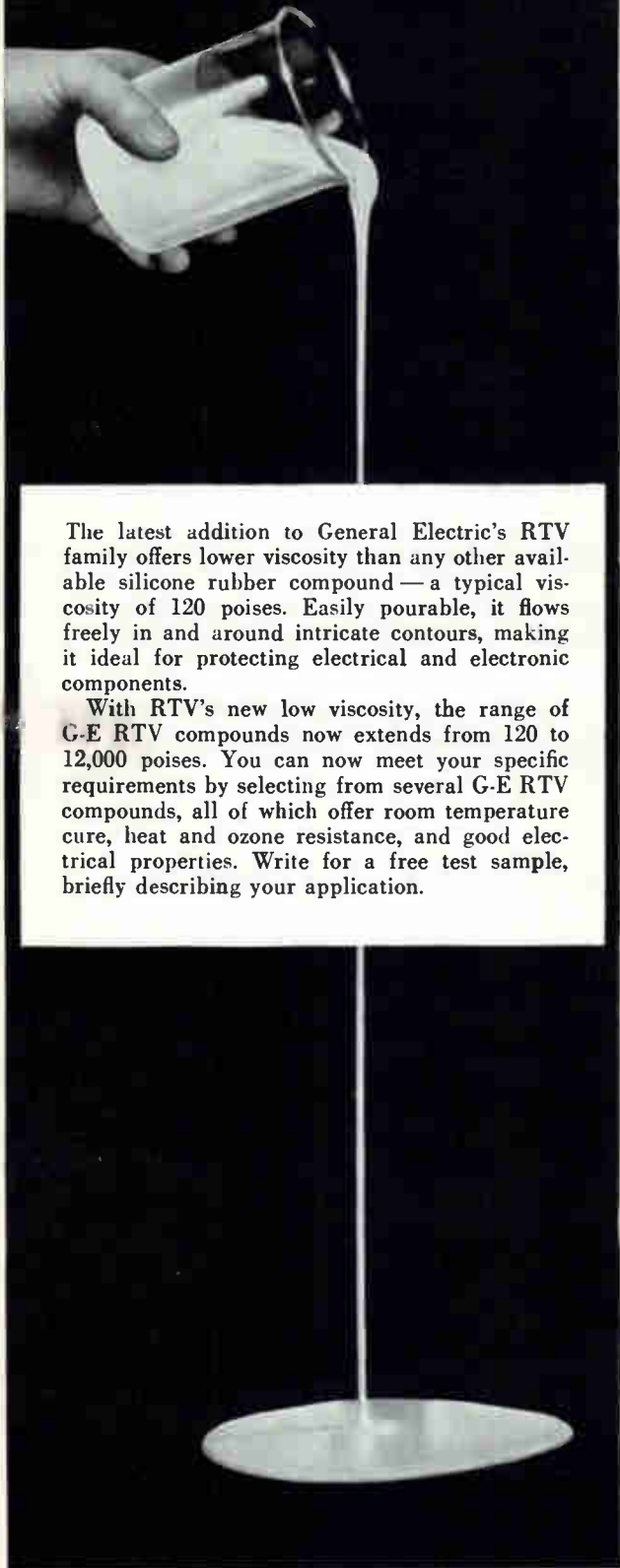
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# General Electric RTV\*

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Temperature  
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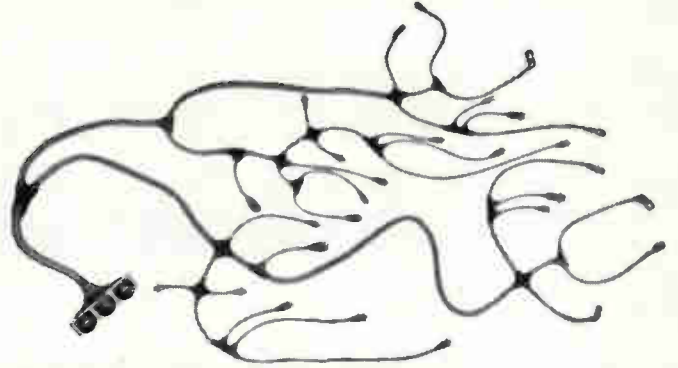


The latest addition to General Electric's RTV family offers lower viscosity than any other available silicone rubber compound—a typical viscosity of 120 poises. Easily pourable, it flows freely in and around intricate contours, making it ideal for protecting electrical and electronic components.

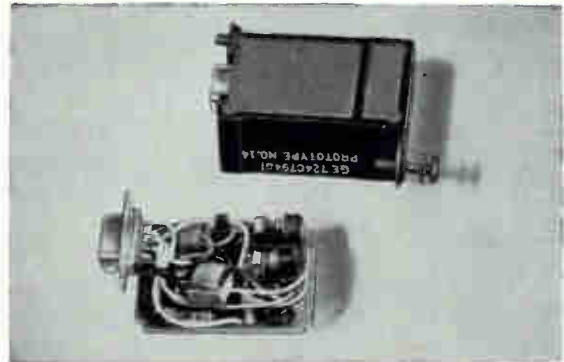
With RTV's new low viscosity, the range of G-E RTV compounds now extends from 120 to 12,000 poises. You can now meet your specific requirements by selecting from several G-E RTV compounds, all of which offer room temperature cure, heat and ozone resistance, and good electrical properties. Write for a free test sample, briefly describing your application.

## liquid silicone rubber

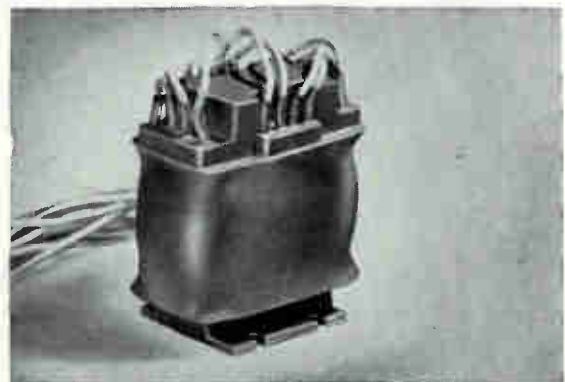
*New low viscosity for easier encapsulation and impregnation*



General Electric silicone rubber used extensively by Aerojet-General Corp. for the Titan ICBM's propulsion-system wiring harness. Tubing is heat-cured silicone rubber, molding G-E RTV and wiring insulated with silicone rubber—all chosen for their stable insulating properties, resistance to temperature extremes and weathering, and stability in storage for many years.



Sight amplifier module potted with RTV by the Armament and Control Section of G.E.'s Light Military Electronics Department. Used on the Lockheed CF-104 and F-104G jet aircraft. RTV provides mechanical support and vibration damping, protects unit against moisture and ozone. (Bottom photo shows module before potting.)



High-voltage, high-altitude transformers from Laboratory For Electronics, Inc. are encapsulated with General Electric RTV to meet MIL-T-27A specs. This prevents flashover at maximum ratings of 2200 volts rms and 80,000 feet. General Electric RTV was selected for its good heat transfer, low viscosity and mechanical strength.

# GENERAL ELECTRIC

Silicone Products Department, Waterford, New York



# REDEYE

... a NEW shoulder-launched guided missile is being developed at CONVAIR/POMONA.

The NEW shoulder-launched guided missile is being developed at CONVAIR/POMONA. REDEYE the one-man weapon will give our ground troops an effective fighting chance against low-strafting and bombing aircraft.

This unique WEAPON SYSTEM and other sophisticated WEAPON SYSTEMS have created an immediate need for Engineers and Scientists with proven capabilities in re-

# CONVAIR/POMONA



CIRCLE 250 ON READER SERVICE C



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*This card may be folded and sealed or stapled and mailed in complete confidence. It will enable the professional staff at Convaair-Pomona to make a preliminary evaluation of your background. A personal interview can be arranged in your city by appointment. U. S. Citizenship required. Every completed inquiry will be acknowledged.*

### PERSONAL INFORMATION (PLEASE PRINT)

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STREET ADDRESS \_\_\_\_\_

CITY & STATE \_\_\_\_\_

EDUCATION	BS	MS	PhD	Date (s):	BS	MS	PhD	Date (s):
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ME	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Mathematics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

School (Highest Degree) \_\_\_\_\_

Please indicate your qualifications below.

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<input type="checkbox"/> SYSTEMS ANALYSIS	<input type="checkbox"/> GUIDANCE AND CONTROL	<input type="checkbox"/> SOLID STATE PHYSICS	<input type="checkbox"/> NUMERICAL ANALYSIS & STATISTICS
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<input type="checkbox"/> TEST EQUIPMENT DEVELOPMENT	<input type="checkbox"/> INFRARED SYSTEMS	<input type="checkbox"/> OPTICS	<input type="checkbox"/> HUMAN FACTORS
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<input type="checkbox"/> SUB-CONTRACT COORDINATION	<input type="checkbox"/> MECHANICS:	<input type="checkbox"/> APPLIED MECHANICS	_____
<input type="checkbox"/> MICRO & MOLETRONICS	<input type="checkbox"/> SOLID STATE CIRCUIT DESIGN	<input type="checkbox"/> THERMODYNAMICS	_____
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new weapon-system and the other advance programs in the phases of research, development, and production design, there is now a need for competent Engineers and Scientists who would like to join this team of creative engineers.

If you feel that you might be able to contribute to the MAULER and other advanced programs, CONVAIR/POMONA would like the opportunity to explore your capabilities.

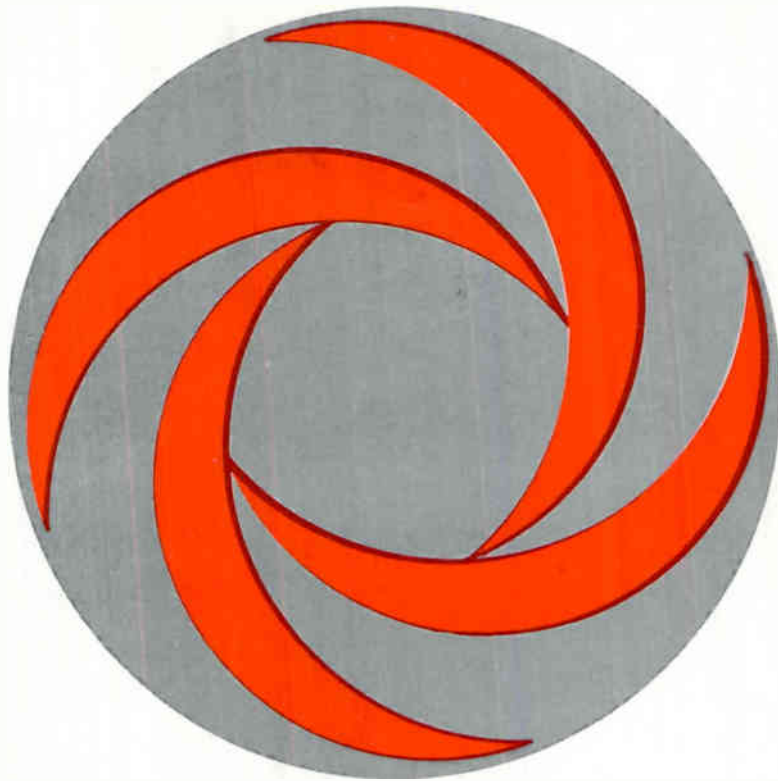
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...a *NEW* shoulder-fired anti-aircraft weapon being developed for the U. S. Army and Marines

The *NEW* shoulder-launched guided missile is being developed at CONVAIR/POMONA. REDEYE the one-man weapon will give our ground troops an effective fighting chance against low-strafting and bombing aircraft.

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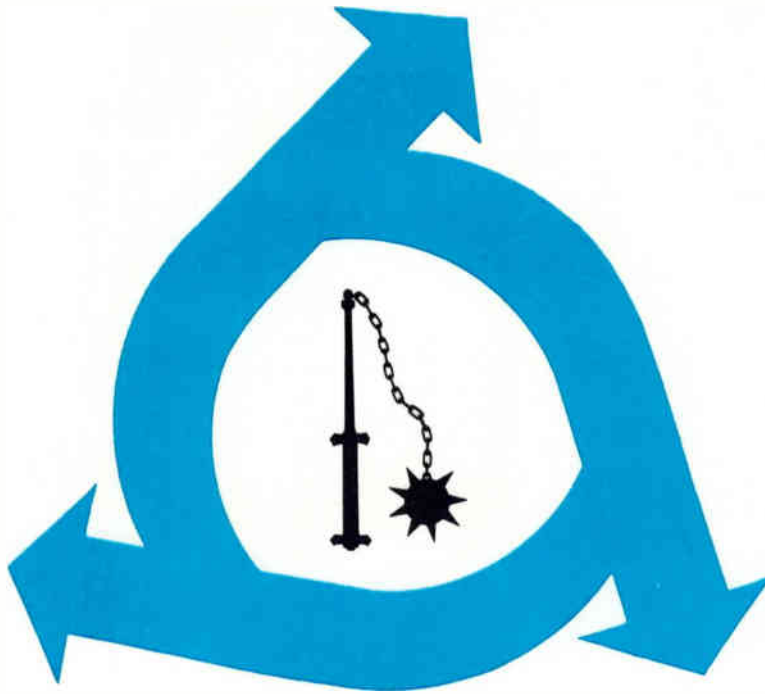
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*Following are editorial reprints available from stock. However, reprints of any editorial that has appeared in electronics in past or current issues may be ordered. For reprints not listed below prices will vary depending upon the length of the article.*



R-2

**Instruments for Design and Production**, December 4, 1959; Key No. R-2: a 16-page report on Voltage, Current and Power Measurement; Impedance Measurement; Frequency Measurement; Waveform Measurement; Tube and Semiconductor Testing; Automatic Testing. Profusely illustrated with charts and graphs.



R-4

**1959 Index to electronics**, December 25, 1959; Key No. R-4: a handy 32-page index to the 3,000-plus pages of technical and technically interpreted business information that appeared in electronics during 1959.



R-5

**The Electronics Market: "Looking into the 60's"**, January 1, 1960; Key No. R-5: is the result of one year's intensive research effort to reveal the U. S. Market, the Manpower Picture, Precise breakdown of the Military, Industrial, Consumer and Replacement Parts Markets with charts, graphs, tables, Buying and Selling Abroad and new approaches in Getting Goods to Market.



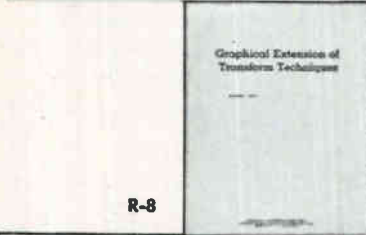
R-6

**Designing High-Power Transistor Oscillators**, January 8, 1960; Key No. R-6. 50c each: reprint of a 4-page article by W. E. Roach, Pacific Semiconductors, Inc. New high-power transistors are usable at over 300mc. Oscillator design is simplified with step-by-step procedure.



R-7

**Research & Development Around The World**, February 12, 1960; Key No. R-7: a 24-page roundup in the countries covered within this report by men recognized as expert... men who were approached personally in electronics' behalf by McGraw-Hill's unique World News Bureau, and we are particularly indebted to representatives in London, Paris, Milan, Stockholm, Zurich, Tel Aviv, Tokyo and Melbourne for the result.



R-8

**Graphical Extension of Transform Techniques**, April 1, 1960; Key No. R-8. 50c each: a 6-page reprint of a feature article that deals with those engineering problems solved more readily with functional - transformation methods. The article reviews Fourier and convolution integrals and presents a graphical convolution technique.



R-9

**What's New in Electron Tubes**, April 29, 1960; Key No. R-9. 50c each: 36-page illustrated report of the latest advances and developments in a classic field of electronics. Thorough analysis of Receiving-Type Tubes, High Vacuum Power Tubes, Gas Filled Tubes, Linear-Beam Microwave Tubes, Crossed-Field Microwave Tubes, Cathode-Ray Tubes, Storage, Counting and Phototubes.

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# HOW COURIER SATELLITE'S

*Communications between a fixed ground station and a high-flying fast-moving satellite presents some knotty problems. Here's how they were solved*

GROUND SYSTEM for the Courier delayed-repeater communications satellite was ready and waiting to go into operation this week, with launch date now tentatively set for August.

Once in orbit, Courier will provide exchange of complex information between distant ground stations by an active repeater satellite. Later, more satellites will be added, including high-altitude hovering satellites that will provide continuous world-wide coverage.

Ultimate goal of the Advanced Research Projects Agency program is a permanent global satellite communications network for military use. Technical direction of the project is by the Army Signal Research and Development Laboratory, Fort Monmouth, N. J.

## *Two Stations*

The ground system that will check the feasibility of the Courier prototype consists of two stations. One is at Army's Salinas Training Area, near Ponce, Puerto Rico, and the other at the Army Signal Corps Astro-Observation Center, Fort Monmouth. More ground stations will be built if the Courier system proves itself.

ITT has responsibility for the ground communications system with Radiation Inc. supplying the antenna installations. Philco is prime contractor for the satellite payload.

Solutions to many problems were devised in designing a ground system that would compensate for the limitations inherent in a high-flying fast-moving satellite 51 in. in diameter.

The satellite accepts information, stores it, and, when interrogated, retransmits it to the interrogating station. During each revolution around the earth, Courier will store messages of 15 million bits a sta-

tion from several ground stations. The total information capacity is equivalent to 40 teletypewriter channels operating continuously at 100 words a minute.

Operating frequencies will be both vhf and uhf. Acquisition and telemetry will be in the vhf band while the communication channel will be uhf.

## *Message Processing*

Messages on teletypewriter tape are sequentially fed to a high-speed, photoelectric tape reader that reads each character in parallel form. A magnetic tape machine records characters in this parallel form at slow speed. Until now, all processing is accomplished while the satellite is below the horizon.

Just before the satellite arrives at the horizon, the ground antenna system operates to acquire the satellite. The 28-ft ground antenna picks up the satellite's beacon transmitter on 108 Mc as the satellite rises above the horizon at an average altitude of 650 miles.

Automatic tracking starts when the satellite rises above the horizon. This is done by a spinning dielectric lens, used successfully in the Tiros tracking system (ELECTRONICS, p 57, Apr. 15).

After the ground antenna has locked on to the satellite, the ground vhf transmitter starts the satellite's uhf transmitter and receiver system.

For ground-to-satellite transmission, the magnetic tape is played back at high speed and converted to serial form before modulating the uhf ground transmitter. The uhf receiving system on the ground may simultaneously be receiving messages from the satellite. These messages are processed in the reverse manner from messages being transmitted. A control console functions as a switching and control facility

for the radio and antenna tracking equipment.

## *Uhf Receiving System*

The uhf receiving system (Fig. 1) uses low-noise parametric converters and a four-fold diversity combining scheme to overcome selective frequency fading and polarization shift caused by discontinuities in the atmosphere and by satellite tumble.

Two nonphase-coherent frequency-modulated uhf transmitters are used in the satellite. Polarization diversity is done with two pre-detection phase combiners, and baseband combining is used for frequency diversity.

The receiver is fail-safe and can be operated in polarization diversity if one frequency only is transmitted from the satellite.

The parametric converters are dual-channel, lower sideband, up-conversion units providing for the reception of carrier frequencies over at least a 100-Mc range. The units use hermetically sealed variable-capacitance silicon diodes and an X-band pump to obtain a 2-db noise figure with a gain of approximately 20 db. One channel in each converter is used as the received signal path. The second channel contains a tunable 2-Gc local oscillator and generates an X-band local-oscillator signal to drive the first mixer. In this manner, the intermediate frequency is not a function of pump frequency.

## *Automatic Phase Control*

The 2-Gc local oscillator is controlled by automatic phase and frequency control from the phase-combiner circuit to maintain approximate phase coherence between the i-f signals to be combined. The afc signals also permit tracking the local oscillator frequency to the received carrier frequency. Doppler

# GROUND SYSTEM WORKS

shift and satellite instability may cause as much as a  $\pm 150$ -Kc shift of the carrier, and accordingly the afc makes possible minimum receiver i-f bandwidth.

The phase-combined signals of each polarization diversity pair are f-m detected and combined by equal-amplitude linear-limiter combiners. The combining scheme enhances the input-per-channel median carrier-to-noise ratio by approximately 4 db.

Since a tracking signal must be provided for the antenna system, the phase-combined signals are also a-m detected. Diversity reception of the tracking signal is achieved through combining of the detected envelopes. Signals from the combiner are also used for automatic gain control in the receivers.

## Vhf Receiving System

The vhf receiving system, shown in Fig. 2, permits the narrow-band acquisition of the low-power satellite beacon and, subsequently, automatically switches to a wider band for telemetry. The voltage-controlled oscillators in both channels of the polarization diversity system are independently swept over a  $\pm 10$ -Kc range at 1-cps rates until phase lock is established in both channels. This swept afc system nullifies doppler shift and instability both in the satellite transmitter and ground station local oscillator.

After a phase is sensed, the phase-lock loop is closed to provide fine afc control of the voltage-controlled oscillator frequency. Upon completion of phase lock, the detected signals in the agc paths are combined for use in the antenna complex for manual acquisition. The 1-Kc filter is automatically replaced by the 6-Kc filter for telemetry, when the receiver senses that the satellite has switched to its higher power or telemetry mode.

## UHF RECEIVING SYSTEM

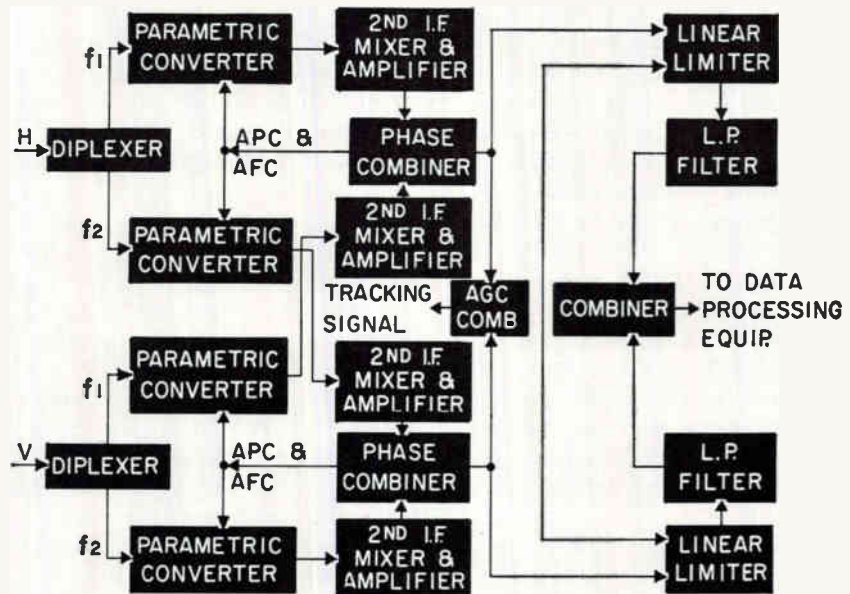


FIG. 1—The quadruple diversity uhf ground receiving system has a 200-Kc i-f bandwidth, system noise figure of 3 db and a dynamic range of  $-140$  to  $-100$  dbw

## VHF RECEIVING SYSTEM

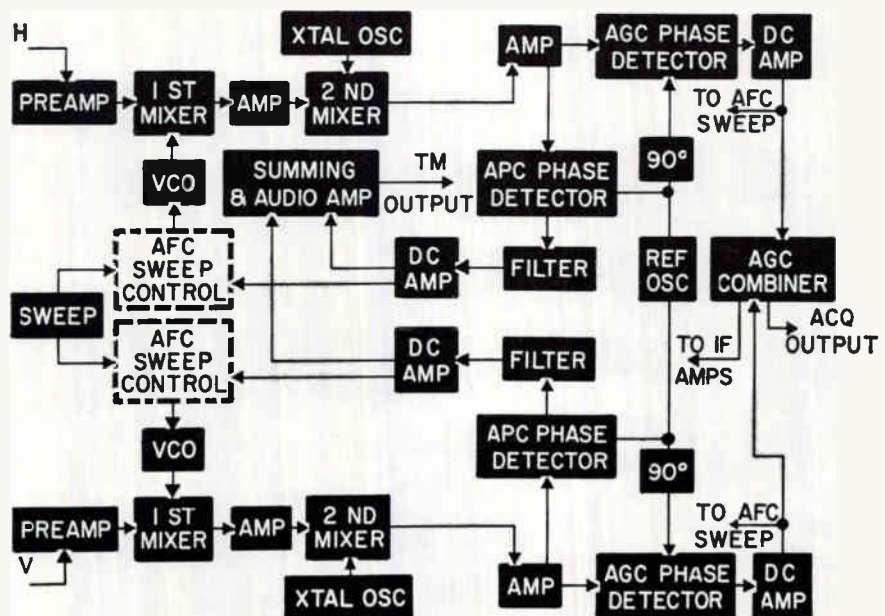


FIG. 2—The dual diversity vhf ground receiving system has a 6-Kc i-f bandwidth, system noise figure of 4 db and a dynamic range for telemetry of  $-145$  to  $-90$  dbw



# Gamma Rays Cause Sporadic Mischief

*Experiments demonstrate that high dose-rates cause intermittent malfunctions in electronic equipment*

HEAT, BLAST and permanent physical damage from radiation are not the only nuclear bugbears that haunt electronics engineers. High radiation dose-rates occurring well beyond the distances formerly thought safe for electronic gear may cause intermittent malfunction, spurious information, and even permanent component failure.

Experiments conducted during the last two years in several big research laboratories have demonstrated that these sporadic ailments can be brought about by radiation dosages at levels hitherto thought safe for electronic equipment. Cause: increased conductivity induced by neutron and gamma bombardment.

Defense Department has been quietly looking into the results of a few of these research efforts in the last few months, is reported to be evaluating several research proposals to find ways of either fighting or using the radiation-induced phenomena.

## *Prompt Gamma Rays*

Equipment located five miles from a 20-kiloton nuclear blast (the

"nominal bomb" of the type dropped on Hiroshima) or 100 miles from a one-megaton explosion, can be exposed to nuclear dose-rates in excess of  $10^7$  roentgens per second. Although this lasts only about a microsecond, the peak value alone causes malfunctions. At these distances, blast and heat effects are negligible and permanent physical damage to equipment from radiation is rare.

Of the 198 million electron-volts of energy released by the fission of an atom of uranium-235 or plutonium, 5 mev is the kinetic energy of fission neutrons and 5 mev represents prompt gamma rays. The prompt gammas are released in the first instant of fission; the peak release in an atomic bomb precedes the fireball and passes within just over a microsecond. The neutrons are released a little later and spread over slightly more time.

At a mile from ground zero, the gamma dose-rate may be of the order of  $10^6$  to  $10^8$  roentgens per second for a 20-kiloton weapon, 300 times as high for a one-megaton weapon.

Gamma radiation and neutrons

striking any material ionize it in part, creating both positive and negative charge carriers. As a consequence, conductivity rises.

## *Induced Conductivity*

Many normally nonconductive materials become conductors under gamma bombardment. The effect has been produced by high dosages—of the order of a million roentgens or more—but the recent experiments demonstrate that short, intense bursts of gamma rays also bring it about.

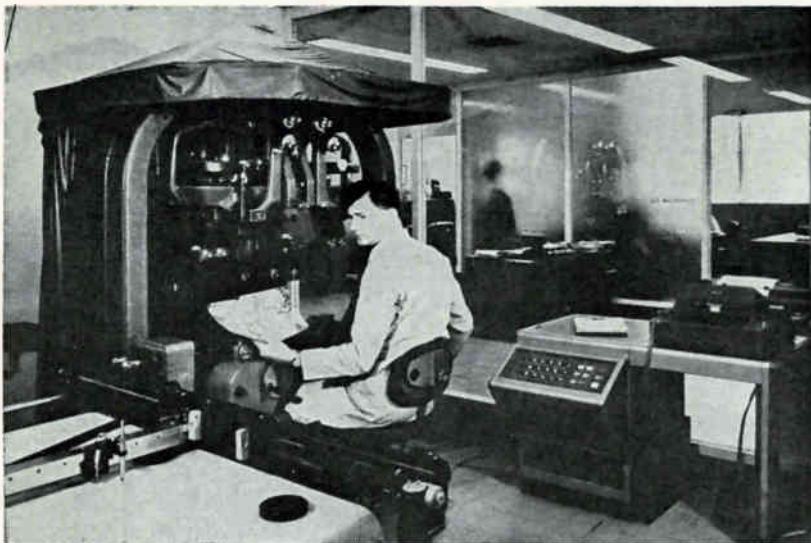
In these experiments, bursts were under 100 microseconds long, and the cumulative dose about 10,000 roentgens—about one one-hundredth the value normally associated with changes in electrical properties. The dose-rate, however, was of the order of 100 million roentgens per second, and produced significant changes in conductivity.

During a gamma burst, resistance of carbon-composition or deposited-film resistors varied inversely as the flux. A 10-megohm 2-w carbon composition resistor, for example, exhibited a drop of almost 9 megohms under a gamma burst of 13 million rads per sec. (A rad is a unit of energy absorbed, equal to 100 ergs per gram. A roentgen of gamma radiation will usually deliver about 93 ergs per gram in tissue.)

Principal cause of the resistance drop is the creation of parallel leakage paths in the surrounding ionized air and through insulation materials; these paths form a temporary shunt of the order of hundreds of kilohms. In resistors smaller than 100,000 ohms, measured changes were small since the shunt path was substantially larger than the test resistance and the change in conductivity of the material itself became significant. A 1,000-ohm resistor in a gamma flux measuring 16 million rads per sec showed a drop of 17 ohms, less than the resistor's tolerance figure.

The same ionized-air shunt around a capacitor added the equiva-

## Digitizer Speeds Contour Mapping



*Data from stereoplotter observation of aerial photos are recorded on punched tape by Airborne Instruments Labs' digitizer for computer processing. System was developed for consulting engineers Lockwood, Kessler & Bartlett*



lent of a 100,000 to 300,000-ohm resistor in the circuit in similar ionizing fluxes. Glass dielectrics, judging by one series of tests, do not change under irradiation as much as other dielectric materials. Permanent changes in capacitance and dissipation factor have been recorded, but available data indicate that the changes may not be due to the gamma bombardment alone.

Transient effects in vacuum-tube diodes showed increases of as much as 400 microamperes in plate-cathode leakage current, with no measurable after-effects. In thyratrons, the existence of shunt paths is compounded by increases in the ionization level of the gas in the tube, with further lowering of the tube's impedance.

#### Time Delay

Organic nonconductors exhibit another problematic effect. After the removal of the ionizing radiation, the conductivity does not return to its preirradiation value anything like instantaneously. To return to within 10 percent of equilibrium value after  $10^7$ -roentgen-per-minute irradiation, polyethylene takes 3 min, polyterafuorethelene 6 hr, polystyrene 3 hr and polymethylmethacrylate 10 hr. The same materials settle to within 1 percent of equilibrium after 30 min, 35 hr, 20 hr and 50 hr respectively. Free radicals are created by the ionization of organic materials; these are quite longlived in the common plastics and may account for the pronounced time lag before decay of induced conductivity.

In semiconductors, the conductivity induced in a reverse-biased *p-n* junction can cause especial damage. Leakage across this junction can result in permanent damage to the transistor. Gain degradation for high-speed germanium transistors is much less than for high-speed silicon transistors.

In one series of tests, transistors exhibited a second leakage peak following the one directly associated with the radiation pulse. The second pulse was only a tenth to a hundredth as severe, but lasted between 10 and 100 seconds, compared to 100 microseconds. The second peak may have been caused by radiation effects on the semiconductor surface, in turn resulting from water vapor in the housing.



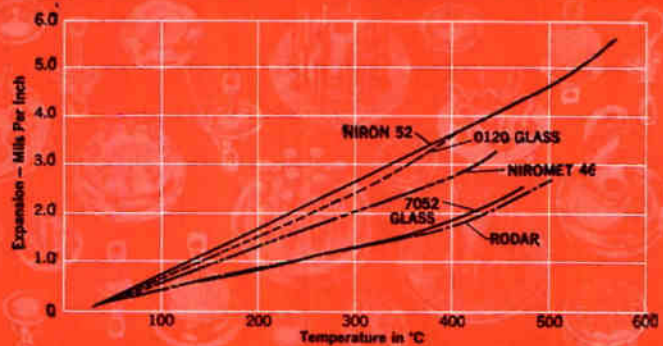
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30 300	44.1	51.7
30 400	45.4	50.8
30 450	50.3	53.7
30 500	57.1	62.1

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\*As determined from cooling curves, after annealing in hydrogen for one hour at 900° C. and for 15 minutes at 1100° C.

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**Dapon Department**

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USABLE COMMUNICATIONS channels in the electromagnetic spectrum may be extended by development of an experimental optical-frequency amplifier announced by Hughes Aircraft a few days ago. Full development of this solid-state device, called a laser (the acronym for Light Amplification by Stimulated Emission of Radiation), could also open the way for new experiments in biology and medicine.

The laser is an outgrowth of Hughes' work with ruby masers. However, the maser operates in the microwave region, while the laser operates at optical frequencies. The laser is a developmental model with only a millisecond pulse output.

A number of U. S. organizations have been working with quantum-mechanical amplifiers in the optical and infrared regions—among them are the Bell Telephone Laboratories, Columbia University, the Lincoln Laboratories, Philco Corp. and the Technical Research Group in Syosset, Long Island.

A crucial problem in development of a true light amplifier has been the getting of a coherent light source. Coherence denotes the sharpness of the frequency band with which one is operating. Ordinary light sources such as incandescent lamps generate energy over a large part of the electromagnetic spectrum (that is, they are incoherent), and much scientific effort has been directed at developing a sufficiently coherent exciter light. In their studies of the optical properties of synthetic ruby crystals, Hughes scientists working under Theodore Maiman exploited the capacity of these crystals to absorb energy over a 700-Angstrom band in the green light region (about 5,600 A.) By irradiating the ruby (aluminum oxide doped with 0.05 percent chromium) with an incoherent green light source, they found it possible to produce regenerative light amplification.

The lamp source they used is a gas-discharge spiral tube circling the ruby rod which, Maiman says, is similar to an electronic photo-flash tube; inference is it may contain a mixture of krypton and neon gases. This lamp energizes the chromium ions in the ruby from their ground state (about 11 Gc) to a higher unstable energy state from



*Synthetic rod-shaped ruby crystal sits in metal casing. Excitation energy comes from spiral gas discharge lamp*

## Light Amplifier Extends Spectrum

*Experimental optical-frequency amplifier could make possible many more communications channels*

which they make a radiationless transition to two slightly lower metastable states called R levels. At least half the population of ground-state ions must, on the average, be raised up and allowed to descend to these two metastable states before regenerative amplification can take place. Once this condition has been achieved, these ions are stimulated by incident light to reradiate their absorbed energy. The ruby rod, which is silvered at both ends, is a cavity that resonates at the output frequency. The output pulse of energy appears predominantly in the so-called  $R_1$  line, 6,943 A (red light). Some energy also appears in the  $R_2$  line, 6,929 A. The 6,943 A radiation, which occupies less than an Angstrom bandwidth, moves in an almost parallel beam and has a peak power of about 10 kilowatts with

a peak power input of one megawatt. Thus, efficiency of this developmental model is about one percent, although efficiencies up to about 10 percent are expected. Amplification is about four or five times.

Because the laser output is so highly coherent, its use in an optical radar could provide a picture of a target, even in outer space, with a clarity unattainable with frequencies in the microwave region.

According to Maiman, his group has done no work as yet on focusing the laser output beam. Nor, he said, have they investigated the optical properties of other solids—the synthetic ruby has proved itself sufficiently interesting.

Full technical results on the laser are described in a paper by Maiman which will appear in the *Journal of Applied Physics* and in *Nature*.



# Another *New* Achievement from El-Menco

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**DM-10**



Approx. 5/16" long...

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## Mica Capacitor...

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■ This sub-miniature DM-10 Mica Capacitor retains the same superior electrical characteristics of silvered mica capacitors as found in much larger sizes. It assures a high order of performance in extreme miniaturization applications — missiles, printed circuits and all compact electronic equipment. Parallel leads provide greater versatility. Tough phenolic casings protect against physical damage and penetration of moisture.

#### Capacity and Voltage Ranges

Working Voltage	Capacity Range
100 WVDC	1 MMF thru 360 MMF
300 WVDC	1 MMF thru 300 MMF
500 WVDC	1 MMF thru 250 MMF

**Operating Temperature:** up to 150° C.

**Characteristics:** C, D, E and F, depending on capacitance value

**Leads:** #26 AWG (.0159") Copperweld wire

EL-MENCO'S DM-10 MEETS ALL THE ELECTRICAL REQUIREMENTS OF MILITARY SPEC. #MIL-C-5B AND EIA SPECIFICATION RS-153

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**DM-15** ... up to 820 mmf at 300 VDCW, up to 400 mmf at 500 VDCW.

**DM-19** ... up to 5400 mmf at 300 VDCW, up to 4000 mmf at 500 VDCW.

WRITE FOR SAMPLES OF EL-MENCO DM-10 CAPACITORS and brochures describing El-Menco's complete line of capacitors.

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# Incentive Fund Improves Quality



*Money Break—Virginia Baranyai receives her share of bonus paid in silver dollars by Assembly Products president John D. Saint-Armour.*

QUALITY CONTROL, through a novel employee incentive pay plan, highlights an improvement program recently inaugurated at Assembly Products Inc., Chesterland, O. The company produces meter relays, panel meters, and other indicating and control equipment.

The new approach centers around a reciprocal bonus plan, wherein production employees are rewarded or penalized, through a bonus fund, as product quality rises or falls.

Company payments to the quality bonus fund, or withdrawals from it, are determined by comparing the monthly cost of repairing returned instruments to a quality "standard," based on the established average monthly repair bill.

One key aspect of the plan is that it makes quality control the intimate concern of all production workers—not merely of engineers, inspectors and supervisory personnel.

The company says the plan has saved approximately \$16,600 in the eight months it has been in effect. Half of this amount has been divided among about 200 eligible production employees.

Each month the fund gains one-half of company savings, or loses one-third of estimated company

losses. Employees base pay is not affected by the system. Corresponding one-third deductions are made from the general profit-sharing pools for key men and company officers. Neither key men nor officers share directly in the special payoff for better quality, however.

"The quality trend went in the wrong direction in the very first month of the plan's operation", reports John D. Saint-Amour, company president. "In every month since then, though, quality has improved."

Recent company reports indicate a monthly repair cost slightly more

than one-third of the allowable "normal".

To help enlist employee support from the beginning, the entire plan was described to all employees at a special dinner meeting. Then to keep interest high, one quarter's bonus was dramatized by being paid in silver dollars, distributed in a wheelbarrow pushed by Saint-Amour through the plant.

Other recently established quality control incentives for the firm's employees include an award system where employees may nominate fellow workers who have submitted usable suggestions.

## Seek Countermissile For Tactical Missiles

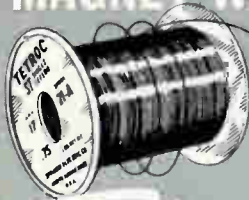
NAVY is exploring the concept of a countermissile designed to intercept and destroy missiles smaller than strategic ICBM systems.

Program, nicknamed Semper by the people working on it at Pt. Mugu, Calif., has been in existence for about a year. It aims to explore the weaknesses of its prospective targets, use analytical and mathematical techniques to determine what can be done in a Navy environment to kill incoming birds.

"Our first problem," an official told ELECTRONICS, "is to define the problem." No decisions have yet been made as to fuel type or guidance method, the official said, "but our philosophy is KISS—'Keep It Simple, Sir'." Probabilities are that the missile, if one ever develops from the program, will be solid-fueled (so as to operate with equal efficiency from surface or subsurface launchers), guided by infrared or some equally simple system.

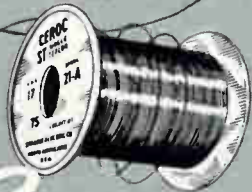


## TWO OUTSTANDING HIGH-TEMPERATURE MAGNET WIRES



*Tetroc*

FOR CONTINUOUS OPERATION AT  
HOTTEST SPOT TEMPERATURES  
UP TO 200°C



*Ceroc*

FOR CONTINUOUS OPERATION AT  
HOTTEST SPOT TEMPERATURES  
UP TO 250°C

For continuous operation at hottest spot temperatures up to 200°C (392°F) and up to 250°C (482°F) for short periods of time—depend upon TETROC—an all Teflon-insulated wire available in both single and heavy coatings.

CEROC is Sprague's recommendation for continuous operation at hottest spot temperatures up to 250°C (482°F) and up to 300°C (572°F) for short periods of time. Ceroc has a flexible ceramic base insulation with either single silicone or single or heavy Teflon overlays. The ceramic base stops "cut-through" sometimes found in windings of all-fluorocarbon wire. Both Tetroc and Ceroc magnet wires provide extremely high space factors.

Write for Engineering Bulletins 405 (Tetroc Wires) and 400A (Ceroc Wires).

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*With its tv camera trained on the claw, this Solaris model gets into position to recover a torpedo*

## Navy to Get Underwater Drone

*Tv-guided underwater workhorse, designed to retrieve torpedoes, has many commercial uses*

PRACTICE TORPEDOES shot from the U. S. Torpedo Station, Keyport, Wash., will soon be recovered by a rugged underwater robot, called Solaris, that sees its way along the sea bottom with 500-watt floodlights and a tv camera.

Guided by a shipboard operator watching the tv monitoring screen, the deepsea drone will be able to swim at a speed of 1.7 knots to depths of 2,000 ft, fasten its claw on objects weighing as much as 7,500 lb, and bring them to the surface.

Solaris, now being designed by Vitro Laboratories under Navy contract, also has commercial potential. The work attachment can be a general-purpose claw for retrieving a variety of objects—sunken treasures, aircraft and ship wreckage; for scooping a cable or pipe from the ocean floor for inspection, or for planting explosives. An electromagnet can be used for salvaging scrap iron. Large floodlights might be used to inspect channel bottoms,

ships' keels, bridge pilings and fouled ship propellers.

Solaris will be connected to the surface ship by a pair of cables. One is a half-inch steel line for supporting the 500-lb vehicle and its catch. The other is an array of power, instrument and tv transmission cables.

Four 500-watt floodlights will normally provide the tv camera with a 15 to 25-ft range. Under ideal conditions, the camera should spot a one-inch-diameter cable at 50 ft. Vitro's design now calls for a Dage 63-AR vidicon system with random interlace. In turbid waters, with visibility reduced to three feet, a high-resolution sonar system will augment the tv visual system, enabling operations to continue.

The vehicle consists of a 3-ft-diameter sphere, two propellers on top, a work attachment below, a tv camera in a watertight case, depth-measuring equipment, operating instruments and a hydraulic mechanism.



## Space Medicine Spurs Telemetry Research

HOW MAN ACTS under stress in various environments is a growing problem, and electronics is being asked repeatedly to help figure out answers.

USAF's School of Aviation Medicine has contracted with 2-year-old Spacelabs Inc. to develop a physiological monitoring system for astronauts to wear. The system as it now takes shape will be built into a lightweight elastic vest. A tiny radio transmitter and rechargeable batteries will telemeter cardiovascular and respiratory data to flight surgeons. Sensors held in place by the skintight garment will pick up heart action, breathing signals and other physiological data.

Federal Aviation Agency meanwhile figures on using a similar but more complex system for recording physiological and psychological data during an exhaustive series of environmental tests aimed at finding out what shakes up an air traffic controller. A telemetry system envisioned as a "two-pound wireless device worn on the body" will allow FAA's Bureau of Aviation Medicine to create a series of controlled adverse environments, watch the effect of volunteer controllers while they work.

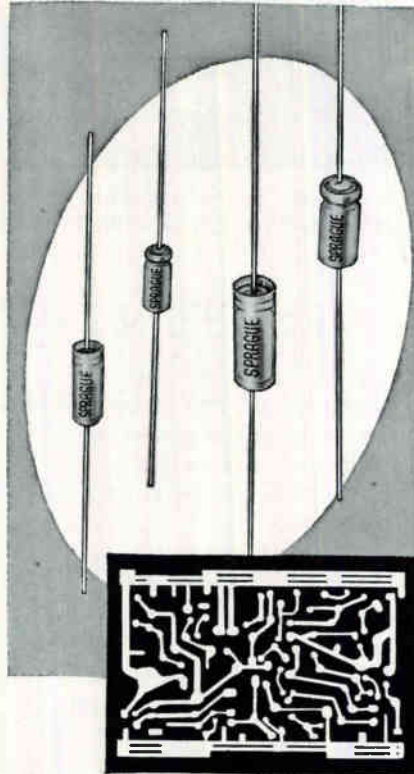
## British Spending 11.9% for R&D

BRITISH electronics industry spends 11.9 percent of its income on research and development, judging from a recent survey of almost 300 electronics manufacturers. Overall electrical industry expenditure was 9.8 percent; precision instrument makers spent 10.7 percent, and the aircraft industry, leading all British manufacturers, spent 35.7 percent.

Department of Scientific and Industrial Research, which made the survey, estimates that all British industry spent about \$900 million on research and development in 1958, 95 percent of which was in industry laboratories, with the rest chalked up in payments to cooperative research institutes, universities, and the like. Less than half of the expenditure was paid for by defense contracts.

(Advertisement)

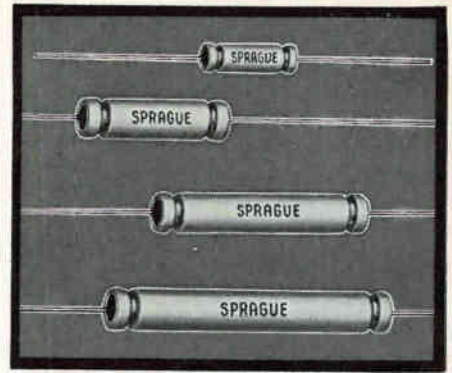
## New Miniature Tantalum Capacitors for 125 C Operation Without Voltage Derating



A new series of reliable tantalum capacitors has just been developed by the Sprague Electric Company to meet the vibration and 125 C operation requirements of military and industrial applications.

The remarkable electrical stability of these new Type 130D Wet-Electrolyte Tubular Sintered-Anode Tantalex® Capacitors is the result of special aging, the use of inert materials, and a low diffusion seal. Construction is designed to meet 2000-cycle military missile vibration requirements. Shelf life is excellent. Shoulder-less shape simplifies mounting on printed wiring boards.

For complete technical data, write for Bulletin 3701 to Technical Literature Section, Sprague Electric Company, 35 Marshall St., North Adams, Massachusetts.



## NEW!...+125C single-case, foil-type TANTALEX® CAPACITORS save space!

When you specify Sprague, you pay no penalty in size and weight because of an extra outer shell on 125C tubular foil tantalum capacitors!

Sprague's new family of foil Tantalex capacitors for 125C operation uses only a single case. An improved end-seal construction does away with the need for a supplementary second outer case. And all units in this new series exceed the applicable performance requirements of MIL-C-3965B.

Polarized capacitors are available under the designation Type 120D in plain foil construction, and under Type 122D in etched foil construction; non-polarized units are listed as Type 121D in plain foil, and as Type 123D in etched foil designs.

Production quantities of all types are available for prompt delivery. For pilot quantities of popular ratings, see your Sprague industrial distributor.

For complete technical data, write for Bulletin 3602A to Technical Literature Section, Sprague Electric Company, 35 Marshall St., North Adams, Mass.





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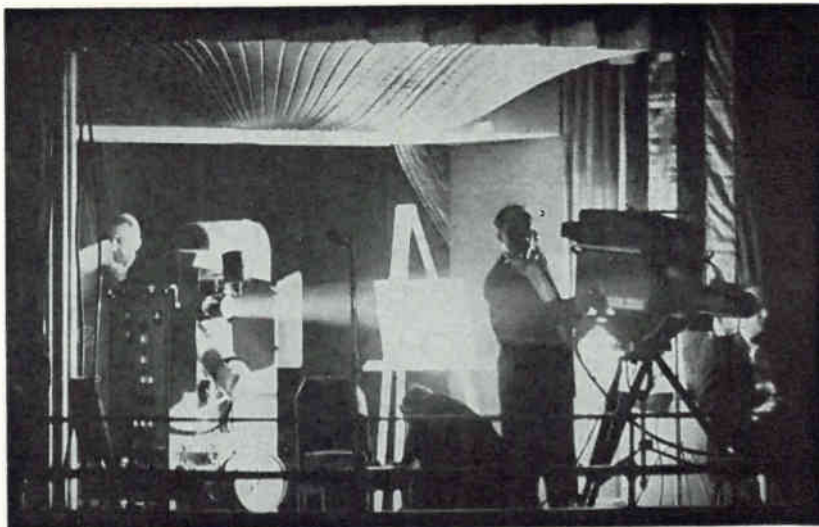
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For details on RCA Drift-Field Transistors, see back cover.



New model tv projectors can produce a picture 23 by 32 ft in size with light intensity almost equal to that of a film projector

## Lay Plans for Tv Projector Sales

PRODUCTION MODELS of large-screen color tv projectors are being imported and demonstrated in the U. S. this week, *ELECTRONICS* learns.

According to R. L. O'Connor, president of Eidophor, his company will receive 40 projector systems during 1960-61 which will arrive here at the rate of four a month.

Production lines are in Zurich, Switzerland, where design and manufacture is conducted by parent company, CIBA, Ltd. Units are priced at \$23,000 each for black-and-white; \$27,000 each for color.

Present ratio of imports is one

color unit for each three black-and-white. Plans currently in formulation promise to explore the industrial and military markets for a variety of data display purposes.

Hardware is reportedly in development which will allow the creation of visual images from a variety of input signal sources by use of this principle. Full details are not yet available, but researchers are thinking of the possibility of using output pulses from computers, and from a variety of analog devices, to translate into large-screen visibility a variety of data displays.

## Overseas Facilities Interest U.S. Firms

MAKE ANYWHERE, sell anywhere, is becoming the philosophy of U. S. electronics companies as one way of meeting foreign competition. Industry will increasingly see production lines set up in less costly overseas labor markets.

In one recent move, Admiral International announced a tie-in with Collier & Beals Ltd., Wellington, N. Z., for manufacture of Admiral tv sets in the island dominion. Tv is new to New Zealand, which recently adopted the 625-line Western European standard. Admiral's international experts expect high sales "limited only by government

restrictions on importation of essential components." The Chicago firm has manufacturing arrangements with companies in nine other countries.

ITT, which has espoused the make-anywhere-sell-anywhere philosophy, recently formed a Delaware corporation called International Telephone & Telegraph Europe, with headquarters in Brussels. ITTE will fall under the wing of ITT's International Standard Electric Co. The Belgian firm will act as coordinator and liaison office for the ITT system's several European companies.



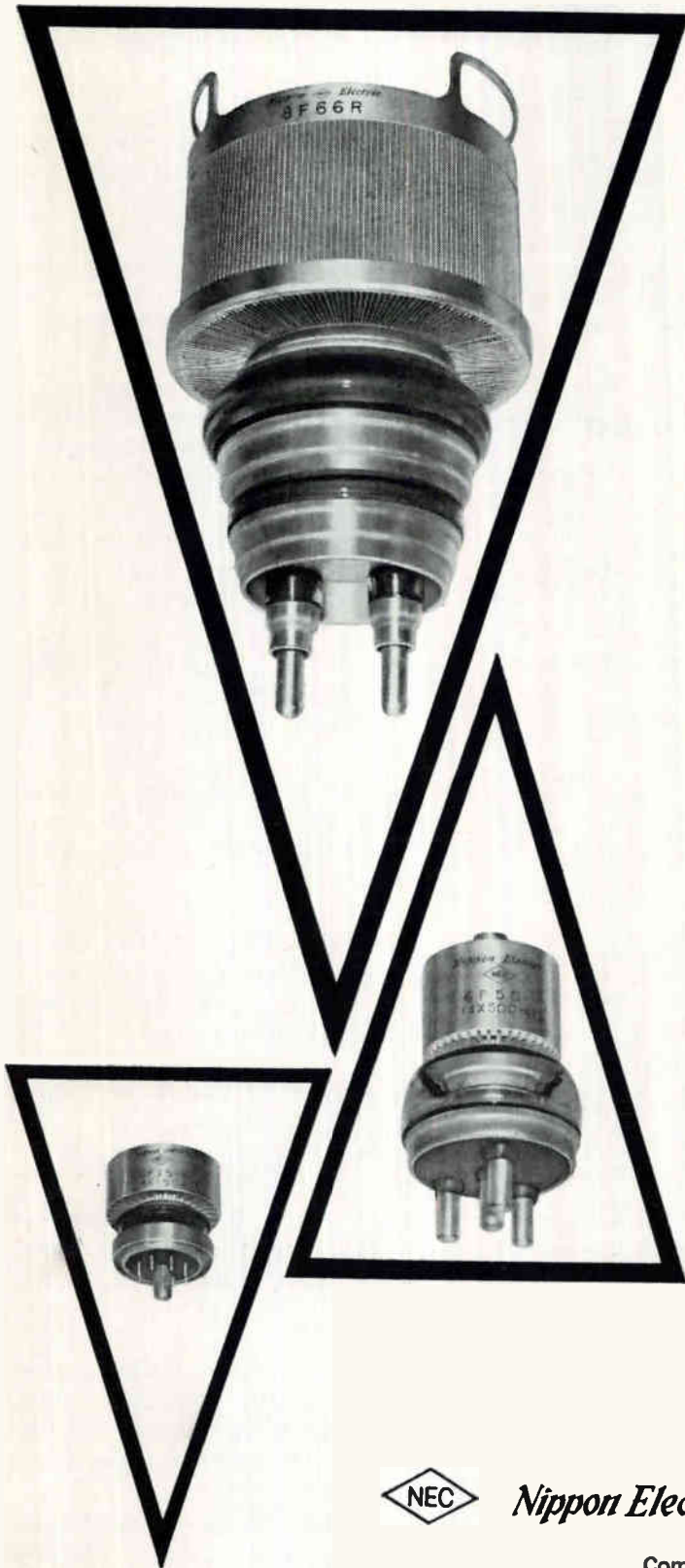
# VHF beam power tetrodes

Each of the following NEC tubes is a direct replacement under all circumstances for the corresponding type.

NEC type	Type To Be Replaced	Cathode/ Filament Volts	Grid-Screen Mu-Factor	Max. Plate Ratings	
				Volts (D.C.)	Dissipation (Watts)
4F15R	4X150A	6	5	1,250	150
6F50R	4X500A	5	6.2	4,000	500
8F66R	6 166	5	10	6,000	10,000

Production of high-power transmitting tubes began at NEC in 1933. A number of "firsts" marked these early years: 1933, first 15 KW short-wave transmitter tube; 1934, first 100 KW standard broadcast tube; 1938, first 50 KW short-wave transmitter tube. In recent years, NEC has been following designs of U.S. Manufactures and concentrating on improving tube life.

The most important improvements have been a new doped-nickel cathode material with high emission at low oxide evaporation rate, and non-sag thoriated tungsten filament material which has completely eliminated filament-grid shorts. NEC considers the life characteristic of its electron tubes to be among the most favorable in the industry.

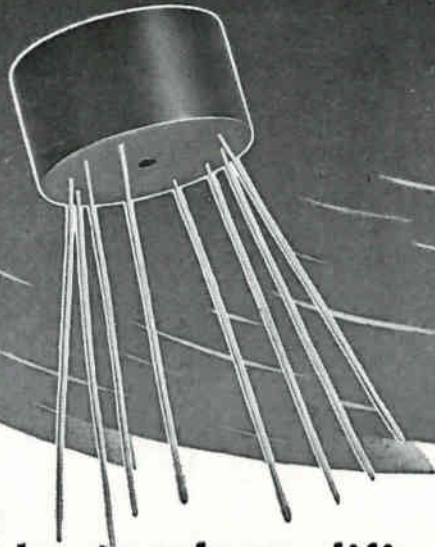


*Nippon Electric Company Limited.*

Tokyo, Japan

Components / Systems

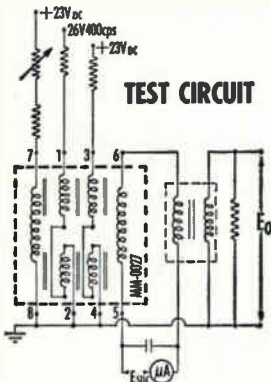




# HST MAGNETIC MODULATOR

*furnishes stable signal amplification*

**THEORY & APPLICATION:** Since certain control and instrumentation systems require amplification of DC signals, it is desirable to employ a static signal converter. Magnitude of these available DC signals is so small that instability of DC amplifying systems results when signal is brought to usable level. Therefore a stable AC amplifier is required to convert low level DC to AC. A magnetic modulator serves this function with the added advantage that a "polarity reversible" DC input is converted to a "phase reversible" output. The output can be rectified to a "polarity reversible" pulsating DC or can be applied to a phase sensitive indicating device. Input impedance is relatively high while the output impedance is inherently low.



**SPECIFICATIONS: Model MM-0027**

**ELECTRICAL CHARACTERISTICS:**

Maximum Output	> 4 V <sub>RMS</sub> @ I <sub>s</sub> 100 μA
Minimum Output	< .05 V <sub>RMS</sub> @ I <sub>s</sub> 0 μA
Voltage Unbalance	< 35%
DC Resistance 1-2	7.3Ω ± 20%
3-4	500Ω ± 20%
5-6	1200Ω ± 20%
7-8	60Ω ± 20%

Frequency 400 cycles

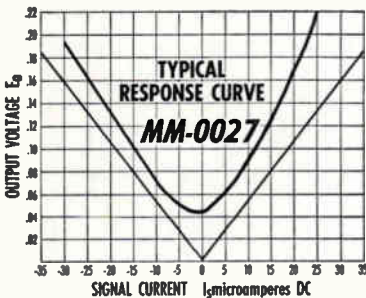
**MECHANICAL CHARACTERISTICS:**

Diameter	1.13" maximum
Height	.68" maximum
Lead Length	2.00" minimum
Mounting	.125" clearance hole

**ENVIRONMENT CONDITIONS:**

Storage Temperature	-65° to +100°C
Operating Temperature	-40° to +70°C
Vibration	.060" total excursion 10-5cps
Shock	15 g's
Altitude	50,000 feet
Humidity	95% relative

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<p><b>Hermetic Seal</b> transformer co.</p> <p>MAGNETIC IRON-CORE COMPONENTS ENVIRONMENTAL TESTING POWER SUPPLIES—SERVO AMPLIFIERS</p>	<p><b>DRESSER INDUSTRIES INC.</b></p> <p>ELECTRONIC OIL • GAS CHEMICAL INDUSTRIAL</p>

## MEETINGS AHEAD

Aug. 1-3: Global Communications Symposium, PGCS of IRE, U. S. Sig. Corps, Statler-Hilton Hotel, Wash., D. C.

Aug. 1-4: Photo-Instrumentation Symposium, Soc. of Photo Instr. Engineers, Ambassador Hotel, Los Angeles.

Aug. 8-11: American Astronautical Society, Western National, Olympic Hotel, Seattle, Wash.

Aug. 8-19: Vibration Testing, Sine, Complex and Random Wave, Theory & Practice, Ling Electronics, Anaheim, Calif.

Aug. 9-12: American Institute of Electrical Engineers, Pacific General, San Diego, Calif.

Aug. 15-19: High-Speed Photography, Stroboscopic Light Laboratory, MIT, Cambridge, Mass.

Aug. 18-19: Electronic Circuit Packaging Symposium, Univ. of Colorado, Boulder, Colo.

Aug. 22: Scientific Apparatus Makers Assoc., Market Managers, SAMA, Statler-Hilton Hotel, San Francisco.

Aug. 22-26: Thermonuclear Plasma Physics Symposium, Oak Ridge, U. S. Atomic Energy Commission, Gallinburg, Tenn.

Aug. 23-26: Association for Computing Machinery, Nat. Conf., Marquette Univ., Milwaukee.

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

Sept. 7-9: Automatic Control, Joint Conf., ASME, IRE, AIEE, ISA, Massachusetts Institute of Technology, Cambridge, Mass.

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

# IN TOUCH WITH NEW WORLDS

## Another project of IBM Applied Scientists: helping solve Einstein's Two-Body Problem

Helping to increase man's understanding and control of reality is a job of IBM Applied Science Representatives. Project by project, through unique and creative applications of data processing, they are changing the worlds of engineering, the sciences, and business.

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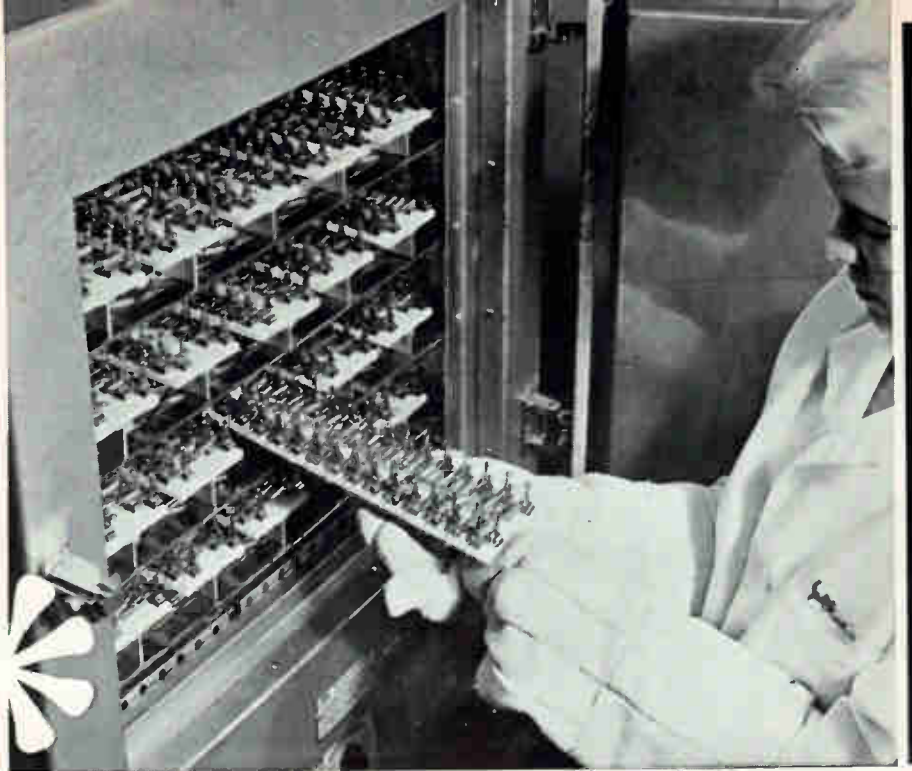
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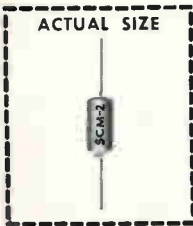


**tan-TI-cap** †

**CAPACITOR  
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BY 250-HOUR  
PERFORMANCE  
LOAD TEST**



**...expanded TI line of type SCM solid tantalum capacitors meets MIL specs**



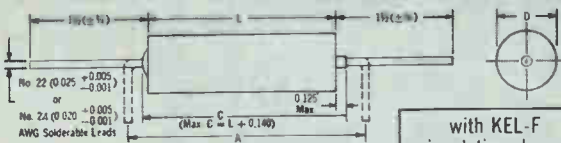
Another assurance to you of Texas Instruments capacitor reliability — 250-hour performance load test on a sample basis of *all* lots of the Type SCM series.

Your margin of design safety is greater with *tan-TI-cap* capacitors. Type SCM capacitors are 100% tested for capacity, dc leakage and dissipation factor, and are aged under load at elevated tempera-

ture. SCM units in all 203 standard ratings (6 - 35 volts, 1 - 330  $\mu$ f) meet and exceed the electrical and mechanical requirements of MIL-C-55057 (Sig. C) and/or MIL-C-21720A (NAVY) specifications for solid tantalum capacitors.

Contact your nearest authorized TI distributor or TI sales office today for your immediate and future delivery requirements.

† trademark of Texas Instruments Incorporated



case size	D	L	*A	wire size AWG	avg. wt. gms.	with KEL-F insulating sleeve			with Mylar insulating sleeve**		
						D	L	avg. wt. gms.	D	L	avg. wt. gms.
F	0.125	0.250	0.482	24	0.4	0.162	0.337	0.5	0.135	0.322	0.4
B	0.175	0.438	0.688	24	1.1	0.210	0.525	1.3	0.185	0.510	1.2
G	0.279	0.650	0.888	22	2.7	0.315	0.735	3.1	0.289	0.722	2.8
H	0.341	0.750	0.988	22	3.3	0.377	0.835	3.9	0.351	0.822	3.4

\* Dimension "A" determined by suspending a one-pound weight from one lead and rotating the case from the vertical position to the horizontal position, and then repeating the procedure for the other lead.  
\*\* Meets all requirements of MIL-C-55057 and MIL-C-21720A, including dimensions.



Specify Type SCM-E *tan-TI-cap* capacitors when 250-hour "burn-in" at rated temperature and voltage on each unit is desired for premium reliability.



Write to your nearest TI sales office on your company letterhead for Bulletin DL-C 1173 which gives detailed specifications on the complete SCM series.

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*Schooner Azara carries the artificial lightning generator. Helicopter supports the 10,000-foot antenna*

## Sea-Going Lightning Generator

*Studies of low frequency propagation over long distances may have practical applications in long range communication, navigation.*

*Artificial lightning atmospherics are produced by sea-going generator*

By M. M. NEWMAN,  
J. R. STAHMANN,  
J. D. ROBB,

Lightning & Transients  
Research Institute,  
Minneapolis, Minn.

E. A. LEWIS,

Air Force Cambridge  
Research Center,  
Bedford, Mass.

SCHOONERBORNE million-volt artificial lightning generator with a 10,000 foot helicopter-supported antenna is being used to produce high-power low-frequency radiated pulses similar to lightning atmospherics. These pulses provide for studying low-frequency propagation over long distances with possible practical applications in the fields of long range communication and navigation. At present the technique is primarily a research tool for vlf propagation studies; it permits better ionospheric measurements and studies of whistlers, normally associated with lightning strokes, by producing artificial

spherics at specific locations. A long high antenna is required to simulate lightning discharges since such discharges may progress for several miles before ending at ground or in other clouds.

The one million volt generator is capable of producing a peak power of about 30 Mw with a 3,000 meter antenna. This power could be increased to about 100 Mw by increasing the generator voltage. At the peak voltage of one million volts, the calculated field strength of a 20 Kc pulse at a receiver 1,000 kilometers distant would be about 20 millivolts per meter. Even at 10,000 kilometers (6,200 miles) the

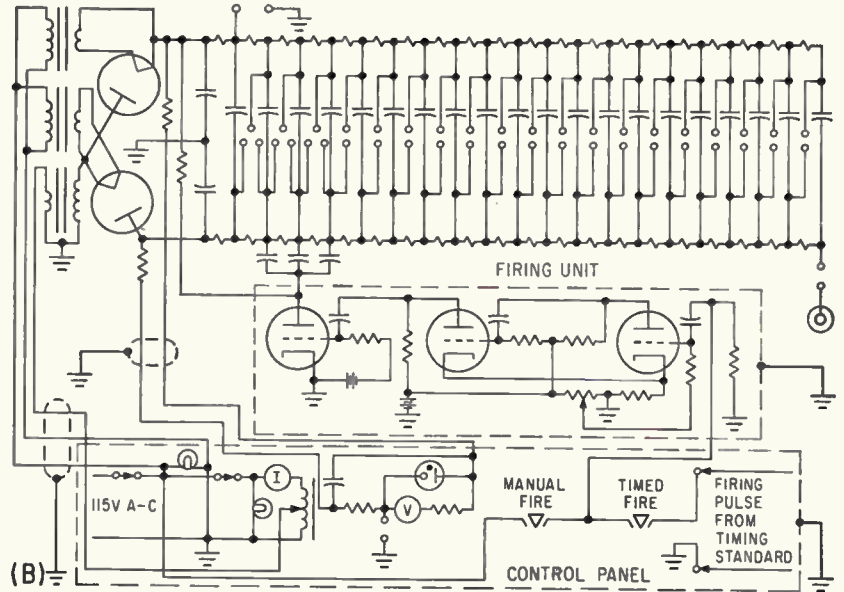
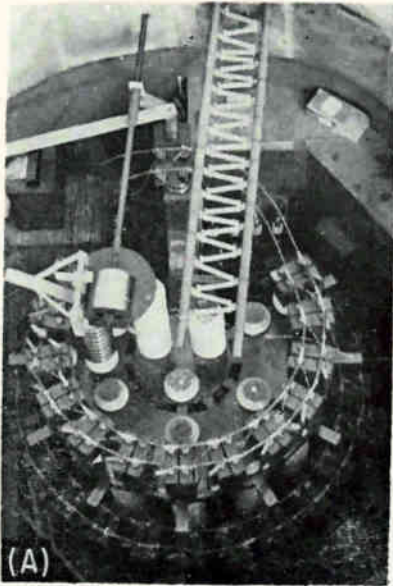


FIG. 1—Million volt impulse generator installed on schooner, seen from above (A), and the generator and controls (B)

signal strength is about 100 microvolts per meter.

The schooner that was used for this research is shown in the photo. Its center mast was removed to make room for the high-voltage generator amidships and the cabin height was increased. The cabin roof slides forward to provide clearance for the high-voltage antenna. A top view of the high voltage impulse generator is shown in Fig. 1A.

The artificial lightning impulse generator, shown schematically in Fig. 1B, is a Marx-type parallel charge and series discharge arrangement of capacitors, charging resistors and switching spark gaps. The generator can be triggered manually or from a time standard. The time standard is synchronized with WWV and the high-voltage pulses can be triggered to within 0.1 millisecond of the start of the WWV time ticks. The drift of the time standard is of the order of 1 millisecond per day (1 part in  $10^6$ ) and its short term stability is one part in  $10^6$ . Normally the time standard is synchronized with the average of the WWV time ticks before generating each sequence of pulses. A block diagram of the transmitting and receiving equipment is shown in Fig. 2A.

The frequency standard crystal-controlled 100 Kc oscillator is divided to 100 cycles and then fed to a phase shifter and power amplifier

which drive a synchronous clock motor. Synchronization with WWV is effected by varying the phase of the 100-cycle frequency standard output with a self-synchronized phase shifter, shown schematically in Fig. 2B. This circuit consists of a power supply, inverter, phase-shifting Selsyn, 100-cycle filter and output amplifier. The output feeds the power-amplifier section. The clock uses a light source and photocell transducer to produce trigger pulses at either one a second or one a minute. These pulses have a rise time of the order of  $10 \mu\text{sec}$ , and trigger the impulse generator (see Fig. 1B).

Similar timing equipment is used in a receiving system to trigger the trace of a recording oscillograph. The antenna has a series filter to remove both broadcast and power frequencies, which may interfere with the reception of the waveform. Receiving equipment of this type has been installed in a mobile vanette installation, which is equipped with a 50-foot vertical receiving antenna. The vanette has a 110 v d-c battery bank, charged from an engine driven generator, supplying motor-driven regulated a-c generators which, in turn, supply power for the equipment. Thus both the generator and receiver are mobile and can be moved to optimum locations for studies. The schooner must be located where it can carry on high-wire operations

without interfering with air traffic or small craft. The vanette can be moved to vary the propagation distance and type of terrain (land or ocean) but should also be located in a relatively interference-free region.

The generator antenna system consists of a 10,000 to 12,000-foot wire suspended from a helicopter and attached to the sea-going bronze-hulled schooner by a controlled torque reel used to keep a relatively constant tension on the wire and to reel it in or out. The wire is stranded copper-weld, equivalent in size to about No. 15, and has a high breaking length of about 30,000 feet. A 100- to 200-foot polyethylene leader isolates the helicopter from the top of the antenna. A release mechanism permits the helicopter pilot to drop the wire quickly in an emergency situation. The antenna current is continuously monitored to detect excessive field gradients which could result in a natural lightning stroke to the wire. Thunderstorm conditions are avoided for helicopter or balloon supported antenna work but these conditions are required for other researches. Normally the antenna hangs fairly vertically near its helicopter or balloon support, drooping into a catenary above the schooner. Other possible orientations shown in Fig. 3A and 3B may be useful for the generation of whistlers.



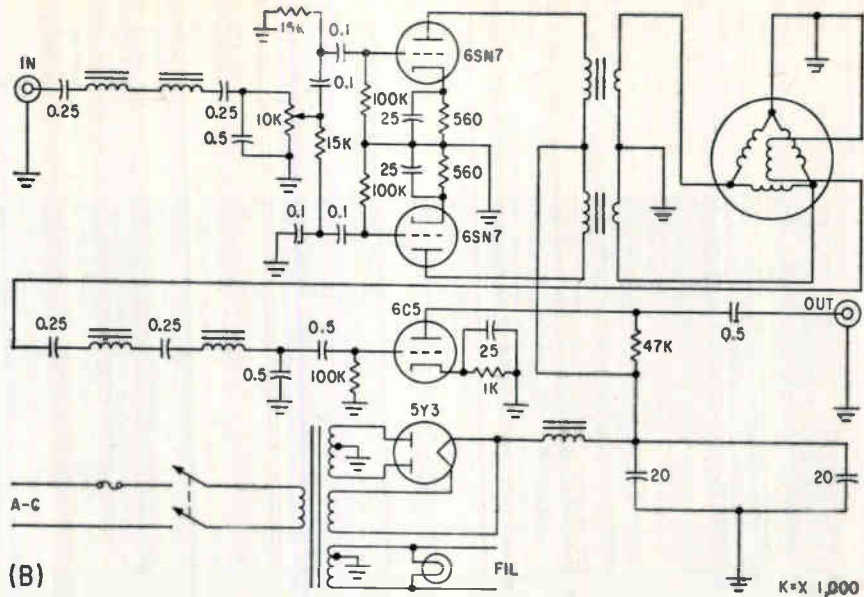
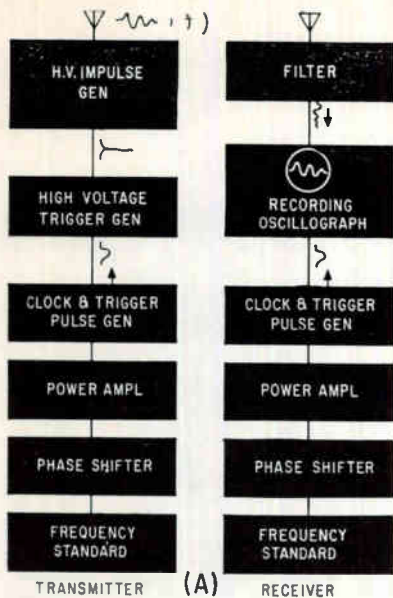


FIG. 2—Artificial atmospheric propagation and receiving system (A), and schematic of phase shifter (B)

The propagated pulse waveform is essentially a damped oscillatory waveform. The frequency and decrement are affected primarily by the generator constants, wire size, wire length and capacitive loading such as may be provided by balloons. A typical waveform of a 25 Kc pulse received at AFCRC during preliminary tests over a distance of 110 kilometers is shown in Fig. 4. This pulse, which overloaded the measuring oscillograph, was received without precise timing by using a continuous sweep and moving film technique over several seconds. Its peak amplitude was of the order of 200 millivolts per meter corresponding close to the level expected theoretically.

A rocket may also be used to provide temporary support for the antenna. The rocket would carry the antenna to a high altitude. The antenna would be pulsed near its peak altitude and also, as it settled slowly, retarded in falling by a small parachute. Another use for this antenna is in the study of natural lightning strokes. Lightning studies from the tops of high buildings, such as the Empire State building, encounter the difficulty of prior draining of the nearby cloud charges thus reducing the severity of the discharge. This cloud-field disturbance can be minimized by projecting a wire probe into the cloud field with a rocket. If the rocket is launched when the field

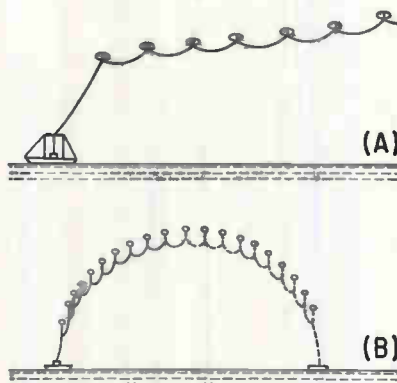


FIG. 3—Antenna configurations for the generation of whistlers: inverted L (A), and semicircular (B)

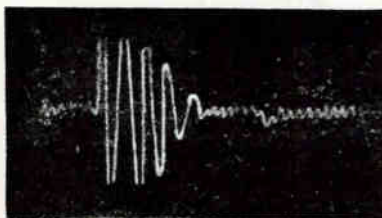


FIG. 4—Waveform received at distance of 110 km

gradient near the ground is high, there would be a high probability of triggering a lightning stroke to the wire. A current shunt and oscillograph would record the current waveform of the stroke. The lower end of the wire could also be connected to the high voltage generator which would superpose a known discharge into the lightning channel for oscillographic studies of

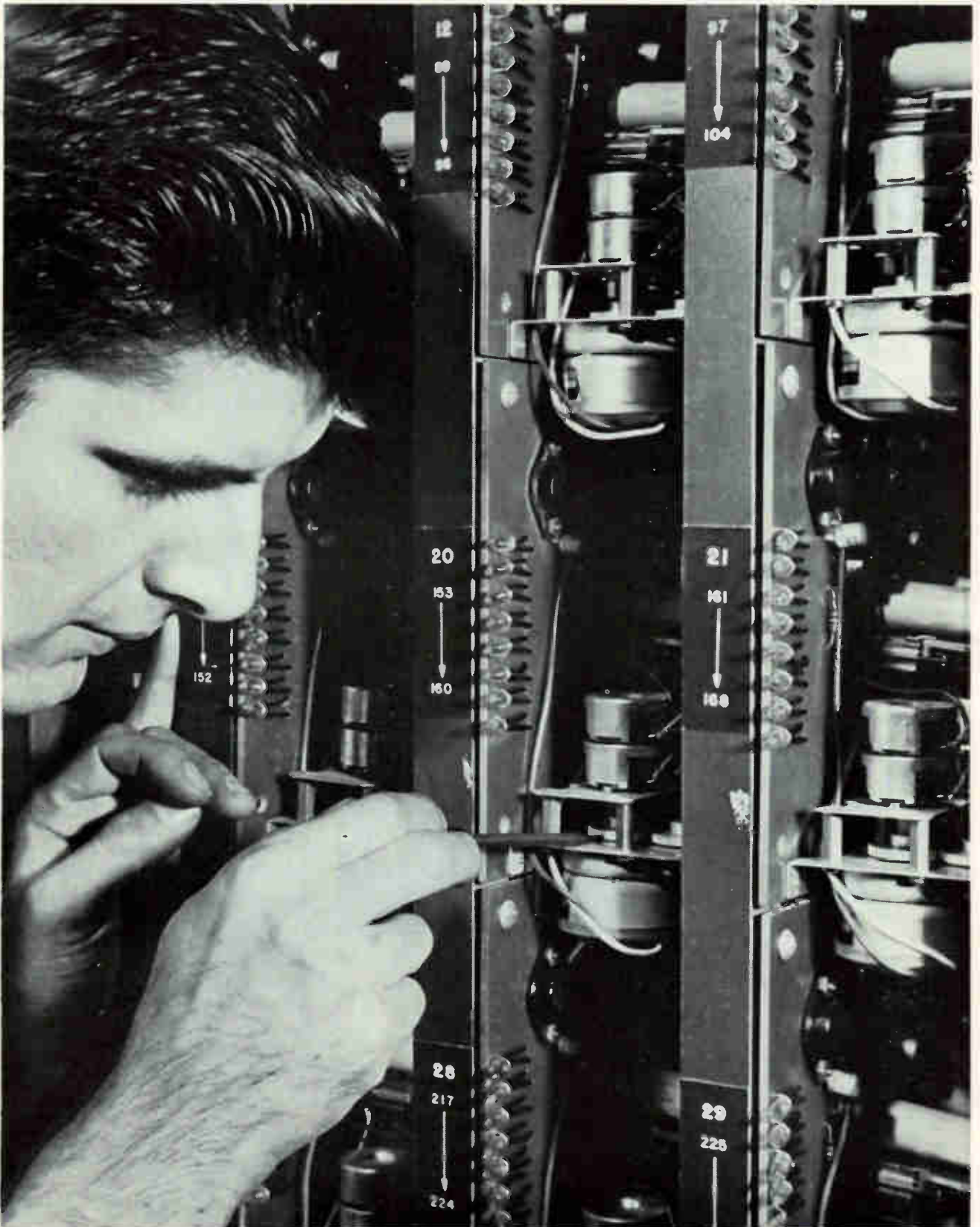
the surge impedance, propagation velocities, and other parameters of the lightning channel itself. In intercepting a lightning discharge it is expected the conductive wire will fuse; however, the path will remain ionized to complete the discharge.

A truck-mounted artificial atmospherics generator was designed for the U. S. Army Signal Research and Development Laboratories, Fort Monmouth, based on the experience of the ship-mounted impulse generator tests sponsored by Cambridge Air Force Center, and a coordinated program on reciprocal pulse propagation is being proposed by Lightning & Transients Research Institute, Minneapolis, Minn. with these two organizations. Included in this program will be an effort to reproduce artificially the whistler mode of propagation channeled by the Earth's magnetic field. Other significant applications of the artificial pulse generator might include calibrating of lightning atmospheric directional equipment and checking accuracy of navigational systems.

The main support in this study of the Air Force Cambridge Research Center, Electronics Research Directorate is acknowledged. Companies contributing to the cost of basic research and equipment used on this program include Joslyn Mfg. & Supply Co., General Cable Corporation and Copperweld Steel Corporation.



# THE PERCEPTRON—



*Technician checks d-c motor-driven potentiometer in one of 512 A-units in the Mark I perceptron*

# AN EXPERIMENT IN LEARNING

*Basic perceptron concept, previously simulated on high-speed computers, is now demonstrated and proved out on an experimental machine. This is a limited-capacity version of what may become a family of efficient pattern recognition systems*

By WILLIAM E. BUSHOR,  
Associate Editor

EXACT KNOWLEDGE of the biological functioning of the brain remains inadequate even in this age of satellites and nuclear energy. Understanding of this process has been aided with the development of the perceptron Mark I by Cornell Aeronautical Laboratory. (See *ELECTRONICS*, p 43, June 24, 1960.)

The perceptron is a minimally restrained artificial nerve network consisting of logically simplified neural elements, or signal generating units, and the connections between them. This synthetic network has been shown capable of learning to discriminate and recognize perceptual patterns and is expected to provide data on the performance of actual physical sys-

tems for comparative study.

A simplified version of a mammalian visual system is shown in Fig. 1A. The retina, a mosaic of light-sensitive points, transmits signals to the visual projection area in the cerebral cortex. Several intermediate relay stations exist in a typical biological system (not shown) which preserve topological characteristics of the stimulus in a reasonably intact form. Beyond the projection area, however, connections appear to be largely random.

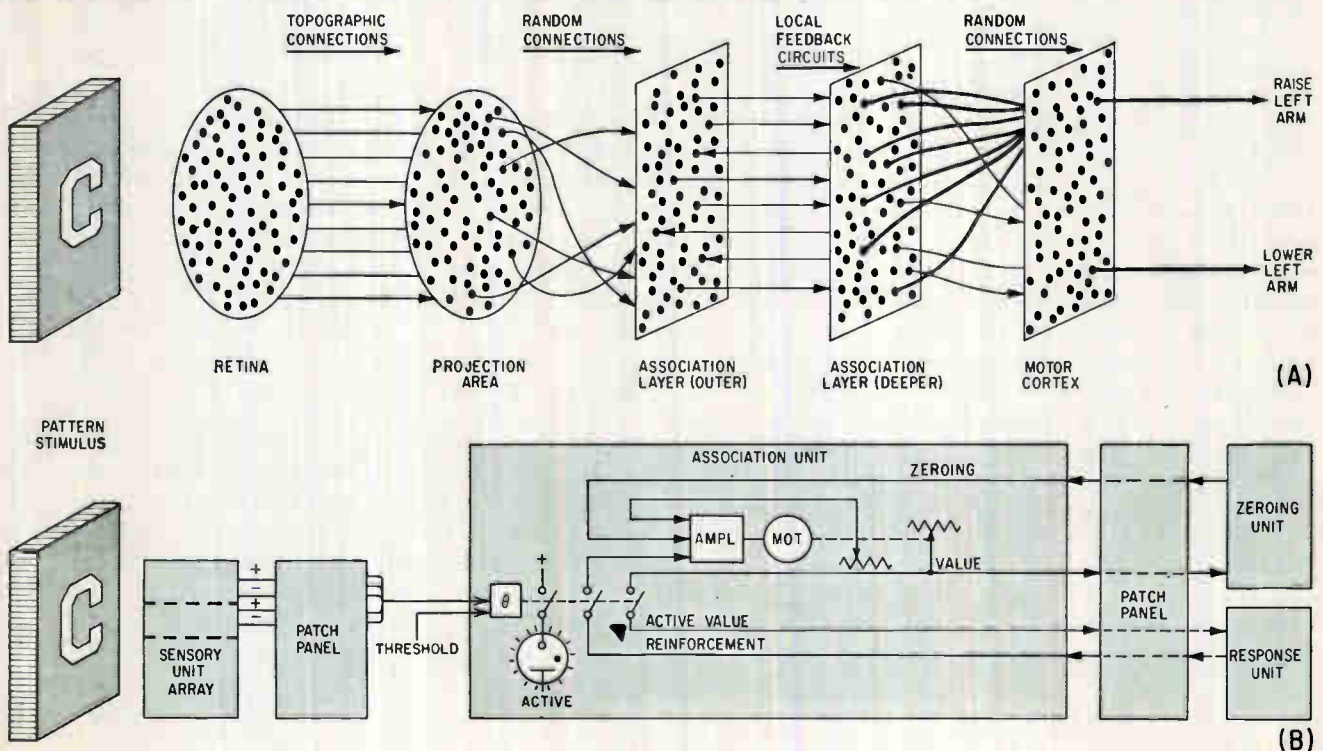
Impulses are delivered through a large number of paths to the association areas of the cortex where local feedback loops are activated so that activity may persist for some time past the termination of the original visual stimulus. Signals are then transmitted from the association area to the motor cortex

which has a topological organization corresponding to the location of muscle groups to be controlled.

Elementary perceptrons used to simulate the biological network are organized as shown in Fig. 1B. The sensory units (S-units) are threshold devices used to translate a stimulus, in this case a light pattern, into a discrete set of electrical signals. Each of the association units (A-units) is a threshold device coupled with a value storing device and receives as an input the sum of a group of the electrical signals from the S-units. These sets of S-unit output signals to be coupled to A-units are available on a patch panel so that various interconnection schemes can be used.

Since the S-unit electrical output signals may be either positive or negative (excitatory or inhibitory)

FIG. 1—Simplified version of a mammalian visual system (A) and perceptron simulating the biological network (B)





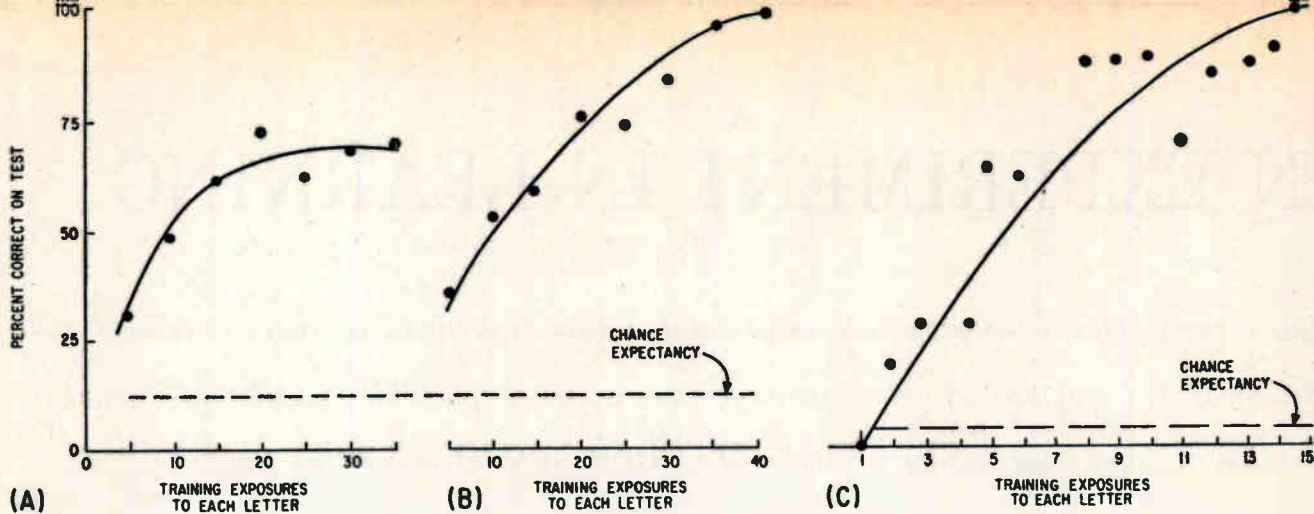


FIG. 2—Forced learning curve (A) and corrective training curve (B) for eight-letter identification task, and corrective training learning curve for 26 letters (C)

the A-unit input may be either positive or negative. If the A-unit input exceeds the arbitrary threshold which is set in manually, that A-unit becomes active. An active A-unit supplies its value as an output signal to the response units (R-units) to which it is connected.

The R-unit input signal is the sum of a set, called the source-set, of A-unit outputs. In this case each R-unit source-set is disjunct—completely separate from all other R-unit source-sets. The R-unit provides a visual indication of its state (the perceptron output) and, in addition, transmits a reinforcement signal to its source-set of A-units. Those A-units in the source-set which are active integrate the reinforcement signal to increment their value. The A-units which are not made active by the particular stimulus do not integrate the reinforcement signal.

The sensory device is a  $20 \times 20$  square matrix of photoresistive cells mounted in a phenolic base plate. Photocell currents actuate transistor-driven relays which supply the excitatory and inhibitory (plus and minus) S-unit output signals. Each photocell which receives sufficient light supplies both signal polarities to a patchboard. Since 20 A-unit connections are made available for each signal from an S-unit, and since there are 400 S-units with bipolar outputs, the patchboard has  $400 \times 20 \times 2$  or 16,000 available output connections.

Inputs to the A-units are also transistor-driven relay circuits. Provision has been made for a second input, the threshold of which is common to all A-units. This arrangement allows manual

adjustment of the number of excess excitatory inputs needed to make the A-unit active. When an A-unit does become active, its relay closes and connects the A-unit value to the output. Also, the integrator input is connected to the reinforcement signal lead from the R-unit and a voltage is applied to a neon lamp for visual indication of its activity.

The A-unit integrator consists of a d-c motor driving a potentiometer. Voltage at the potentiometer arms provides a measure of A-unit integral or value. A second potentiometer on the same shaft provides a local feedback loop to allow decay of the A-unit value with time. Normally, the decay voltage is applied only during the resetting of the A-unit to its zero position for the start of tests.

A-unit outputs are summed in groups of eight for convenience and brought to a small patch board constructed like the one between the S-units and A-units. At this patch board, the source-sets for each R-unit are made up and the connection for A-unit output sums and reinforcement feedback are made. Zeroing connections (to be described later) are also made on this board.

An R-unit is another bistable device consisting of a d-c amplifier driving a relay. This relay causes an indicator to show the condition of the R-unit, 0 or 1, and also provides the reinforcement signal for the source-set of A-units.

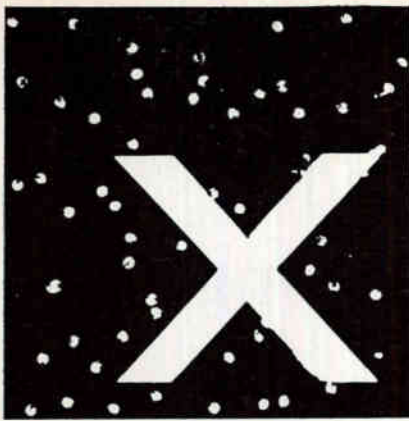
Accompanying each R-unit is a zeroing unit (Z-unit) which is identical in construction. The input of the Z-unit, however, is the sum of all the A-units in a source-set

whether they are active or not. The Z-unit output also goes to every A-unit in the source-set in reverse phase. This operation tends to drive the sum of all A-unit values toward zero with the result that the entire source-set cycles about zero as a relay servomechanism.

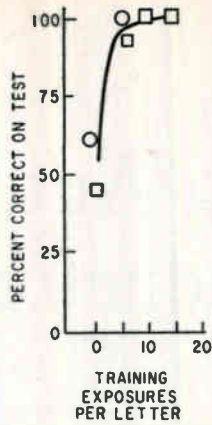
The perceptron contains 400 S-units, 512 A-units and eight R-units and Z-units. To make operation of the machine as easy and versatile as possible, switches are provided to control most of the functions which act on A-unit values. Timing devices are used to determine the reinforcement period. The switches allow the reinforcement voltage to be made one polarity (monopolar reinforcement), two polarity (bipolar reinforcement), reversed or removed. The decay voltage can be removed as can the zeroing voltage. A reset switch allows the A-units to be put into their starting position with the previous learning completely erased. Resetting is done by supplying one polarity of zeroing voltage so that all A-units are driven to one side of their zero position then following by normal zeroing with decay so the A-units cycle about their individual zero positions.

Switches are provided to force the R-units into either their 0 or 1 state so that the reinforcement voltage for any stimulus may be determined by the experimenter. The procedure of setting the R-unit and allowing reinforcement with each stimulus is called force learning. For testing the state of learning achieved, the R-unit is allowed to go to the state dictated by the stimuli but with the reinforcement





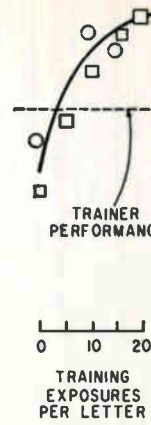
(A)



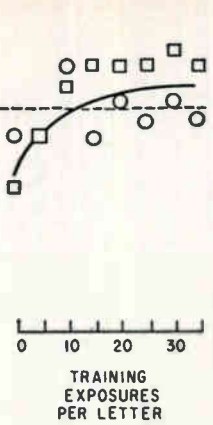
(B)



(C)



(D)



(E)

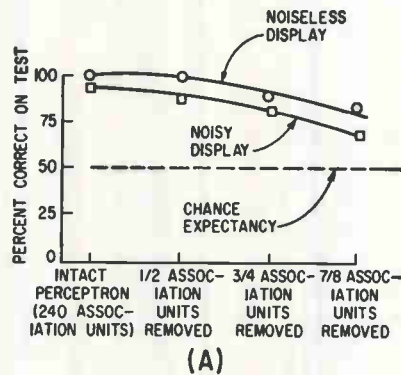
FIG. 3—Example of noisy target display (A), and effects of noiseless and noisy displays with perfect trainer (B and C) and of noiseless and noisy displays with trainer 30 percent wrong (D and E)

turned off so that the A-unit values remain unchanged.

Alphabet learning is of interest in showing how well a perceptron system can learn to perform a non-trivial human task without being provided with any special input. The task consisted of presenting Roman letters of a standard type one at a time to the retina. Their location can be anywhere within a certain region although they are always placed in an upright orientation. To do this, Mark I is subdivided into parallel elementary perceptrons as needed—that is, if eight letters are to be identified, at least three independent binary outputs or three elementary perceptrons are needed.

For example, the perceptron is shown the letter D while simultaneously it is told the identifying response by forcing the response to the correct values and reinforcing them. Then the perceptron is shown another letter, or perhaps the same letter in a different position. Each time the correct response is forced. After a number of forced learning trials, the perceptron is tested by presenting the letters and asking it to identify them—that is, R-unit values are determined by the A-unit. Figure 2A shows the learning curve for identifying eight letters in a relatively large field.

The results shown in Fig. 2B were obtained using a corrective training technique. In this case the A-units are allowed to determine the response unit values from the beginning of training, but when a mistake is made the correct response values are forced and reinforced. Figure 2C shows the learn-



(A)

TARGET (RELATIVE DIMENSIONS GIVEN)	PERFORMANCE (ON 40 TESTS)	TARGET (RELATIVE DIMENSIONS GIVEN)	PERFORMANCE (ON 40 TESTS)
4  20	100%	15  20	100%
2  20	78%	4  15	93%
7  20	100%	8  10	45%

NEW TARGETS (B)

FIG. 4—Effect of A-unit removal on trained E-X discrimination (A) and generalization of horizontal-vertical discrimination to new target (B)

ing curve for identifying the alphabet when all letters are confined to one fixed position.

A series of experiments to study the effect on the learning curve of three main types of interfering conditions were performed. A standard task was used which is rapidly learned under optimal conditions. This task is to identify the letters E and X when they are free to occur anywhere within a small retinal region. Although this task can be performed by a single elementary perceptron, the Mark I was subdivided into two independent elementary perceptrons so that it could be determined how two of them perform the same task.

Noise in the target display is introduced as shown in Fig. 3A. Figures 3B and C compare the learning curves for the E-X discrimination task under noiseless and noisy display conditions. Data points are for the two independently trained perceptrons, each possessing 240 A-units.

To study the case wherein the trainer makes mistakes, random errors were introduced into the

training program. Specifically, the probability of the perceptron being told the correct answer during training was made 70 percent. Figure 3D shows the learning curve for the E-X discrimination task when there is no display noise but the trainer is 30 percent wrong. Figure 3E shows the learning curve when stimulus noise is present and the trainer makes mistakes.

Stability of perceptron performance under damage conditions was simulated by simply removing A-units from a perceptron trained on the E-X discrimination. Figure 4A shows the decline in performance as A-units were removed. To determine how the perceptron could discriminate between noncongruent images not confined to a limited region of the retina, a more extensive generalization was tried. An elementary perceptron of 422 A-units was formed from the Mark I. A performance level of 100 percent measured over 40 test stimuli was rapidly reached. Then various other rectangles were tested with the results shown in Fig. 4B.

# Signal-Seeking Auto Radio Uses Semiconductor Tuning

*Replacing conventional tuning capacitors with silicon semiconductors permits savings in weight, size and cost of radios.*

*Remote and nonmechanical signal-seeking are other advantages*

By J. G. HAMMERSLAG,\*

Semiconductor Division, Hughes Products,  
Newport Beach, Calif.

SEMICONDUCTOR VARIABLE capacitors have made possible and practical radical design changes in the tuning mechanism of radio receivers. In automobile radio receivers, savings in size, weight and cost as well as such advantages as nonmechanical signal-seeking and remote tuning are possible.

The semiconductor capacitor is a semiconductor diode whose capacitance can be varied by varying an externally-applied bias voltage.

The semiconductor junction can be considered as consisting of three distinct zones; the *p* zone with an abundance of positive carriers, the *n* zone with an abundance of negative carriers and a thin depletion

zone where relatively few carriers are present. When the junction is used as a diode, a potential across the junction—positive on the *p* side of the junction and negative on the *n* side, will cause the carriers to bridge the depletion zone and thus form a conduction path across the junction. Reversal of the potential causes the depletion zone to reappear and thus insulate the two sides of the junction from each other. When the junction is used as a variable capacitor, the external potential is applied so that the depletion gap is never bridged with carriers.

Thus the junction assumes the characteristics of a parallel-plate capacitor. The *p* and *n* zones represent the plates of the capacitor and the depletion zone represents the dielectric between the plates. When the potential is applied in a direction

which would not normally cause conduction, the carriers will be pulled away from the depletion zone to a distance that is a direct function of the applied potential. The higher the potential, the further the carriers are pulled away from the depletion zone. Therefore, the higher the potential, the further the parallel plates are pulled apart and the lower the capacitance.

In the case of an abrupt junction—abrupt transition from the *p*-zone, to the depletion zone, to the *n*-zone—such as the case for alloyed junctions, the capacitance varies according to  $C = K/(V_c + V)^n$  where  $C$  equals capacitance,  $K$  is a proportionality constant,  $V_c$  is the contact potential,  $V$  is the externally-applied voltage and  $n$  is a characteristic exponent.

For alloyed junction silicon capacitors,  $V_c$  is approximately 0.5 v,  $n$  is approximately 0.46 and  $K$

\* Now with Western Semiconductors, Inc., Santa Ana, Calif.

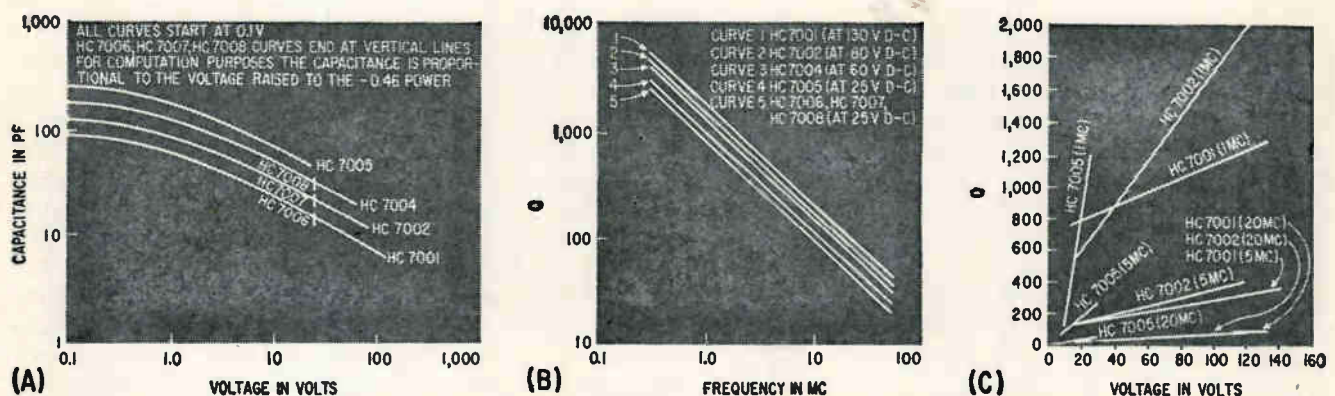
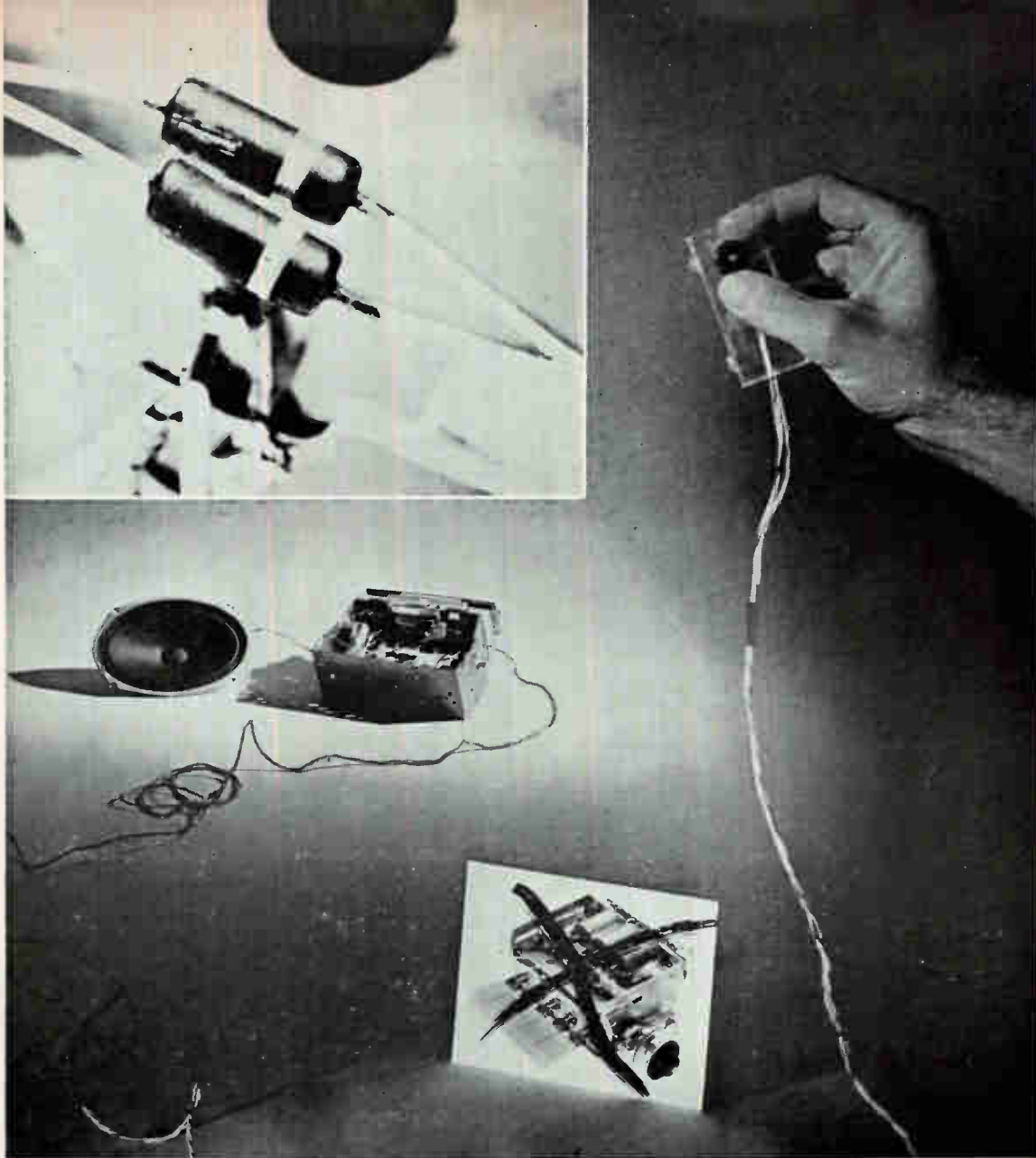


FIG. 1—Variation of capacitance by applied voltage (A), variation of  $Q$  with frequency (B) and variation of  $Q$  with voltage (C) of typical silicon voltage-variable capacitors





Bulky tuning components (lower insert) can be replaced by silicon capacitors (top insert) and potentiometer (held in hand)

varies from device to device with its value depending primarily on the resistivity of the silicon material and the size of the junction.

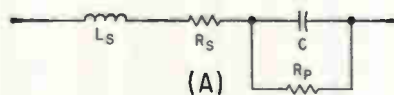
Figure 1A shows some typical curves for different types of silicon voltage variable capacitors.

Although the curves of Fig. 1A show applied voltage down to 0.1 v, the bias voltage can be reduced to zero and even be reversed and increased up to 0.4 v (thereby partially cancelling the contact potential) with the effect of still further increasing the capacitance of the unit.

Maximum to minimum capacitance ratios of 35:1 have been attained though not all of this range is usable.

The silicon capacitor is not a perfect capacitor. In addition to capacitance, the device also has series and parallel resistance as well as series inductance as shown in Fig. 2A.

Series inductance  $L_s$  is usually negligible and parallel resistance  $R_p$



$$Q = \frac{1}{2\pi f C R_s}$$

FIG. 2—Equivalent silicon capacitor (A); simplified equivalent circuit (B)

can be thousands of megohms at room temperature. The equivalent circuit can be simplified to that shown in Fig. 2B.

Series resistance  $R_s$  is the determining factor of the  $Q$  of the device. The  $Q$  of a capacitor used in a resonant circuit should be as high as possible. If the  $Q$  is too low, then voltage gains in tank circuits will be low, resonance curves will be flat and nonselective and some circuits will not work at all. At present, the  $Q$  of available silicon capacitors is relatively low.

According to the relation  $Q = 1/2\pi f C R_s$ , frequency and capacitance both have an effect on the  $Q$ . Since capacitance is dependent on the applied voltage, voltage will





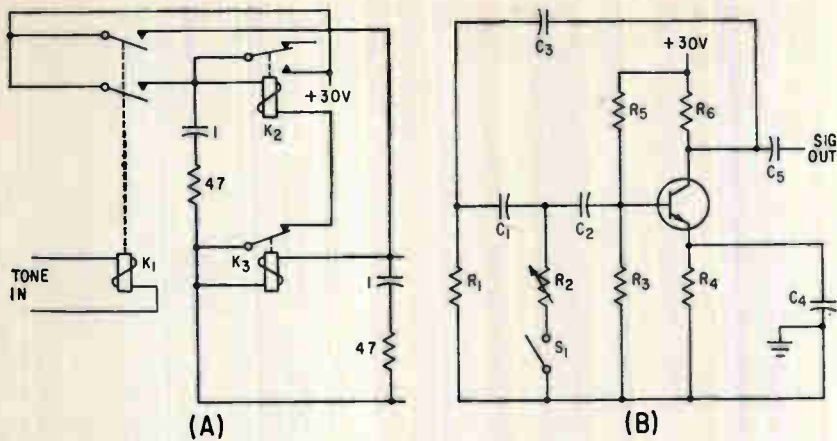


FIG. 1—Reed relay  $K_1$  energizes  $K_2$  to close test loop (A) when correct tone is provided by oscillator (B) to reed relay coil

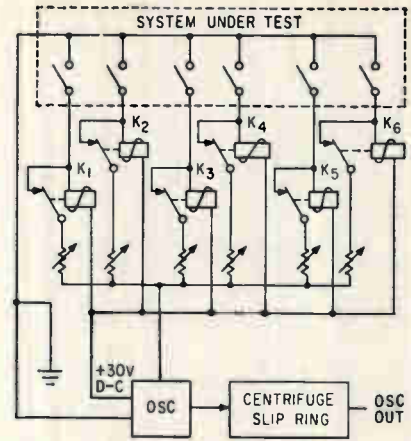


FIG. 2—Data from one source can be distributed to many readouts

# Reed Relays Simplify Monitoring

*Only three leads are required to remote system under test using reed relays and tone-encoded signals. No analog or digital detection needed*

By FRED W. KEAR,  
Lytle Corp., Albuquerque, N. M.

SYSTEM TESTING often requires remote monitoring and control involving many information channels. When a system is not readily adaptable to other methods, information can be transferred using reed relays. Large amounts of information can be monitored simultaneously or consecutively over a single channel without the expense of digital or analog detection.

This monitoring method involves radio or wire transmission of tone-encoded signals that are detected by the reed relay. Associated circuits provide switching to complete the information loop.

In the typical system in Fig. 1, d-c coil resistance of reed relay  $K_1$  is about 7,500 ohms. A tone from a generator in the system under test must provide about 20 volts peak-to-peak to energize the relay. The generator is a simple R-C oscillator with reasonably small drift and is keyed by closure of system test contacts. These closures shunt different preset resistances into the oscillator grid circuit

causing generation of a frequency associated with that particular test closure. The oscillator in Fig. 1B has proved satisfactory.

Each reed of reed relay  $K_1$  in Fig. 1A is cut to a different frequency. Excitation of the coil causes only one reed to be excited by a particular received tone. When the lower reed of  $K_1$  is excited, a pulsating +30 volts d-c is applied across the coil of  $K_2$ . Because of the network across the coil, voltage is more than adequate to energize the relay. When  $K_2$  is energized, it is latched by one of its own contacts. For momentary-type readout, the latching feature can be eliminated.

After the monitoring cycle, the circuit can be reset remotely by a tone of the same frequency as the second reed of  $K_1$ . Intermittent closure of this contact pulls in  $K_2$ , opening the coil circuit of  $K_2$ .

This method can also be used to channel digital information from a single source to a number of readout devices. A single slip ring can distribute a complete information group involving up to a dozen types of information.

Closing a contact in the system

under test in Fig. 2 is comparable to closing switch  $S_1$  in Fig. 1B. One variable resistor corresponding to  $R_2$  in Fig. 1B is used in the oscillator for each system contact. Each resistor is preset for a tone in the readout circuit without interaction with other reeds.

Closure of a system test contact energizes the oscillator. After an adequate time lapse, the oscillator is disabled by one of time-delay relays  $K_1$  through  $K_6$ . A time delay relay is energized by closure of a test contact, and sufficient time is provided for reed response to activate the detection circuit. If closure time is insufficient, separate oscillators must be provided. However, oscillator tones can be transmitted simultaneously. The tones can be deciphered by the reed relay simultaneously if they are separated by at least 30 cps and if no harmonics are within 30 cps of any reed frequency.

This system of monitoring requires only three leads through the centrifuge slip rings—two for power and one for a signal. However, response time is not satisfactory for timed tests except when tolerance requirements are low.

# DESIGN OF STATIC

*Static relays provide an alternative to electromechanical devices, have superior characteristics for some critical applications*

By **ROBERT LANGFELDER,**

Walter Kidde & Co., Inc., Kidde Aero-Space Division,  
Belleville, N. J.

MECHANICAL relays have been widely used throughout the electrical industry for many years. Basically simple devices, they perform well when used in appropriate environmental conditions. Relay shortcomings are due to the use of a mechanical contact; any component with a moving part has certain inherent limitations which may be minimized but never completely eliminated.

In particular, relay performance or life may be unsatisfactory when the application requires fast response or long cycling life; when shock or vibration are severe; when an inductive load causes contact arcing; and in low-voltage, low-current circuits where contact contamination can affect performance.

With the development of the transistor, and, more recently, the controlled or gated rectifier, the possibility of producing relay-like action using only static components became feasible.

For a device to be considered a true static relay, as distinguished from a static switch, isolation between the signal and power circuits must exist, and on and off snap action must occur. Basically, in a static relay circuit, a semiconductor's impedance must change from high to low when a certain signal level is reached, and change

back from this low value to the high value when the original signal level is restored. To simplify the discussion, this semiconductor will be referred to as the contact.

Figure 1 illustrates the rating ranges of four semiconductor element types suitable at the present time. These ratings take into account both presently available characteristics and development types expected in the near future. Of these semiconductor contacts, only the controlled rectifier provides snap action without additional circuits. At least two other contact elements are possible: the magnetic amplifier and the vacuum tube. The former requires a-c power and will, in general, be larger and slower than a controlled rectifier circuit. The latter has comparatively short life, requires filament power, and can, of course, be replaced by a transistor in most cases.

Snap action can be provided by two alternate methods. The first method uses regenerative elements such as the controlled rectifier, unijunction transistor, four-layer diode and the newly developed tunnel diode. The second method uses nonregenerative elements connected in regenerative circuits such as the blocking oscillator, Schmitt trigger and bistable multivibrator. For a d-c signal and no

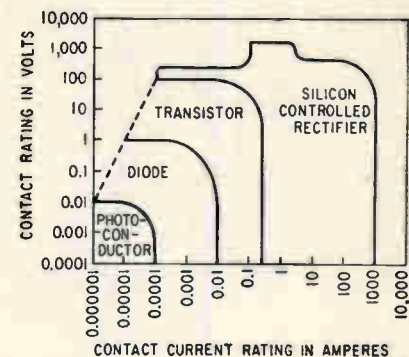


FIG. 1—Voltage and current ratings of static contacts

regenerative element or circuit in the power side, isolation of signal and power circuits requires an oscillator that becomes regenerative when some d-c level is reached. When a regenerative element or circuit is present, the requirement is to develop pulses of opposite polarity at two specific d-c signal levels.

Static relays using only transistor amplifiers require an oscillator. Since a transformer is required for isolation, the simplest oscillator circuit requiring only a single transistor is the blocking oscillator.

Figure 2A illustrates the simplest possible static transistor relay. Collector and base voltage are both provided by the input signal. To provide the low base voltage at a higher collector voltage, a zener diode is provided in series with the base. When the input level exceeds the zener voltage by approximately 0.4 v, the gain of transistor  $Q_1$  increases until the loop gain exceeds unity and oscillations are produced. The oscillations are converted to d-c in the secondary by half-wave rectification. They drive transistor  $Q_2$  well into saturation. When the input voltage is reduced to the point where loop gain is less than unity, oscillations cease and the transistor drive is removed.



# RELAYS for Signaling and Control

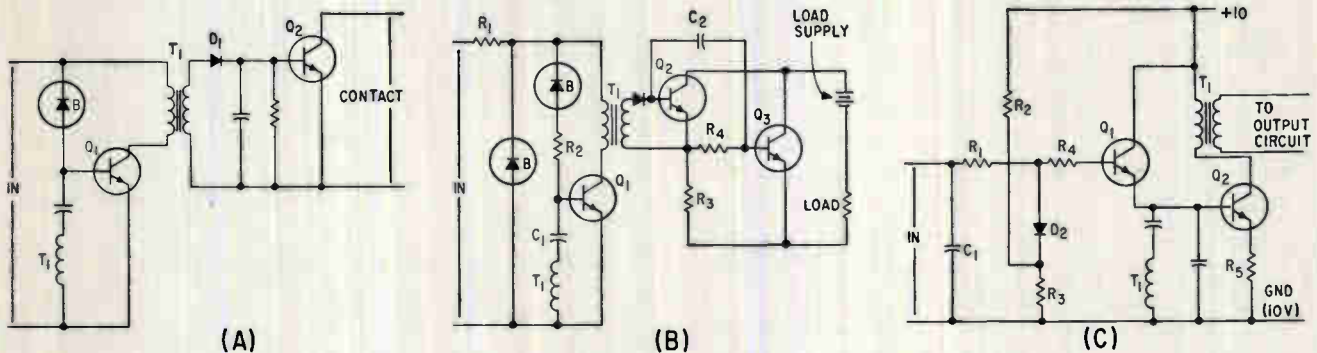


FIG. 2—Simple static relay uses transistor in oscillator circuit (A); modification (B) increases current rating and provides overload protection. Sensitive relay (C) requires only  $4 \mu\text{w}$  control power at room temperature

Half-wave rectification can be used without the capacitor since storage and fall time can maintain  $Q_2$  in conduction when diode  $D_1$  is not conducting. The contact may pull out of saturation at low ambient temperatures with certain transistors; the storage capacitor eliminates the need to select contact transistors. A static relay produced with this design is rated at an output of 20 ma at 28 volts, an input of 3 ma at 10 volts, and an ambient temperature range from  $-40$  to  $+100$  C. Operation is satisfactory to about 20 Kc.

Modification of this simple relay, as shown in Fig. 2B, provides a contact rating of about 250 ma and input overload voltage protection.

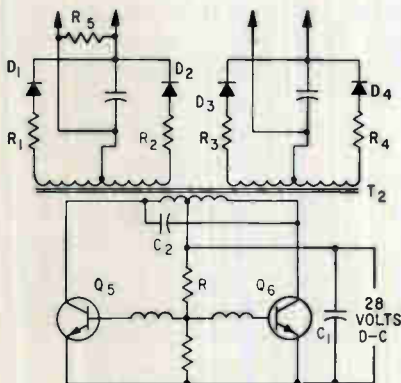


FIG. 3—Converter circuit uses capacitors and resistors to reduce transients and circulating currents

A resistor-zener diode combination and  $R_2$  provide overload protection and an intermediate contact transistor is added to increase the output current rating. Capacitor  $C_2$  is connected to the end of  $R_4$  away from the emitter of  $Q_2$  to increase the R-C time constant and reduce the size of the capacitor required. Auxiliary power to the collector of  $Q_1$  would reduce the required input current to about  $500 \mu\text{a}$ .

One need was a static relay with a contact rating of 250 ma at 28 volts requiring a signal power of less than 50 microwatts. To reduce the input power to this level, an additional stage of amplification and a separate source of collector voltage were required (see Fig. 2C).

Since isolation had to be maintained, the contact supply voltage was used as the input to a d-c to d-c converter whose output was used as the collector supply. The separate supply permitted the elimination of the zener diode in series with the base. The final units had a signal power requirement of under  $4 \mu\text{w}$  at room ambient and a maximum of  $23 \mu\text{w}$  at  $-55$  C. Elimination of the zener diode with the resulting reduction of signal voltage to about 0.7 volt at room ambient complicated the overload protection problem. Because of the

voltage level, a zener diode could not be used. The zener diode voltage was replaced by the forward drop of diode  $D_2$  in series with a voltage obtained from the collector supply by voltage divider  $R_2$  and  $R_3$ . To avoid applying even the voltage that could be developed across this combination directly to the  $Q_1$  and  $Q_2$  base-emitter junctions, resistors  $R_4$  and  $R_5$  were added. The result is that a signal voltage of over 15 volts can be applied over the entire temperature range without interfering with the operation of the final contact.

The final d-c to d-c converter for the collector supply is shown in Fig. 3. Modifications of the standard circuit keep the switching of the converter from interfering with the sensitive input circuit or from appearing in the d-c power line or the signal or contact circuits. Capacitor  $C_1$  keeps the switching from significantly affecting the power line;  $C_2$  increases the rise time of the square wave and reduces the higher frequency components. Resistors  $R_1$  to  $R_4$  and fast recovery diodes  $D_1$  to  $D_4$  prevent the heavy circulating current which would otherwise occur in the transformer secondaries when inverter switching takes place. This current must be minimized or the resulting field may couple into

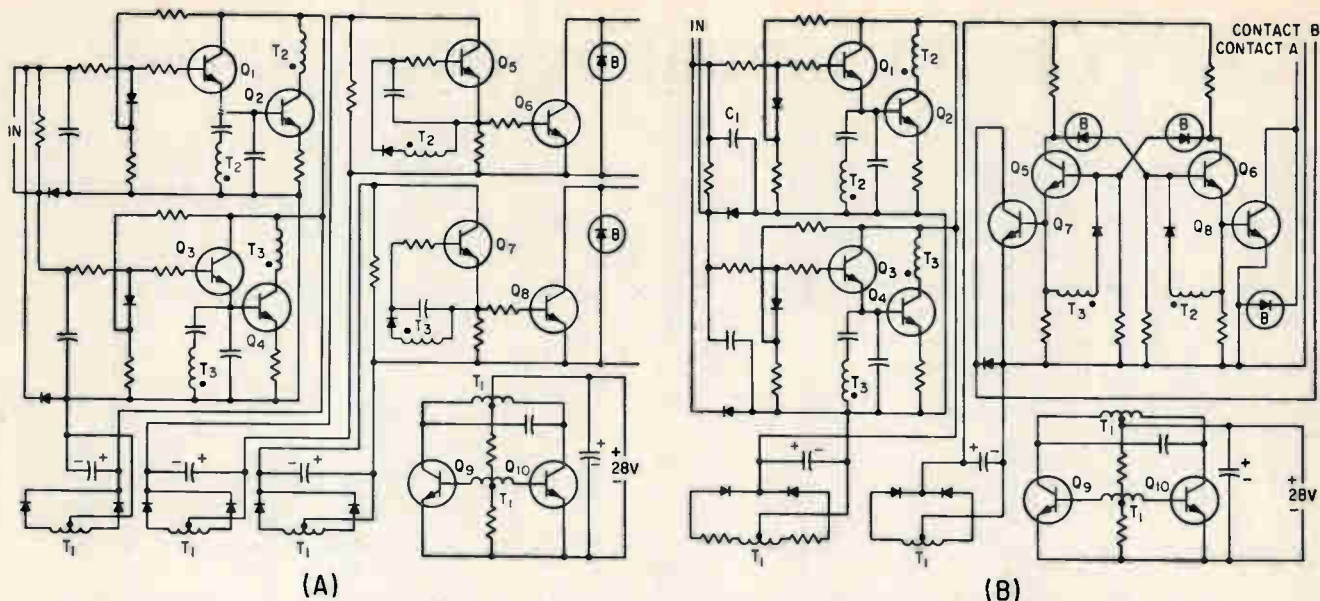


FIG. 4—Polar relay (A) is essentially two simple relays. Latching polar relay uses multivibrator (B)

other circuits through stray capacitance or magnetic coupling.

Four variations of the basic sensitive relay were developed. The purpose was to duplicate the functions of other than simple spst relays.

Figure 4A is a schematic of a polar relay. This is simply two spst relays whose inputs are connected with opposite polarity to the signal circuits. Both input circuits use the same converter secondary and the input diodes block the reverse signal polarity when the normal voltage is applied to the other input. In addition, these diodes prevent the secondary from being short-circuited through the common lines. Separate secondaries were used on the individual output circuits to permit either spdt or dpst connections. Because of differences in mechanical construction, resistors in series with the converter diodes were not required in this unit.

Figure 4B is a schematic of a latching polar relay. The latching function is performed by a bistable multivibrator. The blocking oscillators are used to switch the state of the multivibrator rather than to provide constant base current drive.

Figure 5 is a schematic of a dpst relay. Transistors  $Q_1$  to  $Q_4$  func-

tion as in the spst relay. In addition, the emitter of  $Q_3$  is returned to the converter ground through  $D_1$  and  $R_1$ . When  $Q_3$  is conducting, the voltage across  $R_1$  cuts off  $Q_5$  and hence  $Q_6$ . When the oscillator using transformer  $T_2$  is in a nonoscillatory state, the other oscillator is kept on by the base voltage developed across  $R_2$ .

Figure 6A is a schematic for the conversion of the original spst relay output circuit to yield spdt operation. With the oscillator off, transistors  $Q_1$  and  $Q_3$  are not conducting. The voltage appearing at the collector of  $Q_3$  is large enough to cause zener diode  $D_1$  to conduct and deliver base current to  $Q_5$ , thus closing the normally closed contact. When the oscillator is activated,  $Q_2$  is saturated and the normally open contact is closed. In addition, when  $Q_1$  conducts, causing  $Q_3$  to conduct, the voltage at the collector of  $Q_3$  falls to a value low enough so that  $D_1$  will block, and the base current of  $Q_5$  is reduced to zero, opening the normally closed contact.

Variations of the basic spst circuit are possible. Many other types of oscillators may be substituted for the blocking oscillator. Rectification of the oscillator's output may be full-wave rather than half-wave. The oscillator's preamplifier may be coupled to the oscillator in

other circuit configurations, though the arrangement actually used was found to require the minimum input power of all combinations tested. Additional amplification may be added in the output circuit.

The development of controlled rectifiers of various ratings and verification of their reliability and long life within the last six to twelve months has established this type of element as excellent for static relay contacts for all but the lowest current ratings. Their high gain and regenerative action are highly desirable characteristics when they are used as contacts. Their primary shortcoming is the difficulty of turnoff. Although controlled rectifiers of special design permit some turnoff by reversal of the signal on the gate (the Trigistor, Transwitch and Thyristor), these are basically low current devices, with low ratio of load current to turnoff gate current. Actually, all controlled rectifiers can be assisted in their turnoff by this method at low load current levels. At high current levels, turnoff can only be accomplished by removing or reversing the applied cathode to anode voltage for a period of time.

One method of accomplishing turnoff is shown in Fig. 6B. Pulses of opposite polarity will trigger the



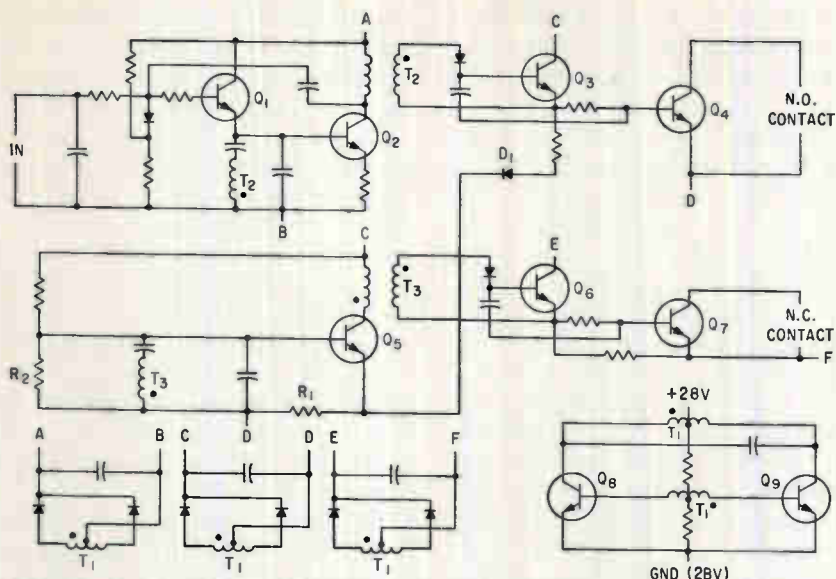


FIG. 5—Double-pole single-throw relay uses oscillator circuits of  $Q_2$ ,  $Q_3$ .

The circuit illustrated, Fig. 6B, is for spst operation. Resistor  $R_2$  can be made much larger than the load and the power loss is small. For spdt operation, the second load can be substituted for  $R_2$ . For multipole relays, the output circuit can be duplicated and extra transformer secondaries added.

For this type of output current and with d-c signals, circuits producing pulses of opposite polarity at certain signal levels are required. These pulses can be produced by regenerative elements such as uni-junction transistors, controlled rectifiers, four-layer diodes and tunnel diodes, or by regenerative circuits such as bistable multivibrators. Some possible circuits that require no auxiliary power are shown in Fig. 7A. Some circuits using an auxiliary supply are shown in Fig. 7B. The latter naturally require less signal power for operation.

controlled rectifiers alternately. Turnoff is accomplished by capacitor  $C_1$  and inductor  $L_1$ , with diodes  $D_1$  and  $D_2$  assisting in improving turnoff characteristics. After the main controlled rectifier  $Q_1$  is triggered, the capacitor will become charged to line potential. When the auxiliary controlled rectifier  $Q_2$  is then triggered, the capacitor will discharge through the load. As its current increases, the current through  $Q_1$  will decrease until turnoff occurs. As the current due to  $L_1$  and  $C_1$  continues to increase, the excess current will flow through  $D_1$ , preventing a significant increase in load voltage at this point. When the current through  $L_1$  and  $C_1$  decreases again and can no

longer maintain the load voltage above the load supply voltage, the normal voltage across  $Q_1$  starts to increase. If a long enough period has elapsed between the turnoff of  $Q_1$  and the reapplication of voltage, the controlled rectifier will stay off. Capacitor  $C_1$  will recharge to the full-load supply voltage with opposite polarity, preparing to retrigger  $Q_1$  and turnoff  $Q_2$ . Turnoff can be accomplished without the inductor but the capacitance required will be much larger. The inductor, in addition, permits a resonant reverse charging of the capacitor, causing rapid fall-off of load voltage to a low value before the slower decay occurs. The inductor also limits the peak diode current.

One limitation of controlled rectifiers as contacts is the maximum holding current. Below this value of current the contacts can be made to close but cannot be held closed when the triggering pulse no longer exists. The minimum load current must exceed the maximum holding current that can occur for any unit at the minimum ambient temperature. Thus controlled rectifier contacts cannot be used for low-current application.

Mechanical relays are limited in their ability to pass low voltages owing to the film which may form on their contacts. Such low-voltage a-c dry-circuit relays can be called signal relays.

One objective of the present static relay development is the investigation of signal relays. There are at least three circuits to be studied. Figure 8A illustrates one circuit upon which some study has previously been done. A symmetrical transistor is used as the contact. When the blocking oscillator is activated, base drive is provided to produce saturation and low bilateral impedance, and to apply the signal to the load with little attenuation. Diodes  $D_1$  and  $D_2$  provide a return path for the base current. If these diodes are perfectly balanced or series resistance is added to provide balance, no d-c

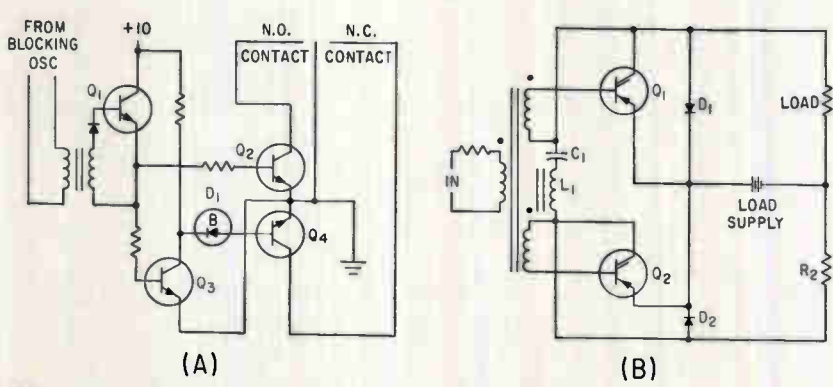


FIG. 6—Basic circuit is modified to give spdt operation (A). Gated rectifiers are used in (B) for spst relay

insertion occurs in the load.

Using a germanium symmetrical transistor, operation with signals as low as 50 millivolts is good. When the blocking oscillator is deactivated, the signal is attenuated at the load by a factor of several hundred to one. Increased leakage occurs through the diode at high frequencies (above 5 Kc) because of the recovery time of diodes  $D_1$  and  $D_2$ .

The second approach is shown in Fig. 8B. A photoconductor is used as the contact and the control voltage is used to light or extinguish the lamp, changing the impedance of the photoconductor approximately from ten megohms to 100 ohms. This circuit is attractive because of its simplicity; and isolation is obtained without a transformer. Although the control power will be high compared to the load signal power, this is not the fundamental problem, and amplification of the control power may be added when an auxiliary supply is provided.

The third circuit is shown in Fig. 8C. This may not be the most practical approach, because of the large number of extra circuit components required, but it illustrates the possibility of using biased diodes as contacts. When a diode is conducting forward current it will pass a reverse current up to the value of the forward current. A d-c to d-c converter provides isolation and transforms the control voltage to the voltage required by the diode. A four-layer diode provides snap action to energize the converter. When the control voltage is low, diodes  $D_1$  to  $D_4$  are not conducting forward current and only negligible signal current can be passed.

The forward paths through the diodes and capacitor  $C_1$  are blocked by the zener diode. When the control voltage exceeds the switching voltage on the four-layer diode, the converter oscillates and passes forward current through the diodes. If this forward current is high compared to the load current, the flow

of load current will barely unbalance the diode bridge and produce a small drop. This attenuation can be reduced almost without limit by increasing the forward current.

Static relays have already reached a state of development where their feasibility cannot be questioned. At present, static relays are in general, larger than equivalent mechanical relays. However, micromodule techniques should make them equal to or smaller than equivalent mechanical relays. Although their cost may always be higher, static relays can be built to do jobs that mechanical relays cannot do.

The work described was performed for USASRD, Fort Monmouth, New Jersey. E. Demers and R. F. Blake developed many of the circuits. A previous article<sup>1</sup> gave details on static relays for power circuits<sup>1</sup>.

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- (1) R. F. Blake, Designing Solid-State Power Relays, *ELECTRONICS*, 33, p 114, May 27, 1960.

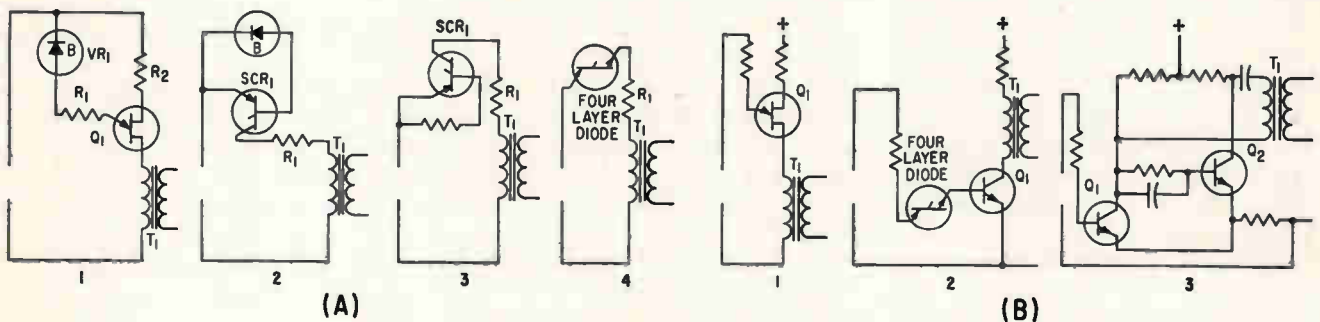


FIG. 7—Pulse producing input circuits requiring no auxiliary input power (A); similar circuits with auxiliary input power need less signal power (B)

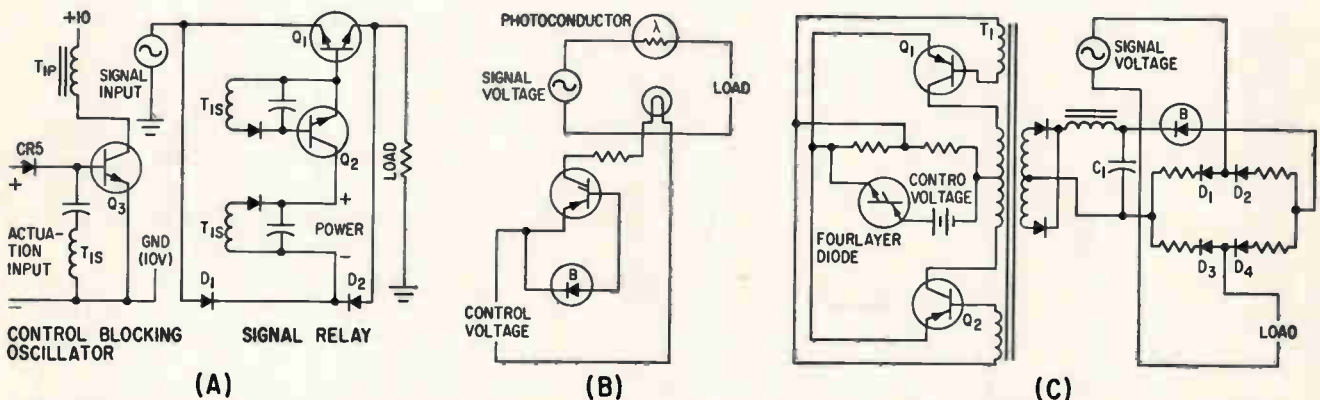
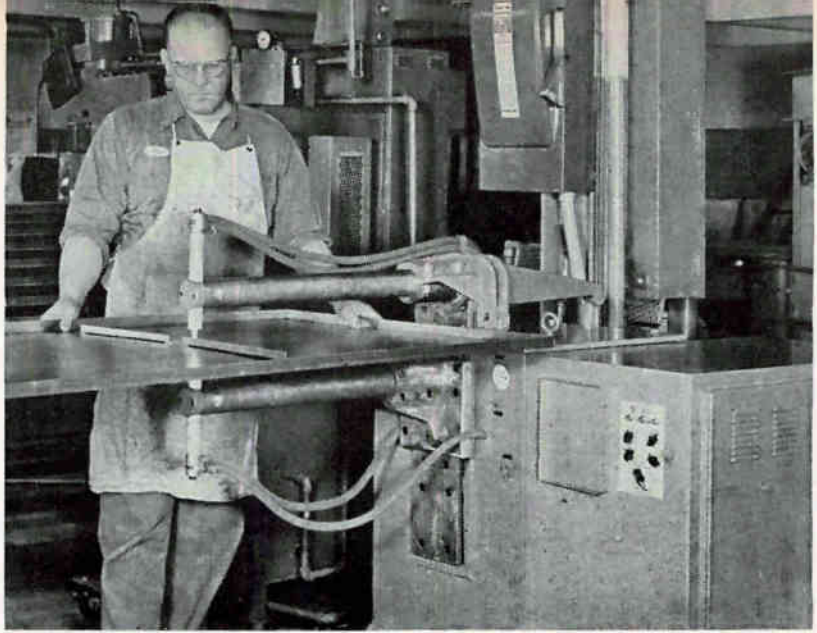


FIG. 8—Symmetrical transistor relay operates with input signal of 50 mv (A). Photoconductor operates as load contact in special purpose relay (B). Biased diodes operate as contacts in experimental circuit (C)



# Using Voltage Spikes in Resistance Welding



Industrial work being done with spike resistance welding equipment

*Capacitor in series with welding transformer is used to obtain voltage peaks of up to four times line voltage. Specially designed coaxial ignitron and welding transformer are employed*

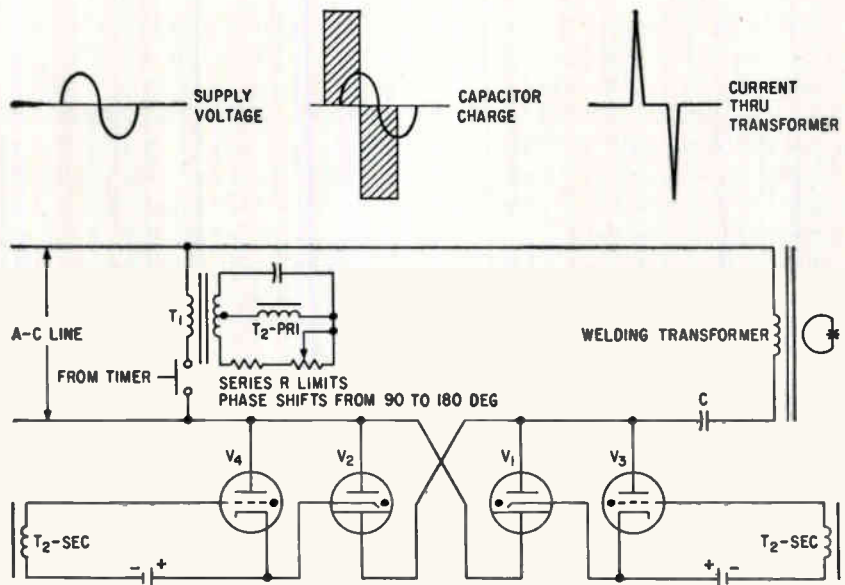


FIG. 1—Circuit indicates method of generating power pulses

By STUART C. ROCKAFELLOW,  
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THE CONCEPT of pulse power is not new. For many years, engineers have been aware of the many advantages inherent in high-current, short-pulse welding. However, the disadvantages encountered, such as slow production rates and the need for large, cumbersome equipment, limited its use as a practical production tool. These limitations have been overcome through the development of new circuits and new components. The result is a practical system of pulse power welding that produces welds of

higher quality and uniformity.

When this spike power system is used for resistance welding, power is fed to the welding transformer in a series of high voltage, high-current pulses. Each pulse has a duration of from 1 to 3 milliseconds, the pulses occurring once during each half cycle of supply line frequency. Thus, if the supply is at 60-cycle line frequency, single phase, there will be a 120-pulse rate applied to the welder. Conventional weld timing is used. Since two pulses are developed for each cycle of line frequency time, with the timer set at 3 cycles, 6 pulses will be developed.

The circuit used for this type of welding is similar to that used for

power-factor corrections. Phase shift is used, in a manner different than that used for 60-cycle welding, to obtain power control.

A circuit using thyratrons controlling the firing of ignitron tubes (Fig. 1) is used to generate the power pulses. Each thyratron ( $V_1, V_2, V_3, V_4$ ) is biased to about  $-50$  volts and the a-c from the phase-shift network can then overcome the bias at various points on the voltage wave depending on the setting of the  $R$  in the phase-shift network.

Ignitron tubes are usually used as the switching means for the welding operation; however, both thyratrons and gated rectifiers have been used for smaller applications.

The 90-degree point on the sup-

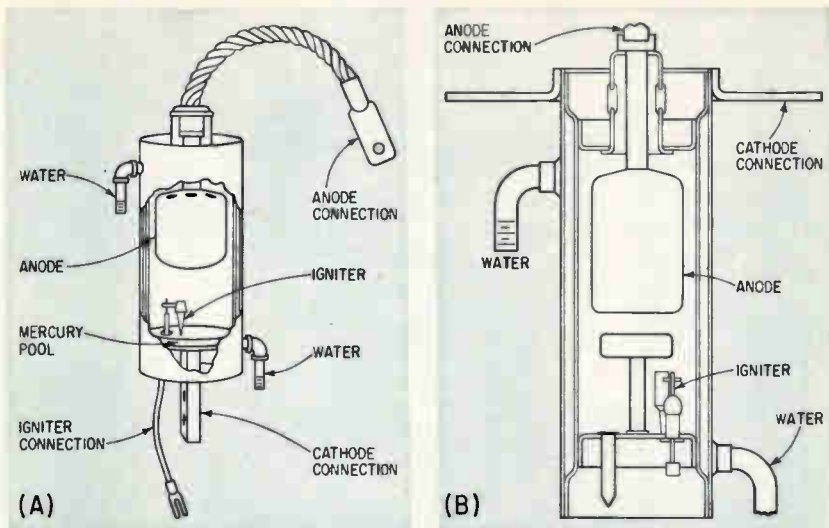


FIG. 2—Conventional ignitron tube (A). Baffled coaxial ignitron (B) passes higher currents

ply-voltage wave is the highest potential obtainable from the supply. Using a 230-volt line, this point represents slightly over 300 volts. To obtain maximum output, the ignitrons are delayed in their firing on each half cycle until the 90-degree point on the wave.

During the first half cycle of weld timing, ignitron  $V_1$  fires and charges capacitor  $C$  to a voltage higher than the supply voltage. This is because of the series  $L$  and  $C$  in the circuit. In the process of charging the capacitor, power is fed through the transformer. The capacitor now remains charged to this value until the next half cycle.

When the negative half cycle of the supply reaches 90 degrees, ignitron tube  $V_2$  fires. Now, the voltage supplied consists of the charge on the capacitor from the previous half cycle plus the peak of the line voltage. The current pulse through the transformer now has greater amplitude than the first pulse generated. Each succeeding generated pulse has an increasing amplitude until the steady-state value is reached. The final peak value is dependent on both the resistance and the inductance in the circuit.

For fast repeating welds, the charge developed during the negative half cycle is left on the capacitor. With this charge, the next weld is started on the positive half cycle and the first pulse of that weld now has the steady-state value and is of the same amplitude as succeeding pulses. A precharging circuit which will give the steady state

values to all pulses can also be used.

By controlling the point on the voltage wave at which the ignitrons are allowed to fire, the voltage supply can be changed to give power control. The peak of the wave will always give the highest power and by phase shifting back in the wave, lower amplitude pulses can be generated. Precharging the capacitor allows a power ratio control of 400 to 1 from a 460-volt line. This represents a peak voltage change from 2,000 to 100 volts.

The frequency of the generated pulses is a function of both the  $L$  and the  $C$  in the circuit. Base width of one pulse is roughly one half cycle of the frequency that will be developed. A rough approximation of frequency can be made by multiplying the base width of one pulse (in milliseconds) by two, then dividing this result into 1,000.

Base width  $t$  of the current pulses can be obtained by the formula  $t = \pi\sqrt{LC}$  with  $C$  being farads and  $L$  being henries. As an example, with an  $L$  of 640  $\mu$ h and a  $C$  of 250  $\mu$ f, the base width of the pulse is about 1.2 milliseconds. This time represents one half cycle of a frequency of about 420 cps. The pulse width remains the same regardless of the supply voltage. Thus, the frequency presented to the transformer will be the same regardless of the power chosen by the phase-shift control.

By multiplying the line voltage by the series combination of  $L$  and  $C$ , pulses can be developed which will have from 3 to 10 times the

value of the peak line voltage. With a 230-volt a-c supply line, pulses will have peaks from 900 to 3,000 volts. In practice the multiplication factor for resistance welding is usually held to between 3 and 4.

Voltage multiplication can be determined by first finding a figure of merit  $K$  of the system. The factor  $K$  takes into consideration the  $L$ ,  $R$  and  $C$  in the circuit and can be found with the formula  $K = 1 + e^{-at}$  where  $e = 2.7$ ,  $a = R/2L$  and  $t = \pi(LC)^{1/2}$ .

After determining the  $K$  factor, the peak voltage across  $C$  (peak  $V_C$ ) and  $L$  (peak  $V_L$ ) can be found by

$$\text{Peak } V_C = K V_{\text{supply}} / (2 - K) \text{ and}$$

$$\text{Peak } V_L = 2 V_{\text{supply}} / (2 - K)$$

The peak voltage developed across the  $L$  in the circuit includes all the voltage drop of the supply lines plus the voltage drop across the transformer. A weak supply line will have a larger drop across the line and less across the transformer while stiff supply lines will allow most of the voltage to be developed across the transformer.

The  $K$  factor of the system also influences the time it takes for the pulses to reach their maximum or steady state value. While no mathematical expression has been derived for this function, it seems that the rise time follows the voltage multiplication as established by  $K$ . With a low  $K$  factor the voltage multiplication is low and the maximum voltage peaks are reached within two pulses (one cycle). With a  $K$  factor of about 1.8 the multiplication is about 10 times and it takes nearly 10 cycles (20 pulses) of time to reach the peak or steady-state value.

Both resistance and inductance from the secondary circuit of the welding transformer are reflected back as a portion of the primary load (by turns ratio squared). In fact, the resistance and inductance properties of the secondary circuit may have greater importance in determining the  $K$  factor than the primary by itself.

In using the  $K$  formula, it is found that an increase in  $L$  will cause the  $K$  factor to increase. As the  $K$  factor increases, the voltage multiplication of the system also increases.

With conventional 60-cycle resistance welding, any inductance



added in the secondary circuit causes a decrease in secondary current. Because of this, a weld made with a large mass of metal in the throat area will be made with less current and will be weaker. Special phase-shifting compensation circuits are often used on welders which accept large masses of metal in the throat while welding. These controls automatically phase shift ahead in the wave as inductance is added in the secondary circuit.

With spike power, inductance added in the secondary circuit causes the  $K$  factor to increase. This automatically raises the voltage across the primary which in turn raises the current passing through the electrodes. Tests indicate that this feature accomplishes current regulation to an accurate degree for any changes in inductance in the secondary circuit.

Because of the short pulses of power, special transformers are used with this process. Conventional 60-cycle transformers offer too much inductance, so the transformers are made with considerably less core material. As an example, a 100 Kva spike transformer has about  $\frac{1}{3}$  the core material of a 100 Kva 60-cycle transformer.

By limiting the pulse widths to

1 millisecond, the transformer can be made for 500 cycles. If the pulse is made to have a base width of  $1\frac{1}{2}$  milliseconds, the frequency would be 333 cycles. These pulses do not occur as full 333 or 500-cycle frequencies, but the wave fronts offered to the transformer represent these rates.

Because of the higher than usual voltages involved, the ignitron and firing circuits are insulated for a minimum of 5,000 volts. High-voltage thyratrons are used in the firing circuit. While usual thyratrons used in resistance welder service are rated at 1,500 volts inverse breakdown, the thyratrons used in this system are rated at 3,500 volts inverse.

Special ignitrons were developed for this type service by the power tube division of General Electric Co. These special ignitrons are designed to give a magnetic guiding effect on the arc column which allows higher currents to be passed through the tube.

Regular ignitron tubes have their cathode connection coming out of the bottom of the tube as shown in Fig. 2A. With this method of construction, the arc column has a tendency to spread to the wall of the tube, increasing the probability

for arc back. The current limitation of the B size ignitron is about 1,200 to 1,400 amp when used for pulse service.

With the GE coaxial ignitron tube, Fig. 2B, the cathode connection is made at the top of the tube using the metal walls of the tube to carry the current to the mercury pool.

The magnetic effect created by passing current along the walls in an opposite direction to the arc column flow tends to keep the arc away from the walls of the tube. The peak current rating of these tubes is at least 60 percent greater than the conventional ignitron tube of the same size. Baffles inserted in the tube between the anode and the cathode pool also decrease the tendency to arc back.

Previous limitations for the use of pulse generation were the current limits presented by the components. With the spike method of pulse generation, the voltage is amplified to give the power gain and still keep within the current limitations of the components. As an example, consider the case where a 1-megawatt peak pulse is to be developed using only the peak of the line voltage (230 volts). The 300-volt peak will require over 3,000 amp to give this peak power. By using the spike method, 3,000 volts can be generated and only 333 amp will be used to obtain the same 1-megawatt peaks.

Using three phase power, it is possible to apply pulse power at a rate of 360 pulses a second to the welder. Figure 3 shows the circuit used to obtain this capability.

Only one transformer is used and it is designed for the pulse frequency but will be roughly three times as large as the single-phase transformer due to the additional power developed. Phase-shift controls for all phases are ganged.

Each set of ignitron tubes is operating at the 60-cycle rate to prevent undue strain on the ignitor circuits and each portion of the transformer is operating as an independent pulse supply with a capacitor in each leg of each phase.

Additional industrial applications for this type of power include arc welding, plating, metal reduction, induction heating and motor drives.

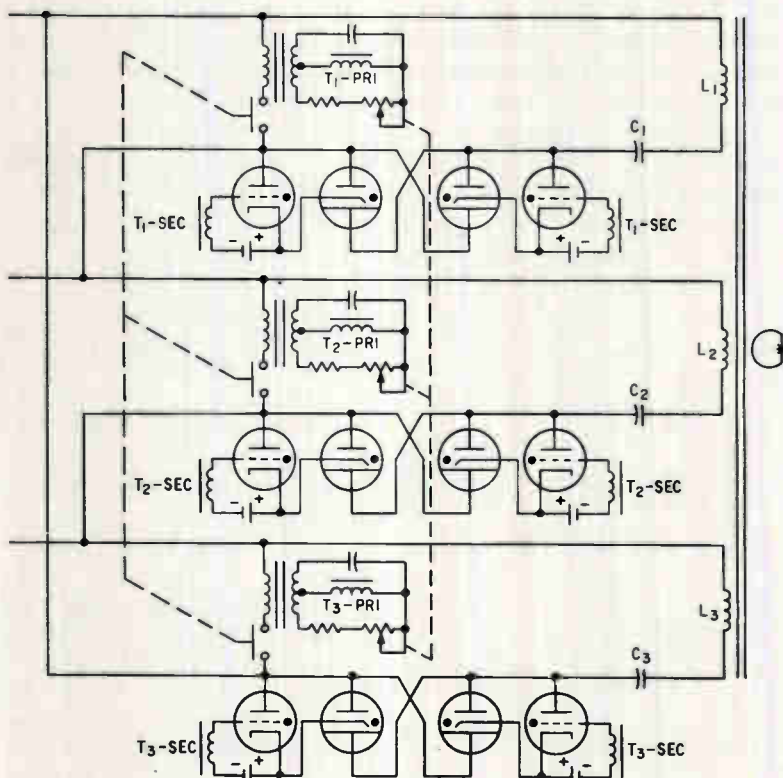


FIG. 3—Three-phase circuit speeds welding operation. Typical application is in seam welding

# Solid-State Pulse Modulator

*Unconventional modulator uses silicon gated diodes, not thyatron tubes, to pulse a beacon transmitter. Modulator functioning and design are described*

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THIS PAPER describes a tubeless, rapidly recovering pulse modulator for use in the Aerobee Multipurpose Beacon. The beacon employs a type 5893 pencil-triode transmitter tube which, at present, is plate-pulsed by hydrogen-thyatron line-pulsing modulators. Because of the long recovery time inherent in this type of modulator, it is now necessary to use three modulators in rotation to accommodate the required pulse rate. The high filament-current drain of the three thyatrons is eliminated in the new pulse modulator by using silicon gated diodes as switches. Recovery time of the gated-diode switch is less than 50  $\mu$ sec.

The silicon gated diode is a three-terminal, three-junction, semiconductor device which behaves similarly to a thyatron. The principal difference is that in the gated diode, triggering is achieved by a current pulse flowing from the gate terminal to the cathode, instead of the grid-voltage pulse used to trigger a thyatron.

Rapid recovery is achieved by using a second silicon gated diode as a switch ( $S_2$ , Fig. 1A) to replace the charging choke of a conventional modulator ( $L_1$ , Fig. 1B). The function of this second (recharging) switch is to hold off the supply voltage while these actions occur: pulse-forming network  $PFN$  discharges through discharging switch  $S_1$  and the primary of output transformer  $T_1$ , thus producing the output pulse; discharging switch  $S_1$  turns off. After a suitable time, recharging switch  $S_2$  is triggered into conduction by a time-delay circuit, recharging the  $PFN$  rapidly.

After  $S_2$  has turned off, the modulator unit is ready to be triggered again. Comparison of the wave-shapes of Fig. 1A and B shows that the two-switch circuit is capable of more rapid recovery than the conventional circuit since the charging choke (Fig. 1B) has to have sufficient inductance to allow the switch to recover before the charging current reaches the holding-current value of switch  $S_1$ .

The circuit is shown in Fig. 2. Resistors  $R_1$  and  $R_2$  and breakdown diode  $D_1$  produce d-c voltages of +18 v and +10 v at points A and B, respectively. In the quiescent state, point C is at +270 v and all the diodes except  $D_1$  are cut off. Points D and E are at +18 v, and  $Q_2$  and  $Q_3$  are cut off.

To produce an output, a negative trigger is applied. The pulse goes through C, to emitter-follower stage  $Q_1$ , which provides a high input impedance. Transistor  $Q_2$  now goes into conduction, triggering discharge switch  $D_2$ . The  $PFN$  discharges through  $D_2$  and the output load ( $D_3$  is cut off at this time), producing an output pulse. This action brings point C to ground

potential, where it remains during the bottoming time; bottoming is about 2  $\mu$ sec, long enough to allow  $D_2$  to turn off. (The sum of the currents through  $R_2$ ,  $D_1$  and  $C_2$  is much less than the holding current of  $D_2$ .) At the end of the bottoming time, recharge switch  $D_3$  is triggered, enabling  $C_{PFN}$  to rapidly recharge through  $L_1$ ,  $R_1$ ,  $D_3$ , and  $D_1$ .

Here's how the triggering of recharge switch  $D_3$  comes about. During the bottoming time, when point C is at ground potential, diode  $D_1$  conducts, holding point D at ground potential. Point E, which quiescently was at +18 v, now undergoes an exponential decay toward ground, the time constant being  $RC$ . (The side of C, connected to point B can be considered at a-c ground for this discussion.) When point E reaches +10 v, transistor  $Q_3$  turns on. Its collector current passes through  $D_3$  and triggers recharge switch  $D_3$ .

The network formed by  $C_2$ ,  $R_2$  and  $D_1$  provides the means of recharging C, rapidly and readying the circuit for another input pulse. During the bottoming time,  $C_2$  discharges through  $D_2$  and  $R_2$ . When recharge switch  $D_3$  is triggered, point C rises rapidly to +270 v, charging  $C_2$  through  $D_1$  and  $C_1$ . The value of  $C_2$  is chosen so that the capacitive voltage-divider action raises the voltage on C, from 0 v to +8 v, its quiescent value. Thus the circuit can be retriggered as soon as recharge switch  $D_3$  has recovered.

If, however, the circuit is retriggered before the recharge switch has recovered, the circuit will be placed in a runaway condition. In this state, both switches are closed, forming essentially a short-circuit across the power supply. Neither switch can turn off because of the current passing

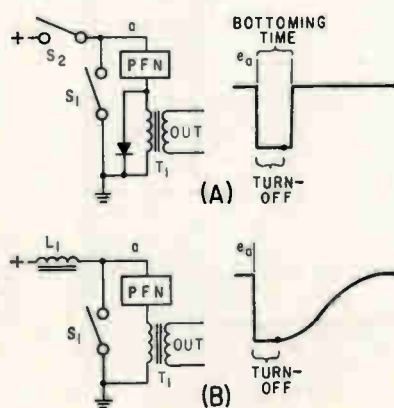


FIG. 1—Simplified diagrams of new modulator (A) and conventional modulator (B)





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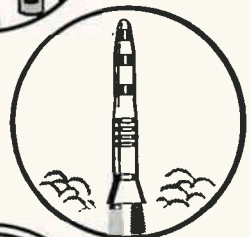
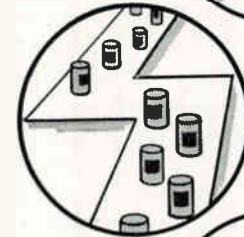
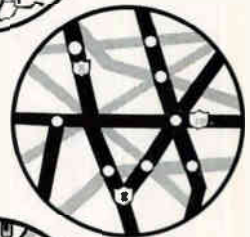
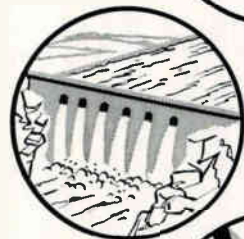
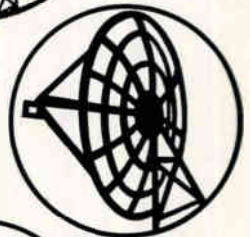
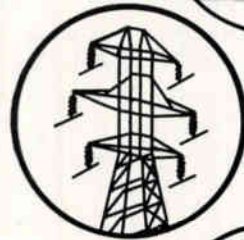
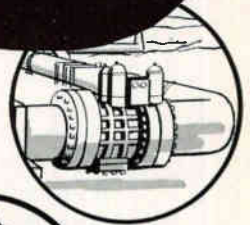
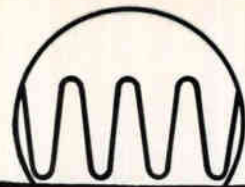
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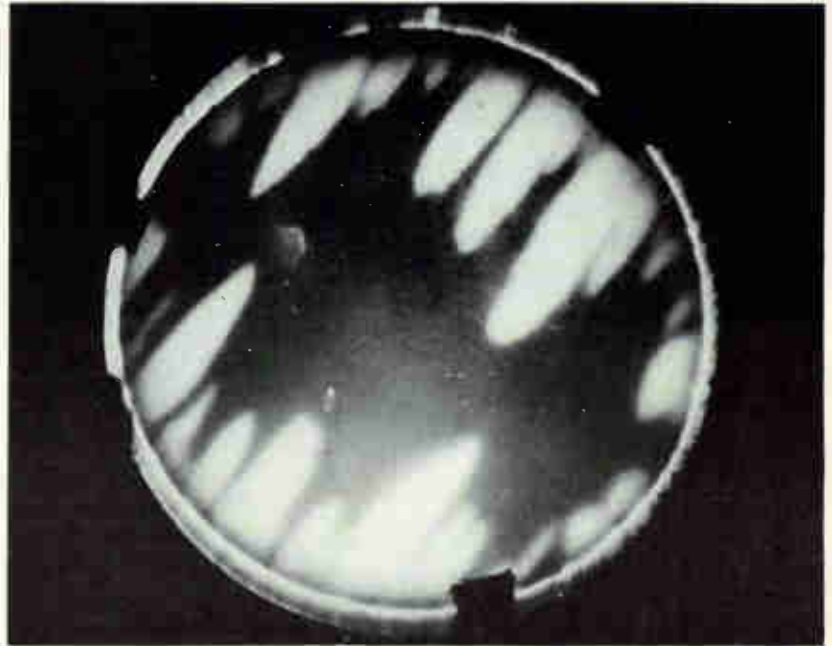
# Technique Makes Superconductivity Visible

SUPERCONDUCTIVITY may be better understood as a result of a newly developed technique for studying the phenomenon. Information being acquired through use of the method is expected to speed development of practical electronic devices based on superconducting materials. Computers, aircraft and missile guidance systems and other electronic equipment could benefit directly from superconducting components operated at temperatures near absolute zero.

The new technique has been developed at the General Electric Research Laboratory, although the approach was originally used at the Naval Research Laboratory. It permits direct visual observation of transformations between the normal and superconductive states.

The experimental technique uses a combination of magnetic and optical effects to make visible the changes taking place in the intermediate state, a condition in which portions of the sample are superconductive and other portions are not. Structure of the superconductive sample and the manner in which it changes when subjected to a magnetic field are strongly affected by impurities and by metallurgical treatment of the specimen. The scientific significance of being able to observe the intermediate state directly is that it will provide a better understanding of the factors affecting the specimen. The final result is the possibility of faster development of practical electronic devices based on superconductivity.

The new test method has already produced a great deal of information. It has permitted both observation of previously unexplored phenomena and more rapid and complete study of known phenomena. In particular, this technique has provided data about the motions of normal and superconducting domains that could not be observed before. It has also provided a fast and accurate method for measuring basic magnetic properties of super-



*Dark areas of cold-rolled tantalum are superconductive while light normal areas are elongated in rolling direction*

conductors.

The method is based on the principle that a sufficiently strong magnetic field can change a material from the superconducting to the normal state. However, as long as the material remains superconductive, it is a perfect magnetic insulator.

In the test setup, the specimen to be observed is usually prepared in the form of a flat disk or plate, although vacuum-deposited thin films have also been studied in this manner. A plate of special cerium phosphate glass about one-hundredth inch thick is placed on top of the sample. When magnetized, this type glass has the property of rotating the plane of polarized light. A beam of monochromatic polarized light is beamed on the glass, and the reflected light is viewed through a polarizing filter that can be rotated to any desired angle.

The material under study is usually cooled in liquid helium to a temperature of about 1.5 degrees above absolute zero. At this temperature, the material is normally superconductive. However, it can be switched

back and forth between the superconductive and the normal states by a varying magnetic field. At certain levels of magnetic field strengths, the specimen is in the intermediate state, with portions in both the normal and superconductive states.

The portions of the glass plate directly above the superconductive areas are shielded by them from the magnetic field. Therefore, these parts of the glass are not magnetized. However, portions of the glass directly above normal areas in the sample are not shielded and therefore are magnetized.

Those parts of the glass that are magnetized rotate the plane of polarized light reflected by them, while the parts that are shielded do not. By adjusting the polarizing filter through which the reflected light is observed, the magnetized portions of the glass can be made to appear dark and the unmagnetized portions to appear light. The opposite affect can also be achieved.

Since the pattern of light and dark areas on the glass correspond exactly to the pattern of supercon-



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15 db min.  
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1.3:1  
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2 lbs.

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Model X-127

380 to 420 MC

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0.5 db max.

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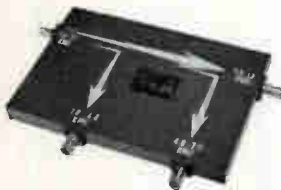
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ducting and normal material in the sample, changes in the state of the sample can be observed and photographed directly.

## Reproducing Computer May Improve Offspring

THEORETICALLY, machines could reproduce themselves, with the offspring an improved version of the original machine. The second machine could in turn produce an improved design of itself. The process could continue indefinitely with size and its consequences determining a practical limit.

The self-improving series of machines were described by Professor John Myhill of Stanford University during a two-week computer seminar at the University of Michigan. Although little has been heard of the concept, it is not new, having been pointed out by John von Neumann and others.

The original machine, a computing system programmed to reproduce itself and to improve its offspring, would be man-made. Improvements would be based on devising better circuits, so that the second machine would operate faster and more efficiently than its parent. Although the same basic components would be provided to each machine, improvements would stem from better selection and proper assembly of the components into circuits.

The logic system could also prove theorems. Because of increasing improvements, successive descendants could prove more theorems and perform more computations than their predecessors.

Practical limits to the reproducing process would be related to size. Successive machines would become increasingly larger requiring additional power. Eventually increasing size would increase switching time because signals would have to travel greater distances.

Practical engineering problems are not presently being considered because a definite approach to physical realization of the system has not been evolved. However such computers are theoretically possible and practical implementation is believed feasible. Profes-



sor Myhill believes the self-reproducing computer will be built when someone wants to built it and has the available funds.

At least one self-reproducing machine exists. Bell Labs has produced an electric toy train that takes cars from sidings and reproduces itself.

### Data Samples Provided For High-Speed Events

INFORMATION SAMPLES can be handled at the rate of 2.5 million per second by a new analog-to-digital converter. It is designed for handling data related to high-speed events like nuclear explosions and missile flights.

Output from the Raytheon-developed converters permits use of digital computers. These accurate, versatile machines can sometimes handle problems that no other equipment can, and they can deal with many problems simultaneously.

Analog inputs to the converter can be provided by a variety of transducers, possibly installed in a modern aircraft or rocket. The computer, occupying less than one cubic foot, can also be installed in the vehicle. The digital output from the converter can then be telemetered back to earth for use in digital data processing equipment. Because of the high rate at which samples are provided, a more accurate and complete evaluation of vehicle performance can be made.

When missiles are tracked by radar, the converter can provide samples of information about its trajectory at a faster rate. By establishing trajectory sooner, earlier interception is possible and the probability of interception is increased. Similarly, in radar tracking of guided missiles, trajectory data provided at a higher rate can improve guidance on the rocket's assigned mission.

Accuracy of the converter is one-half percent of full scale. Raytheon engineers believe that when associated equipment can handle samples of information at the rate of the present converter, converters can be designed to handle 10 million samples per second.

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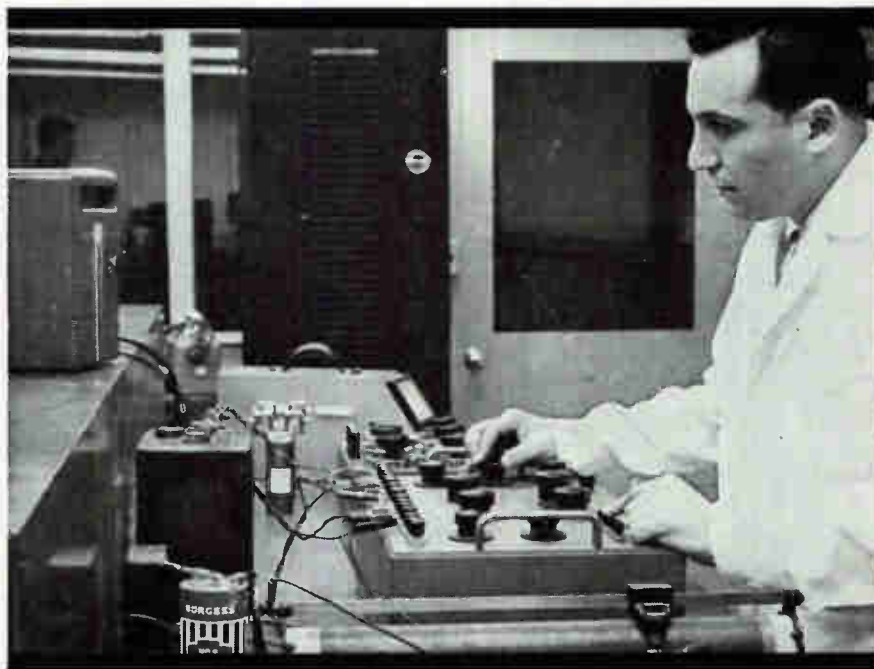
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# Program Sets Up Materials Science Center

THE ADVANCED Research Projects Agency, Department of Defense, disclosed that Cornell University, University of Pennsylvania, and Northwestern University have been selected to set up vastly enlarged programs for the expansion of basic research in the science of materials.

Under an unprecedented long-term contract Cornell will receive \$6.1 million for the first four years of this program, according to Cornell President Deane W. Malott.

The contract provides for interdisciplinary research and graduate student training in materials, and will combine the efforts of portions of five departments in two colleges at Cornell. Cornell University will organize a Materials Science Center to administer the ARPA contract and to expand basic research and training of Ph. D. research scientists in materials.

"Materials science" is the investigation of physical and chemical processes in solids such as metals. The design of new materials for nuclear reactors, rocket engines, transistors, and other modern devices is based on this kind of research.

Cornell will construct a new \$4-million building on its campus within the next three years. The building will house graduate research of the Laboratory of Atomic and Solid State Physics, the administrative offices of the Center, and several of the common technical facilities such as electron microscopes. ARPA will reimburse Cornell for construction costs of this building over a 10-year period after it is occupied.

Cornell may build a substantially larger building, of which the ARPA construction would be a part, to house in addition a physics and chemistry library and some of the other activities of the Department of Physics.

The four-year headway of the ARPA-Cornell pact will be maintained—the fifth year's financial support to be discussed next fall, and further support annually.

A substantial part of the \$6.1-million contract will go into research equipment, including about \$700,000 for individual research projects and \$1.2 million for common facilities. The facilities will permit Cornell graduate students and staff to work with the most modern physical, chemical, and metallurgical techniques available.

The basic research scientists who comprise the initial staff of the Center also will have use of a new atomic reactor being built by the University, the new \$5.7-million research library nearing completion, and other outstanding facilities already extant at Cornell.

The staff of the ARPA project will be faculty members and research associates already at the University. Additional faculty will be added during the next few years. Teaching and supervision of graduate student research will continue to be the main tasks of these scientists.

Initially, the work of the Laboratory of Atomic and Solid State Physics will comprise the largest part of the Center. This Laboratory, which was organized a year ago, includes faculty and graduate students from the Department of Physics and the Department of Engineering Physics. Later, the greater growth of Metallurgical Engineering and Engineering Mechanics and Materials will make these departments equally important.

Cornell was one of the first universities to enter solid state physics, which generally was not recognized as a distinct science until after World War II. Substantial parts of the work at Cornell are concerned with imperfections, transport processes, magnetic resonances, internal friction, photochemical processes, surface phenomena, ferroelectrics, magnetic phenomena in dilute alloys, optical processes in the far ultraviolet, X-rays, cooperative phenomena, ferromagnetism, many-particle theory, and thermal conductivity.

A second area of emphasis in the Center is chemistry, with about a quarter of the current staff. This research is concerned with electron and X-ray diffraction, inorganic polymers, solid-vapor reactions, electronic processes in oxides, diffusion in polymers, polymers under high pressure, catalysis, photoconductivity, and theoretical physical chemistry.

The third participating field of endeavor is metallurgy, with about a sixth of the staff work on metallurgical science in the fields of intermetallic compounds, freezing transformations, solid-solution strengthening, nucleation, properties of and phenomena in iron-base alloys, plastic deformation, and fracture.

The fourth substantial research area represented is mechanics and materials, making up a tenth of the staff. Scientists in this field will deal with elastic constants as functions of pressure, ferroelectrics under impulse loading, and diffusion and creep under hydrostatic pressure.

The number of professors in the Center will be increased from about 30 to about 60 in the next ten years. Four more areas of scientific investigation, namely mathematics, industrial engineering, geology, and electrical engineering, probably will be added to the Center's research program in the near future.

The Cornell Materials Science Center will enable interdisciplinary cooperation in the fields mentioned, and the increased staff will permit the University to train about twice as many Ph.D. scientists in these areas of study. The entire research program conducted by the new Center will be integrated with the program for training graduate students on a personal basis in the use of methods and equipment that will be as modern as that in any industrial laboratory.

The organization of the Materials Science Center is not a substitute for the conventional organization of colleges, departments, and divi-





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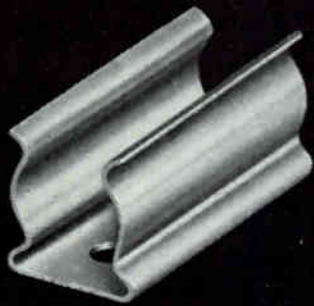
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sions within Cornell's present structure. The creation of the Center will make research that crosses department or even college lines easier and more productive.

One of the objectives of the program is to stimulate the understanding necessary to exploit solid-state physics, chemistry, and physical metallurgy to produce new materials or develop promising new processes.

The daily operation of the Materials Science Center will be the responsibility of a director, an associate director, and an administrative assistant to be selected in the next few weeks. Individual scientists of the Center will retain the responsibility for planning and operation of the individual research programs.

The Executive Committee will determine the scope and direction of the Cornell materials science research and training program through its approval of individual projects that are to be supported in any way by the interdisciplinary laboratory contract. The Committee will be responsive to annual review sessions and to the advice of the representatives of ARPA and other Government agencies, which will continue to support much of the Cornell work in this field.

Cornell contract negotiations with ARPA were headed by President Malott, Provost Atwood, and Theodore P. Wright, vice president for research, with the aid of Dean Corson and Henri S. Sack, professor of engineering physics.

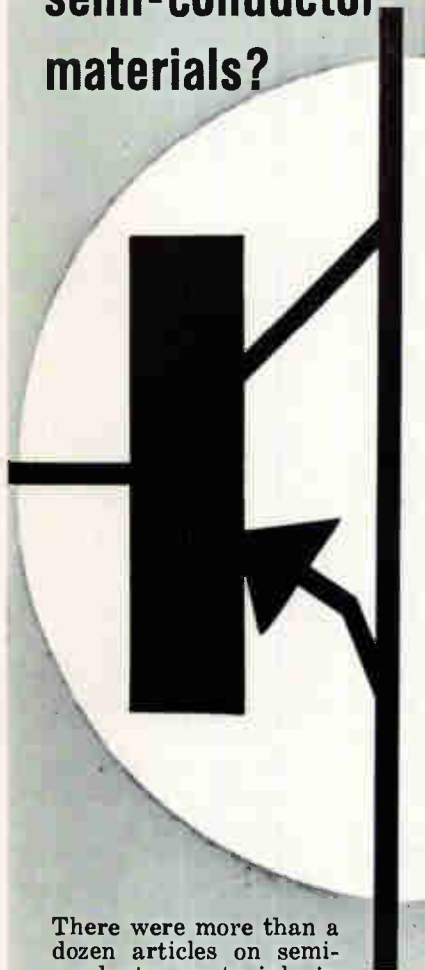
### Reinforced Teflon Is Abrasion Resistant

WIRE INSULATION made from a new type of fluorocarbon resin (Teflon) offers improved resistance to abrasion, plastic flow, cut-through and heat. This extension of standard Teflon properties has come about through a special process developed by W. L. Gore & Associates, Inc., Newark, Del.

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do you know  
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semi-conductor  
materials?



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electronics**

abrasion and cut-through is the result of orienting more than 90 percent of the fibers parallel to the wire surface (random orientation would average about 50 percent).

Parallel orientation of fibers supports concentrated loads and resists penetration of sharp edges. This obviates the need for glass fiber wrapping or braid for surface protection; thus, it saves space, reduces weight and provides an all-Teflon insulation with uniform dielectric properties.

How well the new material performs is borne out by tests run in accordance with military specifications. Standard Teflon insulations achieve an abrasion-resistance rating of 35 in. when tested in accordance with NAS 703; the specification calls for a minimum of 48 in. Type AR attained a rating of 52 in., with none of the 8 trials falling below the minimum required for the rating.

Tested under MIL-W-7139A, the AR composition's abrasion-resistance rating is 35 in., well above the specified minimum of 22 in. which ordinary Teflon constructions are normally hard put to meet.

Cut-through resistance about three times as great as that of standard Teflon was established in still another test series. Moreover, the AR composition compares favorably with straight PTFE in dielectric constant, and remains about equal in volume resistivity.

Perhaps of greater importance in many aircraft and space-vehicle applications, the new fiber-filled compound increases Teflon's heat resistance. Mechanical properties remain satisfactory for many hours—probably even weeks—at temperatures of 325 C to 400 C, as opposed to a useful life measured in minutes for standard PTFE under moderate compressive stress. Even if the Teflon burns away, the protective mat of mineral fibers continues to prevent shorting of the conductor; the fibers themselves have long-term resistance to temperatures of about 2,000 F.

Type AR insulation is available in the form of Mono-Tet AR single-conductor wire, Multi-Tet AR multiple-conductor flat ribbon cable, and in shielded and coaxial conductors.

# NATIONAL NCL Chokes

**R-45 series**, a new family of ferrite bead chokes for use as filament chokes, parasitic suppressors, and series elements of low-pass filters for frequencies from 5 to 200 mc. Insulated with an impregnated fiberglass sleeving, these chokes will handle 2 amperes of filament current with voltage drop of less than 0.02 volts, temperatures to the Curie point of 125°C.

**R-40 series** ferrite-core chokes... extremely high Q for small size. They are primarily for use in networks and filters at frequencies from 50 kc to 1500 kc, and as resonant elements in IF and RF circuits. Fungus-proof varnish impregnation per MIL-V-137A.

**R-25 series** MIL-inductance chokes for high frequency circuits, as filament chokes and peaking coils, inductance per MIL-C15305A, coil forms per MIL-P-14, and impregnation per MIL-V-173A.

**R-33, R-50 and R-60 series** RF coils are wound on molded phenolic forms per MIL-P-14 and coated with a tough, fungus-resistant varnish. R-50-10 choke is wound on a powdered-iron coil form instead of phenolic.

National features a full line of stock choke items, and will wind chokes to your specification on any standard form. Send us your requirements. Write for components catalog.

**National** Since 1914  
Company, Inc. Malden 48, Mass.

# Ceramic Shell Molds Large Castings

LARGE, INTRICATE investment castings can be made by combining lost wax and shell molding techniques. The lost wax process, employing a solid mold, is ordinarily used for relatively small precision castings.

Castings weighing 84 pounds are currently being shell-molded by Arwood Corporation, New York, N.Y., which believes castings of 100 to 200 pounds are practical. Weights given are for steel; the process is also used for lighter metals. Arwood showed its production methods at its Groton, Conn., plant.

Among the process advantages reported by the firm are: parts can have more intricate coring or shape, there are no restrictions on location of gates and risers and

other restrictions in the casting setup are reduced, less time and material is required, and the castings have finer grain and finish.

Wax or plastic patterns are made by conventional methods. The pattern is fitted with a pipe handle and dipped into a refractory slip made of alumina, zirconia and silica. After excess is drained, the coating is stuccoed with fine refractory grain to provide a mechanical bond for the backup coating. The backup coating is also stuccoed. Several coatings, usually 6, are applied and the shell is dried for about 24 hours.

The shell is flash dewaxed at 1,800 F and fired for 30 minutes at 1,600 F. The mold can be cast

while the shell is still hot, or the shell can be stored and reheated before molding. Sand is used to support the shell while the molten metal is poured. After cooling, the shell is vibrated to crack it off and the casting is heat-treated, finished and inspected.

## Servo Winder Improves Space Factor of Coils

By W. H. ATWOOD,  
Avo Ltd., London, England

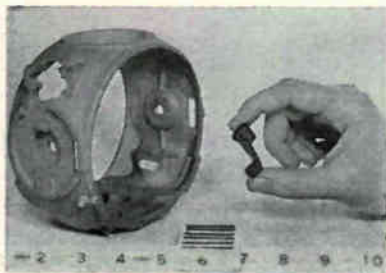
COILS WOUND on bobbins have slight variations in the number of turns per layer. Geared winding machines, with direct connection between drive mandrel and traversing carriage, permit crossed turns when the wire gets in advance of the feed due to the variations.

Crossed turns can be eliminated and space factor utilization improved 8 to 10 percent by servo control of the wire angle in relation to the coil winding. This feature is incorporated in the machine illustrated top p 87, which handles wire sizes between 1.2 and 0.05 mm (approximately AWG 16 to 44).

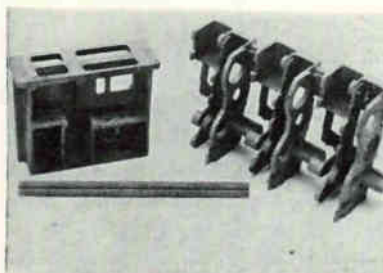
Speed of the traversing mechanism's drive motor is electronically controlled so that the wire is fed to the coil from the correct position with a predetermined angle of lag. The angle, adjustable between 0.1 to 1 degree of lag on the coil, is set by experiment before winding.

The angle is monitored by a moving coil detector as shown in Fig. 1. The wire feeds over a pulley and is spring-pressed against a reference face on the pulley. From the pulley, the wire passes through a follower arm free to rotate horizontally. The arm varies the position of a moving coil rotor in an a-c field, producing an output proportional in amplitude and phase to the angle moved.

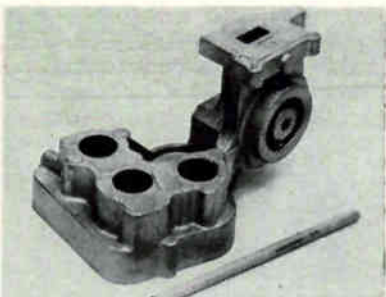
The position signal feeds a single phase-sensitive amplifier (Fig. 2), a pentode. Phase detection is obtained by applying line frequency voltages to the screen grid. Am-



Shell-molded gyro part dwarfs small investment casting



Missile chassis mount (left) and instrument housing



Rotary antenna coupler is cast in aluminum



Gating system is wax-welded to the pattern



Pattern with gating is given several coats of ceramic

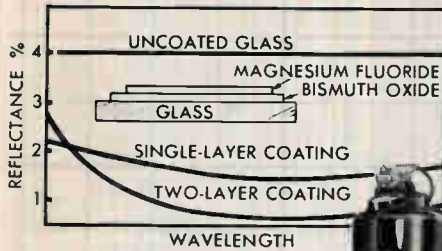


Sand provides mechanical bond between ceramic coats



## DURABLE TWO-LAYER ANTI-REFLECTION COATINGS

FOR LOW REFRACTIVE INDEX GLASS



High and low index films deposited to controlled thickness producing efficient reduction of the reflected light.

**SIMPLE...ONE-CYCLE  
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Efficient deposition of anti-reflection, transmission, and multi layer coatings on to low refractive index glass using a built in film thickness measuring device are easily carried out in a simple, single deposition cycle on the Speedvac Model 19VE5 coating unit. By combining a unique type of A.C. sputtering, and evaporation techniques the problem of absorption free and durable films have been overcome.

\*Multi layer coatings are carried out on a six position turret head evaporation source.



Model 19VE5

## EDWARDS HIGH VACUUM INC.

1920 Buffalo Avenue, Niagara Falls, N.Y.

In Canada: Edwards High Vacuum (Canada) Ltd., Box 515, Burlington, Ont.

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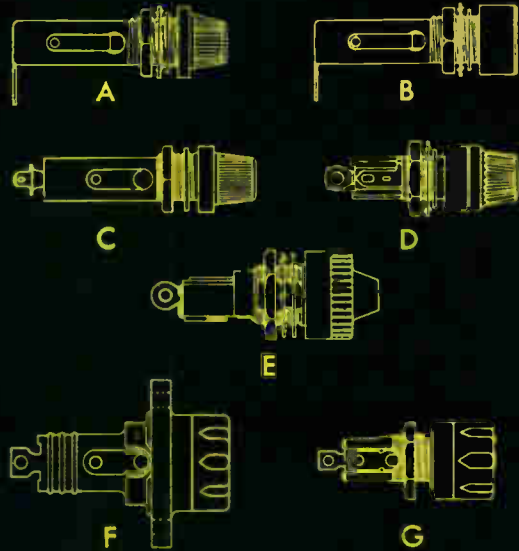
**KYORITSU ELECTRICAL INST. WORKS, LTD.**  
NO. 120, Nakane-cho, Meguro-ku, Tokyo, Japan.  
Cable Address "KYORITSUKEIKI TOKYO"

CIRCLE 201 ON READER SERVICE CARD

July 22, 1960

## OTHER FUSE POSTS MAY LOOK LIKE THESE... BUT ONLY LITTELFUSE HAS **PIQ**\*

A Fuse Post to meet every application—every requirement.



**EXTRACTING FUSE POST!** Fuse is held in end of removable knob for quick, safe and easy replacement of blown fuse. Safe "dead front" fuse mountings assured. U L Approved.

- A—3AG Fuse Post (finger operated knob)—No. 342001
- A—8AG Fuse Post (finger operated knob)—No. 372001
- B—3AG Fuse Post (Screwdriver Slot)—No. 341001
- B—8AG Fuse Post (Screwdriver Slot)—No. 371001
- C—4AG Fuse Post (Finger Operated Knob)—No. 442001
- D—3AG Miniature Fuse Post (Finger Operated)—No. 342012
- E—NEW INDICATING 3AG FUSE POSTS! (344,000 series) It Glows When The Fuse Blows. Long life incandescent bulb for low voltage ranges—2½-7V; 7-16V; 16-32V. New high degree vacuum neon lamp for high voltage ranges for greater brilliance and visibility—90-125V; 200-250V.
- WATERTIGHT FUSE POSTS Specially designed for use where excessive moisture is a problem.
- F—5AG Watertight Fuse Post. Has flange mounting.—No. 571004.
- G—3AG Watertight Fuse Post—No. 342006
- G—4AG Watertight Fuse Post—No. 442006

For complete details on these items and quotations on special application requirements, write to: Dept. E-7

Precision Engineering  
Design Know-how  
Quality Craftsmanship

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DES PLAINES, ILLINOIS

CIRCLE 85 ON READER SERVICE CARD

85

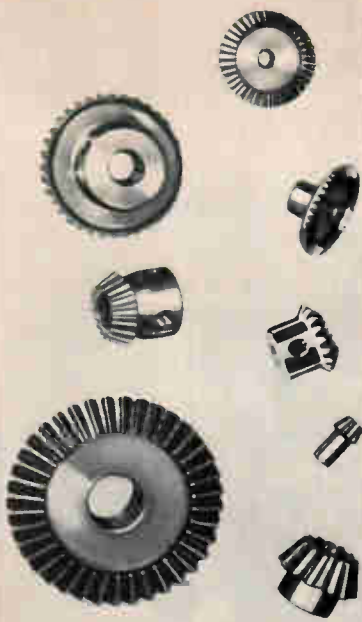
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A few of the many varieties of straight bevels we are regularly producing are shown above. Tell us your needs.

## STRAIGHT BEVELS



THE *Finest* IN GEARS

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CIRCLE 202 ON READER SERVICE CARD

# 60 NOW 50 WATTS! IN A DURABLE SOLDERING PENCIL

EXTRA-LONG-LIFE ELEMENT  
DOUBLE-LIFE CLAD TIP

Does the work of 100 watts  
yet weighs but 2 ounces!

New unique design in handle ventilation, plus stainless steel housing, insures a cool handle.

A new development makes possible a multi-coated copper tip which gives long life under the severe conditions brought about by the powerful 60 watt rating.

#### MODEL 24S —

Equipped with 1/4" XTRADUR TIP for extra long life. Solder adheres to working surface only. No drip or creep.

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### HEXAICON ELECTRIC CO.

130 WEST CLAY AVENUE, ROSELLE PARK, N. J.



SERVING INDUSTRY FOR A QUARTER OF A CENTURY

plier output is used to generate control signals for the leadscrew drive motor  $M_1$ , that are proportional to the angle error and speed of the mandrel drive motor  $M_2$ . The latter provides a proportional coupling between mandrel and lead-screw speeds.

The control signals are obtained from the amplifier's angle proportional signal. The signal is series-fed to the field coils of a d-c generator  $G_2$  coupled to  $M_2$  and also to one field coil of  $G_3$ , a constant-speed d-c generator coupled to a constant-speed motor  $M_3$ .

The speed proportional output signal from  $G_2$  is applied through a potentiometer to the other field coil of  $G_3$ . The armature output volt-

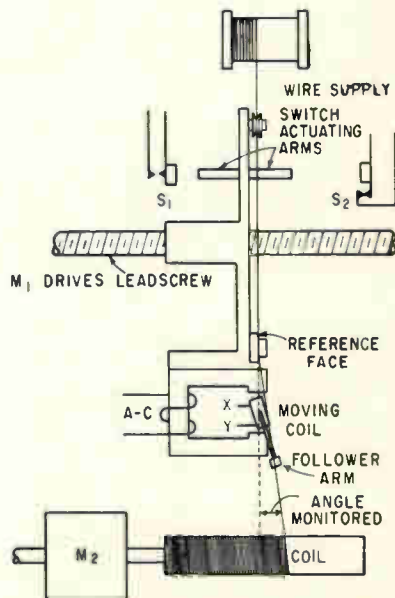


FIG. 1—Traverse and monitoring section

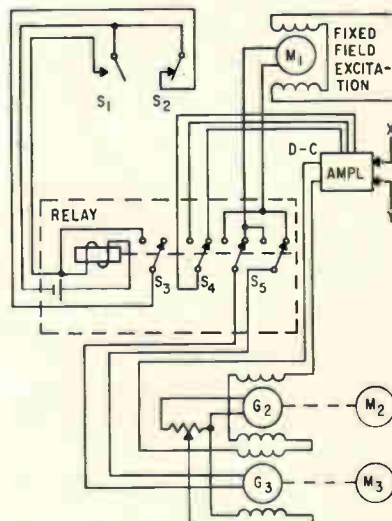
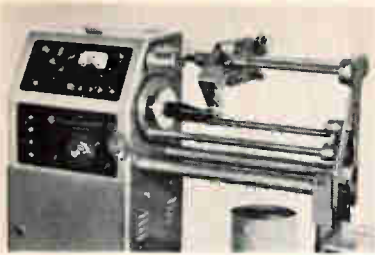


FIG. 2—Wiring.  $M_1$  and  $M_2$  correspond to Fig. 1





Wire feed angle is monitored by traverse mechanism

age of  $G_s$  is thus proportional to both the wire lagging angle and the mandrel drive speed. The output powers the armature of the leadscrew drive's constant field, shunt-wound d-c motor  $M_s$ . Varying the ratio of the proportional angle and speed signals varies the wire angle lag. Lag can be controlled between 0 to 1 degree.

Two snap-action switches  $S_1$  and  $S_2$  are operated by the switch actuating arms (Fig. 1) just before the end of the traverse.  $S_1$  is normally open and  $S_2$  normally closed. Their operation reverses the armature connections of  $M_1$  and applies a reverse phase reference supply to the amplifier. In the relay,  $S_3$  is the hold-on contacts,  $S_4$  the phase change contacts and  $S_5$  the motor direction contacts.

### Staples Clinch Sleeving



STAPLES are used by Telex, Inc., St. Paul, Minn., to clench vinyl sleeve wire couplings. The staples also serve as an anchor for the hearing aid receivers attached to the wires. The machines (Bostich 35 Stitchers) are fed round wire from a spool and are equipped with movable arms which clamp the work so the operator can remove her hand before the staple is driven. The company reports that production rate per operator is 325 an hour compared with 104 per hour with hand pliers.

July 22, 1960

## THERE'S A NORTH ATLANTIC INSTRUMENT TO MEET YOUR REQUIREMENTS, TOO...

Now — from North Atlantic — you get the complete answer to AC ratio instrumentation problems — in the laboratory, on the production line, in the field.

Specialists in ratiometry, North Atlantic offers a complete line of precision instruments to handle any ratio measurement task. All are designed to meet the most demanding requirements of missile age electronics — provide high accuracy, flexibility, component compatibility and service-proven performance. Some are shown above.

If your project demands total solution to ratio measurement problems, write for Data File No. 10Q. It provides complete specifications and application data and shows how North Atlantic's unparalleled experience in ratiometry can help you.



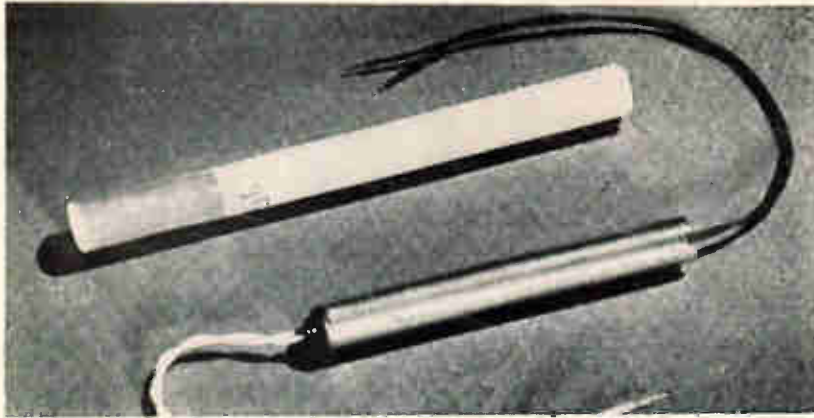
<p><b>1. RATIO BOXES</b> Both laboratory standards and general duty models. Ratio accuracies to 0.0001%. Operation from 25 cps to 10 kc.</p>	<p><b>2. COMPLEX VOLTAGE RATIOMETERS</b> Integrated, single-unit system for applications where phase relations are critical. Accuracy to 0.0001%, unaffected by quadrature. Three frequency operation. Direct reading of phase shift in milliradians or degrees.</p>	<p><b>3. PHASE ANGLE VOLTMETERS</b> Versatile readout system for all ratiometry applications, providing direct reading of phase, null, quadrature, in-phase and total voltage. Broad-band, single-, or multiple-frequency operation.</p>	<p><b>4. RATIO TEST SETS</b> Ratio reference and readout in one convenient package for production line and similar applications. Can be supplied with any desired combination of ratio box and phase angle voltmeter.</p>
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**NORTH ATLANTIC INDUSTRIES, INC.**  
TERMINAL DRIVE, PLAINVIEW, L. I., N. Y. • Overbrook 1-8600

CIRCLE 87 ON READER SERVICE CARD

87

# New On The Market



## Electrooptical Relay Has NO MOVING PARTS

CIGARETTE-SIZED electrooptical relay that can perform the work of a substantial portion of relays, potentiometers and commutators presently in use will be introduced by Raytheon Company, Industrial Components Division, Newton 58, Mass., at the Wescon Show in August.

Tubular in construction and without moving parts, the new unit, called Raysistor, has a conductance on-off ratio of 1,000,000 to 1; it can perform up to 100 operations per second. The device includes a light source in the control end, which when excited, actuates a photoconductor in the signal end, allowing either a-c or d-c information to pass.

Raysistor has an on life of 2,500

hours, irrespective of the number of switching operations. The unit is nonpolar and its input is isolated from the output. Used in series or parallel combinations, without the introduction of common-ground problems, it may be applied to logic circuits and matrices for telemetering or signal commutation. The Raysistor can switch without introducing transients in the signal circuit. As a potentiometer it is free of contact noise.

Developed to provide a high-speed, nonmechanical commutator for use in the Rayspan spectrum analyzer, the device is useful for high-speed repetitive scanning of small banks of filters.

CIRCLE 301 ON READER SERVICE CARD



## Micro-resistors Offered BY WILRITE

NEW LINE of micro-resistors, reportedly based on a novel concept and process, has been announced by

Wilrite Products, Inc., Cleveland, Ohio. The resistors can be solder-pot dipped, and tinned ends can

be soldered into submicromodules without changing the resistance value.

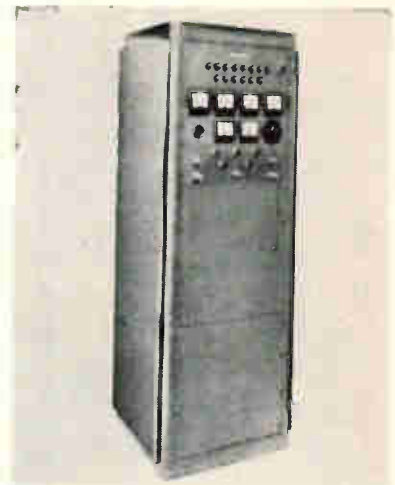
These microminiature resistors, measuring 0.125 in. length and 0.020 in. in diameter, are rated at  $\frac{1}{4}$  watt with resistance values of 100,000 ohms at 1-percent tolerance. Units having resistance values up to 500,000 ohms are expected to be available shortly.

CIRCLE 302 ON READER SERVICE CARD

## Microwave Modulator DESIGN VERSATILITY

HIGH-POWER microwave modulator that accommodates any of 76 magnetrons, covering the range from 5,400 Mc to 35,000 Mc, with peak outputs from 20 Kw to 500 Kw, has been announced by Narda Microwave Corp., 118 Herricks Rd., Mineola, N. Y.

The modulator is complete, compact, and self-contained, including high-voltage power supply, pulse generator, meters, viewing connections for all principal param-



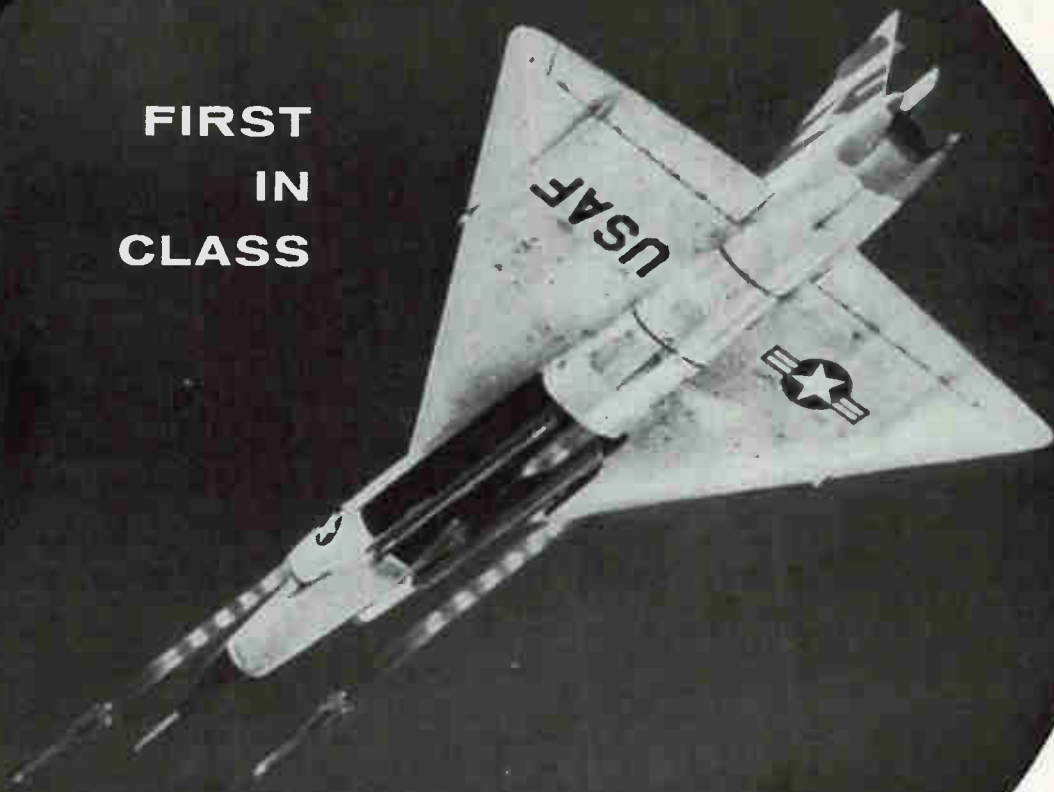
eters, controls and protective circuits. Provision is made for internal mounting of the desired magnetron. Silicon rectifiers in the high-voltage power supply give efficient operation, long life, and excellent overall performance.

The high-voltage power supply is continuously variable from 0 to 8 Kv at 200 ma; pulse power output is 37 Kv at 40 amperes max.; magnetron filament supply is continuously variable from 0 to 20 volts at 16 amperes.

The free-running pulse generator is continuously variable from 180 to 3,000 pulses per second; pulse width is one microsecond with other



**FIRST  
IN  
CLASS**



## **FALCON MISSILE**

Playing follow-the-leader at 50 millisecond intervals, three *Super Falcon* missiles rocket ahead of their diamond-shaped supersonic shock waves. Homing in on radar, these deadly air-to-air missiles locate, track, and destroy their prey, with the same killer instinct of the birds they're named after.

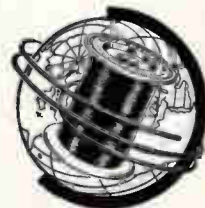
Hughes Aircraft, the developer and manufacturer of these missiles and the Armament Control System that triggers them, specified Hitemp magnet and Teflon\* wire for their missile, and Teflon wire for its control system.

Hitemp Wires, Inc., the leading specialist in high temperature insulated wires and cables, proudly answers roll call with those developers and manufacturers enlisted in defending our American birthright—*Freedom*.

## **HITEMP WIRES, INC.**

1200 SHAMES DRIVE, WESTBURY, NEW YORK

\*Registered trademark for DuPont fluorocarbon resins.

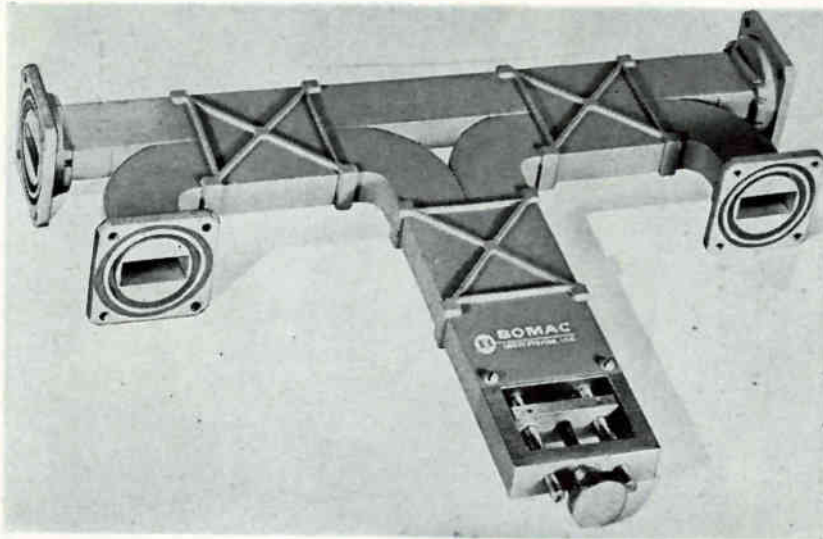


values available on special order. The pulse generator can also be synchronized with an external sine wave or pulse generator; an outlet is provided for synchronizing external equipment with the repetition rate of the modulator. Many characteristics can be altered with minor modification.

For safety, automatic overload

sensing is used in the high voltage supply; time delays and automatic sequencing circuits ensure proper operation and adequate warmup. Interlocks immediately shut off and discharge all high-voltage circuits; there are no external high-voltage leads. The modulator is priced at \$9,375.

**CIRCLE 303 ON READER SERVICE CARD**



## Variable Power Divider

### FOR MICROWAVE CIRCUITS

VARIABLE power divider provides a variable signal useful for microwave testing. The device can also be used to mix two signals while maintaining considerable isolation between them. Isolation of 25 db or more between transmitter and receiver is possible, through a common antenna and without switching. The power dividers are manufactured by Bomac Laboratories, Inc., Salem Road, Beverly, Mass.

The unit shown, when provided with two suitable loads, will transmit microwave energy to the output

terminal at a level which may be varied from zero to essentially full input power. Either of the two terminals opposite the input terminal can be used as the output terminal. A load capable of receiving full transmitted power is then attached to the remaining arm. Adjusting the knob will gradually shift output from one terminal to the other, giving a variable power level at the selected terminal.

Four models are available, frequency range from 2.6 to 17.0 Gc.

**CIRCLE 304 ON READER SERVICE CARD**

## Tape Recorder

### FOR MISSILES

MEDIUM-SIZED airborne tape recorder, designed for reliability over a wide temperature range under extreme shock and vibration conditions, has been announced by the Leach Corp., Special Products Division, 516 E. Compton Blvd, Compton, Calif. The recorder, called MTR-800, can be used to eliminate lapses of memory that missiles develop in telemetry during reentry

phases (due to ionization) and in over-the-horizon transmissions.

The MTR-800 weighs nine pounds, measures 7½ by 5½ by 4½ inches and can be made to record on 7 or 14 channels. It can be used on land, in air or in space.

Tape speeds are 0.25 ips to 60 ips; wow and flutter is less than 0.5 percent rms at 60 ips (static condition); tape capacity is 300 feet of

one-mil Mylar; tape widths are ½ inch or 1 inch; recording time is 60 sec at 60 ips and 4 hrs at 0.25 ips; starting time is less than ½ second; and reversing time is less than 1 second at 15 ips.

The unit can withstand vibration (without shock mounting) of 15 g from 5 to 2,000 cps; acceleration of 200 g; impact of 1,000 g; temperatures from -50 F to 200 F; and humidity from 0 to 100 percent RH with condensation. Power requirement is 400 cps, 115 v, 30 w (at 60 ips).

Immediately available; basic price, about \$5,000 and up, depending on optional electronic gear.

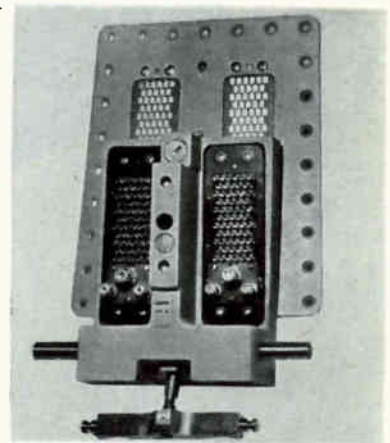
**CIRCLE 305 ON READER SERVICE CARD**

## Umbilical Connector

### COOLING CONNECTIONS

COMBINING 126 pins and two ½-in. cooling lines, umbilical connector is used to activate the Polaris missile. Disconnect is accomplished by a shearing action.

Spring-leaf contacts (No. 4 through No. 20 contact size) and two ½-in. water-methanol electronic cooling lines are integrated into one compact connector plug which mates with an airborne receptacle that is an integral part of the missile. Up-



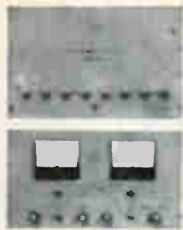
ward movement of the missile disconnects the umbilicus during launching and causes retraction of the connector into a cavity within the launch tube.

The connecting surface of the receptacle on the missile is electrically isolated upon disconnection.

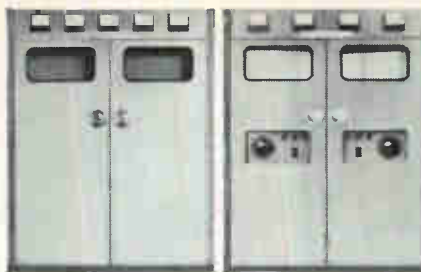
The connector was designed and is built by E. B. Wiggins Oil Tool

**CIRCLE 91 ON READER SERVICE CARD →**





**Specifications | Model 125 Amplifier**  
 Pass band ..... 4 - 64 Mc  
 Pulse power output ..... 0.5 kw (nominal)  
 Power gain ..... 20 db (nominal)  
 Input impedance ..... 50 ohms  
 Output impedance ..... 50 ohms  
 Maximum duty factor ..... .02  
 Maximum pulse width ..... 2000  $\mu$ sec  
 Prime power ..... 115 v, 1 $\phi$ , 60 cps  
 Dimensions :  
 Amplifier rack panel ... 10.5" h, 19" w, 28" d  
 Power supply rack panel .....  
 ..... 12.25" h, 19" w, 20" d

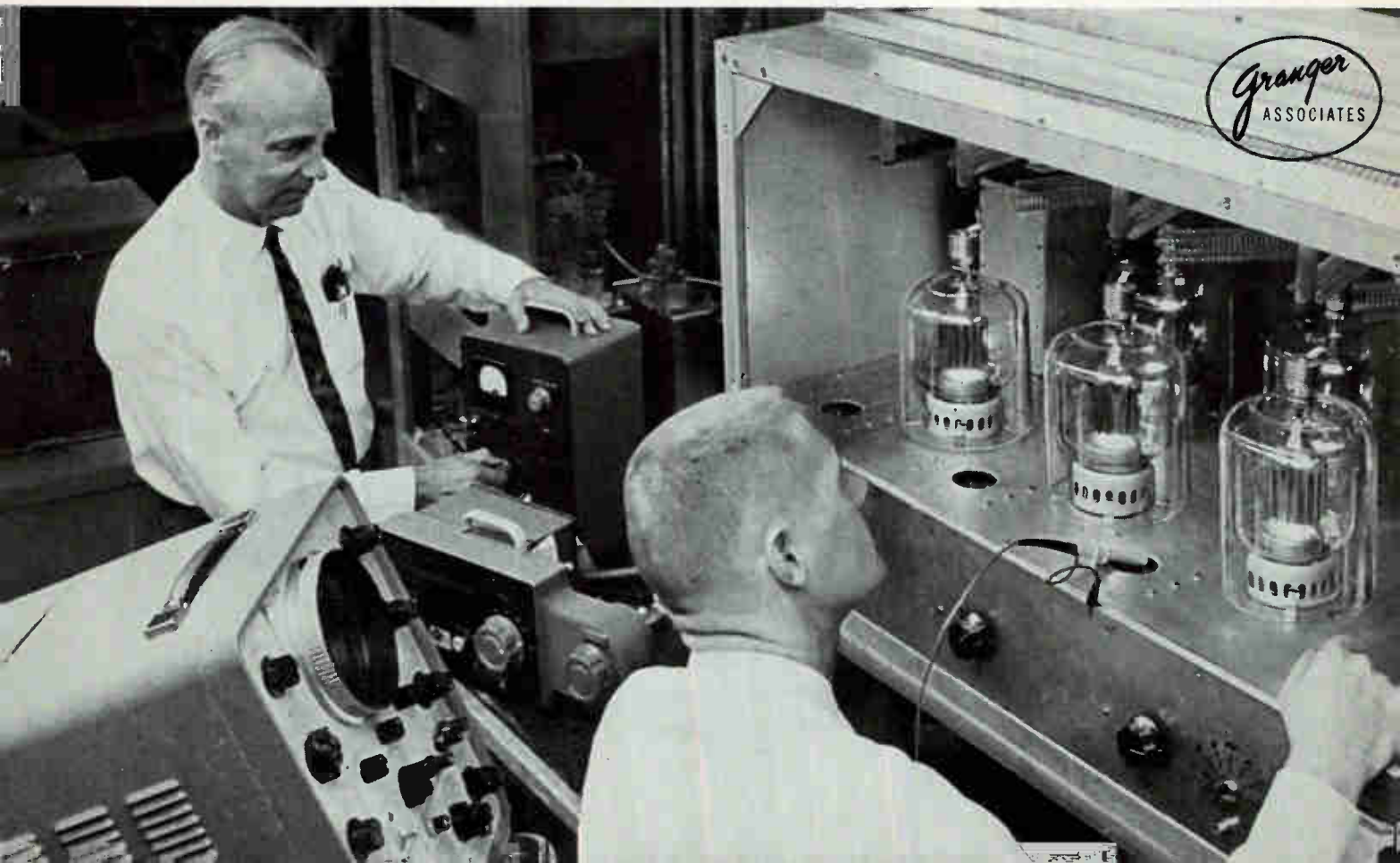


**Specifications | Model 116 Amplifier**  
 Pass band ..... 4 - 32 Mc  
 Pulse power output ..... 100 kw (nominal)  
 Power gain ..... 24 db (nominal)  
 Input impedance ..... 50 ohms  
 Output impedance ..... 50 ohms  
 Maximum duty factor ..... .02  
 Maximum pulse width ..... 2000  $\mu$ sec  
 Prime power ..... 230 v, 3 $\phi$ , 60 cps  
 Dimensions :  
 2 cabinets, each ..... 64" h, 49" w, 32" d

Frequency-independent high power transmitting systems are now possible for the first time with this new line of amplifiers. Available in output power levels from 10 watts to 100 kilowatts, G/A's amplifiers offer power gains up to 24 db over 16:1 frequency bands in the hf range. These performance characteristics are ideal for system applications in ECM, propagation research and ionospheric radar where fast frequency change over extreme bandwidths without retuning is essential. They are already incorporated in a complete G/A-developed ionosphere sounder system—a good example of the company's capability in high power radio equipment. Related system "building blocks" from Granger Associates include wide-band antennas, baluns, multicouplers, T/R switches... special hardware conceived and produced by men who understand its purpose. Thorough knowledge of theory and application backed by design experience: that's the type of system capability offered by G/A. Send for further technical information, or inquire **HIGH POWER** about our engineering staff openings.

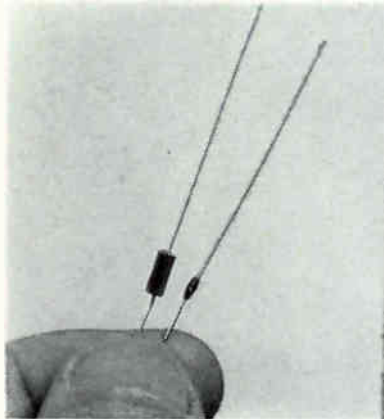
# PULSE DISTRIBUTED AMPLIFIERS FROM GRANGER ASSOCIATES

974 Commercial Street | Palo Alto, California | Davenport 1-4175



Co., Inc., 342 E. Olympic Blvd., Los Angeles, Calif.

**CIRCLE 306 ON READER SERVICE CARD**



### Ultraminiature Capacitors

**BARIUM-TITANATE TYPE**

ULTRASMALL capacitors are useful in airborne and space equipment and in solid-state computers. One type, called Ceramin, is being man-

ufactured by Electronics Corp., Cliff at Cedros, Solana Beach, Calif.

Measuring (less leads) only 0.025-inch long, Ceramins are 0.098-inch diameter for capacitances from 47 to 560 pf and 0.125-inch diameter for capacitances from 680 to 1,200 pf when fully encapsulated in glass. They are also temporarily available encapsulated in flexible epoxy for use in unitized, user-potted assemblies for critical space-weight conditions.

The barium-titanate capacitors are precision-tuned to 5-percent tolerance to 125 C, or 10-percent tolerance to 150 C, and meet requirements of MIL-C-11015A and EIA-SMC-1 specifications.

**CIRCLE 307 ON READER SERVICE CARD**

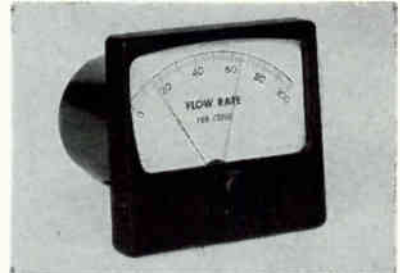
### Two-Pointer Meter

**MAXIMUM, CONTINUOUS**

TWO POINTS are used to show both the maximum reading and the in-

stantaneous reading of the circuit being monitored. The meter includes sampling circuits to determine the maximum signal; it is available from Assembly Products, Inc., Chesterland, Ohio.

Until reset, the adjustable pointer remains at the maximum signal



reached over any period of time. The other pointer provides continuous signal indication. Any variable that can be expressed as an electrical signal can be measured.

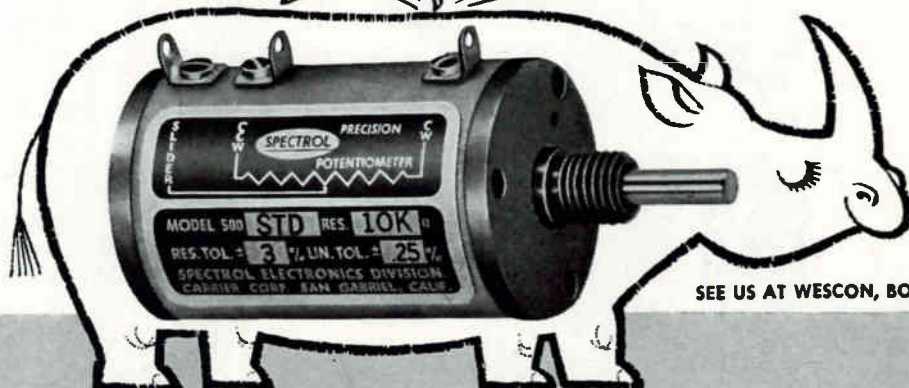
In operation, the adjustable pointer is set manually anywhere on the dial. The signal pointer then rises to the maximum reading

# TOUGH NEW HIDE...

Another **SPECTROL** First



*(Diallyl Iso-Phthalate)*



SEE US AT WESCON, BOOTH 1004



pointer and kicks it upscale in short bursts until the signal remains constant or declines. This action is accomplished with self-releasing circuits that sample the signal.

The meter is available in ranges from 0-10 ma to 0-50 amperes, or 0-5 mv to 0-500 volts, a-c or d-c.

Cases are 2½-in. round and 4½-in. rectangular, black Bakelite. Circuit components are mounted in a housing in back of the meter.

**CIRCLE 308 ON READER SERVICE CARD**

## Gear Drive Unit

### PRECISION-BUILT

M. SWEDGAL, 258 Broadway, New York 7, N. Y., sole U. S. agent for Jackson Bros. (London) Ltd., announces an all new gear drive unit no. 5160. Spring loaded gears and ball bearings insure permanent freedom from backlash. The ratio is precisely 56.25:1. Positive end stops for 180 deg travel of driven spindle. Maximum torque, 18 oz in.

Spindles are stainless steel; frame, steel; gears, brass.

**CIRCLE 309 ON READER SERVICE CARD**



## Inverter

### D-C TO A-C

FREED TRANSFORMER CO., INC., 1718 Weirfield St., Brooklyn 27, N. Y. Chief feature of this d-c to a-c inverter is an output wave form that is a sine wave, with a maximum distortion of 5 percent, which can work into a wide range of loads from 0 to full output. Output voltage varies with input voltage if the inverter is not used with a transistorized regulator. Freed

offers regulators for use in this connection. The inverter can be hermetically sealed for military applications.

**CIRCLE 315 ON READER SERVICE CARD**



## Transistor Holders

### FOUR-PIN DEVICES

SEAELECTRO CORP., 139 Hoyt St., Mamaroneck, N. Y. The TC-400T "Press-Fit" four-pin Teflon transistor holders feature fast and economical chassis insertions. They are constructed with extra-long terminals which act as a heat sink and permit soldering of transistors in place with greatly reduced danger of damage to the transistor elements. They are available in

# . for SPECTROL POTS

We haven't thought of a short, catchy name yet for Diallyl Iso-Phthalate, but maybe that's not too important. We'll be happy if you remember that this rugged new body for Spectrol pots is tougher than any other known plastic pot casing.

Essentially, Diallyl Iso-Phthalate consists of glass fibers suspended in plastic and molded under pressure. It has the following special characteristics:

**Absorbs virtually no moisture.**

**Maintains dimensional stability under typical military environments.**

**Has high insulation resistance.**

**Withstands temperatures to 450° F.**

This is a big improvement over previous plastic bodies. Accordingly, we have made Diallyl Iso-Phthalate casings available in many models in the broad Spectrol line. Your Spectrol rep has details, or just drop us a line at the factory.



## NEW ENGINEERING AID

Have you received your pot selector chart? Suitable for wall mounting, this 24" x 30" chart contains complete and easily read specifications on 37 standard models of single and multi-turn precision potentiometers and three models of turns indicating dials (Multi-dials). For your free copy, contact your Spectrol engineering representative or write us direct. Please address Dept. 42.

# SPECTROL

## ELECTRONICS CORPORATION

- 1710 SOUTH DEL MAR AVENUE, SAN GABRIEL, CALIFORNIA
- 1250 SHAMES DRIVE, WESTBURY, L. I., NEW YORK



**ENGINEERING  
REPORT  
ON BENDIX COMPONENTS**

show underwater bearing and distance information for Sonar

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displays heading and bearing distance data to Vortac Station

**VOR NAV**

furnishes bearing and distance to computed destination

**DOPPLER**

## NAVIGATIONAL INSTRUMENTATION

### Compact Bendix Indicators with wide application range

Eclipse-Pioneer is long-experienced in the design, engineering, and production of lightweight, compact, versatile navigation instrumentation to meet both today's and tomorrow's needs.

Some examples are Bearing Distance Heading Indicators (illustrated), Radio Bearing Indicators,

Omni Magnetic Indicators, Radio Magnetic Indicators, Distance Indicators, and Remote Couplers for use in TACAN, ILS, VOR, SONAR, and DOPPLER systems.

If you have a navigation instrumentation problem, benefit by our precise skills in this specialized area. Call or write today.

**Eclipse-Pioneer Division**

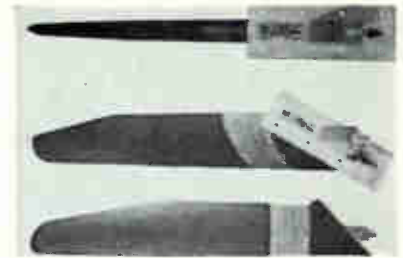
Teterboro, N. J.



District Offices: Burbank and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C.  
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

production quantities in the nine EIA colors plus white for color coded chassis assemblies.

**CIRCLE 316 ON READER SERVICE CARD**

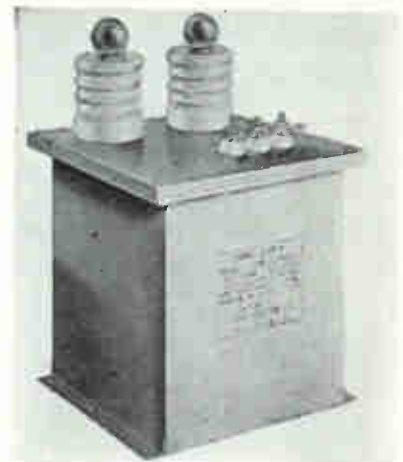


### Low VSWR Antenna

#### BROAD FREQUENCY RANGE

LAND-AIR, INC., 7444 Wilson Ave., Chicago 31, Ill. Model LA 80-320 is a very broad frequency range receiving antenna designed for use on high-speed aircraft. In the 80 to 400 Mc range it presents a vswr of less than 4:1; from 70 to 420 Mc (using a 50 ohm transmission line), the vswr is less than 7:1. The antenna features a resin-impregnated fiberglass sleeve which provides the important electrical separation between the stub and the base, and concomitantly provides a sturdy, reliable dielectric coupling. It measures 35½ in. long, 5½ in. wide, 1¾ in. thick, and weighs only 8½ lb. It withstands the vibration, shock and mechanical stress requirements of MIL-A-18376A.

**CIRCLE 317 ON READER SERVICE CARD**



### H-V Power Supply

#### LOW CURRENT

THE POTTER CO., 1950 Sheridan Road, North Chicago, Ill. New h-v d-c power supply provides infinitely



variable output from 0 to 30,000 v d-c at 1.0 ma rated current output. Designed for operation up to 85 C, the model PHV 30-1M60V has all components immersed in high quality oil and sealed to insure long life, minimize corona and provide dependable operation. Its applications for laboratories and other industrial users include dielectric testing, electrostatic paint spraying, capacitor chargers, c-r displays and electronic dust precipitators. Input voltage can be varied from 0 to 118 v to obtain the required output voltage. Ripple is less than 1 percent at full rated output. Both input and output terminals are made with high grade ceramic. The h-v output terminals are insulated from the case to provide either positive or negative polarity voltage. Price is \$169.

**CIRCLE 318 ON READER SERVICE CARD**



### Band Pass Filters PRECISION UNITS

BARKER & WILLIAMSON, INC., Bristol, Pa. New "F" series of band pass filters are available in 90, 150 and 180 cps models designed for navigational aids, instrument landing systems, receivers, control units, monitors and associated test instruments. Units feature precise response curves. At 1 db down, the 90 cps filter has a bandwidth of 8 cps. At the same level, the 150 cps filter has a 11 cps bandwidth, and the 180 cps filter a bandwidth of 12 cps. Insertion loss, input and load impedances are the same for the three units in the series, permitting operation in identical or parallel circuitry. Manufactured to MIL and FAA specifications, the filters are

hermetically sealed in metal cases measuring 3 by 3½ by 3¼ in. high. Ambient temperature range is -20 to 60 C.

**CIRCLE 319 ON READER SERVICE CARD**

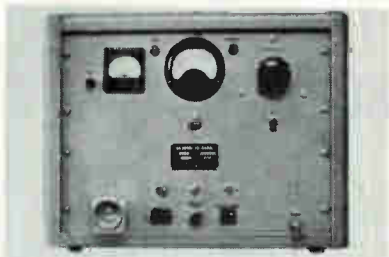


### Magnetrons

#### BOWL-MAGNET DESIGN

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has developed a compact, light-weight bowl-magnet design for its line of voltage-tunable magnetrons. An example is the new Z-5337 VTM which operates as a complete r-f power source in the 2,900-to-3,100 Mc frequency range. Its weight is 1.5 lb. It has a diameter of slightly over 3 in. and height of less than 1 in. The Z-5337 has a minimum c-w power output of 4 w across its designed frequency range and may be electronically tuned over all or part of the range. Tuning rate is 2.6 Mc per volt.

**CIRCLE 320 ON READER SERVICE CARD**



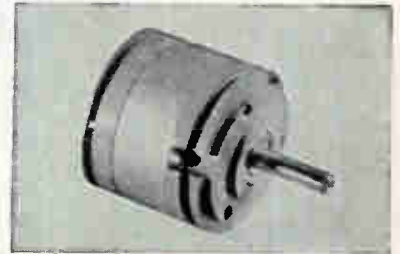
### Calorimeter Bridge HIGH POWER

ELECTRO IMPULSE LABORATORY, 208 River St., Red Bank, N. J., announces a new series of calorimeter bridges from 10 w to 5,000 w full scale with 2 percent or better accuracy and frequency range from d-c to 12,000 Mc coaxial or waveguide. Designed for continuous operation at full scale power, these bridges are direct reading on all scales. They require no thermometers or flow meters and are self-compensating for wide changes in ambient temperature. Provisions are made for external galvanom-



### GEAR HEADS

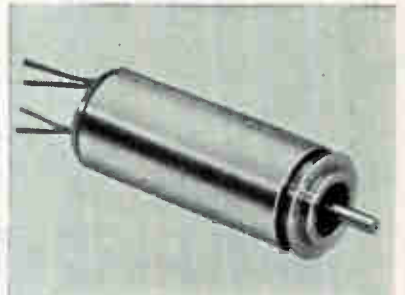
Compact units that provide output motor speed reductions.



These easily detachable heads are available in various frame sizes, and supply reductions in ratios ranging from 7.22:1 to 42,471.90:1. Ball bearings are Class A. B. E. C. 5, or better, and gears are cut to AGMA Precision II tolerances, or better, with backlash held to 30 minutes, or better. Adaptable to variety of motors and motor generators. Write for details.

### ½-INCH LOW INERTIA MOTOR

Designed for instant response in servo systems.



The CK-1066-40-A1 Bendix low inertia motor is a two-phase, four-pole, 400-cycle induction type and is one of the smallest motors available for servo systems. Measures only 0.50" in diameter and 1¼" in length. Unit consists of a squirrel-cage rotor that rotates on precision ball bearings, a two-phase stator, and a stainless steel housing. Standard motor has tapered shaft, but units can be obtained with other type shafts and with center-tapped control windings.

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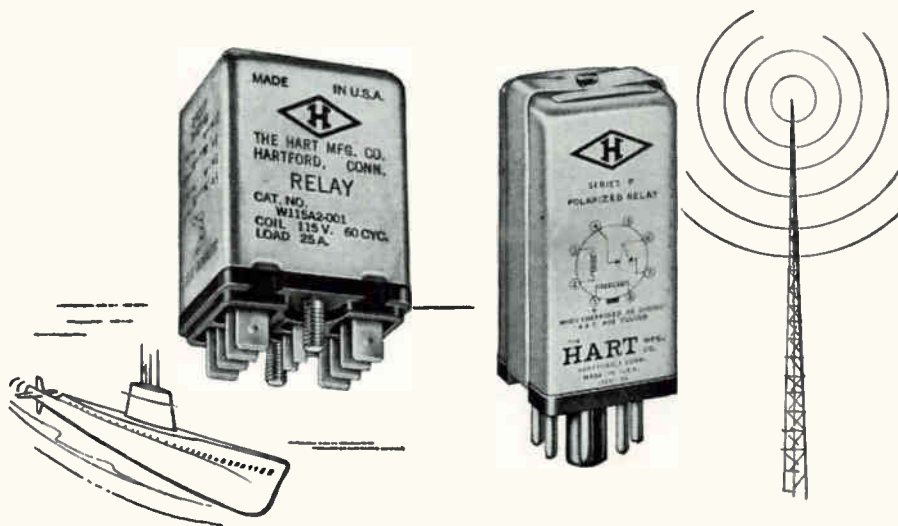
Eclipse-Pioneer Division



Teterboro, N. J.



## Heart of the Control System



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Look into the heart of the control system for a missile, a computer, a nuclear submarine, or a great many other critical applications. You might be surprised how often you'll find "Diamond H" relays.

Unless, of course, you're one of the increasing number of engineers who've already selected "Diamond H" relays for a spot where they just have to work despite all sorts of adverse conditions.

Hart makes relays of three basic types: miniature, hermetically sealed, aircraft-missile relays (Series R/S); high speed, sensitive, polarized relays (Series P), and general purpose AC, DC relays (Series W).

Technical literature outlining the wide range of characteristics available with each type relay is yours for the asking. You'll find "Diamond H" engineers uncommonly adept at working out a variation of the basic designs to meet your set of specific requirements.

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**THE HART MANUFACTURING COMPANY**

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eter and wattmeter. Completely self-contained with r-f load, these instruments measure only 22 in. by 17 in. by 18 in.

**CIRCLE 321 ON READER SERVICE CARD**

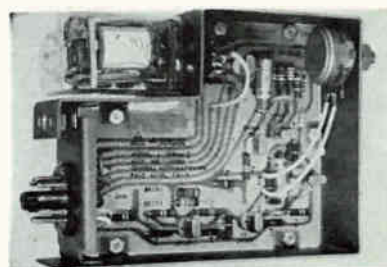


### Demodulator

PHASE-SENSITIVE

GENERAL KINETICS DIVISION of Hydra-Electric, Inc., 3151 Kenwood St., Burbank, Calif. Model SD127 has been designed for use in high-performance electrohydraulic and other servo systems. Four high-quality germanium transistors are employed in a full-wave switching configuration of highly linear output. Units are available for airborne as well as ground-based service. Unit may also be used as a modulator. Carrier frequency may be 60 cps to 5 Kc. Null voltage is less than 5 mv. Output impedance is less than 600 ohms. Temperature range is  $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . Price is \$102.98.

**CIRCLE 322 ON READER SERVICE CARD**

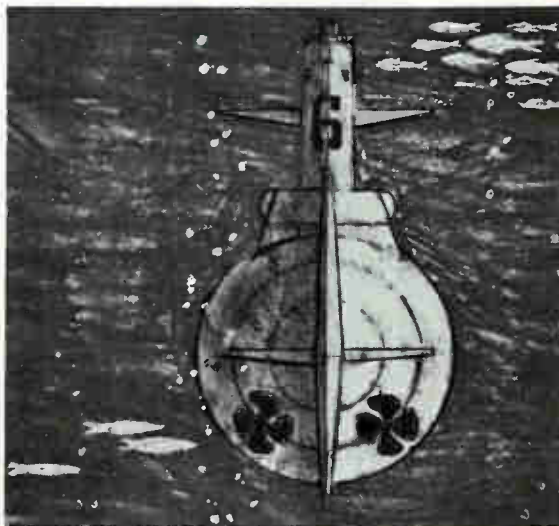
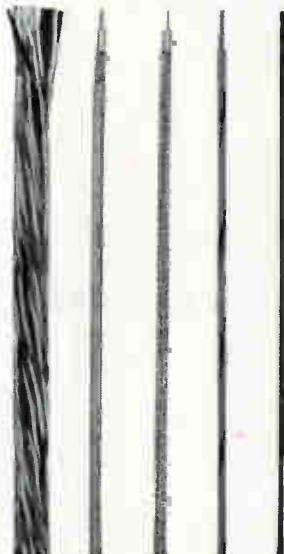
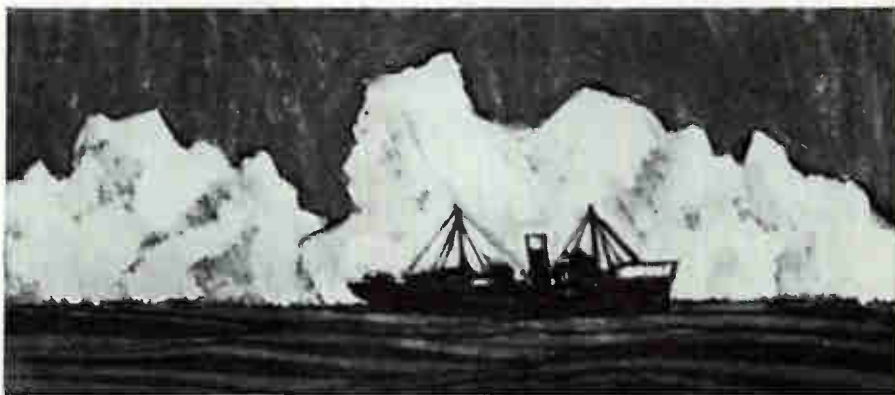
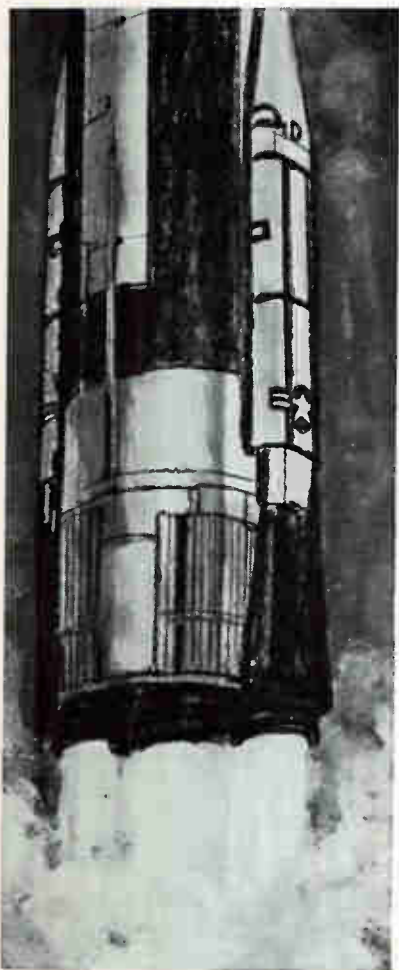


### Voltage Comparator

FAST RESPONSE

GENERAL AUTOMATICS INC., 2443 Ash St., Palo Alto, Calif. This transistorized tolerance detector's high sensitivity, fast response and wide range of application make it a logical automotive installation. Discriminating on the basis of weight, gage or in any application where measurement is converted to voltage, this sensor remains insensitive to positive levels, reacts in less than





# KEL-F<sup>®</sup> Brand Plastic wire coating— tough skin for problem environments

Rattling vibration . . . shattering cold . . . water immersion—even problem environments like these are overcome by electrical wiring and cable utilizing KEL-F Brand Plastic as the coating.

The Surprenant Mfg. Co., Clinton, Massachusetts, has been using KEL-F Plastic as a wire coating for the past 10 years. The reason? It meets their own high quality standards and rigid requirements, as well as military specifications.

They have developed cable jacketing and wire coating of KEL-F Plastic with resistance to extreme vibration, acceleration, shock and cut-through, even at temperatures as low as  $-69.5^{\circ}\text{F}$ . This non-flammable insulation exhibits good dielectric qualities and has a low dissipa-

tion factor, with zero moisture absorption and excellent compressive strength with resultant resistance to cold flow.

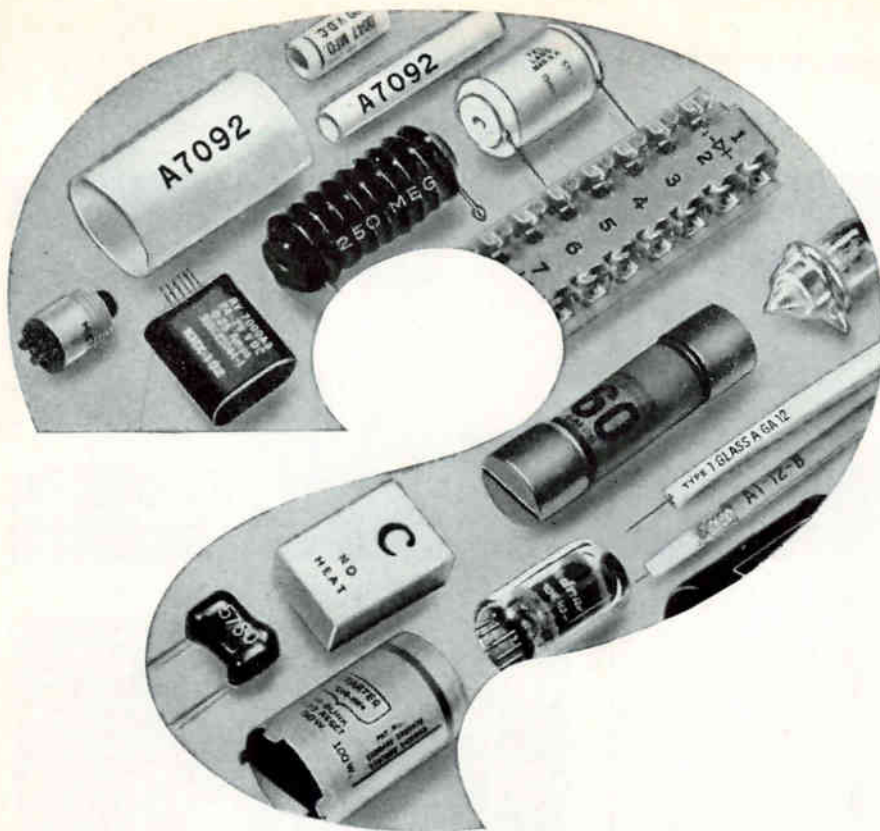
In areas where space is at a premium, Surprenant Mfg. Co. has found that it is easy to achieve excellent concentricity, even at very thin extrusions, using KEL-F Plastic. It extrudes at  $475-625^{\circ}\text{F}$ ., and is melt-processible. The plastic may be custom-colored too, and Surprenant coatings and jackets are available in 9 stock colors (including white), and transparent.

If environment is a problem for your electrical wiring, a skin of KEL-F Plastic may well be the answer. For complete performance data, write today to: 3M Chemical Division, Dept. KAX-80, St. Paul 6, Minnesota.

"KEL-F" is a Reg. T.M. of 3M Co.

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This 12-page booklet explains how the electrical or electronic product *you* make can be marked — at production speeds — with clear imprints that hold. Are you looking for a way to mark odd shapes — a *practical* short-run marking method — an ink that will hold on an unusual surface, or withstand temperature, handling, moisture or other conditions? This catalog describes machines, printing elements and inks that will meet *your* requirements in the marking of products ranging from subminiature components to panels and chassis. There are special sections with practical answers to color banding, Underwriters' Laboratories manifest label legend marking, tape and label printing, wire and tube marking, efficient "in-line" marking. For your copy of the Markem Electrical Catalog, write Markem Machine Co., Electrical Division, Keene 5, New Hampshire.

# MARKEM

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50 milliseconds. With a hysteresis of less than 250 mv at 25 C, input impedance of 100 K ohms, the comparator can be used with reference levels between  $\pm 250$  v to provide limit indications with accuracies of better than 0.05 percent full scale. Output is in form of two 5 ampere spdt contact closures.

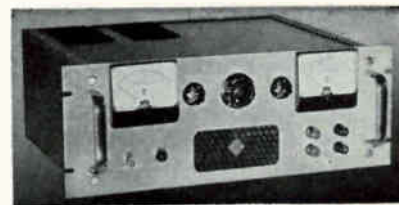
CIRCLE 323 ON READER SERVICE CARD



## TWT Amplifiers BROADBAND

MICROWAVE ELECTRONICS CORP., 4061 Transport St., Palo Alto, Calif., is offering broadband X-band twt amplifiers for test instrument application. The M2201-A operates over the 7,000-12,400 Mc frequency range; the M2201-B, over the 8,000-12,400 Mc range. The M2201 series of tubes utilize metal-ceramic construction, low temperature oxide cathodes and ceramic rod-supported helices. As a result of these fabrication techniques, the tubes provide long life, very low spurious modulation and high mechanical and electrical stability. The tubes are priced at \$850 each.

CIRCLE 324 ON READER SERVICE CARD



## Power Supply

HIGHLY REGULATED

MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N. J. Model ST100-10 transistor power supply is a high power output unit in the moderate to low price range. Rated at 0-100 v d-c, 0.10 amperes continuous duty, the output is continuously variable over the entire range. Vernier control provides approximately 1 v variation for full rotation at all settings. Line regulation is 0.005 percent for changes between 100 and 135 v a-c, and load regulation is 0.01 percent for

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**TIME** means both money and reputation to system builders. To help customers save both, over 10,200 klystron and traveling wave tubes have been shipped **ON TIME** from Sperry's Gainesville, Florida plant. If prompt tube delivery is vital to your system, call Gainesville, FRanklin 2-0411 collect, for full information about Sperry capabilities.

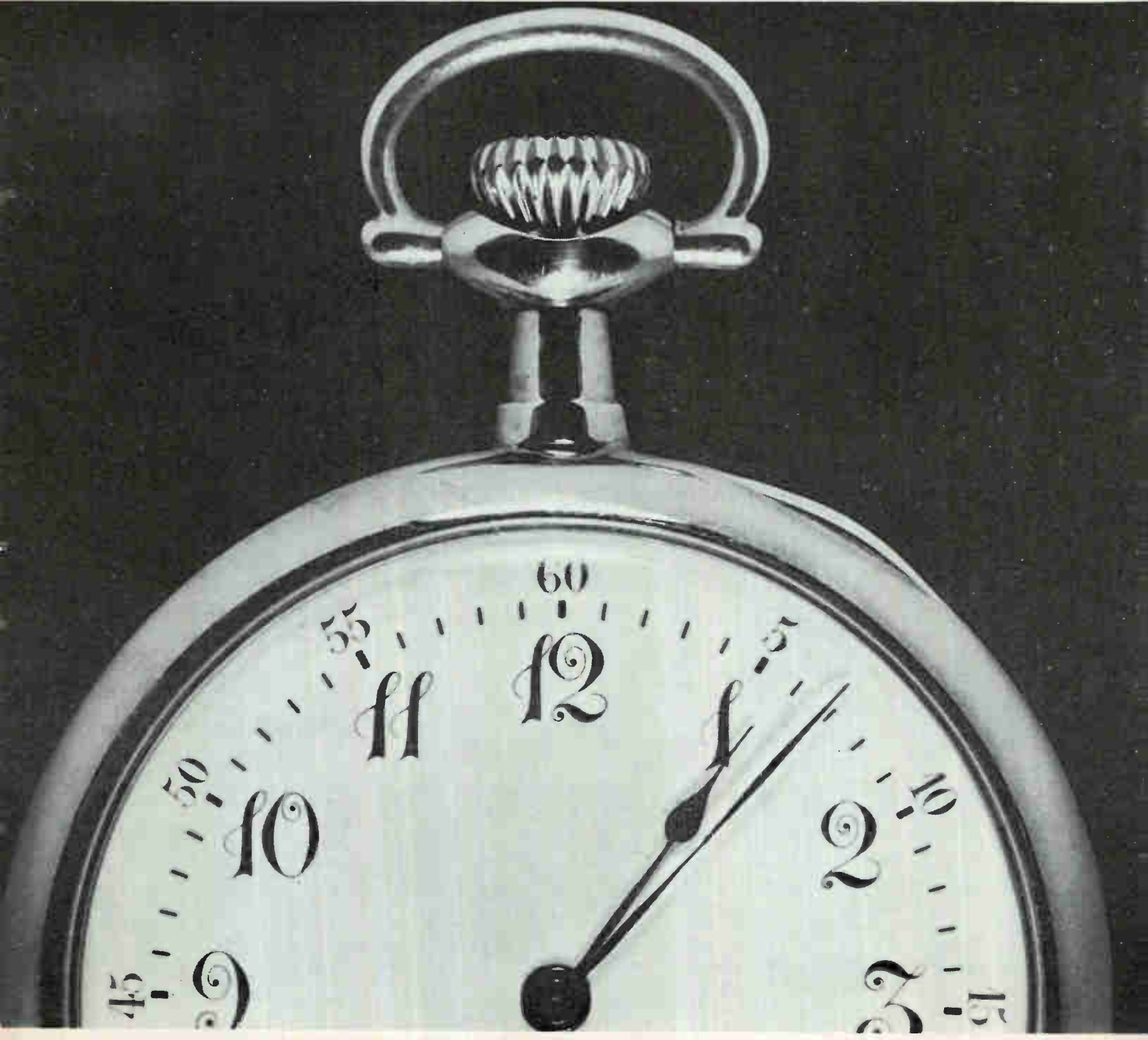
**SPERRY**

**ELECTRONIC  
TUBE  
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Gainesville, Florida • A Division of Sperry Rand Corporation



**SPERRY'S FAMILY OF TRAVELING WAVE TUBES** covers P through X Bands with unusually high output and light weight. These characteristics, combined with the inherent ruggedness of metal-ceramic construction, conduction cooling and wide-range thermal compensation, make Sperry traveling wave tubes particularly suitable for airborne applications.





## 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

changes from 0 to full load. Specifications include: ripple, less than 500  $\mu$ v rms; overshoot, 1.0 percent maximum; and recovery less than 50  $\mu$ sec.

**CIRCLE 325 ON READER SERVICE CARD**



### Tape Splicer FOR FAST PROGRAMMING

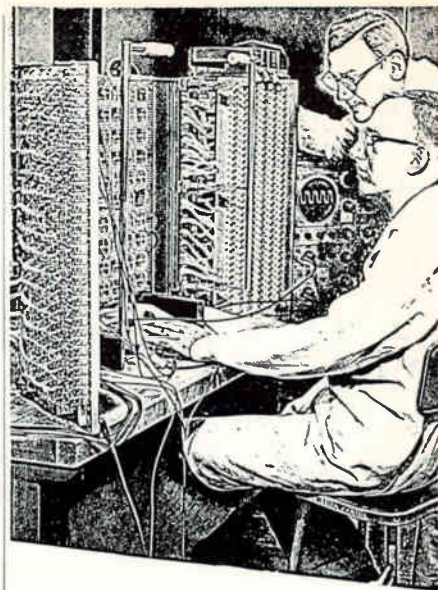
CALIFORNIA TECHNICAL INDUSTRIES, 1421 Old County Road, Belmont, Calif. Model 219 tape splicer is an ideal accessory unit for use with tape-programmed automatic test systems. It permits rapid splicing of punched tapes for editing, mending, or correcting. New information can be added and deletions can be made with no loss of desired information. Unit makes strong and accurate splices and, in addition, can clean clogged punch-holes with ease. By greatly speeding tape-program operation, model 219 adds still further efficiency and economy to automatic testing. Price is \$28.

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### Differential VTVM HIGHLY ACCURATE

THE DECKER CORP., Forty-Five Monument Road, Bala-Cynwyd, Pa., announces a true differential d-c vtvm capable of 1 percent accuracy throughout the scale. Model 410 features a zero center scale with full scale ranges of  $\pm 0.3$ , 1.0, 10, 30 and 100 v d-c, and a single input impedance of 20 megohms and 40 megohms differential. In transistorized circuitry the instrument readily provides off ground readings without loading. The 410 also can be used as a unit cathode fol-



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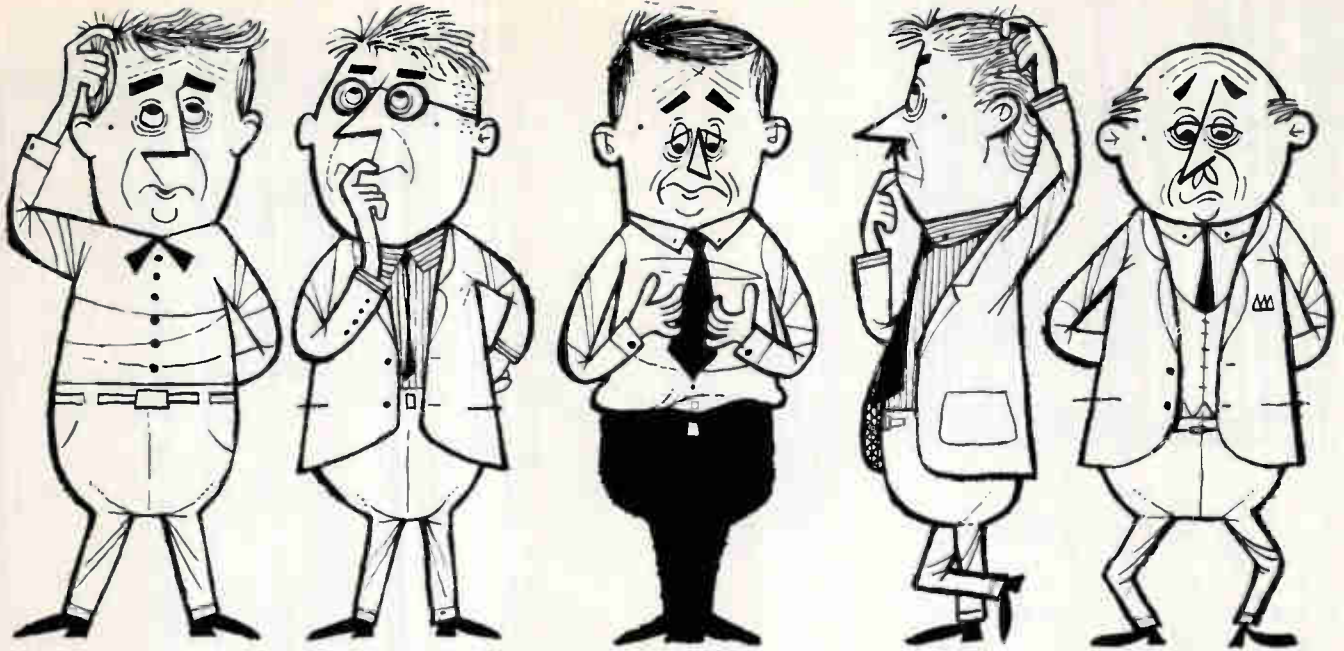
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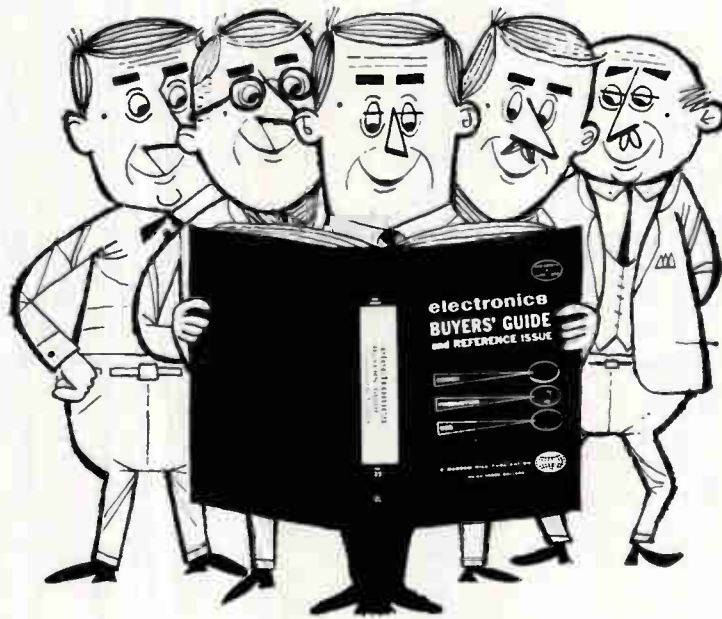
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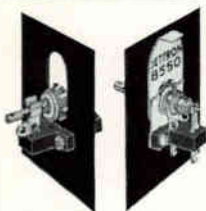
# Special Sockets and Connectors

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**CD-7140** — Printboard Application Socket for R.C.A. Micromodule. Measures only .400 maximum square by .094 high. Insulation resistance greater than 50,000 megohms. Employs silver plated beryllium copper contacts and DIALL FS-5 insulating material.



**CAT. 8550**—Ultra High Frequency Socket for the G.E. GL-6299 Triode is sold in kit form containing all the necessary parts for mounting by the customer on a chassis barrier. It provides excellent isolation of the input from the output.



**CAT. 8715**—Ultra-High Temperature Socket for G.E. 7296 Triode can be soldered to printboard or mounted above or below a chassis. High Alumina insulating material; contacts gold plated Inconel-X. For continuous operation at 1000° F (538° C).

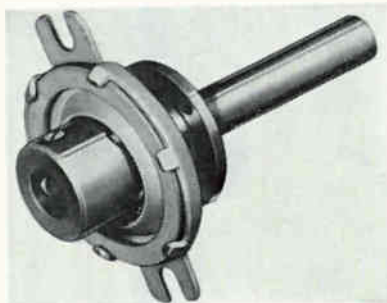
## JETTRON PRODUCTS • INC

56 Route 10, Hanover, New Jersey  
 Telephones: TUcker 7-0571-0572

Sales Engineers in Principal Cities

lower, having an open circuit gain of 0.85 which can be varied in definite steps by the input divider maintaining the input impedance with an output impedance of 1,000 ohms.

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### Planetary Ball Drive PRECISION-BUILT

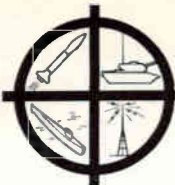
M. SWEDGAL, 258 Broadway, New York, N. Y., sole U. S. agent for Jackson Bros. (London) Ltd., announces a new planetary ball drive No. 4511/DAF. Simple and powerful epicyclic friction drive. Ball bearings. Ratio 6-1. Dimensions 1 3/8 in. diameter, 1 1/4 in. long, plus 1 1/8 in. shaft. 15-20 oz. in.

**CIRCLE 328 ON READER SERVICE CARD**



### D-C Power Supply FOR GROUND SUPPORT

PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif., announces model M-1216-1 d-c power supply with an output of 22-33 v at 50 amperes for aircraft ground support. The compact (8 by 16 by 10 in.) supply has an efficiency of 70 percent at 28 v and 25 to 50 amperes. All-static and reactor-controlled, it maintains its d-c output at from 22 to 33 v, no load to full load, on an input of 220/440 v nominal +10 percent, -15 percent, 3-phase, 60 cps ±5 percent. Ripple is less than 5 percent rms. Well suited for such applications as operating aircraft relays in test



## OPENINGS IN Systems Analysis Design & Development Evaluation

### Systems Analysis

Weapons Systems analysts with BS or MS in mathematics or physics, or BSEE, to work on weapons system and component lethality, evaluations, optimization studies, feasibility studies, and concept synthesis. Also a BSEE or MSEE with a minimum of 3 years in electronic systems with emphasis on remote control, data handling, signal processing.

### Design and Development

A number of openings now exist for experienced design and development engineers with the following qualifications:

BSEE or MSEE, minimum 3 years experience in any of these fields: Solid state circuit design, including amplifiers and switching circuitry; RF techniques, including circuit design; antenna design, propagation studies, modulation techniques. Signal processing and data handling, including techniques for encoding, decoding, storage, digital data processing, display, system integration. Also: openings for BSEE with minimum one year in synthesis servo analysis or servo application.

### Evaluation

BSEE. Prefer 1-8 years in test, design, or related areas. Work involves testing specific unit systems, parts, or materials. May involve designing and building non-standard testing equipment; field or simulated field testing; tests on production instruments.

*All above openings are in Minneapolis area. For complete information, write Allan J. McInnis, Professional Manpower Staff, Ordnance Division, Honeywell, 600 Second St. North, Hopkins, Minn.*

## Honeywell



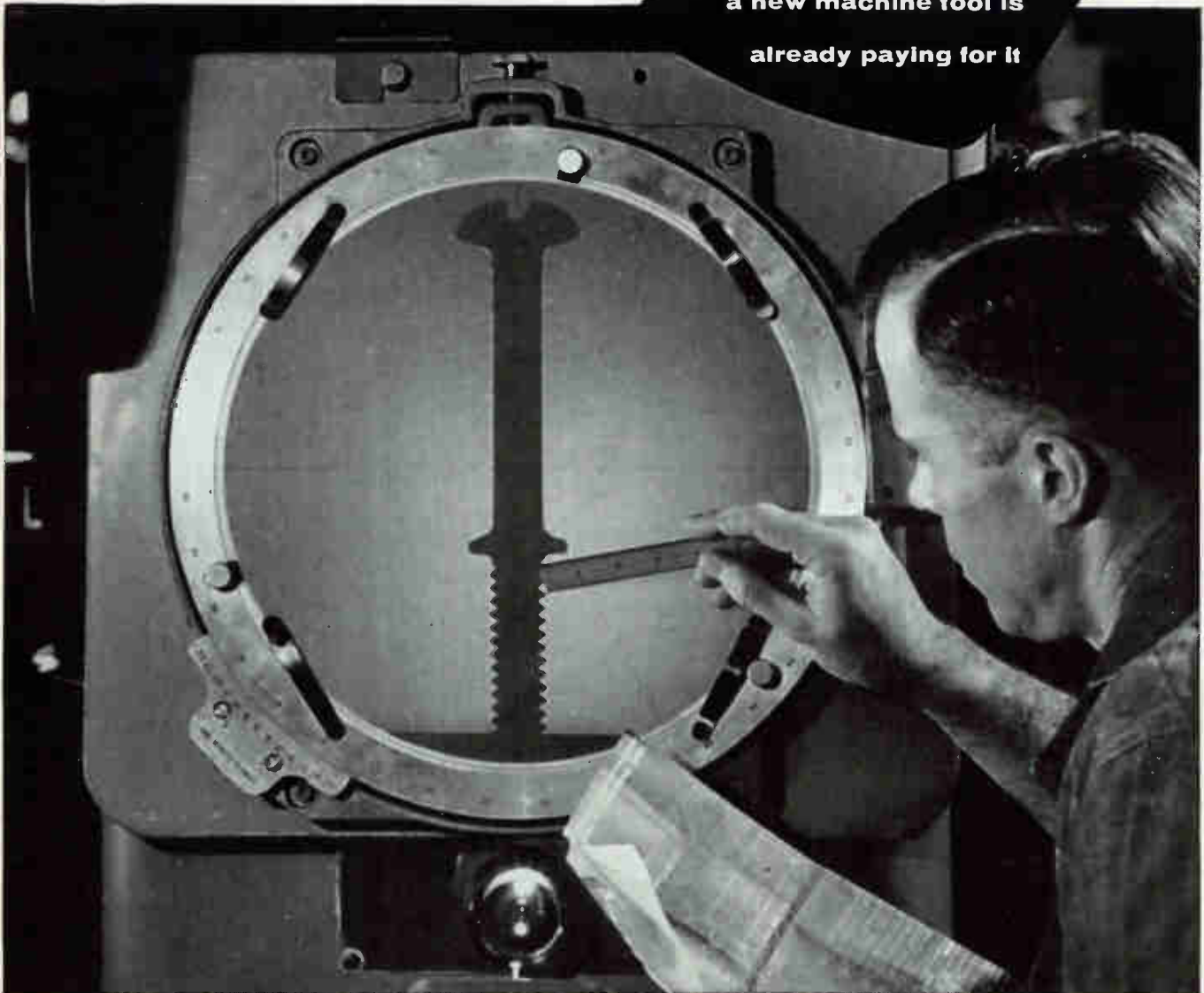
Military Products Group

*To explore professional opportunities in other Honeywell operations, coast to coast, send your application in confidence to H. D. Eckstrom, Honeywell, Minneapolis 8, Minn.*



# JONES & LAMSON OPTICAL COMPARATORS

the man who needs  
a new machine tool is  
already paying for it



## J & L Optical Comparator is a production tool

At John Hassall, Inc., Westbury, L. I., nails, screws, rivets, fasteners, and other small parts are "Job-Designed" to satisfy the customer whose requirements cannot be adequately met by the standard item.

Rigid AN (military) specifications are strictly adhered to whenever required. In all cases, the Jones and Lamson Optical Comparator has become an almost indispensable production tool.

In the cold heading process used at Hassall, the J & L Comparator acts as a monitor for controlling the essentials of the production process. Tools for manufacture of dies are checked for proper cutting edge and angle. The dies them-

selves are checked for cavity contour and angle by taking plastic impressions. Finished parts, accurately magnified 10 times under the critical eye of the Comparator, are checked at a glance for tolerances. But, even more importantly, this inspection gives essential information as to when and where dies may be worn, or where other areas of the *manufacturing process* should be changed. How easy it is for production control and tolerance requirements to be maintained!

J & L Comparators, featuring magnifications up to 250X are ready to go to work for you. Write for literature. Jones & Lamson Machine Company, 539 Clinton St., Springfield, Vermont.

# YOU CAN SEAL

# VACUUM

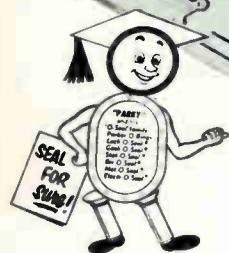
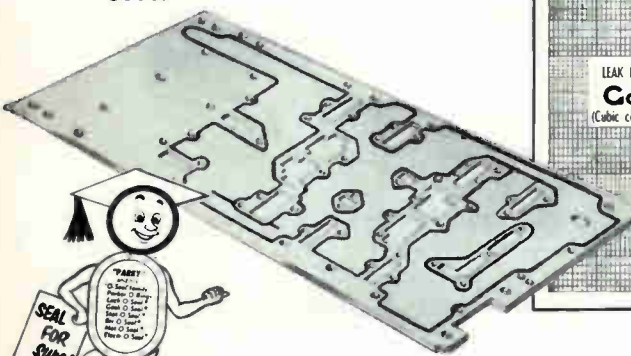
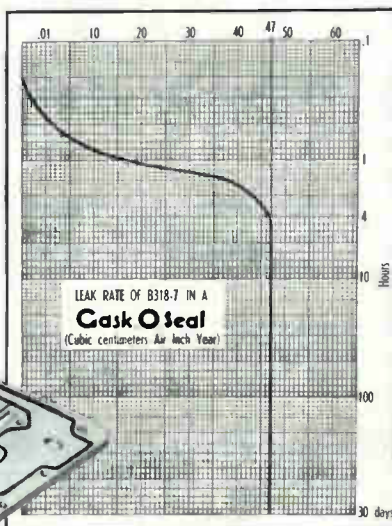
## and still get serviceability!

Gask-O-Seals meet, or exceed grade A MIL-8484 specifications for hermetic sealing, yet they are mechanical. That means you can seal a vacuum and still achieve full serviceability — easy access for repair, maintenance, re-setting, etc. You can seal components, "black-boxes," instruments, even complete systems — and re-seal them with the same seal!

The seal shown below illustrates the versatility of Gask-O-Seal — one piece seal actually doing the job of ten! Think of the freedom of design such a seal offers. Can they be put to use for your products, too?

The chart at right is an actual reproduction of a test which reveals a leak rate of less than 1 cc/air/inch/year—exceeding top hermetic requirements.

For more information about Gask-O-Seals send for catalog 5800.



## Parker SEAL COMPANY

Culver City, California and Cleveland, Ohio

A DIVISION OF PARKER-HANNIFIN CORPORATION

Parker also makes seals for wave guide flanges that prevent R/F leakage and provide a positive no-leakage seal; a self sealing flush-head rivet called Riv-O-Seal, and many other specialized seals as well as O-Rings and Back-Up Rings. Your inquiry is invited.

benches, the power supply uses silicon rectifiers for adverse environmental conditions. It meets MIL specs.



### Time Delay Relay

HERMETICALLY SEALED

THERMAL CONTROLS, INC., 41 River Road, North Arlington, N. J. Model 900G thermal time delay relay is a rugged, economical, miniaturized standard 9 pin-in-socket, hermetically sealed in a metal can. Time delay ranges are 2 sec to 180 sec with a voltage range of 6.3 v to 115 v a-c or d-c (heater). Unit is engineered for both military and commercial uses, wherever a rugged miniature thermal device is required. Company also manufactures a complete line of hermetically sealed thermal devices with time delay ranges of 2 sec to 300 sec in either glass or metal cans.

CIRCLE 329 ON READER SERVICE CARD



### V-T Voltmeter

& VIDEO AMPLIFIER

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J. Highly accurate, low level high frequency r-f voltages from 250  $\mu$ v to 1 v can be easily measured with the Microlter, a combination 50 Mc vtm and wide-band video amplifier. Featuring improved stability over the entire frequency range the new unit provides direct readings within 1 percent accuracy on a large, full scale 6 in. mirror-back meter—with no tuning. Maximum output volt-

←CIRCLE 104 ON READER SERVICE CARD



age of video amplifier is 0.5 v at 75 ohms with an amplifier gain of 45 db. Operating range of the Microleter is from 50 cps to 50 Mc with direct readings in volts and decibels.

**CIRCLE 330 ON READER SERVICE CARD**

## Resistors

### LOW INDUCTANCE

GB COMPONENTS, INC., 14621 Armita St., Van Nuys, Calif., announces a new line of low reactance resistors in the total resistance ranges of its present high precision encapsulated wirewound product lines. Company says this development is a major breakthrough in making available to the industry an extremely accurate resistance product without the undesirable characteristics of high distributed capacitance and objectionable levels of electrical inductance.

**CIRCLE 331 ON READER SERVICE CARD**



## Variable Delay Line

### VERY SMALL SIZE

JFD ELECTRONICS CORP., 6101 Sixteenth Ave., Brooklyn, N. Y. Especially suited for p-c board applications, this delay line provides a high ratio of delay to rise time in minimum space. The high impedance variable tap provides extremely fine resolution per turn. Provision is made for locking shaft in any position. Other characteristics provided are: exceptional ruggedness, precise pulse fidelity,  $-55$  C to  $+125$  C operating temperature range, high resistance to environmental conditions, such as moisture, humidity, shock and vibration. It features 0.1 in. grid spacing for p-c mounting, approximately 1 db per  $\mu$ sec attenuation, extremely

July 22, 1960



## ADVANCED ENGINEERING

## PRECISION FABRICATION

**to convert your antenna concepts  
into reliable structures.** For information,

contact the Blaw-Knox Equipment Division, Pittsburgh 38, Pa.

# **BLAW-KNOX**

## ANTENNAS

**CIRCLE 107 ON READER SERVICE CARD**

107

FLIGHT PROVEN

# TR-10



## fm telemetry transmitter

(HALF SIZE)

The TR-10 is one of a family of transistorized flight proven airborne components used in UED FM/FM and PCM systems and also available to industry. Now in quantity production, the TR-10 is doing service in such missiles as Minuteman, Terrier, Javelin/Journeyman, Sergeant, Hound Dog and in space programs such as Midas, Samos and Pioneer. Outstanding characteristics of the transmitter include:

- Output / 2.5 watts with true FM modulation over complete 215-265 mcs telemetry band.
- Reliability / 99.9% for 500 hours.
- Modulation Frequency Response /  $\pm 2$ db from 3 cps to 300 KC.
- Vibration Induced Noise / less than 3 KC deviation at 20 g's from 20 cps to 2000 cps.
- Qualifies to Radio Noise Specification MIL-STD-442.
- Modulation Linearity / less than 1% from straight line at 125 KC deviation.
- Exceeds military environmental specifications including MIL-E-5272.

UED's soundly-conceived and solidly-built systems and components can help solve your design problems. Data sheets, test reports and technical consultation on request. Write or call:



United ElectroDynamics, Inc.

MU 2-1134 SY 9-7161

200 ALLENDALE RD., PASADENA, CALIF.

low temperature coefficient and positive end stops.

CIRCLE 332 ON READER SERVICE CARD



### Bridge Rectifier SINGLE-PHASE

LEDEX, INC., 123 Webster St., Dayton 2, Ohio. The new single-phase full-wave silicon bridge rectifier provides a light, compact, shock resistant power supply. The  $\frac{3}{8}$  in. by 1  $\frac{1}{8}$  in. diameter unit, molded in epoxy resin to withstand extreme environments, has a high surge current rating of 35 amperes, a recurrent peak rating of 5 amperes, and a peak inverse voltage of 200. Operating temperature is  $-65$  C to  $+120$  C.

CIRCLE 333 ON READER SERVICE CARD



### Motor Generator WEIGHS 9 OZ.

KEARFOTT DIVISION, General Precision Inc., 1150 McBride Ave., Little Falls, N. J., has available a new size 11 servo motor-generator which features a zero deg phase shift and a signal to noise ratio of 290:1. The R830-26 is designed primarily as a low inertia rate generator but can also be used to replace most size 15 units in high gain damping applications. In-phase speed-sensitive output variations due to variations of ambient temperature are stabilized to within 0.2 deg C throughout the temperature range. Speed-sensitive voltage and frequency variations are stabilized to within  $\pm 0.2$  percent for voltage and 0.03 percent/cycle for frequency.

CIRCLE 334 ON READER SERVICE CARD





**INDUCTION  
SOLDERING  
UNIT**



Model PM 1

**FOR SMALL PARTS AND ASSEMBLIES**

Simplifies, improves and speeds up component production. Provides local heat to otherwise inaccessible spots. Safe and simple. Max. power input 775 watts, 100 watts standby; 115 volts, 60 cycles. 15 3/4" x 21 1/2" x 15". 150 lbs. Bulletin on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Co., Manchester, N.H., U.S.A. In Canada, Honeywell Controls Limited, Toronto 17, Ontario.

**Honeywell**



CIRCLE 203 ON READER SERVICE CARD



**There's  
going to be  
a meeting**

Who's going to get together and *what* are they going to talk about?

Electronics men are meeting all over the country to talk about everything from ultrasonics to quantum electronics.

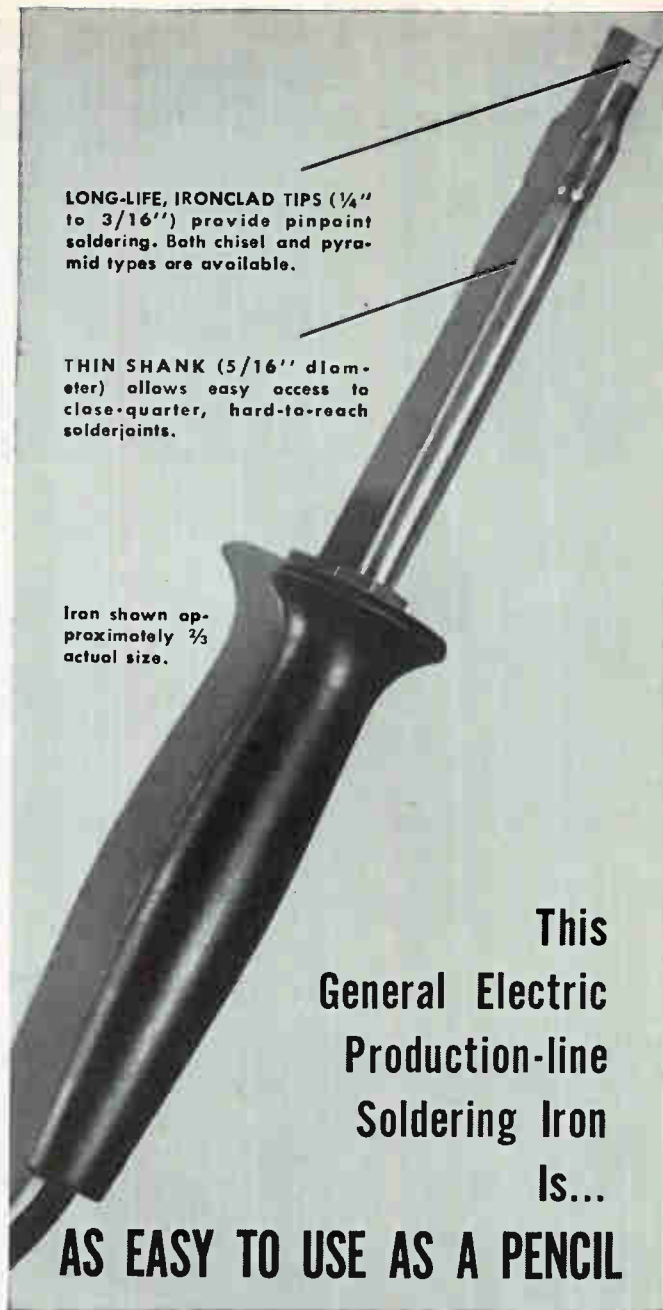
*electronics* tells you where and when "Meetings Ahead"... gives you the highlights later on.

Another reason why it will pay you to subscribe to *electronics* (or renew your subscription) right now. Fill in the box on Reader Service Card. Easy to use. Postage free.

**FIND WHAT YOU NEED IN...**

**electronics**

July 22, 1960



LONG-LIFE, IRONCLAD TIPS (1/4" to 3/16") provide pinpoint soldering. Both chisel and pyramid types are available.

THIN SHANK (5/16" diameter) allows easy access to close-quarter, hard-to-reach solderjoints.

Iron shown approximately 2/3 actual size.

**This  
General Electric  
Production-line  
Soldering Iron  
Is...**

**AS EASY TO USE AS A PENCIL**

**LIGHTWEIGHT IRON PROVIDES HIGH-SPEED  
SOLDERING WHERE OTHER IRONS CAN'T REACH**

For electronic, instrument, and communication equipment production lines, and for maintenance—where hard-to-reach joints must be soldered in a hurry—General Electric's Lightweight Soldering Iron offers the ideal solution.

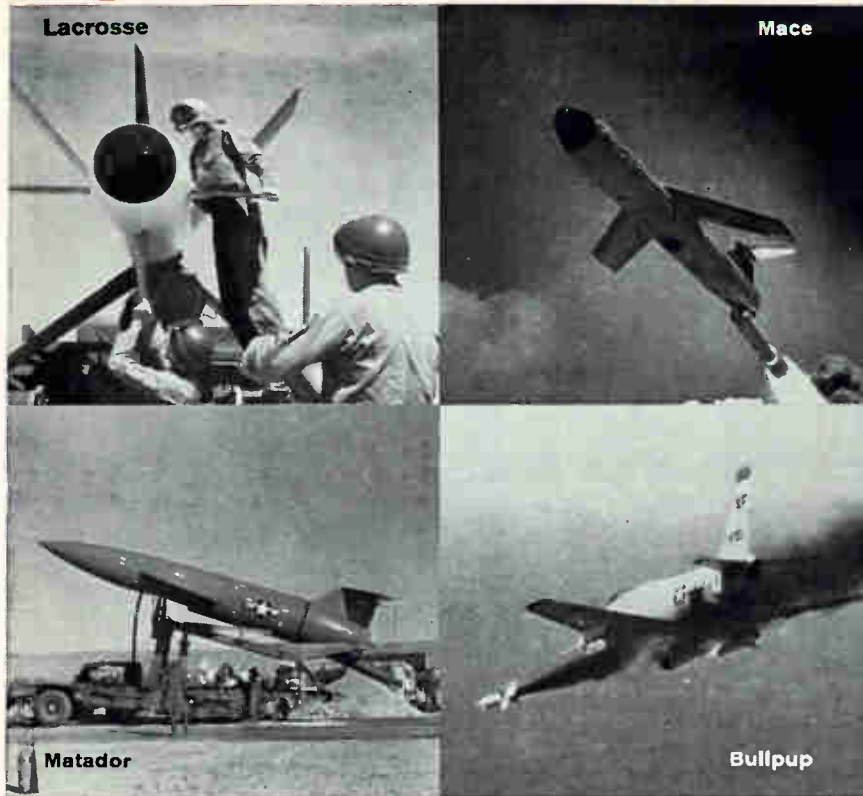
It weighs only 8 1/2 ounces, and handles like a pencil. A thin shank and small tip sizes let you solder in tight places where regular-size irons won't go. Rated 120 volts, 60 watts, the iron features extremely fast heat recovery to provide reliable, uniform solderjoints in seconds.

Want more information? Contact your General Electric distributor or nearby G-E Apparatus Sales Office, or write Section 758-02, General Electric Co., Schenectady 5, N. Y.


**GENERAL  ELECTRIC**

CIRCLE 109 ON READER SERVICE CARD

# BUILT BY MARTIN



## FOUR OPERATIONAL MISSILES



FOREMOST

in

SONAR

EDO CORPORATION

College Point, L.I., N.Y.

Since 1925

For HEAVY DUTY  
WORK! Severest Electrical  
Services!



P-506-CE  
Plug with Cap

JONES  
PLUGS &  
SOCKETS

500 SERIES

Proven  
Quality



S-506-DS  
Socket with  
deep brackets

For 5,000 Volts 25  
Amperes per Con-  
tact Alterable by  
circuit Character-  
istics.

Socket contacts phosphor bronze knife-switch type, cadmium plated. Plug contacts hard brass cadmium plated 2, 4, 6, 8, 10, and 12 contacts. Plugs and sockets polarized. Long leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized (rust proofed). Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

Write for Jones BULLETIN 22  
for full details on line.



HOWARD B. JONES DIVISION

CINCH MANUFACTURING COMPANY

CHICAGO 24, ILLINOIS

DIVISION OF UNITED-CARR FASTENER CORP.

CIRCLE 205 ON READER SERVICE CARD

## Literature of

**CHART DRIVES** Inco Co., division of Barry Controls, Hollis St., Groton, Mass., has published a catalog describing multi-speed chart drives for use with a variety of strip chart recorders.

CIRCLE 350 ON READER SERVICE CARD

**TRANSISTOR CHARACTERISTICS** Derivation And Tabulation Associates, 95 Harrison Ave., West Orange, N.J. A new brochure illustrates and describes D.A.T.A.'s transistor characteristics tabulation, a comprehensive digest of the world's transistors, completely updated twice a year with a supplement between complete editions.

CIRCLE 351 ON READER SERVICE CARD

**FREQUENCY DISCRIMINATOR** Magnetic Research Corp., 3160 West El Segundo Blvd., Hawthorne, Calif., has published an engineering data sheet containing complete details on its 115-v 400 cycle, 0-5 v d-c range frequency discriminator model 91-105-0.

CIRCLE 352 ON READER SERVICE CARD

**ELECTROLYTIC CAPACITORS** Pyramid Electric Co., Darlington, S. C., has available a four-page engineering bulletin on the type ML subminiature aluminum electrolytic capacitors.

CIRCLE 353 ON READER SERVICE CARD

**MICROPHONES** The Astatic Corp., Conneaut, Ohio. Catalog M10 includes information covering specifications, applications and prices along with charts showing typical response-frequency characteristics of the company's microphone line. Accessories are also listed.

CIRCLE 354 ON READER SERVICE CARD

**TIME DELAYS** G-V Controls Inc., 101 Okner Parkway, Livingston, N.J. Technical publication No. 80 describes a new concept of versatility in transistorized time delays.

CIRCLE 355 ON READER SERVICE CARD

**DATA TRANSLATOR** Electronic Engineering Co. of California, 1601 East Chestnut Ave., Santa Ana, Calif. A new data sheet describes the ZA-26965 data translator which



## the Week

converts coded input data recorded on punched paper tape into an alphanumeric code with a format directly acceptable to an IBM 704/705 data processing machine.

CIRCLE 356 ON READER SERVICE CARD

**SWITCH CATALOG** Cherry Electrical Products Corp., 1650 Deerfield Road, Highland Park, Ill. Technical engineering data and ordering information are contained in a new full line snap-action switch catalog. Enclosed and open stack switches are featured for practically unlimited precision snap-action switch applications.

CIRCLE 357 ON READER SERVICE CARD

**WIRE AND CABLE** Tensolite Insulated Wire Co., Inc., Tarrytown, N. Y., has published an up-to-date product catalog containing engineering information on wire and cable. A new self-reading code numbering system is employed which simplifies the identification of insulated wire and cable.

CIRCLE 358 ON READER SERVICE CARD

**PRECISION GEARS** Dynamic Gear Co., Inc., Dixon Ave., Amityville, L.I., N.Y. Master catalog No. F-128 lists over 50,000 Dynaco precision gears that are available from stock.

CIRCLE 359 ON READER SERVICE CARD

**ENVIRONMENTAL TEST EQUIPMENT** Standard Cabinet Co. Inc., 56 Washington Ave., Carlstadt, N.J. Bulletin No. 60B illustrates and describes environmental test equipment for altitude, temperature, humidity, fungus, sand and dust, rain and sunshine, salt spray, and explosion.

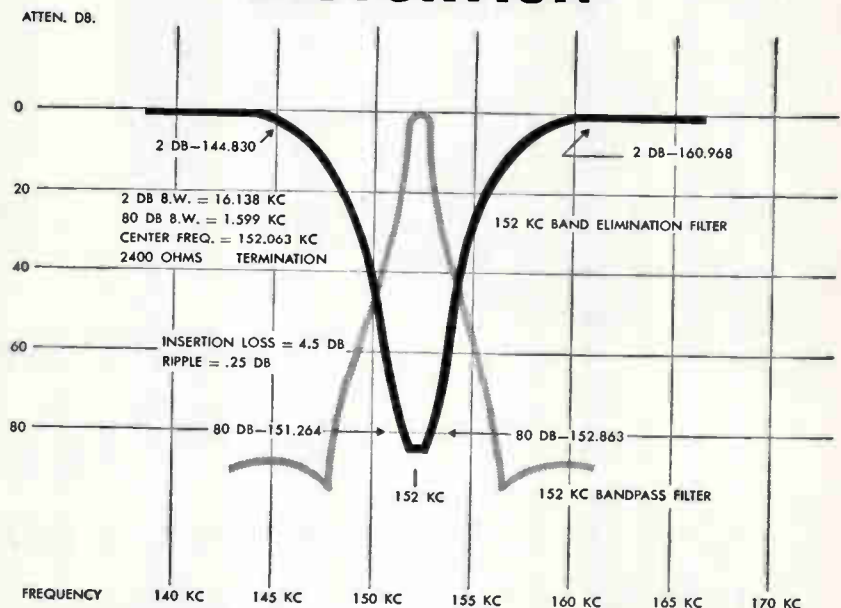
CIRCLE 360 ON READER SERVICE CARD

**MICROMINIATURE TRANSFORMERS** James Electronics Inc., 4050 N. Rockwell St., Chicago 18, Ill. New catalog page gives complete technical specifications of model C-2650 microminiature transformer kit of 10 transformers covering the full range of input impedances and impedance ratios to conveniently apply transformers in transistor circuits.

CIRCLE 361 ON READER SERVICE CARD

*High selectivity,  
attenuation and precision matching of . . .*

# NEW HILL FILTERS ASSURE FAST, PRECISE MEASUREMENT OF INTER-MODULATION DISTORTION



Actual operational curves, obtained from point-to-point readings, from Hill 34900 and 34800 filters developed to fulfill customers' specific requirements.

These two highly stable, precision-matched Hill Electronic filters permit fast, exceptionally accurate measurement of inter-modulation distortion in communications systems. A band elimination filter places a narrow, deep notch in the white noise being passed through the equipment under test. Distortion generated in the notch is then isolated for measurement by the narrow band filter. The high degree of selectivity and attenuation of these filters, and the excellent alignment of one within the other are demonstrated in the actual operational curves shown above. Used together, these filters provide 80 db attenuation from 6 to 252 kc.

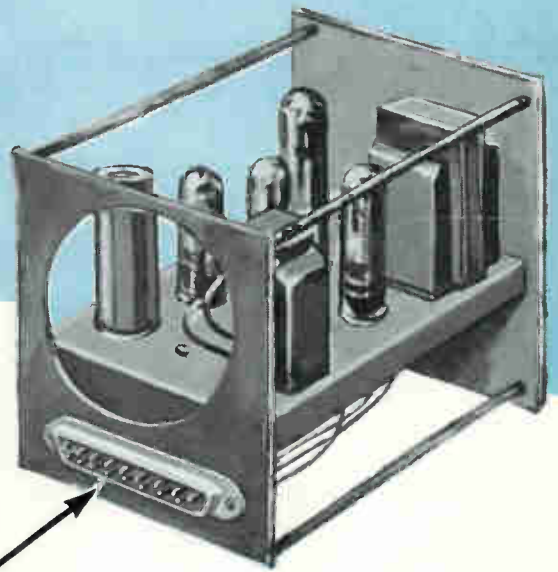
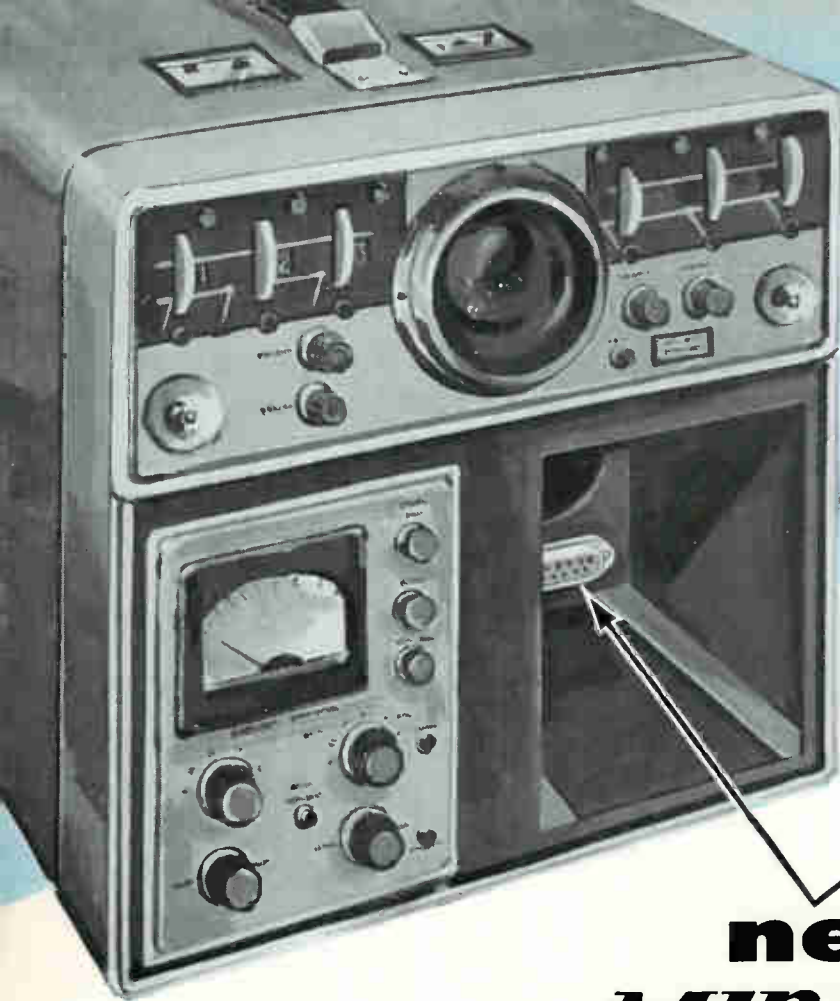
This is a typical example of Hill's creative engineering that develops outstanding solutions to customers' specific problems involving LC and crystal control filters as well as precision frequency sources and other crystal devices.

**WRITE FOR BULLETINS 34800/900**

They contain details and specifications concerning the filters described above.

**HILL ELECTRONICS, INC.**

MECHANICSBURG, PENNSYLVANIA



**new!**

## *Min Rac 17*

### miniature rack & panel connectors with POKE-HOME<sup>®</sup> contacts

Solve space, weight and size problems with AMPHENOL's new Min Rac 17 connectors, true miniatures with the "Big Plus" advantage of Poke Home contacts! Min Rac 17's are rack & panel connectors ideally suited for today's compact chassis designs, connectors half the size and weight of standards, delivering full size efficiency. And with the patented Poke Home contact concept (U.S. Pat. 2,419,018), Min Rac 17's are easily, reliably assembled—contacts are crimped or soldered outside the connector body, then "poked home" for assembly.

Min Rac 17's are available in 9, 15, 25, 37 and 50 contacts in rack & panel, cable-to-chassis and cable-to-cable designs. Contacts are gold plated. Shells may be ordered with clear chromate or gold iridite finish.

*These remarkable connectors are available now—write for full catalog!*

**AMPHENOL**

**CONNECTOR DIVISION**

1830 S. 54th AVE., CHICAGO 50, ILLINOIS

*Amphenol-Borg Electronics Corporation*



## NEW BOOKS

### The Theory of Optimum Noise Immunity

By V. A. KOTEL'NIKOV

McGraw-Hill Book Co., Inc., New York, 140 p.

THIS book should prove extremely worthwhile for any reader with the necessary background who is willing to give it a serious reading. Although advanced mathematical techniques are not utilized, considerable sophistication on the reader's part has evidently been assumed.

Most useful and unusual aspect of the book is that the author remains keenly aware of the practical implications and limitations of the mathematical relationships developed. Temptation to lose the reader in a maze of elegant mathematics has been effectively resisted, a quality notably absent in most other texts in this field. Although this book can not be considered ideal, it does offer considerable promise for graduate level work in view of the existing scarcity of suitable books.

The approach used in this text is both clear and direct. Mathematical tools required throughout the book are clearly and concisely stated. Only a minimum of general introduction and definitions is required since the author does not give a review of the elements of probability theory and frequency analysis which normally take up a substantial part of any text on this topic. Throughout, the author maintains a facility for developing the significant relationships in terms that are meaningful. Despite the conciseness of the text, a number of practical examples are developed that serve as excellent illustrations.

Perhaps the book's most remarkable quality is the impressive array of topics that are treated in very little space. It must be read slowly, but is well worth the reading.—MAURICE C. NEWSTEIN, *Technical Research Group, Inc., Yosset, N. Y.*

## THUMBNAIL REVIEWS

**Electrical Engineering Fundamentals.** By J. P. Neal, McGraw-Hill Book Co., Inc., New York, 1960, 402 p., \$8.50. Avowed purpose of this

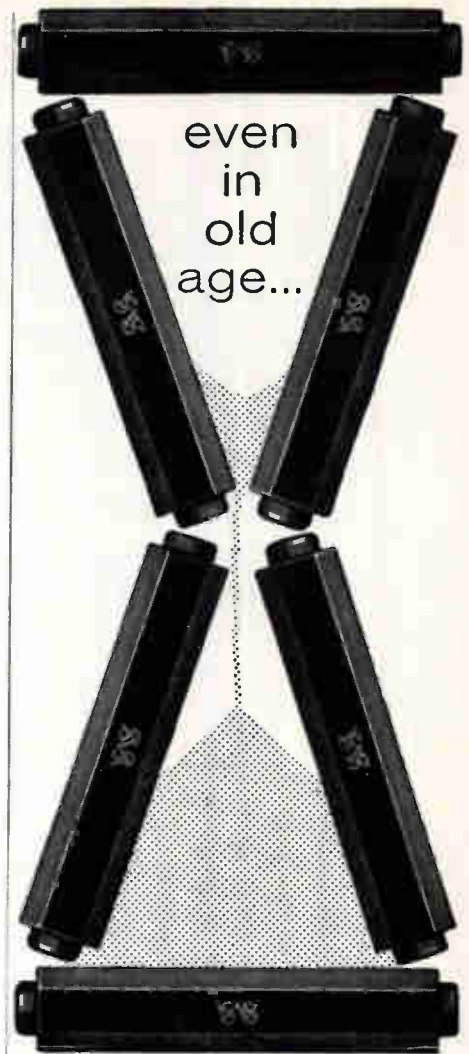
book to provide a higher-level introduction to electrical engineering theory than heretofore available is realized. Included are sections devoted to measures of electromagnetic characteristics; vector concepts; local current, electrostatic, magnetic and electromagnetic fields; and electric network structure and analysis. Author assumes student has taken college physics courses in mechanics, electricity and magnetism, and mathematics courses in analytic geometry, algebra and calculus. The rationalized mks system of measures is used throughout.

**Cybernetics and Management.** By Stafford Beer, John Wiley & Sons, Inc., New York, 211 p., \$4.50. Not a textbook nor technical treatise, this book is a general exposition explaining the origins, nature and industrial potentiality of the new science of cybernetics. Content is addressed to scientifically educated and imaginative managers. Mathematical level never extends beyond algebra. Although this is a comprehensive, fundamental and lucid treatment, a supplemental reading of Norbert Wiener's "The Human Use of Human Beings" (not referenced by Beer) could be most profitable.

**Vector Analysis.** By M. Schwartz, S. Green and W. A. Rutledge, Harper & Brothers, New York, 1960, 556 p., \$7.50. Although written primarily to facilitate study by the beginning student, this book also will serve as a reference for advanced students and a self-study text for engineers. Authors consider vector analysis as both a mathematical discipline and a language of physics, thus chapters on applications are interspersed with mathematical theory and development throughout the text. This is a timely book published as the field takes on increasing importance to electronics engineers.

**Two-way Radio.** By Allan Lytel, McGraw-Hill Book Co., Inc., New York, 311 p., \$9.50. This book concerns mobile-to-fixed or mobile-mobile communication, bearing mainly on introductory information for technicians handling receive-transmit gear. Unfortunately, the author's editors did not put the word mobile into the title; there are hundreds of thousands of fixed stations in two-way fixed communication. The text needs more than its sparse discourse on single-sideband radio-telephony. Moreover, the book's price is double that of better books on booksellers' shelves.

**Correction.** Price and pagination information given in review of "Physics for Students of Science and Engineering—Parts I and II" (p 130, May 13, 1960) applies only to Part I; Part II is 510 pages and costs \$6.



*S. S. White*

## MOLDED RESISTORS retain their values!

S. S. WHITE Molded Resistors retain their original values and never deteriorate due to age!

S. S. WHITE resistors serve dependably in hundreds of commercial... industrial... and scientific applications. They are characterized by low noise level... precision... stability... negative temperature and voltage coefficients. Non-hydroscopic base withstands temperature and humidity. They are compact, have excellent stability and mechanical strength.

For full details, write for our Bulletin 5409. We'll be glad to help you apply these high-quality, "all-weather" resistors to your product. Just drop us a line.

FIXED RESISTANCE VALUES  
RANGE FROM 1000 OHMS TO  
10,000,000 MEGOHMS!

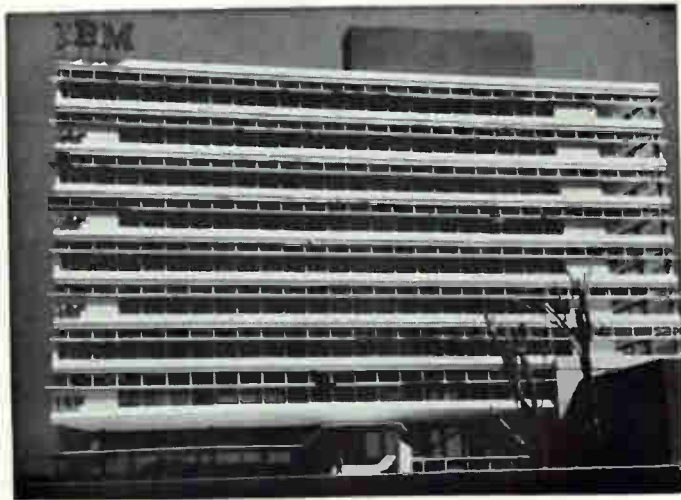
65X Molded Resistor ..... 1 watt  
80X Molded Resistor ..... 3 watts

*S. S. White*

S. S. WHITE INDUSTRIAL DIVISION

Dept. R 10 East 40th St,

New York 16, New York



## IBM Expands In West Berlin

CONSTRUCTION recently began on a new \$2-million office building to house IBM-Germany's headquarters in Berlin. The building will also contain an electronic data processing center.

"The reason why we are building in Berlin this moment," says Arthur K. Watson, president of the IBM World Trade Corporation, "is due to our conviction that the future of Berlin is closely linked to ours. But we don't build here for sentiment . . . we do it for a good and sound business reason."

In a press conference preceding the ground breaking ceremonies, the general manager of IBM Germany, J. H. Borsdorf, announced that IBM sales in Germany increased 27.3 percent last year to DM336 million (approximately \$80 million) over 1958. A similar increase is predicted for this year.

IBM investments in Germany rose from some \$20 million in 1958 to \$27 million last year, according to Borsdorf, who pointed out that IBM Germany is the company's largest operation abroad. It has plants in Sindelfingen near Stuttgart and in Berlin. Employed personnel numbers 6,800.

The German IBM subsidiary's production program includes all types of IBM equipment: electronic computers and other data processing equipment, electric typewriters and time systems. The subsidiary

manufactures approximately 27 percent of all IBM products throughout the world. IBM has 45 sales offices in Germany today.

The new building, scheduled for completion in October, is being erected on the Ernst Reuter Platz, one of the future show-places of Berlin. The 11-floor structure (9 floors above the street level) will be 180 ft long, 50 ft deep, and 110 ft high (above surface).

Construction plot size is 3,745 sq yd, to which might be added another 1,675 sq yd for parking space. Total covered area will be 10,510 sq yd.

The ground floor—5 ft above the surface and at the same level with a parking platform—will contain the data processing center.



**Elect Anderson  
Executive V-P**

ELECTION of Tore N. Anderson as executive vice president and gen-

eral manager of FXR, Inc., Woodside, N. Y. manufacturer of microwave and other electronic equipment. is announced.

He joined the company as assistant to the president earlier this year after 12 years with Airtron, Inc., a division of Litton Industries. He was named Airtron's chief engineer in 1951, a director and vice president in 1953, and director of engineering in 1956.

Anderson has been chairman of the Waveguide Connector Standardization Subcommittee of the Electronics Industry Association since 1954; participated recently in the Ulm, Germany, meetings in preparation of an international standard for waveguides and waveguide connectors. Since 1959 he has been a consultant to the Defense Department's Advisory Group on Electron Parts, Working Group on Transmission Lines.



**Appoint Mallory to  
Newly Created Post**

GEORGE L. MALLORY has been appointed to the newly created post of vice president-operations for Gates Radio Co., Quincy, Ill., 38-year-old manufacturer of a-m/f-m/tv broadcasting transmitters, automatic programming equipment and other electronic communications products.

Mallory was formerly manager of manufacturing for the electronic section of The Martin Company's Denver Missile division, and before that was assistant general manager of the Marine Products division of The Bendix Corp. in Los Angeles.

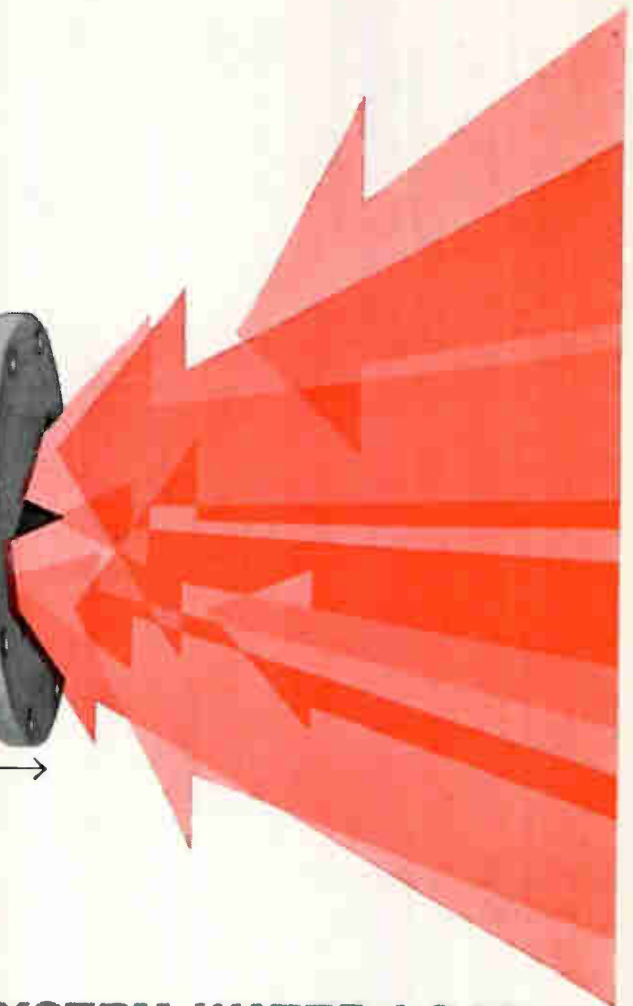
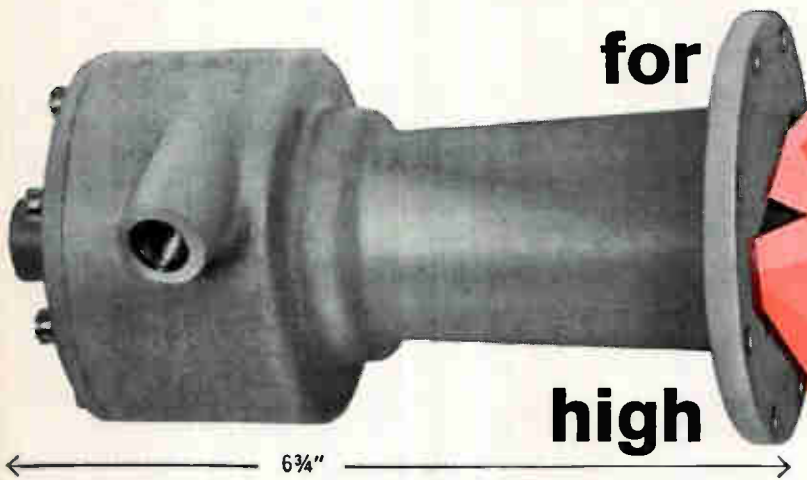
Parker S. Gates, president of Gates Radio, said the appointment of Mallory reflects the company's high rate of current business and



# DEAD END

for

high  
power  
problems



## SPERRY E42C1 RADAR SYSTEM WATER LOAD

The problems of handling high peak and average powers in ground based radar systems are ended completely by the new Sperry Water Load. Small and rugged, where previous units have been both large and delicate, this termination can handle extremes of power easily, and with relatively low water flow. Most other liquid coolants may also be used.

The Water Load is one integral unit with standard flanges, and input and output water ports with standard pipe fittings. The unit may be easily adapted to existing systems, and can replace antennas of every type for test and other purposes.

Used with thermocouples to measure incoming vs. outgoing water temperatures—plus a flow meter—the Water Load becomes a calorimeter to compute average system power.

Many other high power lab, test and research uses will suggest themselves. Address inquiries to Clearwater, outlining your projected application. *Sample quantities available for evaluation.* Please write us stating your requirements and frequency band.



### Typical Specifications:

Model	Peak Power	Average Power	Height	Length	Weight
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July 22, 1960

CIRCLE 115 ON READER SERVICE CARD 115



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its extensive future growth program. He also stated that Gates Radio is chalking up its second consecutive record year since joining Harris-Intertype in November 1957.



Name H. S. Wolff  
Laboratory Chief

HANNS S. WOLFF has been appointed chief of the new electronics laboratory at Republic Aviation Corp., Farmingdale, L. I., N. Y. The new facility which he will head is one of seven advanced research laboratories to be incorporated in Republic's new \$14-million research and development center.

Wolff has been active in the electronics field, both here and abroad, for 32 years. He comes to Republic from the W. L. Maxson Corp. where he had been a member of the engineering staff since 1956. Prior to this assignment he was vice president and chief engineer of Leetronics, Inc., and earlier was chief engineer at General Fuse, Inc.



Elco Corporation  
Hires Travis

LARRY R. TRAVIS has been appointed to the position of director of engineering and production at Elco Corp., Philadelphia, Pa. He will function under H. E. Ruehlemann,

Elco's vice president of engineering and production.

Travis comes to Elco directly from Westinghouse, Metuchen, N. J., where he was manager of the mechanical engineering section. He served the latter company from 1954, following his assignment at Sylvania as supervisor of components engineering department; and prior to that, was senior development engineer with American Optical Corp.

## Autronics Moves To Larger Quarters

AUTRONICS CORPORATION, a subsidiary of Interstate Engineering Corporation, has moved to larger quarters in Pasadena, Calif. The new quarters give this manufacturer of specialized time delay relays and other miniaturized electronic devices improved production and research facilities.



## Telemeter Magnetics Appoints Criddle

LINDEN G. CRIDDLE was recently named director of manufacturing for the data equipment division of Telemeter Magnetics, Inc., Culver City, Calif. He will direct all phases of production of the firm's standard lines of magnetic core buffer memories and solid state memory systems.

Prior to joining TMI, Criddle served as vice president and director of operations for the Consolidated Systems Corp., a subsidiary of Consolidated Electrodynamics Corp. He also spent several years with American Machine and Foundry Corp. as head of their Tobacco Division's electronic engineering development laboratory.



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To assist Senior Engineers and Scientists in the development of HF communications and data process equipment. Should have formal electronics schooling and 2 years' experience in circuit design, checkout or analysis of HF communications, Radar Pulse, Analog/Digital or Data Recovery equipment. Construction of prototypes of new and interesting equipment and design of individual components of communications and data processing systems will comprise the major efforts of selected applicants.

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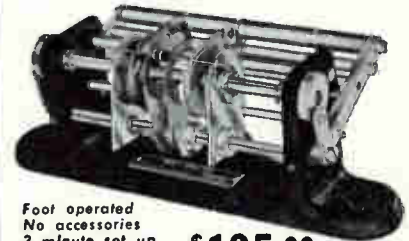
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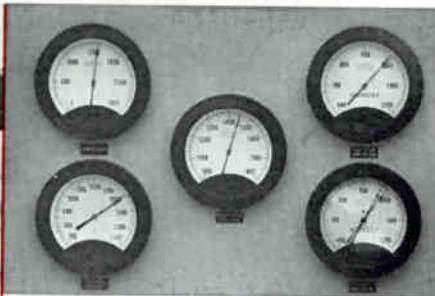
## More Than Likely, Your Business Can Use Such a System.

You can use one to watch events or operations that are tedious, difficult, dangerous, or even impossible for men to watch.



Dependable KIN TEL TV systems see where men cannot survive; withstand tremendous extremes in temperature and pressure; perform both critical and routine jobs inexpensively, faultlessly, safely, tirelessly.

You can use one for data transmission.



All types of visual information—from blueprints to fingerprints to graphs—are transmitted over great distances quickly, accurately. Such systems save money, reduce errors and confusion, speed operations.

You can use one for surveillance work.



KIN TEL cameras scan vast areas; guard valuable equipment and property; never blink, quit, sleep, or make an error; watch many operations at once; transmit all information to a central monitoring point.

You can use one for on-the-job training.



Students study operations viewed by a KIN TEL camera. Such systems permit mass teaching that gives each student an unobstructed view; provide on-the-spot realism; end expensive, disturbing plant tours.

## Here's What a Kin Tel System Can Do for Your Business

It can do what it is doing, right now, for hundreds of other firms. It can increase the over-all efficiency of your entire operation. It can help you tighten production and inventory controls, help you better your services to customers and clients. It can reduce errors and confusion and duplication. It can cut costs. It can save you time and money. It can free valuable men from tedious and routine tasks. It can give you the modern tools you need to keep pace in this highly competitive market.

For a more specific analysis of how KIN TEL TV can go to work for you, write direct for catalog 6-103 and the name of your nearest KIN TEL engineering representative.

## 8 Reasons Why So Many Firms Insist on Kin Tel TV Systems

- 1. Reliability.** KIN TEL equipment is designed to keep working, day in and day out. It's the first choice for ICBM and other missile programs that depend on TV, that can't afford to compromise with reliability.
- 2. Picture Quality.** Full 650-line resolution provides maximum delineation, essential for qualitative observation of complex operations, and for transmission of printed material.
- 3. Automatic Operation.** KIN TEL TV is the only closed circuit system that provides entirely automatic, through-the-lens compensation for light-level changes of several thousand to one.
- 4. Sensitivity.** With KIN TEL equipment, the light needed to read this page is enough for sharp, clear pictures; and usable pictures can be provided with less than one foot-candle illumination.
- 5. Ease of Installation.** No site preparation is needed, no interacting electrical adjustments are required. All units fit in standard 19-inch racks.
- 6. Simplicity of Operation.** With no changes in lens iris to make, the only thing the operator has to know is the location of the on-off switch.
- 7. Adaptability.** A complete line of shelf-item system components and a variety of cameras and monitors permit observations of nearly every kind of operation, under all kinds of conditions.
- 8. Application Help.** You don't have to waste your money and time on application engineering. At no obligation, KIN TEL's nationwide factory-trained field engineers will determine whether or not a TV system can be put to profitable use in your intended application.

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*KIN TEL—pioneer and leader in closed circuit television*



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specifically matched to your design requirements... for superior high frequency performance—up to 50 Mc and above as rf amplifiers ... up to 125 Mc and above as oscillators.

RCA now offers a comprehensive group of industrial drift field transistors specifically designed for industrial and military high-frequency communications, instrumentation, controls, navigation and mobile equipment.

These application-tailored types capable of operating up to 50 Mc and above in rf amplifier service and 125 Mc and above in oscillator service will permit a large safety factor in your equipment designs and assure long-term operating reliability. They feature a maximum junction temperature rating of 100°C; a maximum transistor dissipation rating of 120 Mw in free air at 25°C, and higher ratings with heat sink; and maximum collector-to-base voltage rating of -40v, except for the 2N1226 which has a -60v rating and is intended for those critical military and industrial applications requiring such a high voltage. Millions of RCA drift field transistors now in use are your proof that RCA drift field types are today's number one answer to the designer requiring top performance and reliability at low cost.

Call your RCA Field Representative now and ask him about RCA Industrial Drift Field Transistors with performance specifications tailored to your specific needs. For additional technical data, write RCA Commercial Engineering, Section G-19-NN-4, Somerville, N. J.

2N1023 2N1224 2N1397 2N1226  
2N1066 2N1395 2N1397

2N1226 2N1395 2N1397

1.5 MC

12.5 MC

30 MC

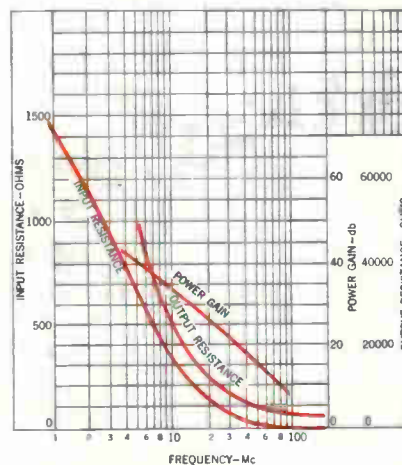
50 MC

### HIGH FREQUENCY AMPLIFIER PERFORMANCE

RCA TYPE NUMBERS

	2N1023			2N384			2N274		
$h_{fe}$ 20 to 175 (JEDEC TO-44)	2N1023			2N384			2N274		
$h_{fe}$ 20 to 175 (JEDEC TO-33)	2N1066			2N1225			2N1224		
$h_{fe}$ 50 to 175 (JEDEC TO-33)	2N1397			2N1396			2N1395		
50 Megacycles (sig. freq.) Common Base Circuit	Min.	Type	Max.	Min.	Type	Max.	Min.	Type	Max.
Power Gain (db)	18	21	24	15	18	21	—	—	—
Input Resistance (ohms)	—	25	—	—	30	—	—	—	—
Output Resistance (ohms)	—	8,000	—	—	5,000	—	—	—	—
30 Megacycles Common Emitter Circuit	Min.	Type	Max.	Min.	Type	Max.	Min.	Type	Max.
Power Gain (db)	20	23	26	16	20	24	—	—	—
Input Resistance (ohms)	—	100	—	—	50	—	—	—	—
Output Resistance (ohms)	—	8,000	—	—	5,000	—	—	—	—
12.5 Megacycles Common Emitter Circuit	Min.	Type	Max.	Min.	Type	Max.	Min.	Type	Max.
Power Gain (db)	—	—	—	24	28	32	17	22	27
Input Resistance (ohms)	—	—	—	—	250	—	—	150	—
Output Resistance (ohms)	—	—	—	—	16,000	—	—	4,000	—
1.5 Megacycles Common Emitter Circuit	Min.	Type	Max.	Min.	Type	Max.	Min.	Type	Max.
Power Gain (db)	—	—	—	—	—	—	40	45	50
Input Resistance (ohms)	—	—	—	—	—	—	—	1,350	—
Output Resistance (ohms)	—	—	—	—	—	—	—	70,000	—
2N1226—High Voltage Transistor for Video Amplifier and General Instrumentation Service is identical to 2N1224 except maximum collector-to-base and punch-through voltage rating 60v.									
RCA Drift Field Transistors can be supplied to meet MIL-S-19500B specifications									

Common-Emitter Circuit, Base Input.  
Ambient Temperature = 25°C  
DC Collector-to-Emitter Volts = -12.  
DC Emitter Milliamperes = 1.5.



Performance Characteristics for  
Types 2N1023, 2N1066, 2N1397

### RCA SEMICONDUCTOR & MATERIALS DIVISION FIELD OFFICES

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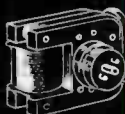


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