

# ELECTRONIC DESIGN

MARCH 30, 1960

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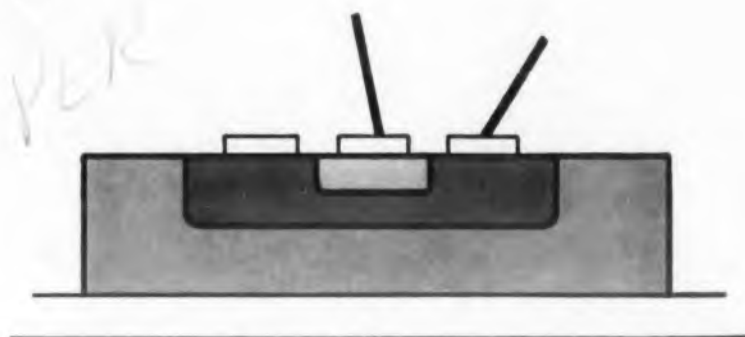
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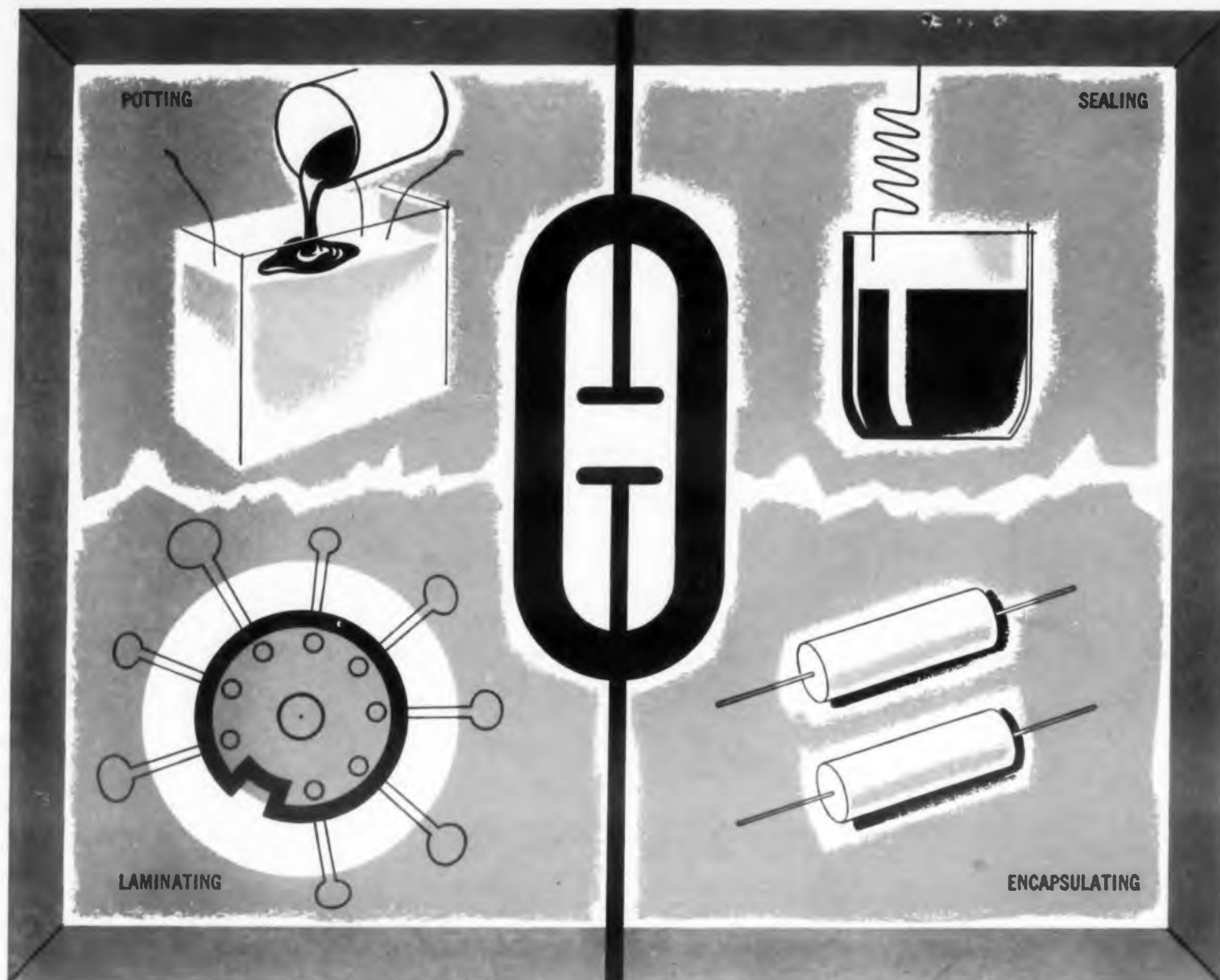
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NOW FOR SALE ... p 10



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CIRCLE 1 ON READER-SERVICE CARD

#### POTTING

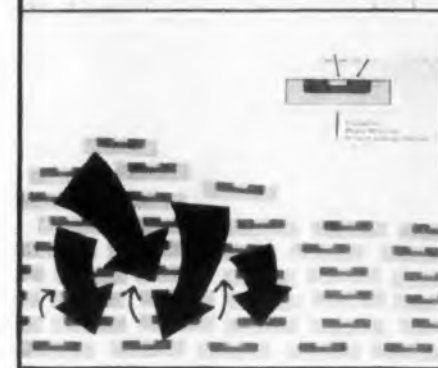
#### SEALING

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## ELECTRONIC DESIGN



COVER: Low-leakage transistors are the subject of this issue's cover. *ELECTRONIC DESIGN*'s art director has used arrows to illustrate base-to-collector current flow. The large, black arrows (pointing downward) represent the normal current flow. The small, red arrows (pointing upward) represent the low, reverse-leakage current. A schematic (upper right hand corner) shows the transistors' planar structure which makes low, reverse-leakage current possible.

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## Highlights Of This Issue

An announcement of the first commercially available solid state circuits appears in *ELECTRONIC DESIGN*'s news section. The circuits are bi-stable multivibrators that may be custom designed to specs. Texas Instruments Inc. is offering these off-the-shelf items. The information was released in time to permit *ED* to fill you in on developments that led up to the announcement. More application data will be coming in a subsequent issue.

**Speaking of solid state**, this seems to be the week for interesting announcements in the field. Recently, Fairchild Semiconductor declared that it had developed a new planar structure transistor that is said to feature extremely low reverse leakage current. *ELECTRONIC DESIGN* thought it deserved more than usual attention, so it has been treated as a product feature in this issue.

**The Special Report** on radio frequency interference (RFI) continues with an article by Jules Deitz of the Federal Communications Commission. Entitled "FCC Control of RFI," the piece tells how the Commission is intent on thwarting man's contribution to the pollution of the radio spectrum. Deitz cites examples of electronic devices regulated by FCC rules, parts 15 and 18. His article appears on p 56.

**Project BLADE** is the Air Force plan to replace the existing punch card system with a highly centralized computing system. The exclusive story behind the project was reported directly from Washington, D. C., by *ELECTRONIC DESIGN* assistant editor Manfred Meisels. He spoke to many of the people who are responsible for the conception and eventual operation of the project. From the military, he obtained the requirements information that the Air Force is laying before manufacturers. From industry leaders, he reports the reaction that many of these men showed when first becoming aware of the Air Force scheme. The Air Force expects to spend about \$60 million on the rental project. This plum has been tossed up to 28 computer manufacturers.

CIRCLE 2 ON READER-SERVICE CARD ➤

# The most precise, sturdiest thermal relay ever built... best for missile applications

*... from the leader in thermal relay design!*



Now, for missile environments and for all applications where greater precision is necessary, G-V Controls offers the revolutionary new PT Thermal Relay—the most precise thermal relay ever built!

And the PT's **sturdiness** is unequalled in thermal relays. It withstands missile vibration and shock far better than any other thermal relay.



#### SPECIFICATIONS

**Time Delay:** 3 to 60 seconds (Factory Set)  
**Setting Tolerance:**  $\pm 5\%$  ( $\pm \frac{1}{4}$  sec. min.)  
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**Heater Voltages:** 6.3 to 115 v. for delays up to 12 sec.; 6.3 to 230 v. for longer delays.  
**Power Input:** 4 watts. Rated for continuous energization at  $125^{\circ}\text{C}$ .  
**Contacts:** SPST, normally open or normally closed. Rated 2 amps. resistive at 115 v. AC or 28 v. DC.

Write for Product Data Bulletin #PD-1015

**Insulation Resistance:** 1,000 megohms  
**Dielectric Strength:** 1000 v. RMS at sea level. 500 v. RMS at 70,000 ft.  
**Vibration:** Operating or non-operating, 20 g up to 2000 cps  
**Shock:** Operating or non-operating, 50 g for 11 milliseconds  
**Unidirectional Acceleration:** 10 g in any direction changes delay by less than 5%, 50 g by less than 10% with proper orientation.  
**Weight:** 2 to  $2\frac{1}{4}$  ounces.

**G-V CONTROLS INC.**  
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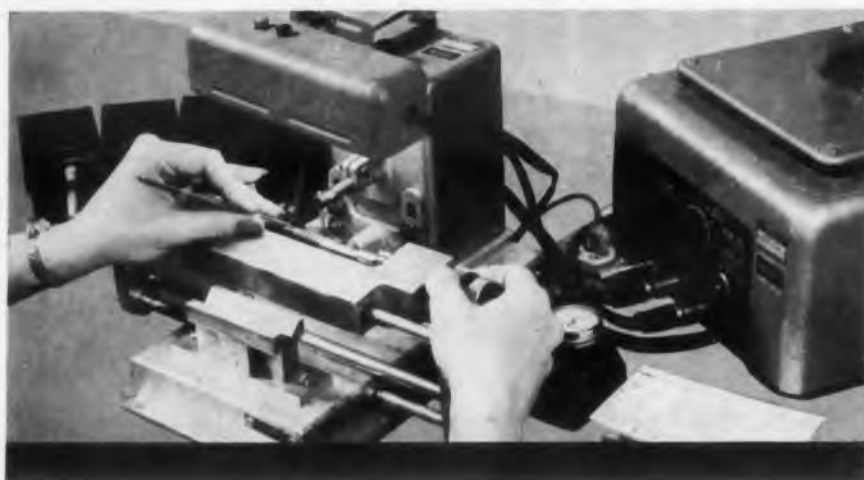


HOW TO PRODUCE

33 UNIFORM MINIATURE

WELDS OF

4 DIFFERENT METALS



### Collins Radio Achieves Production Goals with Weldmatic Welding

A new, exceptionally reliable mechanical filter—key component in the Collins version of the highly strategic Single Sideband Radio—is now in production using an all-welded construction provided by Weldmatic equipment. This advanced filter makes possible improved selectivity characteristics and better utilization of the radio spectrum. Unvarying uniformity of the weld nugget and absolutely no displacement of the positioned parts are required specifications. Electrical characteristics are extremely critical . . . each of 33 connections must be identical in production quantities! After extensive evaluation, Collins selected Weldmatic's 1032 Miniature Welding Head and Model 1026 Power Supply . . . the combination that has enabled Collins to meet its production goals. They're a real team for precision welding: the miniature head with perfect vertical electrode motion and accurate repeatable pressure—the power supply with ultra-short current flow (0.001 second) over a continuously variable heat range. Why not consider Weldmatic for your metal-joining problems? WRITE for our free 20-page brochure describing techniques, applications, and Weldmatic's sample welding service.



Weldmatic pressure gage reads firing force...calibrated from 0 to 50 lbs., insures exact weld pressures from job to job. (Right) Welded filter cartridge and completed miniaturized Collins filter.

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CIRCLE 2 ON READER-SERVICE CARD

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## Coming Next Issue

If you were at the recent IRE Show, you must have chatted with, or bumped into, an *ELECTRONIC DESIGN* editor. The entire staff was at the New York City Coliseum to cover the latest in components, systems, materials and trends. Photos, as well as the usual detailed news story, will give you the most complete round-up of the show. If you were there, read about the things you just didn't have time to see. If you couldn't make it to the show, find out what the important news was.

Tubes, a multitude of them, will be covered in a Special Staff Report on the latest advances in the field. The report is based on the new tubes at the IRE Show, but will also discuss experimental work being done in the laboratory.



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Engineering notes  
from the **SM/I**  
**REPORTER**

BY STANLEY M. INGERSOLL, Capabilities Engineer



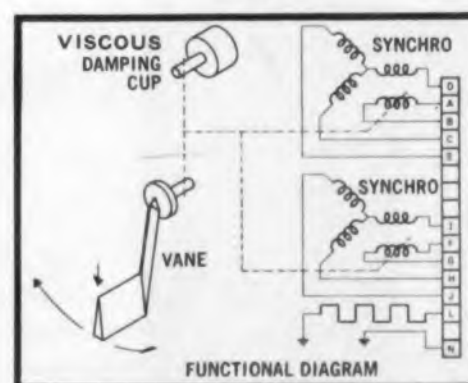
Report No. 5

TR 722-2 Angle of Attack Transmitter

Precision built and self-powered, the TR 722-2 provides an electrical output proportional to the direction of local airflow surrounding an aircraft. It may be used to transmit local angle of attack or yaw, and its output signal can be applied directly to a visual indicator. The TR 722-2 is ideal for use on all types of military jet aircraft because of its accuracy, inherent stability, compact packaging and rugged design. The vane air foil used is drag stabilized and has passed rigid military qualification programs. The TR 722-2 has been qualified by Wright Air Development Center and is listed on Qualified Parts Lists under MS24378. The unit meets or exceeds MIL-T-25627 and amendments.

Typical Performance Specifications

Electrical Output .....	Two Synchro Transmitters
Electrical Angle .....	135°
Mechanical Angle .....	50°
Sensitivity:	
90 to 125 knots .....	0.2°
125 knots to Mach 4.37 .....	0.1°
Power Requirements .....	115V at 400 Cycles
	26V at 400 Cycles
Heater .....	115V
	135 Watts Max. at .....
	30°C.
Electrical Output Error .....	±0.2°
Temperature Range .....	-54°C. to +93°C.
Damping .....	0.75 Critical at 110 knots
Weight .....	1.8 lbs. max.



TR 722-2  
Angle of Attack  
Transmitter

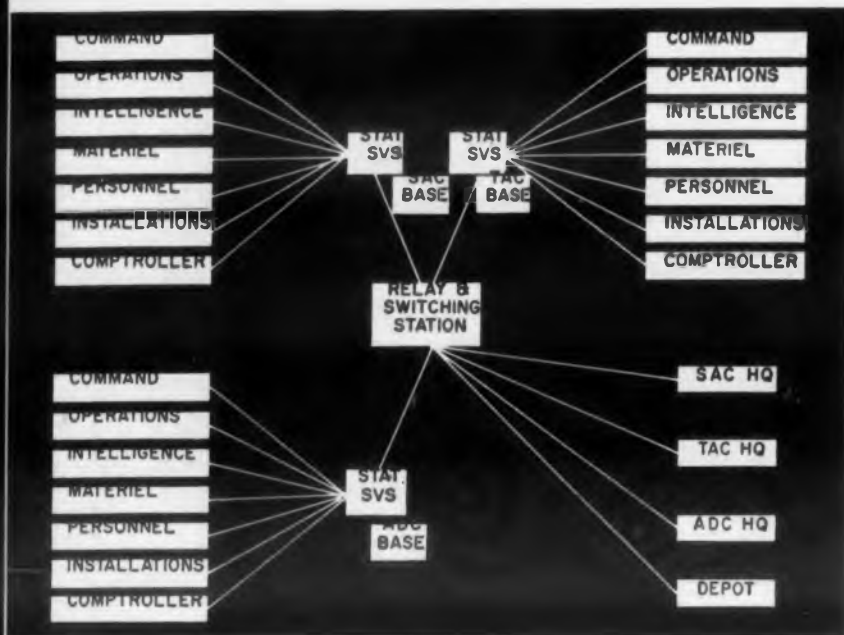
For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

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CIRCLE 3 ON READER-SERVICE CARD



THIS IS THE HOOK-UP that the Air Force hopes to achieve with Project BLADE. It is expected that the system will be able to include other bases.

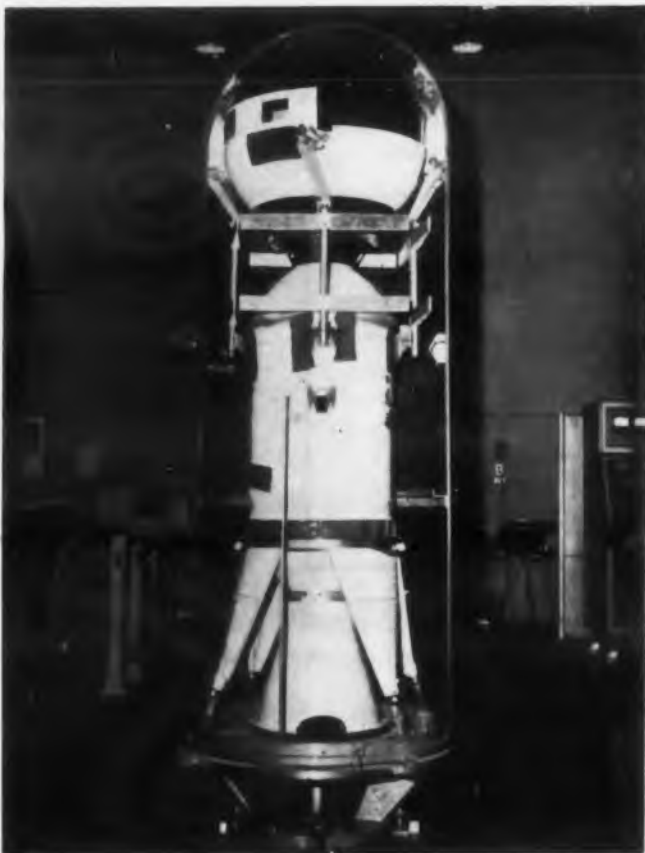
## Air Force Ditching Old Data Processing; Will Rent Central Computer Systems

**A** GENERAL overhaul of the Air Force's data-processing set-up is in the works, with \$60 million a year being offered to manufacturers for the rental of new computers. The service is scrapping its present complex of punch-card accounting machines, which perform a variety of individual data-processing functions at some 200 bases. By 1965 it expects to consolidate these scattered operations into versatile, high-speed, high-storage computer centers at each base.

The requirements for the new data-processing systems are stiff—so much so that a typical reaction among the 28 manufacturers approached has been, "You want an awful lot for your dollar."

The reorganization is called Project BLADE (Base Level Automation of Data Through Electronics). In outlining its requirements in a letter to the manufacturers, the Air Force asked for a high degree of versatility, rapid input-output, inquiry and communication to meet a variety of peacetime accounting, as well as wartime logistic and command, information functions. Key requirements for computer equipment are as follows:

- High-storage capability—up to 40 million alpha numeric characters per installation. Much of this capacity is to be in high-speed, random-access memories.



PIONEER V PLANETOID rests on top of the third stage of its rocket booster before launching March 11. Four solar-cell paddles were added to the instrument package before it was launched into a solar orbit.

## New Era Dawning With U.S. Sun Satellite

### Pioneer V Instrumentation Provides First Charting of Interplanetary Space

**S**PACE electronics is entering a new era as Pioneer V loops into a solar orbit between Venus and earth, sending back the story of its journey through interplanetary space.

For the first time electronic instrumentation is providing data from interplanetary space. Unlike the Russian moon-rocket, Pioneer V has moved beyond the earth's gravitation field to send back information.

Within a few days, when the planetoid is about 5 million mi from earth, transmission will be switched from a 5-w to a powerful 150-w space transmitter. Space Technology Laboratories, Inc., of Los Angeles, coordinator for the Pioneer V project under contract from the National Aero-

navics and Space Administration, hopes to receive signals from the vehicle out to 50 million mi.

Tucked inside of the 94.8-lb Pioneer V's fiberglass package are electronic instruments designed to perform important interplanetary space experiments.

Instrumentation, Dr. Richard C. Boonton Jr. of STL told ELECTRONIC DESIGN, is similar to that carried in Explorer VI, the paddlewheel satellite (*ED*, Sept. 2, 1959, p. 8). The two 378-mc transmitters used in the space experiment are an exception, explained Dr. Boonton, navigation engineer for the project and manager of the Guidance and Navigation Dept. in STL's Research and Development Div. This frequency was chosen, he



■ Fast response to a variety of on-line inquiry situations. The use of parallel data processing is indicated.

■ Quasi-real time output devices with rapid display.

■ Simplified programming.

■ Variable record length capabilities.

■ Common language.

■ Rapid automatic communications with other computing installations and with remote input-output devices.

■ 100 per cent solid-state circuitry for maximum reliability.

■ Low cost—somewhere near present rentals for medium-size computer installations but with the capabilities outlined above.

#### The Critical Problem: Inter-Machine Linkage

Inter-machine communications are thought to be the most critical bottleneck in BLADE. Inquiry stations will be remote from the computer, and communication between several bases, as well as with data processors at headquarters, is a part of the scheme. The high-speed flexibility and common language demanded here are yet to be achieved.

The biggest complaint at BLADE against computing equipment in general concerns input-

(Continued on p. 6)

explained, because at the time the project was planned this was the highest frequency at which reliable transistorized equipment was available.

#### Frequency Evaluation Likely After Data Analysis

Although frequency changes are not presently planned, there will probably be a re-evaluation of the frequency problem after results of the Pioneer V experiment are analyzed, he commented. If a new frequency was selected, Dr. Boonton added, it would be in the 400 to 2,000 mc range because this offers the best combination of reliability and equipment advantages.

Pioneer V contains a telebit system designed by STL to provide analog-to-digital conversion of measurements so that data can be memory-stored in the vehicle between digital transmission periods. Telemetry data is transmitted by biphasemodulating a subcarrier which then phase-modulates the 378-mc carrier. Pulse rates can be varied so that fast data transmission is possible at relatively short ranges and slow transmission can be used at great distances.

Interrogation of the planetoid from ground stations is timed so that Pioneer V's broad beam

(Continued on p. 7)

## Sharper Definition... Improved Gray Scale... with

# RAYTHEON "KILOLINE" RECORDING STORAGE TUBES

A Raytheon-designed tetrode gun insures higher resolution — 1,000 TV lines at 50% modulation — and improved control over beam cut-off in Raytheon's new CK7571/QK685 and CK7575/QK787 recording storage tubes. A new multiple collimating lens improves background uniformity and results in a signal-to-shading ratio of ten.

These advanced design features, plus low noise and stable operating characteristics, make Raytheon recording storage tubes ideal for frequency and scan conversion. Among the applications where these tubes play an important role are:

- Scan conversion for bright display and target trails.
- Slow-down video for transmission of still pictures over telephone lines.
- Stop motion to permit analysis of production machinery or to stop action in a sporting event.
- Signal-to-noise improvement of radar or other still pictures by integration.
- Conversion of television pictures from one transmission standard to another.
- Indication of moving targets by electrical comparison of pictures taken at different times.

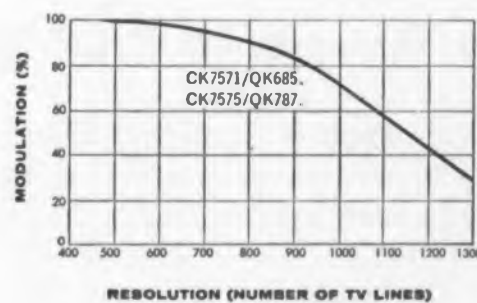
For scan conversion applications, both r.f. read-out and video cancellation techniques have proved equally effective with Raytheon single- and dual-gun storage tubes.

Raytheon's single-gun CK7571/QK685 and dual-gun CK7575/QK787 recording storage tubes are available from stock in sample quantities. Detailed technical data bulletins are yours for the asking — write direct to Dept. 2527.

#### TYPICAL OPERATING CHARACTERISTICS CK7571/QK685 and CK7575/QK787

Anode Voltage.....	4,000 Vdc
Magnetic Focus Resolution.....	1,000 Lines (nominal)
Electrostatic Resolution.....	700 Lines (nominal)
Output capacitances:	
CK7571/QK685.....	12 $\mu\text{f}$ (nominal)
CK7575/QK787.....	27 $\mu\text{f}$ (nominal)
Maximum Deflection Angle.....	30 Degrees

#### TYPICAL RESOLUTION CURVE



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CIRCLE 5 ON READER-SERVICE CARD

## NEWS

### Air Force Ditching (cont. from p. 5)

output devices. "Input and output," said one project officer, "are the big roadblocks. Input and output plus communications are the crux of BLADE and where it will pay off."

In detail, the storage system would be divided into modular units, each having 5 to 10 million character storage, to permit convenient expansion. Much of the storage capacity could be met by relatively low-priced, high-speed tape units. But a significant percentage would have to consist of a true, high-speed, random-access memory. Considerable buffer storage is required to handle on-line inquiry and external communications.

Internal processing speed need not be high, as it would be negated by the slower access times of the low-cost electronic files to be used. Also, input-output equipment has yet to match presently attainable computing speeds. Multiple search and processing capability is preferable to high speed in handling the variable amounts of on-line inquiry expected.

### Better Output Devices And Simpler Programing Needed

Output devices beyond anything now available are demanded. The Air Force command concept does not lend itself to summary or statistical data processing for after-the-fact analyses. Up-to-the-minute graphical and numerical display is needed on inquiry for the operation of increasingly responsive weapons.

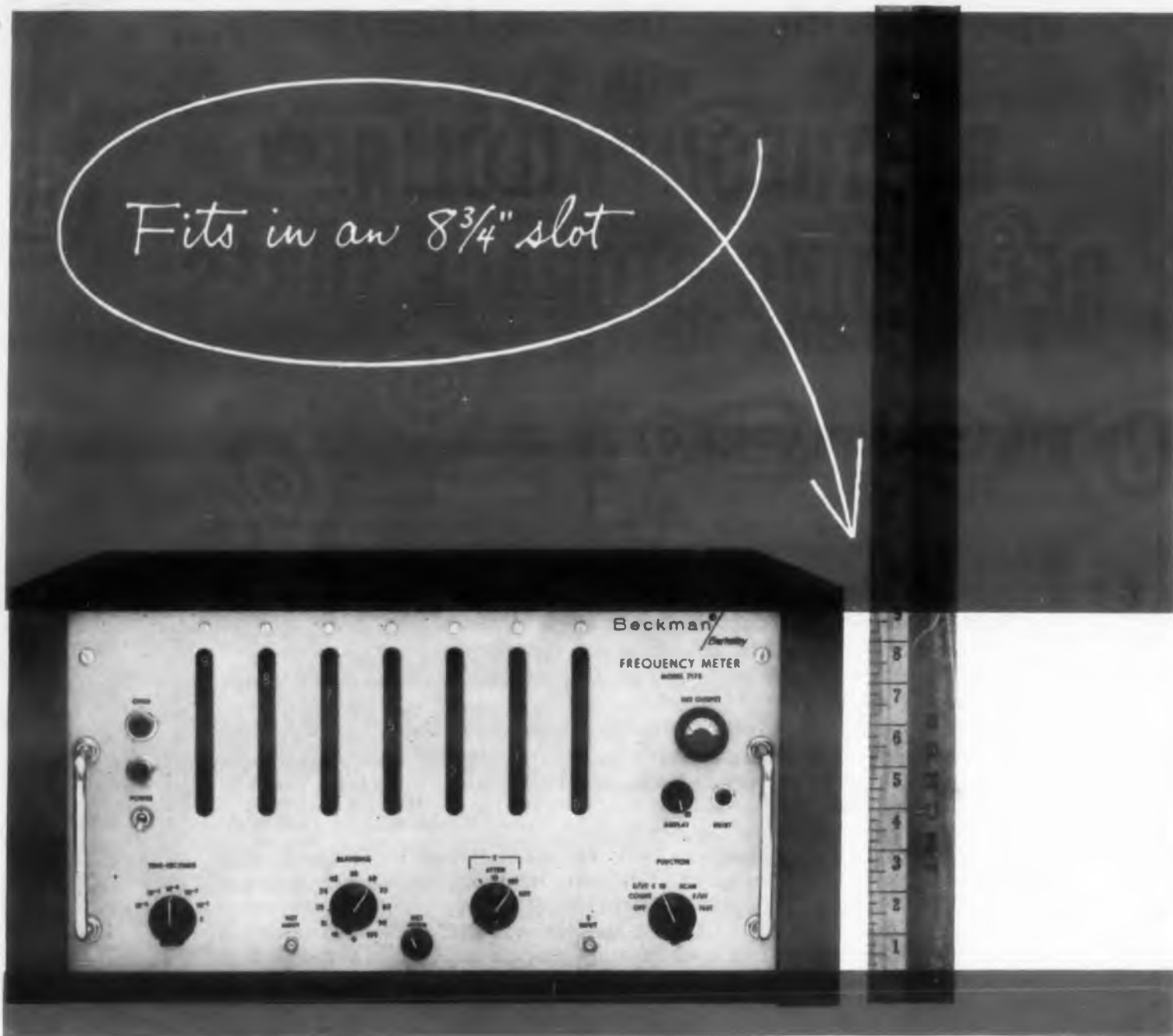
Simplified programing is a must. Frequent re-programing will result from changes in local requirements and combat situations. Operator proficiency will be low because of limited experience and rapid turnover.

Low cost is desirable not merely for its own sake but because BLADE, despite its large-scale concept, is only an interim step in the Air Force's data-processing plans. BLADE, as such, is expected to be in operation between 1965 and 1975. By then a regional concept for computing installations will be phased in.

Among the callers at the Pentagon have been several large industry concerns not now in the data-processing business but evidently willing to look over the situation. Air Force policy is to encourage "competitive free enterprise in industry."

Among the more recent computer developments being studied for possible use at BLADE are Univac Solid State 80, IBM 1401 and RCA 301 with Aeronutronics HIRAC memory.

Project BLADE is the responsibility of the Air Force Office of Statistical Services, headed by Col. Marshall R. Gray. ■ ■



## Measure 10cps to 110Mc with one compact meter

**Comprehensive range for only \$1895.** Never before has so broad a range been offered for so low a price—a combination made possible by closely integrating a simple heterodyne converter with a top-notch 10Mc counter. Frequencies up to 10Mc are measured by direct counting. To measure frequencies above 10Mc, the operator simply rotates reference frequency selector until panel meter shows strong deflection, then reads counter indication. Measurements take less than a minute to make. Accuracy far exceeds FCC requirements over communications range. Possible error is .00004% or less from 1Mc to 110Mc.

Write for technical bulletin on Model 7175.

Frequency measuring range  
10cps to 110Mc  
Sensitivity  
100mv rms into 1M ohms  
up to 10Mc  
100mv rms into 100 ohms  
up to 110Mc  
Accuracy  
Oscillator accuracy  $\pm 1$  cps  
Oscillator stability  
3 parts in  $10^7$  per week  
Recording facility  
Rear jack carries code signals  
to actuate Beckman printer  
Dimensions:  
8 3/4" x 19" panel, 17" deep  
Weight  
Ready for rack: approx. 47 lbs.  
In cabinet: approx. 60 lbs.  
Price \$1895

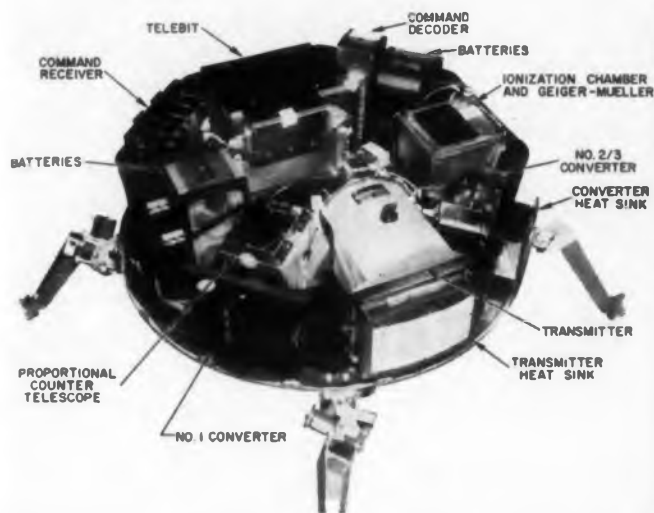


# Beckman®

Berkeley Division  
Richmond, California

CIRCLE 6 ON READER-SERVICE CARD





**Tight packaging** allows a maximum number of experiments to be performed by Pioneer V as it orbits the sun between Earth and Venus.

### New Era Dawning (cont. from p. 5)

antenna is directed toward the earth during transmitting periods. Interrogation time is computer-calculated, Dr. Boonton said, based on the orientation of the vehicle's spin axis. This spin axis is known because of data received at the time that automatic guidance of Pioneer V was terminated, which occurred when the space-package separated from the second stage of the Thor-Able launch vehicle shortly after the March 11 launching.

### Doppler System, Other Instruments Provide Experimental Data

A doppler command system within Pioneer V, upon receiving the command signals from the ground, initiates experimental adjustments within the planetoid and controls data storage and transmission.

The doppler system is also used to measure velocity of the vehicle within 10 ft per sec during transmission times.

Power for the electronic equipment is being supplied by nearly 5,000 solar cells, of 8-per-cent efficiency, packed into four paddles mounted on the sides of the instrument package.

A 1/2-lb, search-coil magnetometer will supply information on magnetic fields encountered by the vehicle in interplanetary space, and an STL designed aspect detector using a photocell to sense the position of the sun will supply directional information on these fields.

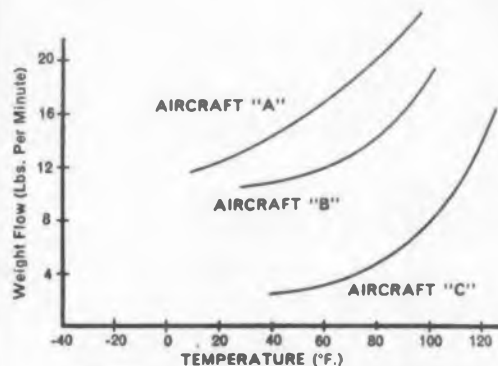
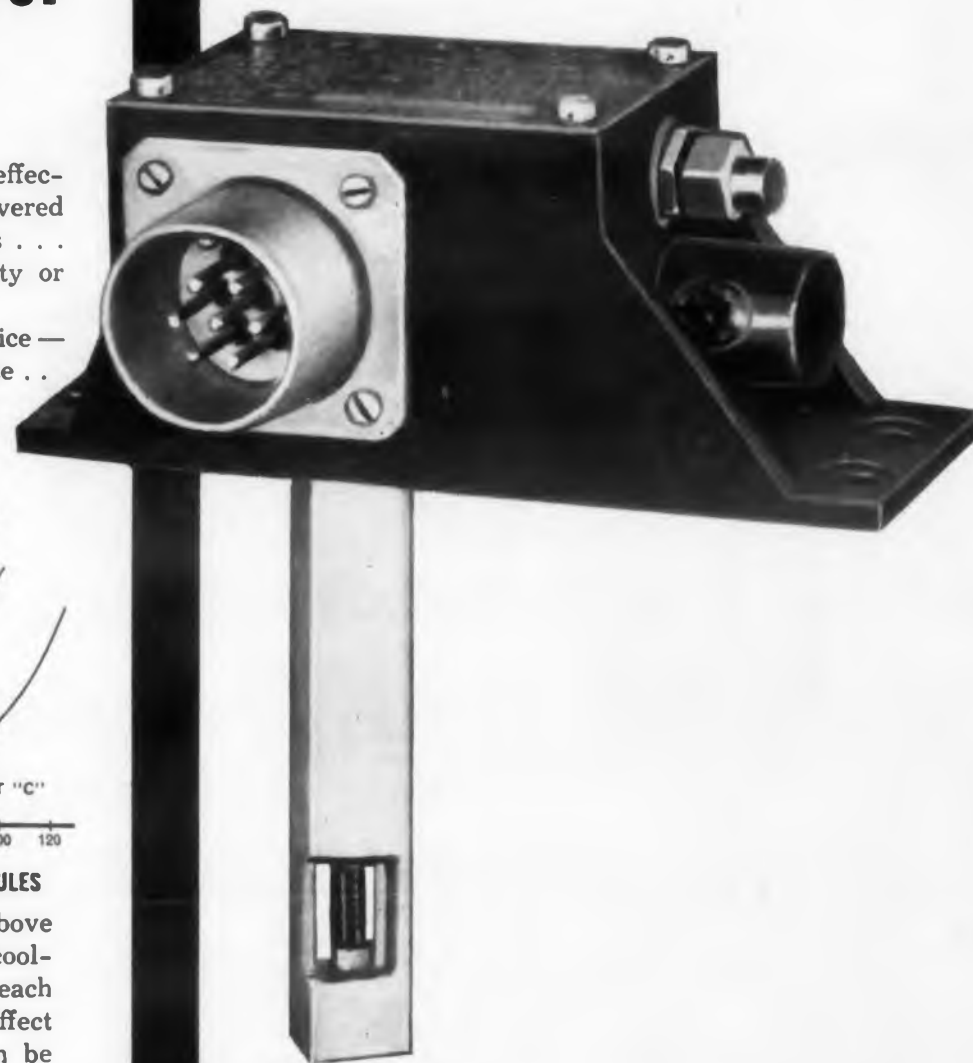
Other instruments carried by the planetoid will supply radiation information, and data on the number and nature of micrometeorites encountered.

Mean Time Between Failures for the instrumentation carried in Pioneer V is estimated at 2,000 hr, according to a NASA spokesman. ■ ■

## VAP-AIR cooling effect detector

Senses the actual cooling effectiveness of the air being delivered over electronic components . . . regardless of volume, density or temperature delivered.

A unique and proven device — lightweight, positive, accurate . . . under all conditions.



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NAME \_\_\_\_\_

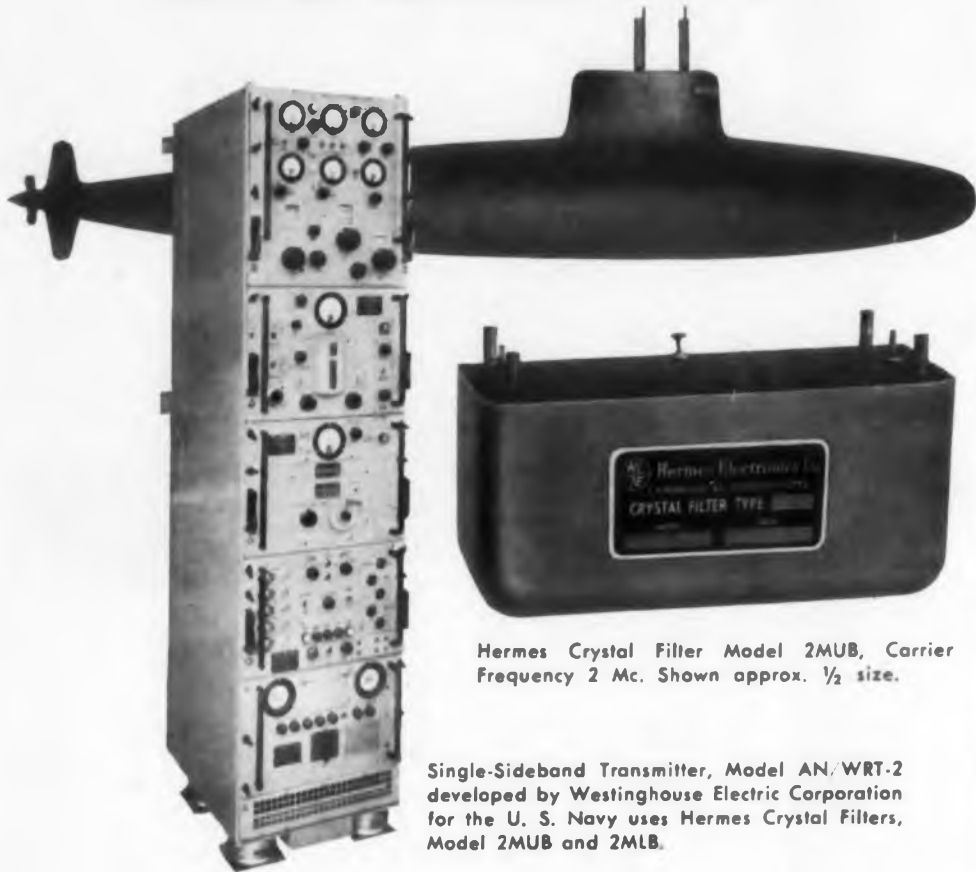
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ADDRESS \_\_\_\_\_

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CIRCLE 7 ON READER-SERVICE CARD

## FIRST Navy Militarized SSB Transmitter Generates Cleaner Signal Using HERMES CRYSTAL FILTERS



Hermes Crystal Filter Model 2MUB, Carrier Frequency 2 Mc. Shown approx. 1/2 size.

Single-Sideband Transmitter, Model AN/WRT-2 developed by Westinghouse Electric Corporation for the U. S. Navy uses Hermes Crystal Filters, Model 2MUB and 2MLB.

Recently installed on the atomic submarine SKIPJACK (SSN585), the Westinghouse Electric AN/WRT-2 SSB Transmitter is now standard Navy equipment.

Single sideband signals are generated in the AN/WRT-2 by the selective filter method employing Hermes 2MUB and 2MLB Crystal Filters. These 2.0 Mc Crystal Filters not only offer all the basic advantages of the filter SSB generation method, but reduce the number of heterodyning stages required to translate the modulated signal to the required output frequency. The attendant decrease in unwanted signal generation results in a cleaner signal. The AN/WRT-2 is also a more reliable transmitter because fewer components are used.

In addition to the 2.0 Mc Crystal Filters, Hermes has also supplied SSB units at 87 Kc, 100 Kc, 137 Kc, 1.4 Mc, 1.75 Mc, 3.2 Mc, 6 Mc, 8 Mc, 10 Mc and 16 Mc. These Crystal Filters are presently installed in airborne HF, mobile VHF and point to point UHF SSB systems.

Whether your selectivity problems are in transmission or reception, AM or FM, mobile or fixed equipment, you can call on Hermes engineering specialists to assist in the design of circuitry and the selection of filter characteristics best suited to your needs. Write for Crystal Filter Short Form Catalog.

*A limited number of opportunities are available to experienced circuit designers. Send résumé to Dr. D. I. Kosowsky.*

# Hermes

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CIRCLE 8 ON READER-SERVICE CARD

## NEWS

# New Defense Board Urged With a Voice for Industry

EIA Seminar Hears Call for 4-Way Planning;  
Electronics Executives Hit Contract Tactics

**A**N ELITE advisory group for defense planning—drawn from industry, the armed forces, Congress and the Executive Branch of government—was advocated in Washington at the Defense Planning Seminar of the Electronic Industries Association. The proposal was advanced by Congressman Gerald Ford (R, Mich.), ranking member of the House Armed Services Appropriations Subcommittee.

At the same meeting industry received advice on defense planning, and the military was questioned sharply on its contract demands and other practices.

In describing his concept of a joint advisory defense body that would include industry, Representative Ford said:

"Unlike other planning groups, this group could plan effectively, as it would bring together all aspects of defense planning and procurement. Since the group would not be the creation of a single agency or interest, its recommendations would form a sound basis for decisions all along the line—from initial system planning to authorization of funds."

### 400 Delegates Consider Defense Plans and Savings

Planning for defense and getting more defense per dollar were the key issues considered by some 400 delegates from the electronics industry and the armed forces. Military representatives admitted that the services had in the past been reluctant to delegate weapon sys-

tems planning to industry but that the opposite situation now prevailed.

Major defense-planning challenges to industry were defined by L. Eugene Root, vice president of Lockheed. He listed the problems as:

- The rapidly changing state of the art, which makes equipment obsolete almost before it is developed.
- The uncertain international situation, with alternate saber-rattling and disarmament conferences.
- Limited funds.

■ Competition within the defense establishment and within industry.

To meet these challenges, Mr. Root suggested two rules for industry: "Plan or perish," and diversify or die."

Electronics today accounts for 14 per cent of the defense dollar, it was brought out at the seminar. By 1970, one military speaker predicted, this figure will increase to 20 per cent.

But John M. Sprague, Deputy Assistant Secretary of Defense, told the seminar that military spending would probably remain near its present level during the foreseeable future. Conservative fiscal policies striving toward a balanced budget and a sound dollar will prevail, he said.

The growing market in industrial electronics is a hedge against defense cutbacks, Mr. Root noted. He said industrial electronics sales were expected to top those for military electronics long before 1970.



# PHILCO... FOR HIGH SPEED SILICON SWITCHES

## Military Is Assailed On Contract Demands

The military was criticized by company executives at the session. A frequent complaint was against demands for excessive performance. It was felt that large economies could be effected if the armed forces would "give a little." Brig. Gen. Elmer L. Littell, head of the Army Signal Supply Agency, replied:

"We will continue to strive for the very best; cutting corners does not pay in the long run. Only by pushing industry to extend the state of the art can we move ahead."

Industry planners wanted to know how the armed services expected them to pay for research from company funds while negotiating tough contracts that drove profits below the legally allowed maximum.

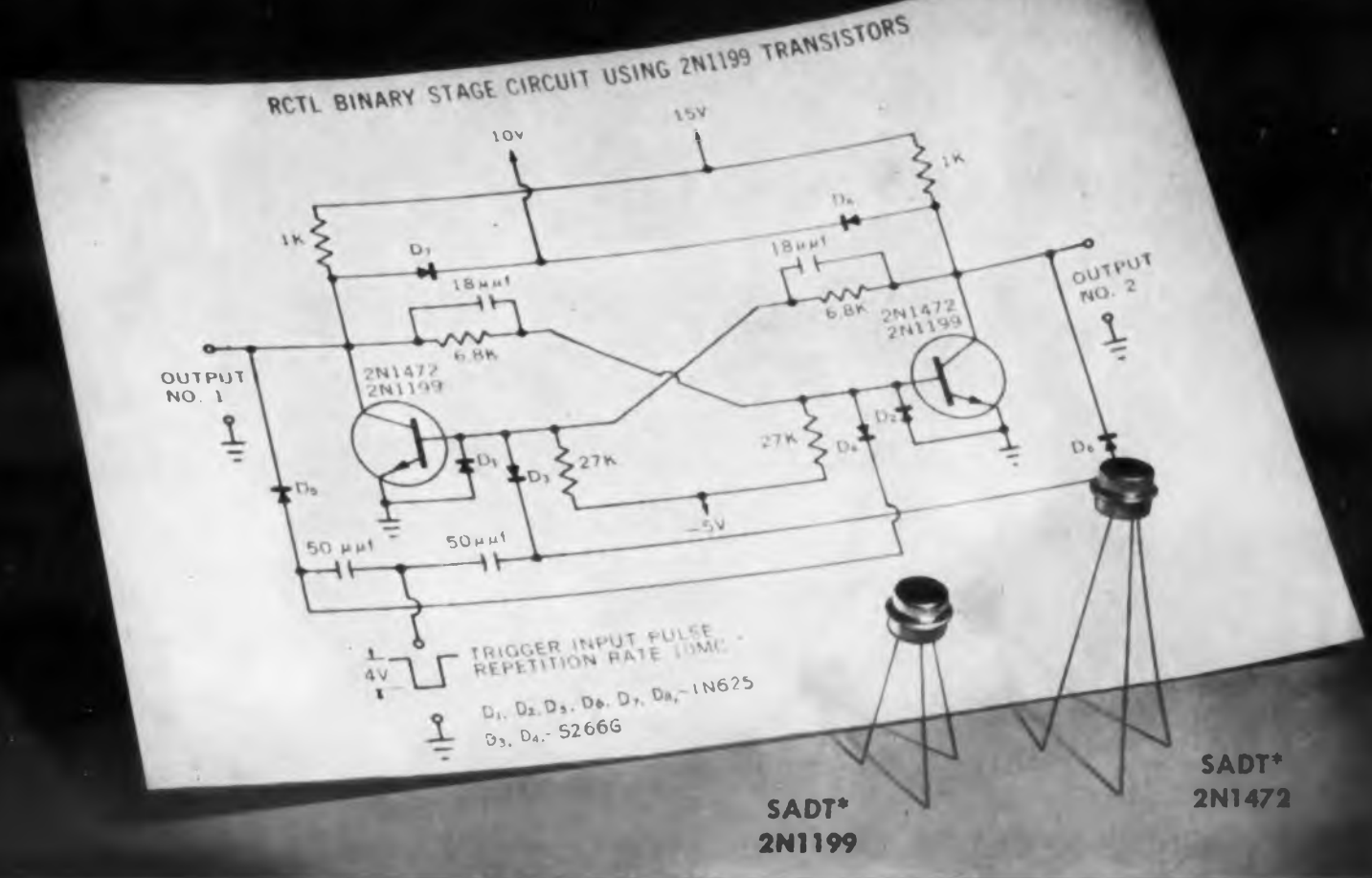
The military practice of inviting proposals for weapons systems when funds are not yet earmarked also drew criticism. See-saw appropriations from year to year were cited as making efficient planning difficult and driving up development costs in the long run. Representative Ford was himself critical of this practice, but he noted that the trend was improving.

## R&D Duplication Scored; Navy Defenders Practice

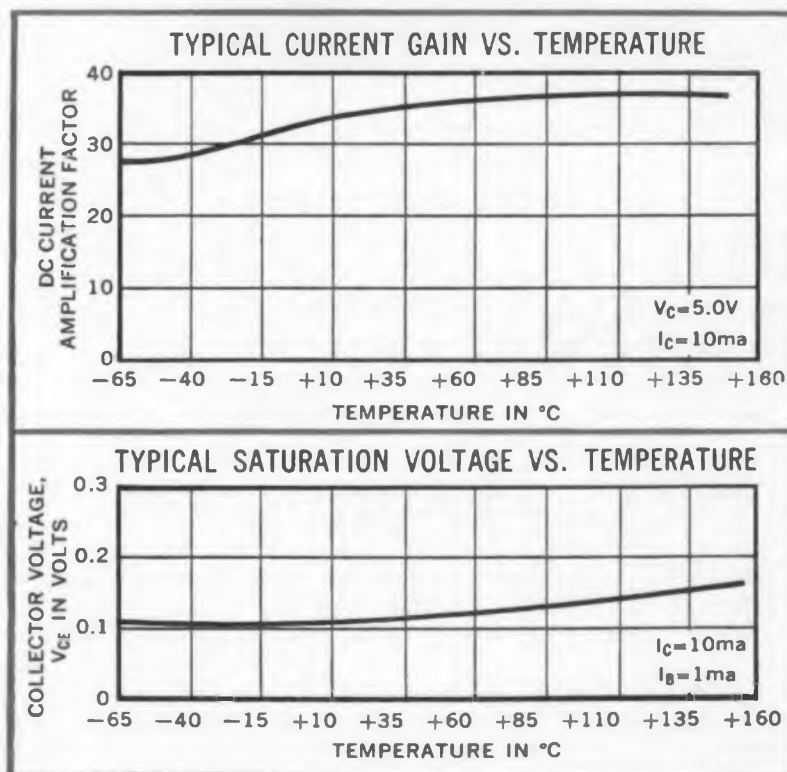
Some delegates thought that the armed services were employing a "shotgun" approach by granting several study contracts for the same weapon systems and R&D contracts for competing systems. But Vice Admiral John S. Sides, director of the Navy's Weapons Systems Evaluation Group, replied that this approach was not as expensive as it might appear.

R&D in its early states," he said, is fairly cheap—at least in comparison with total systems cost. We can afford to look around to see what is best before we invest in advanced development and manufacture. These days about \$2 billion seems to be the average cost to get a major weapons system into being and about \$4 billion before it is available in force." ■ ■

CIRCLE 9 ON READER-SERVICE CARD ➤



## PHILCO HIGH FREQUENCY NPN SILICON TRANSISTORS OFFER EXCEPTIONALLY LOW SATURATION VOLTAGE



Available in quantities 1-999 from your local  
Philco Industrial Semiconductor Distributor.

The high frequency response, together with the very low saturation voltage of these silicon Surface Alloy Diffused-base Transistors (typically 0.125 V), permits practical design of 5 mc pulse circuits, using conventional saturated switching configurations. With non-saturating techniques, pulse rates as high as 30 mc are obtainable. The typical switching circuit shown above will operate satisfactorily at trigger pulse rates up to 15 mc. When triggered with a 4-volt pulse at a 10 mc rate, the rise time will be typically less than 24  $\mu$ sec over a temperature range of  $-60^{\circ}\text{C}$  to  $+130^{\circ}\text{C}$ . The typical fall time will be less than 36  $\mu$ sec over the same temperature range.

Both of these transistors have demonstrated consistently more stable characteristics over a wide temperature range than any other silicon transistors available. Both meet the environmental and life test requirements of MIL-S-19500B.

### NEW, MORE COMPLETE DATA SHEETS

The new data sheets on these transistors, for the first time, provide the designer with complete information upon which he may predict switching speeds in any circuit. They also contain the full military environmental and life test specifications, in accordance with MIL-S-19500B. Copies are available on request. Write Dept. ED-360.

\*Reg. U.S. Pat. Off.

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By any standard of comparison, new PMI smooth torque DC Servo Motors are establishing exciting new perimeters in military and industrial applications. Now in full production these low inductance (<500 micro-henries), fast response motors offer the optimum in smooth torque from a fraction of an RPM to rated 3000 RPM.

A major technological advance, the new direct drive DC Servos—with printed armatures—feature high torque to inertia ratio and greatest capability of high pulse torque in intermittent use. The new servos are low impedance devices and as such are suitable for use with semi-conductor circuits.

	MODEL PM-368	MODEL PM-488
Inertia	.005 ounce-inch-seconds <sup>2</sup>	.018 ounce-inch-seconds <sup>2</sup>
Running Torque (continuous)	12 ounce-inches	32 ounce-inches
Mechanical Time Constant	.025 seconds	.025 seconds
Pulse Torque (intermittent)	100 ounce-inches	220 ounce-inches
Size	4 1/4" D x 2 1/4" L	5 1/4" D x 2 3/4" L

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CIRCLE 10 ON READER-SERVICE CARD

## NEWS

### Photoconductive Potentiometer Uses Light as Wiper Arm

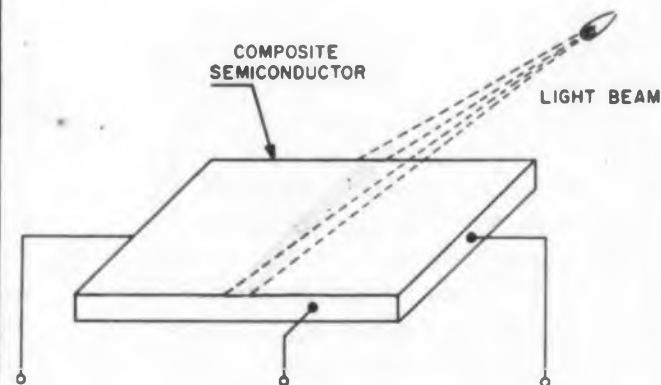
A new potentiometer development uses a composite semiconductor strip for a resistive element, and a light beam for a contact arm. When the photoconductor is exposed to light, the output voltage is proportional to the position of the light beam along the strip, but is independent of the width of the beam. Above a certain threshold, output is also independent of light intensity.

Developed by Giannini Controls Corp., 918 E. Green St., Pasadena, Calif., the Photopot's first use will be in an attitude indicator for missiles. Location of a beam of sunlight on the photoconductive strip will signal the missile's in-flight position.

Varying the geometry of the semiconductor slab shown in the drawing provides the output resistance range. Output resistance can run from one K to thousands of megs, Giannini asserts, because the design is no longer limited to the composite materials that can withstand a wiper's abrasion. With this wide range the Photopot can operate directly into either transistor or vacuum tube amplifiers.

Since a light beam can be swept rapidly, the input response of the Photopot is not limited by the large amounts of power needed to move a mechanical wiper at high speeds. The output time response is determined by the electrical characteristics of the composite strip. The material can be a single crystal with kilocycle response; or polycrystalline, with fractional-cycle response under normal conditions. With very high beam intensities the response of polycrystalline material is as good as the normal operation of single-crystal material.

So far, satisfactory operation is obtained with light intensities as low as one ft candle. Work on new materials, says Giannini, is expected to lead to operation with weak radioactive emanations instead of light sources.



As light beam moves along length of semi-conductor strip voltage output changes. Output is independent of beam width.



Applications for the new development are numerous. By forming the composite strip in non-uniform thickness or width along its length, a function generator with almost any non-linear output can be produced. The scope of functions which can be generated is, of course, much wider than with traditional methods of card cutting or non-linear winding. Easier to build too.

By varying either the light intensity (below a certain threshold) or the excitation voltage as a function of one variable, and by shifting the position of the light beam by a second variable, the output will give the product of the two variables—an analog multiplier.

A shaft position detector can be built by using the polycrystalline material to form a circular strip. The output voltage is proportional to the angular position of the excitation beam. Changing the thickness or width of the strip gives trigonometric or other functions of angular displacement.

### Industry's First Solid Circuits Now Available to Designers

The first solid circuits are now commercially available, marking the beginning of a new era for the electronics industry.

Texas Instruments, Inc., which developed the monolithic devices, has produced evaluation quantities of a binary multivibrator operating at a 200-kc repetition rate.

According to the company, the solid circuits are produced by extensions of mesa-transistor production techniques. Diffusion, oxide-masking, evaporation and chemical forming are used to make a single-crystal semiconductor wafer behave as a complete circuit. Thus "most reliability-decreasing interconnections are eliminated," the company says.

Orders are being accepted for solid-circuit logic blocks, gates, oscillators, NOR circuits and flip-flops. The multivibrator available for evaluation measures 0.250 x 0.125 x 0.131 in.

More details on this landmark development will be described in a forthcoming issue of ELECTRONIC DESIGN.



Solid-circuit added package developed by Texas Instruments for American Bosch Arma is a combination of seven individual semiconductor networks.

ELECTRONIC DESIGN • March 30, 1960

Type 148P and Type 149P

YELLOW-JACKETS



smallest

of Sprague's  
film capacitors  
for entertainment  
and commercial  
electronics



### YELLOW-JACKET WRAPPER-PROTECTED FILMITE 'E' CAPACITORS

are the smallest of Sprague's family of film capacitors. Type 148P and 149P Yellow-Jackets are designed for compact radio receivers, test equipment, communications equipment, and similar applications. They are especially suited for transistorized and low-voltage tube circuits, as well as all other applicable circuits in which size, weight, and cost are important considerations.

Yellow-Jacket capacitor sections are of extended foil design...wound from ultra-thin, especially selected polyester film and thin gage foil under carefully controlled atmospheric conditions. They are protected against moisture by an outer wrap of polyester film. End seals are of a plastic resin which bonds securely with the film wrap in order to assure long service life.

This construction results in a light-weight capacitor of minimum size, having a distinct space advantage over metal-encased, molded, or wax-coated cardboard-case tubulars of comparable ratings.

Yellow-Jacket Type 148P (cylindrical) and 149P (semi-oval) capacitors are recommended for use in applications requiring reliable operation within the temperature range of -55 C to +85 C at rated working voltages of 100, 200, 400, and 600 volts d-c.

For complete technical data on these Yellow-Jackets, write for Bulletin 2063A to Technical Literature Section, Sprague Electric Company, 347 Marshall St., North Adams, Mass.

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is BETTER THAN 0.25%

for frequencies 50 cps to 10 KC



Price \$450

## BALLANTINE'S LINEAR AC to DC CONVERTER Model 710

The Model 710 Linear AC to DC Converter converts an AC voltage to a DC voltage which can be measured with an accurate DC device such as Type K Potentiometer, Digital DC Voltmeter, Recorder, etc. With such a combination, a wide range of voltages can be measured with up to 0.25% accuracy, which is considerably better than accuracies of present-day vacuum tube voltmeters. Such a system is more sensitive, covers a wider frequency and voltage range, and is much more rugged and foolproof than a laboratory standard instrument of comparable accuracy. It is also adaptable for use by untrained personnel and on production lines.

The instrument covers an input voltage range of 1 mv to 1000 volts which is divided into six decade ranges. For every decade range the DC output varies from 0.1 volt to 1 volt. The input impedance of the converter has a resistive component of 2 megohms shunted by 15 pf to 25 pf, depending on the range.

The output of the Model 710 Converter is a linear function of the input voltage within each decade. A small error may exist in the decading of the input attenuator or in the frequency response of the amplifier. This error does not exceed  $\pm 0.25\%$  over a frequency range of 50 cps to 10 KC and  $\pm 0.5\%$  over a range of 30 cps to 50 KC. The upper frequency limit of the instrument is 250 KC, at which point the accuracy is  $\pm 1\%$ .

The DC output of the converter is single ended and has a maximum output emf of 1 volt with a source impedance of approximately 10,000 ohms. The instrument is the average responding type for distortions as much as 30%, but is calibrated in RMS of a sinewave.

Also available in 19 inch relay rack as Model 710 S/2 Price \$455

Write for brochure giving many more details

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CIRCLE 12 ON READER-SERVICE CARD

## NEWS

### Signal Corps Automates Engineering Drawings Procedures

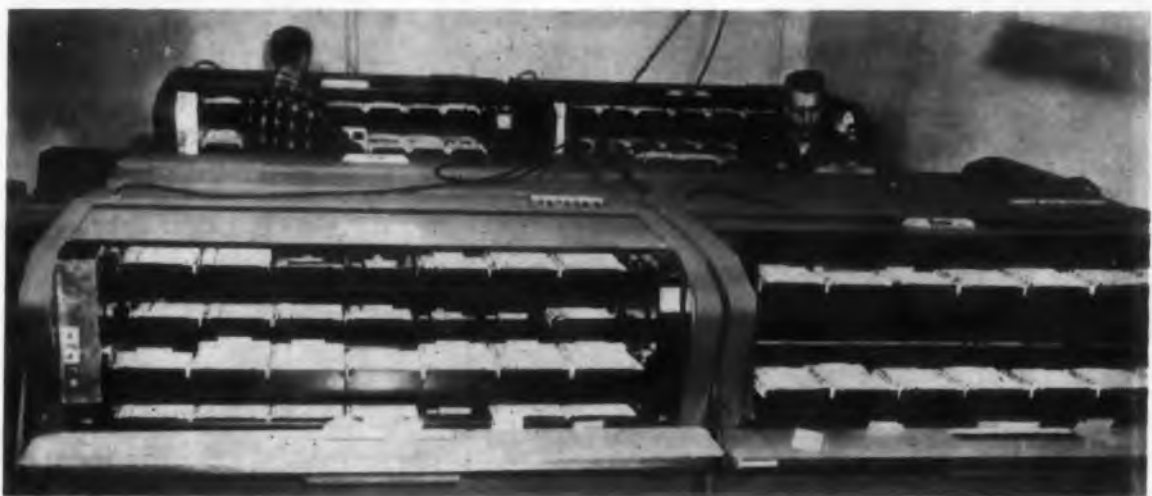
**M**ICROFILMED engineering drawings mounted on punched cards are being used by the U.S. Army Signal Corps to automate procedures used in supplying production and maintenance engineering information to industry.

Sets of microfilm-mounted cards are being sent to Signal Corps agencies throughout the world and to the Air Force by the Army Signal Equipment Support Agency, Fort Monmouth, N.J. Engineering data from 220,000 Signal Corps drawings are included. ■ ■

Under the new system each engineering drawing is microfilmed for mounting on a punched card. Here a technician microfilms a Signal Corps drawing.



Before automation, location of drawings meant finding a card in the card index file at left, which included over 600,000 cards, and then getting a blueprint from the files shown at right. The file included 220,000 Signal Corps and 400,000 manufacturers' drawings. All this has been replaced by the punched-card system below, which allows any drawing to be located within 90 secs. Drawings on microfilm are mounted in apertures provided on the punched cards.







Information about drawings is key-punched onto IBM cards which contain apertures for microfilm mounting. Many previous hand recording operations are eliminated, and technical data can be more easily indexed by sorting the cards.



This equipment cuts individual frames from microfilm rolls and mounts them into the proper cards. Shipping of drawings in microfilm form reduces weight about 80 lb for each 1,000 drawings, according to the Signal Corps.



Engineers can examine microfilmed drawings at viewers placed in convenient areas. It takes about 30 times more space to store original drawings than it does for the microfilmed duplicates in punched cards.



**CBS Indium-bonded  
Diodes Give You  
Missile Reliability**



**DIODE  
SURVIVAL  
BETTER THAN  
99.985%!**

Near perfection is demanded of computer diodes used in missiles. CBS Reliable Indium-bonded Diodes meet this challenge with an Acceptable Quality Level of 0.015% . . . a degree of quality never before achieved in semiconductor mass production. Only one diode out of 6500 can fail!

This dependability is available for your computer applications in a wide line of new CBS Reliable Indium-bonded Diodes. Exceptionally rugged design, advanced processing techniques, severe mechanical tests, and automatic electrical tests make the difference. Ask your Manufacturers Warehousing Distributor or your local sales office about these CBS Reliable Indium-bonded Diodes today. Get technical bulletin E-314R.

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##### Environmental

- Temperature cycling, -65° to 85°C
- Hermetic seal, 100 psi
- Moisture resistance exceeding MIL-STD-202A
- Shock, 1000 G for 1 millisecond
- Centrifuge, 20,000 G
- Vibration, 15 G at 50-2000 cps
- Salt spray and lead fatigue

##### Electrical

- Automatic, both forward and reverse
- Pulse recovery time, JAN 256 circuit
- Electromechanical stability and noise
- Storage, 1000 hours at 85°C
- Over-all quality exceeds MIL-S-19500B



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CIRCLE 13 ON READER-SERVICE CARD



## The Matrix of Site Instrumentation

Site instrumentation—from complete electronic installation management to the engineering of customized systems and sub-systems—is a specialty of Western Design. ■ Typical of Western Design's site instrumentation capability is the new data calibration system for the Air Force Minuteman ICBM, designed to certify performance of transducers in the Hercules solid propulsion system. This automatic system, with both permanent and quick-look read-out, measures 160 transducers in 10 minutes, incorporates high safety stand-

ards and can be operated remotely by unskilled personnel. ■ For reliable, imaginative site instrumentation, check Western Design... a company with strong corporate financial back-up and extensive experience in military electronic and electro-mechanical equipment, sub-systems and systems. For further information, write for Data File ED-1029-1.



**Western Design**

DIVISION OF U.S. INDUSTRIES, INC.

SANTA BARBARA AIRPORT, GOLETA, CALIFORNIA

## NEWS

### RCA Reported Building 2 Computers, Disk File

Two transistorized data-processing systems, one of them using a disk memory file, will soon be added to Radio Corp. of America's data processing line, according to industry reports.

An RCA spokesman declined to comment on the reports.

The company's Data Processing Div. has up to now marketed only one system, the RCA 501, a medium-scale, modular computer whose size is flexible.

The two new computers, one a large-scale and the other a small-scale, will move RCA into a much stronger competitive position with International Business Machines Corp., industry sources point out.

#### Disk Memory in Small Unit

The RCA 601, with a 1.5- $\mu$ sec memory-access time, will be the large-scale entry. The RCA 301 will be the small machine. This computer will use a disk-file memory, according to reports.

Both new systems will be similar to the RCA 501 in modular design, it was learned.

The 601 will be capable of processing eight programs simultaneously, as long as only one is arithmetic, sources indicate.

Instruction control units providing commonly used combinations of elementary instructions will be available for simplifying programming.

The 601 will use 48-bit words which can be either numeric, alpha-numeric or octal, with half-word instructions, it was learned.

◀ CIRCLE 14 ON READER-SERVICE CARD



## Aircraft Waveguide Units Sealed by New Method

A new technique for sealing waveguide components for high-altitude aircraft has been developed for the Air Force.

Windows, made of glass-reinforced Teflon laminates, have been developed with a reflection coefficient of less than 2-1/2 per cent over a bandwidth of 40 per cent for C, X, and Ku band waveguides. Low reflection over a wide band has been achieved by use of irises and recesses for compensation.

The windows are bonded to the waveguide flanges with temperature stable epoxy resin. The Teflon laminates used in the windows are more desirable than fragile glass or quartz materials because of their flexibility, according to engineers at the Armour Research Foundation.

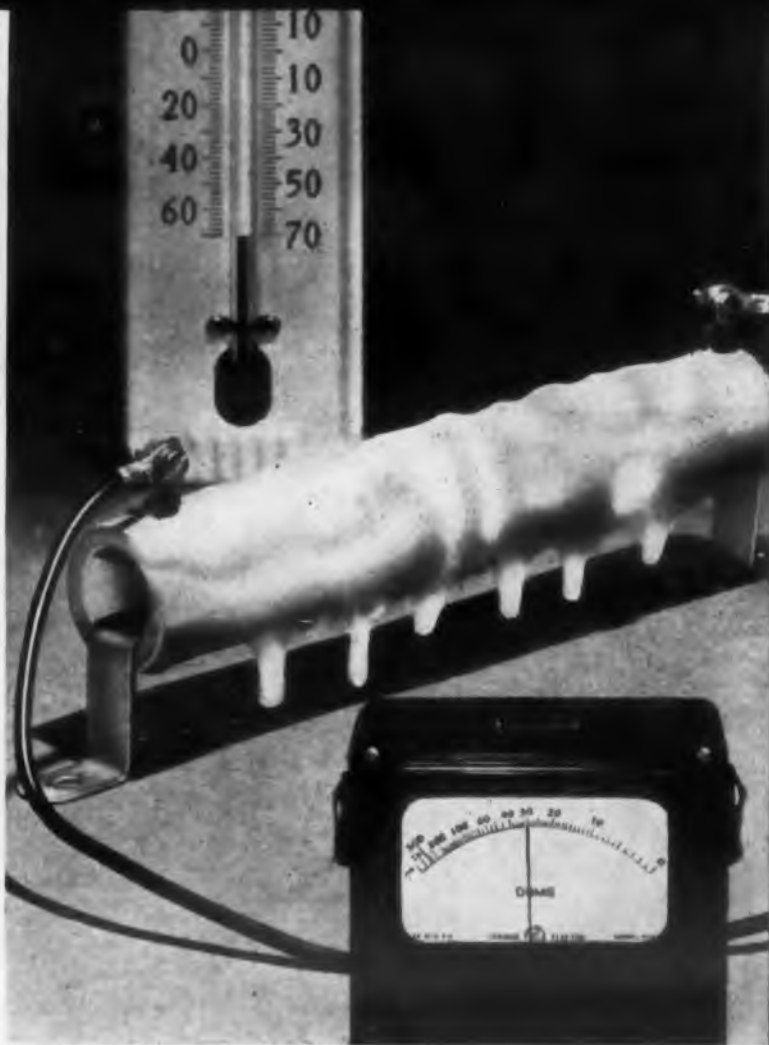
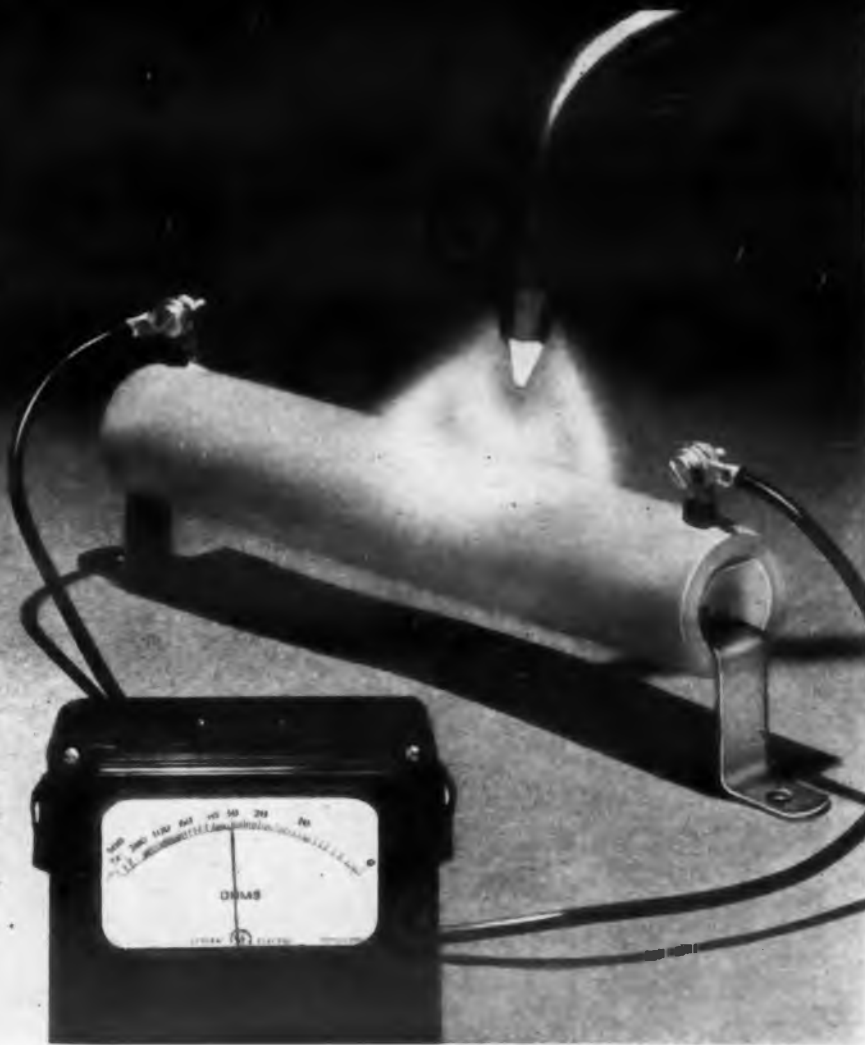
Each window is in two half sections—one on each end of a waveguide component—thus making waveguide components of this type universally interchangeable.

## No Tubes in New TV Amplifier



Remotely controlled amplifier for television receivers has seven transistors and one power diode. It responds to ultrasonic signals from a hand control unit that can turn a television set on or off, adjust the volume and change channels. The amplifier was developed by Admiral Corp. of Chicago.

CIRCLE 15 ON READER-SERVICE CARD



TESTS ON NEW GENERAL ELECTRIC RESISTORS PROVE . . .

# Stable operation from +700° to -70° F

Under searing heat or sub-zero cold, General Electric resistors maintain their rated ohmic values. Actual laboratory tests have proved that these vitreous-enameled resistors hold their rated resistance under ambient temperatures from +700 F to -70 F.

These General Electric resistors are available in over 1400 combinations of ratings (5 to 200 watts), types, and mountings. Stable operation is but one

of their outstanding qualities: They have sufficient terminal strength to hold up to 21 pounds of right-angle pull, and special terminals are available to hold up to 34 pounds. Their vitreous-enameled coating provides resistance to adverse atmospheric conditions.

Like to know more? Ask your General Electric Apparatus Sales Engineer for a free set of sample resistors and test them yourself! And mail this cou-

pon today for the 36-page catalog containing complete information on ratings, dimensions and ordering directions.

### NEED OTHER COMPONENTS?

General Electric also has complete lines of contactors, relays, and plate rheostats for all your control needs. For more information, contact your General Electric Sales Engineer or mail this coupon today! Industry Control Department, Salem, Virginia.

# GENERAL ELECTRIC

D-c contactors and relays—feature new "building-block" construction to give maximum flexibility with minimum inventory.



Plate-type rheostats—windings are completely encased in metal to give longer and more reliable service for any application.



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General Electric Co.  
Schenectady 5, N. Y.

Please send the following bulletins:

- GEA-6592—Vitreous-enameled resistors
- GEA-6474—Plate-type field rheostats
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## NEWS

### 'Ham' Cites Two Ways Satellites Relayed Signals

An amateur radio operator has credited two possible effects with bringing about what may have been the first two-way radio communication with the aid of artificial satellites.

The "ham," Raphael Soifer of New York City, along with Perry Klein of Bethesda, Md., claimed to have bounced radio signals off the Explorer VII or Sputnik III satellites, or their ionized trails. At the time of contact, both satellites were passing over the Atlantic Ocean about 150 mi east of Atlantic City.

Mr. Soifer, a freshman at MIT, believes that the contact was accomplished by two possible methods. One is known as the Kraus Effect, or CW Reflection. This makes use of the wake of ionization that a satellite leaves behind. Under proper conditions, radio signals can be bounced off these ionized regions.

The other method is re-radiation of signals from the antennas of passing satellites because of the closeness of radio frequencies used. The antennas of both satellites are at a frequency of 20 mc. Contact was reported made on 21.011 mc with both sets operating at about 300 w. No directional antennas were used.

### Machining Control Called Accurate to 0.000025 In.

A new two-axis, numerical system is said to control precision machining in increments of 0.000025. It is reported that the system permits machining to tolerances of 0.0001 in. in production of templates, and 0.0002 in. in contour boring and turning operations.

Developed by Bendix Aviation Corp., Detroit, the system uses a punched tape input. A photo-electric reader allows tape reading of 300 lines per sec in the forward direction and 600 lines per sec in the

◀ CIRCLE 16 ON READER-SERVICE CARD

Type: Waveguide termination reference cavity  
 Frequency Range: 5975-6475 mc  
 Loaded Q: 1000-1400  
 Frequency Resolution: Can be set from 0.05%  
 Accuracy at 70°F: ±0.01%  
 Stability: ±0.1% over temperature range of 70°F ±70°F  
 RF Connectors: PL1 MA or UG 344-U  
 Construction: Invar cavity and tuning elements

Frequency Range: 85.8-100.0 mc  
 Bandwidth at 3 db points: 8.5 mc  
 Bandwidth at 20 db points: 30 mc max  
 Insertion Loss: 7 db max  
 Input VSWR (with matched load): 1.5 max  
 Number of Resonant Sections: 4  
 Number of Tuning Controls: 1 (screwdriver control)  
 Mode: TEM<sub>111</sub>

Frequency Range: 1200-1400 mc  
 Bandwidth at 3 db points: 8-10 mc  
 Bandwidth at 35 db points: 35 mc max  
 Insertion Loss: 2 db max  
 Input VSWR (with matched load): 1.5 max  
 Number of Resonant Sections: 3  
 Number of Tuning Controls: 1  
 Mode: TEM<sub>111</sub>  
 Calibration: Can be furnished with counter dial

Frequency Range: 2700-2950 mc  
 Bandwidth at 3 db points: 5 mc min  
 Bandwidth at 50 db points: 45 mc max  
 Insertion Loss: 3 db max  
 Input VSWR (with matched load): 1.5 max  
 Number of Resonant Sections: 4  
 Number of Tuning Controls: 1 (screwdriver adjustment or counter dial)  
 Mode: TEM<sub>111</sub>

Type: Absorption type frequency meter with crystal detector  
 Frequency Range: 8.3-9.7 kmc  
 Loaded Q: 5000 min  
 Absorption Dip: Approximately 1 db  
 Calibration: Direct reading spiral dial, 1 mc markers  
 Frequency Resolution: min of 1.32 mc  
 Accuracy at 70°F: ±0.1%

Frequency Range: 10,000-10,600 mc  
 Bandwidth at 3 db points: 9 mc min  
 Bandwidth at 35 db points: 30 mc max  
 Insertion Loss: 2 db max  
 Input VSWR (with matched load): 1.5 max  
 Number of Resonant Sections: 4  
 Number of Tuning Controls: 1  
 Mode: TEM<sub>111</sub>  
 Calibration: Counter dial versus frequency

Frequency Range: 2.3-3.5 kmc  
 Bandwidth at 3 db points: 17 mc min  
 Bandwidth at 20 db points: 1000 min  
 Insertion Loss: 2 db max  
 Input VSWR (with matched load): 1.5 max  
 Number of Resonant Sections: 2  
 Number of Tuning Controls: 1  
 Mode: TEM<sub>111</sub>  
 Calibration: Micrometer versus frequency  
 Frequency Resolution: 78 kc vernier div low end  
 Accuracy at 70°F: ±0.1%

Frequency Range: 2700-2950 mc  
 Bandwidth at 3 db points: 5 mc min  
 Bandwidth at 50 db points: 40 mc max  
 Insertion Loss: 3 db max  
 Input VSWR (with matched load): 1.5 max  
 Number of Resonant Sections: 4  
 Number of Tuning Controls: 1 (screwdriver adjustment)  
 Mode: TEM<sub>111</sub>

Type: Transmissiometer cavity  
 Frequency Range: 7100-8500 mc  
 Loaded Q: 1500 ±20%  
 Transmission Loss: 8 db max  
 Calibration: Counter dial versus frequency  
 Accuracy at 70°F: ±1 mc  
 Stability: ±1.2 mc over temperature range of 70°F ±70°F  
 RF Connectors: UG 51-U

Frequency Range: 11.6-12.5 kmc  
 Bandwidth at 3 db points: 9 mc min  
 Bandwidth at 20 db points: 35 mc max  
 Insertion Loss: 2 db max  
 Input VSWR (with matched load): 1.5 max  
 Number of Resonant Sections: 2  
 Number of Tuning Controls: 1  
 Mode: TEM<sub>111</sub>  
 Calibration: Counter dial versus frequency

Frequency Range: 7.5-8.5 kmc  
 Bandwidth at 3 db points: 10 mc max  
 Bandwidth at 35 db points: 75 mc  
 Insertion Loss: 1 db max  
 Input VSWR (with matched load): 1.3 max  
 Number of Resonant Sections: 2 ea channel  
 Number of Tuning Controls: 1 per channel

Frequency Range: 10.8-11.6 kmc  
 Bandwidth at 3 db points: 9 mc min  
 Bandwidth at 35 db points: 35 mc max  
 Insertion Loss: 3 db max  
 Input VSWR (with matched load): 1.5 max  
 Number of Resonant Sections: 4  
 Number of Tuning Controls: 1  
 Mode: TEM<sub>111</sub>

Frequency Range: 2700-2950 mc  
 Bandwidth at 3 db points: 10 mc ±2 mc  
 Bandwidth at 40 db points: 120 mc max  
 Insertion Loss: 2.5 db max  
 Input VSWR (with matched load): 1.5 max  
 Number of Resonant Sections: 2  
 Number of Tuning Controls: 2  
 Mode: TEM<sub>111</sub>  
 RF Connectors: 53-135 microdot

Frequency Range: 5350-5905 mc  
 Bandwidth at 3 db points: 18 mc min  
 Bandwidth at 20 db points: 28 mc max  
 Insertion Loss: 4 db max  
 Input VSWR (with matched load): 2.0 max  
 Number of Resonant Sections: 3  
 Number of Tuning Controls: 1 (screwdriver adjustment)

Frequency Range: 2.5-3.2 kmc  
 Bandwidth at 3 db points: 4 mc min  
 Bandwidth at 60 db points: 60 mc max  
 Insertion Loss: 3.5 db max  
 Input VSWR (with matched load): 1.5 max  
 Number of Resonant Sections: 4  
 Number of Tuning Controls: 1  
 Mode: TEM<sub>111</sub>

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## \*over 400 microwave frequency meter or filter designs

With hundreds to choose from, you can select the microwave frequency meter or tunable band pass filter to meet your exact requirement. If the unit you need is not already in stock, it can be produced readily by modifying one of the Frequency Standards meters or filters now available. This means both minimum lead time and development costs.

Send your technical requirement for a prompt analysis or meet with our staff to discuss your specific problem.

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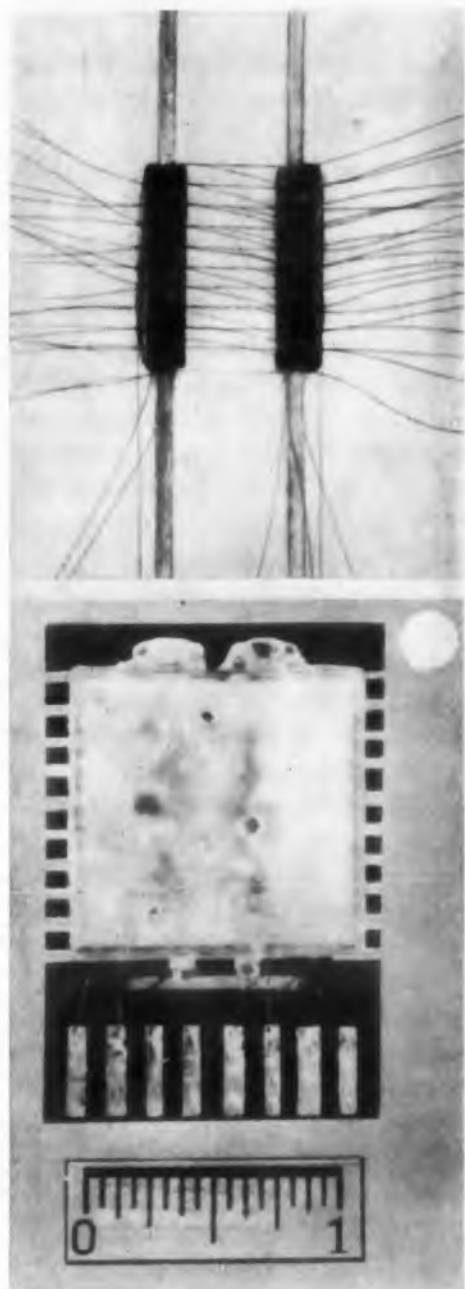
CIRCLE  
ELECT



reverse.

An error-detection circuit in the tape reader prevents errors from entering the interpolator.

### Another All-Magnetic Logic Unit



Experimental model of a 10-bit shift register employing all-magnetic logic. Developed by Bell Laboratories, Murray Hill, N.J., this unit operates at 10 kc, and others have been run satisfactorily at 50 kc. The design (interior view, above; assembled view, below) has been employed in registers of up to 800-bit capacity. Core interrogation is non-destructive, and gain is sufficient for considerable fan-out. The device is one in a series of all-magnetic, integrated logic elements under development at Bell.

CIRCLE 17 ON READER-SERVICE CARD ➤

ELECTRONIC DESIGN • March 30, 1960



The F8U-1P Crusader recently set new coast to coast speed record. CAI camera control system with Edison Time Delay Relay was used to automatically provide sharp, clear aerial photographs of the entire flight.

#### HERE'S WHAT A CUSTOMER SAYS ABOUT EDISON TIME DELAY RELAY...

"The CAX-12 servo power unit is a very vital part of the intricate 'brain' of the automatic camera control system, and naturally, we must have absolute reliability in all components. Therefore, as you know, we have relied on Edison Thermal Time Delay Relays since the original design of this CAX-12 and similar units. Since space for this type of equipment is at a premium, the compact size was a most important factor in original selection, but our units must also withstand severe environmental testing, involving vibration, moisture, shock, pressure fluctuation and extremes of temperature. Needless to say, the Edison Relay met all of these exacting requirements in our laboratories, and we've been specifying Edison ever since!"

(The above letter was received from Chicago Aerial Industries)

Chicago Aerial Industries has developed a camera control system that allows one jet pilot to do the job of ten expert aerial photographers... automatically.

Heart of this new unit is the CAX-12 servo power unit. It accurately synchronizes film speed with speed of the jet — changes lens openings in response to electronic signals — regulates shutter speed and controls driving motor on cameras.

Because this power unit is vital to the camera control system component reliability is a must. That's why CAI relies on

Edison's Thermal Time Delay Relay being inserted in the CAX-12 servo power unit.

Edison Thermal Time Relays exclusively for CAX-12.

Edison's line of miniature time delay relays are available for a wide range of electronic applications. They are light, small, rugged and offer these advantages:

- Designed to withstand vibration frequencies to 1500 CPS
- Exceptionally high rate of contact closure
- Permanent calibration and hermetic seal
- Extremely rigid mechanical structure using high-strength, high-expansion alloys.

## Thomas A. Edison Industries

INSTRUMENT DIVISION

88 LAKESIDE AVENUE, WEST ORANGE, N. J.



# THE MOST TAPE HANDLER FOR YOUR MONEY

The Potter 906 II, the high-speed digital magnetic tape handler that has come of age gives you higher performance, greater reliability and lower cost than any other tape handler on the market—bar none.

If you're interested in computer efficiency, you'll appreciate the kind of high performance shown by the actual test results plotted to the right. The Potter 906 II is the first and only tape transport to offer full forward-reverse cycling at 120 ips with 1" tape.

You'll be interested, too, in the other advantages that the 906 II now gives you for the first time. Among these are—

1. Low skew tape guide permits conventional recording at 400 bpi density.
2. Densities of 1500 bpi can be achieved by using this transport with the Potter Contiguous Double Transition system—450,000 8-bit characters per second on 1" tape.
3. Transistorized control of all functions simplifies computer design.
4. Simplified packaging for easy maintenance.
5. A price—far below other makes—that proves the economy of superior design.

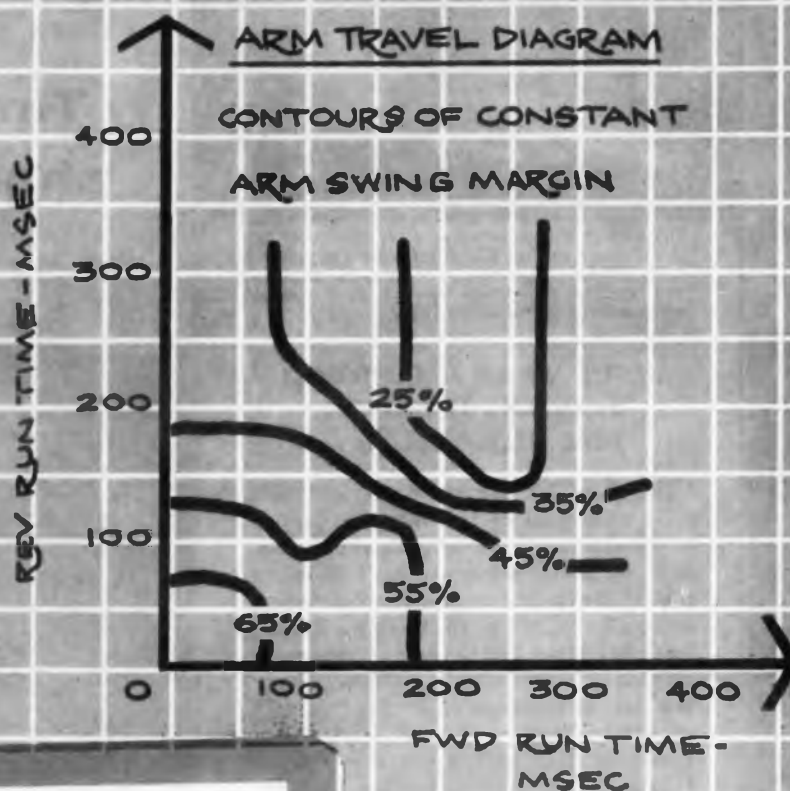
Compare them any way you like—spec for spec, dollar for dollar, space for space—and you'll agree that the high-performance, low cost, Potter 906 II is the most tape transport at any price.

## MODEL 906 II Magnetic Tape Handler



Note the simplified packaging for accessibility and easy maintenance.

## HERE'S PROOF



### SPECIFICATIONS

#### TAPE SPEED

100 and 50 ips, standard.  
Maximum speed: 150 ips.  
Minimum speed: 1.0 ips.

#### START TIME

3 milliseconds or less.

#### STOP TIME

1.5 milliseconds or less.

#### STOP DISTANCE

0.100" ± .035" at 100 ips.

#### REWIND

300 ips constant speed either direction. 1¼ minutes for 2400 feet, millisecond start-stop, with 1/2" tape.

#### INTERCHANNEL TIME DISPLACEMENT

±2 microseconds at 100 ips from center clock to outside track on 1/2" tape.

#### COMPUTER INPUTS

All functions including speed selection, FWD, REV, FAST FWD, FAST REV, controlled with 0 volt "OFF," -5 volt "ON," level type signal. Other level or pulse control signals can be accommodated on special order.

#### BLOCK FEED REP RATE

200 blocks/second maximum.

#### TAPE TENSION

3 oz. nominal, 1/2" tape. Maximum tension in guide system, approximately 6 oz.

#### SIZE

24½" high swing-out panel for 19" rack mount. Hinge mounts separately for ease of installation.

## NEWS

### New Switching Technique Reduces Line Contacts

A technique combining time-division "highway" principles with a "resonant transfer" principle cuts the space needed for electronic switching. While other switching systems require from 16 to 20 contacts a line, this approach requires about 1.3 contacts, according to the developer, North Electric Co. of Galion, Ohio.

The new technique is to be used primarily in electronic equipment for large commercial offices.

### Low Loss With Resonant Transfer

The resonant-transfer principle, conceived by Gunnar Svala, North Electric's director of research, and his associates, uses a series-resonant circuit for the pulse forming network. The capacitor also serves as the terminating capacitor of the filter. Half-sine-wave pulses are generated if the closure time of the switches is adjusted to exactly one-half cycle of the resonant circuits. During the half-cycle, the charge in the capacitor at one filter will swing over to the capacitor at the other filter, and vice versa, with very little loss.

The system, called the Time Division Multiplex Electronic Switching System, is said to provide many advantages. By using a common control marker, provision is made for a universal numbering plan with alternate routing. The highway-switching scheme keeps the transmission path as simple as possible and reduces delay, distortion and equalization problems.

### Millisecond Speeds Possible

Other features the system is said to possess include complete four-wire through-switching, with speeds in milliseconds to accommodate both data and voice transmission, as well as pushbutton dialing at each station.

Utilizing plug-in modular design, the system is reported ideal for tactical mobile and fixed installations. It is said to be fully compatible with any existing commercial or military

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Overbrook 1-3200

◀ CIRCLE 18 ON READER-SERVICE CARD



communications equipment.

The North Electric system has been chosen for the 412-L project, an Air Weapons Control System. Prime contractor for the project is General Electric, Syracuse, N.Y.

The 412-L system is a ground-environment complex with radars, data processing, communications and other special types of control equipment.

The contract award to North Electric is put at "several million dollars."

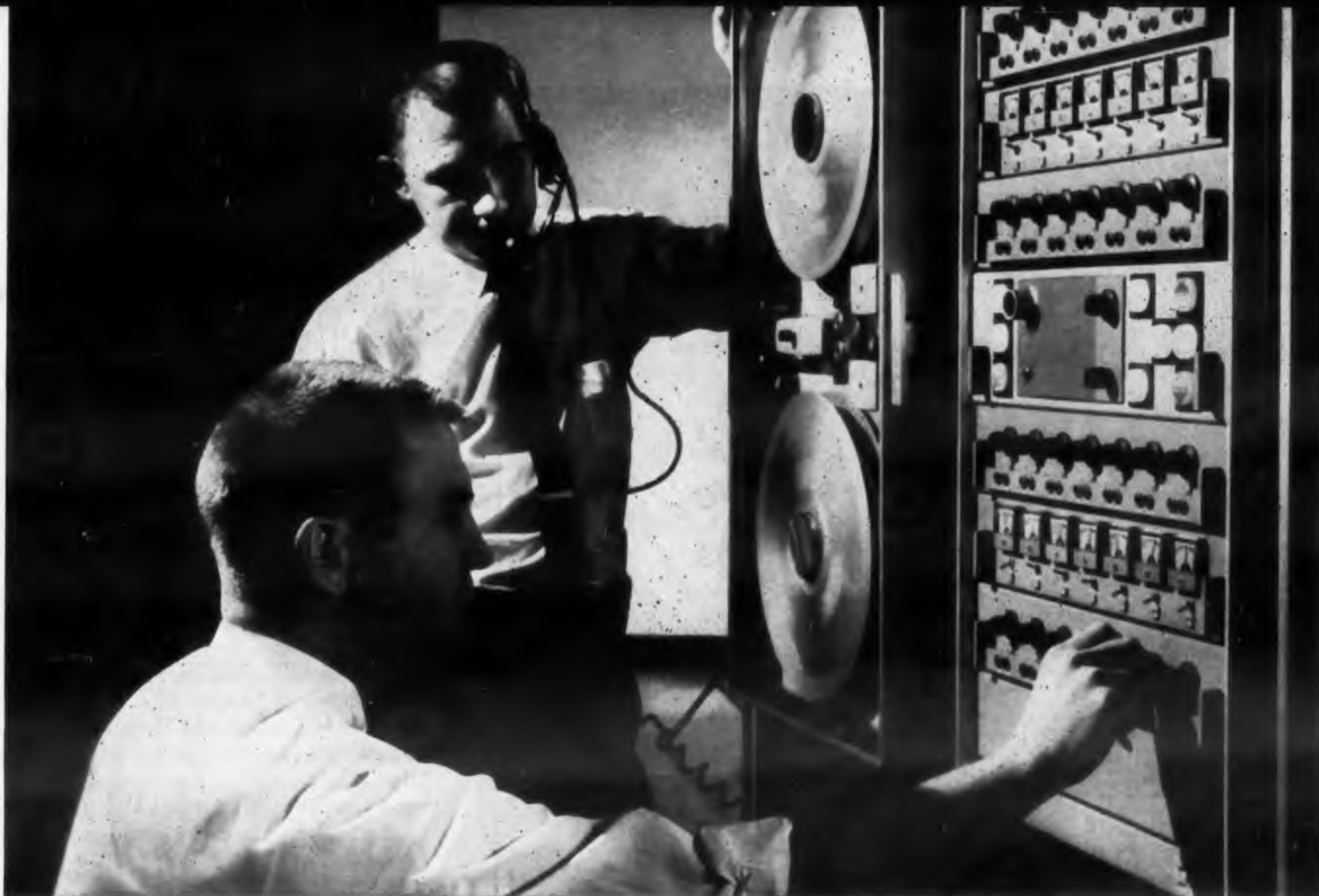
### Animal Body Reactions Telemetered to Scientists

Scientists have announced the development of two telemetering devices for recording animal reactions in the laboratory and on the farm.

The laboratory device is a temperature telemeter that can be implanted in an animal for its lifetime. John H. Busser, who made the device for the Office of Naval Research, said it requires no batteries. The animal under study is placed in a low-frequency power field. From the field, the telemeter picks up energy to transmit findings to a receiver. Researchers expect to modify the device to make possible the transmission of blood pressure and heart-beat information.

Another device, developed by the College of Agriculture of the University of Nebraska, records pressure changes in the stomachs of farm animals. According to an article by Loyal C. Payne in *Science*, this device is a modified Hartley oscillator. When it is placed in the rumen, or upper stomach, of a cow, fm signals are transmitted to a receiver whenever a pre-selected pressure is exceeded. The pressure at which transmission begins is determined by the capacitance across the coil of the circuit.

The disadvantage of this telemeter is that it must be recovered by surgery or slaughter, Mr. Payne reports. However, the low cost of each unit and the long life of the battery should balance this disadvantage, he adds.



AMPEX

## specifies Tung-Sol transistors for FR-600 analog tape recorder

The Ampex FR-600 records the same bandwidth at half the tape speed previously required. It's the first Ampex laboratory-type instrumentation recorder to offer all solid-state electronics. Frequencies as high as 250 kc can be handled (at a tape speed of 60 ips). FM, pulse-duration modulation, direct and digital recording modes are available through plug-in amplifier modules. FM response from d-c to 20 kc within 1/2 db is double that previously available. The FR-600 is already handling data recording in the new Minuteman missile project.

With reliability the keyword, the choice of components for the FR-600 had to be an exacting one. Tung-Sol germanium power and switching transistors were specified for several major assignments. Tung-Sol's high stability 2N379 transistors deliver reliable power to the motor drive amplifier, the FR-600 control unit, and each bay power supply of the recorder.

Tung-Sol's precision 2N414 germanium switching transistors handle important switching functions in the direct record amplifier, direct reproduce amplifier, FM record, FM reproduce, pre-amplifier and frequency standard.

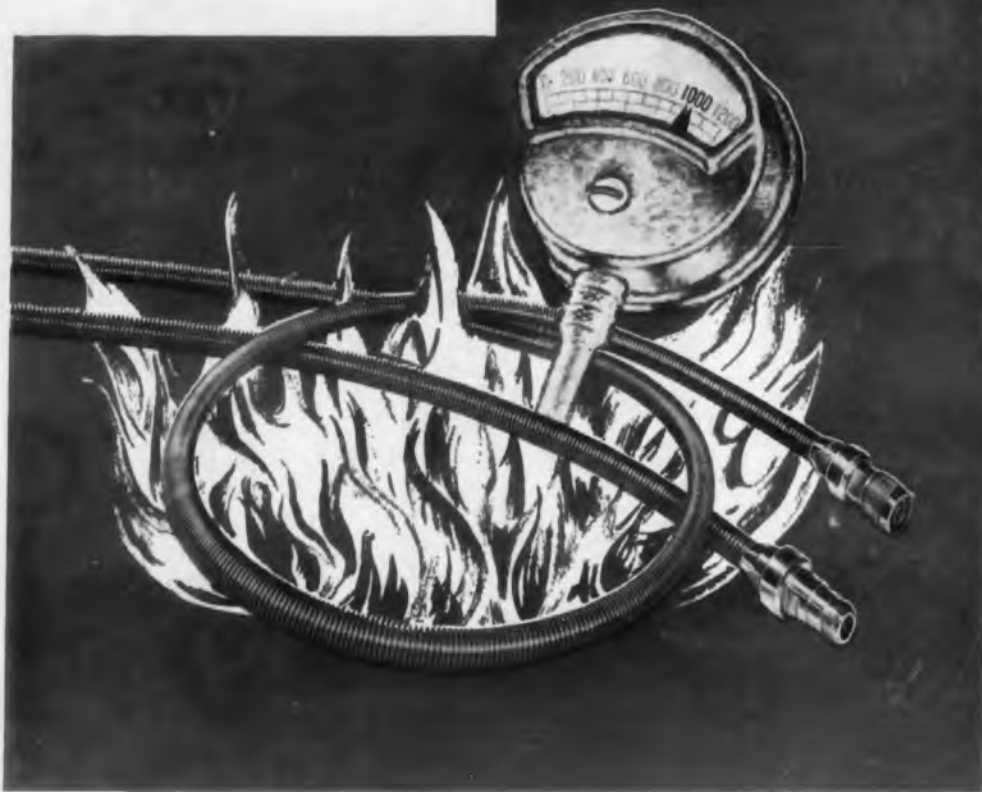
More and more are Tung-Sol components assuming critical tasks in modern electronics where long-life reliability is paramount. Whether in industrial, military or commercial applications, there's a Tung-Sol tube or semiconductor for virtually every need. Every component is the product of production processes and quality control that have made Tung-Sol the name synonymous with the finest componentry. Tung-Sol Electric Inc., Newark 4, N. J. TWX: NK193

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



# TUNG-SOL®

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## A CABLE SYSTEM OPERATES AT 1000°F CONTINUOUSLY!

The biggest news in coaxial cables during 1959 was the development by AMPHENOL Cable & Wire Division of flexible RF cable that operates at 1000°F continuously. Obviously of tremendous value in aircraft and missile applications, where temperatures of this order are commonly encountered, the 1000°F system is also being used in two other vital areas:

1. High temperature applications between the highest possible limit of RG-/U cables (482°F) and 1000°F. Electrical characteristics in this range are excellent.
2. Nuclear applications. The 1000°F system is resistant to nuclear radiation and is ideal in reactor use. The flexibility of the cable gives added value in nucleonics.

The cable system is furnished with 1000°F Series N terminations and in standard lengths up to 200 feet. It is altitude insensitive and moisture resistant; it's resistant, as well, to shock and vibration.

A flexible RF cable system capable of operation at ultra-high temperatures and in nuclear environments is another example of AMPHENOL Cable & Wire Division's CABLE-bility!



## CABLE & WIRE DIVISION

S. HARLEM AVE. at 63rd St., CHICAGO 38

Amphenol-Borg Electronics Corporation

CIRCLE 20 ON READER-SERVICE CARD

# WASHINGTON REPORT



Ephraim Kahn

DESIGN ENGINEERS will participate more fully in the Defense Dept.'s standardization programs. Standardization of items used by all of the military services will be stressed on the drawing board and in development. Furthermore the Defense Dept. will try where possible to use existing industrial standards and specifications, instead of writing its own. So far the military standardization program has led to removal of nearly a million items from U.S. buying lists.

ENGINEER EMPLOYMENT OPPORTUNITIES over the next 15 years are expected to double. By 1975, the Labor Dept. predicts, there will be 2 million engineers working. Scientists, too, are expected to be in an expanding labor market; more than 600,000 will be needed by 1975, with physics and mathematics the most rapidly growing fields. The number of technicians that will be needed is put at about 1.7 million.

NEW FCC CHAIRMAN Frederick W. Ford, is a career government lawyer who pays close attention to technical developments. Publicly he is probably best known for urging the Federal Communications Commission "not to lie in ambush" but to inform the public and broadcasters—in advance of violations—of its concept of public interest, convenience and necessity. Mr. Ford has been a moving spirit in the FCC's discussions with the Office of Civil and Defense Mobilization concerning the creation of a contiguous vhf band for TV by swapping some of the military's frequencies in the vhf area for uhf frequencies now assigned to civilian TV. He is also credited with developing the FCC's proposed interim TV allocations plan. This envisages putting short-spaced vhf TV channels into major market areas that have less than three regular channels.

NAVY HAS SPELLED OUT the meaning of its qualified products list. The service notes that the mere fact that a product has been accepted for listing does not mean that it will automatically be accepted. A place on the list is "neither a supplement to nor a substitute for acceptance testing under contract." It is intended to make sure, before a contract is written, that the prospective supplier can deliver the goods.

PROGRESS PAYMENTS CLAUSE in the Defense Dept.'s uniform contract has been changed. Object is to spur more subcontractors, especially small concerns, into using this type of financing. Optional after April 1, the new clause becomes mandatory after July 1. Its existence is in good part attributable to Congressional criticism of the mili-



tary's relationships with smaller businesses. Under the new clause, prime contractors will have to make available to small subcontractors substantially the same progress payment facilities that the primes have.

**AUTOMATIC PRODUCTION** of small, precise electronic components for the Nike-Zeus system should get top priority when (or if) the Defense Dept. unfreezes all or part of \$137 million in sequestered pre-production funds.

**MORE SINGLE PROCUREMENT** of items used by all three military services has been urged by the staff of the Congressional Joint Economic Committee. It finds "mismanagement, waste and duplication" in independent buying of simple commercial items.

**NO MAJOR CHANGES** in the Air Force's relationships with industry are anticipated by its Deputy Chief of Staff for Materiel, Lt. Gen. Mark E. Bradley Jr., even though the service is trying to build up its own management and research team. Stressing that the most important aspect of military buying for space projects was reliability, General Bradley noted that the high cost of a space vehicle "will dictate a degree of reliability which we are presently not enjoying." Air Force policy will continue to call for "one contractor to develop and integrate" major weapons systems.

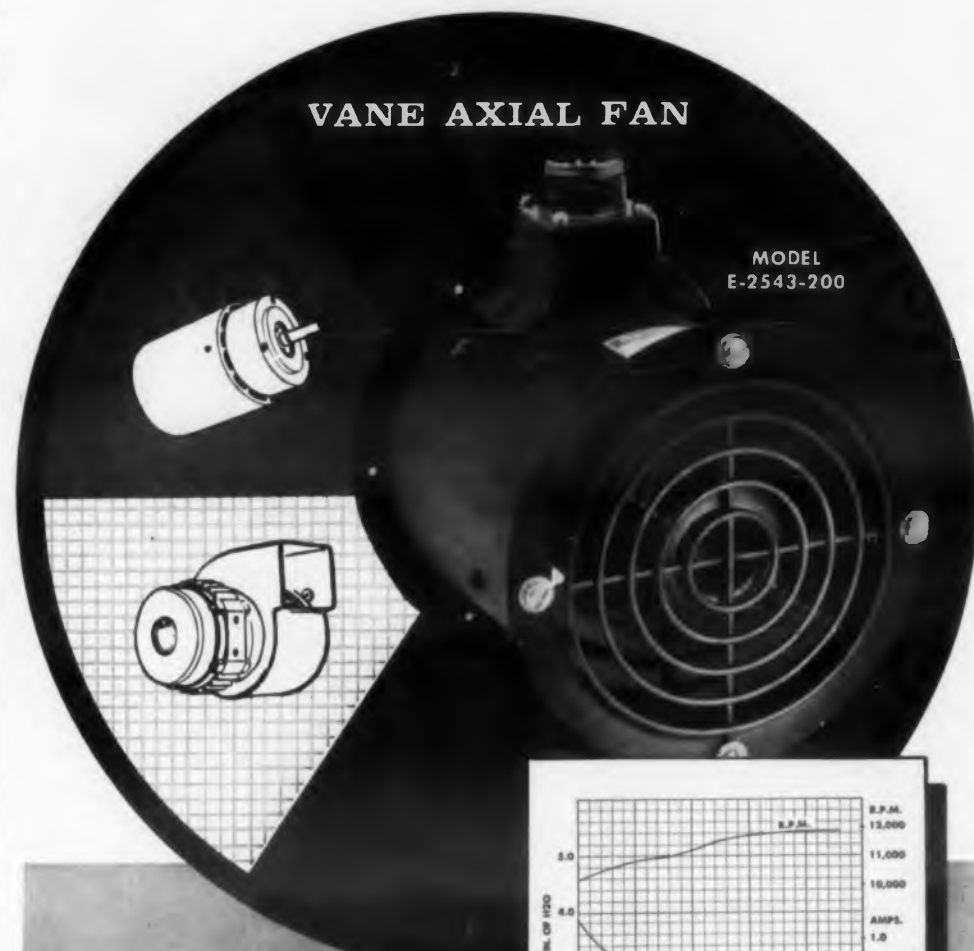
**CONGRESSIONAL PROBE OF SUBSIDIES** may reach into military procurement. The Joint Economic Committee—which already plans to inquire into automation and technological change and the economic impact of defense procurement—is basing its investigation of subsidies on a simple dictionary definition. Subsidize is defined as "to aid or promote, as a private enterprise with public money." A subsidy is "a governmental grant to assist a private enterprise determined advantageous to the public." The inquiry is a long-range undertaking, and no schedule has been drawn up. Still to be decided is whether it will include private companies that do all, or nearly all, of their business with the government and those specifically set up to compete for government contracts.

**NEW CONTRACT COST PRINCIPLES** have been clarified a bit by Pentagon officials. Contracting officers have been told in general how to apply the new rules, which become mandatory July 1, to pre-existing pacts. Provisions of existing cost-reimbursement contracts will in most cases be allowed to continue through the term of the agreement.

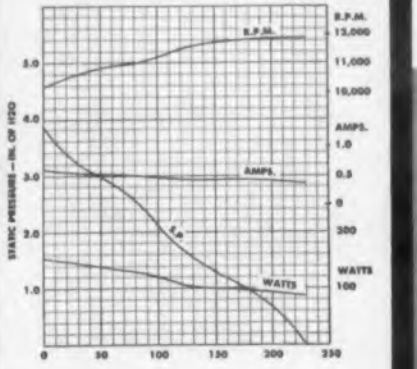
**INDEPENDENT R&D** comes in for special treatment under the new cost principles. The Pentagon wants to work out cost-sharing agreements with business concerns before research and development are undertaken. (Under the new rules, the military can finance independent research more liberally than development.) A screening group is to be set up in the Pentagon to survey proposed projects and to decide how much of the cost will be borne by the government.

**VANE AXIAL FAN**

MODEL  
E-2543-200



**SPECIFICATIONS:**  
 200V 400 cps 3 phase  
 200 CFM at 3/4" S.P.  
 Weight: 3 lb. 8 oz.  
 Ambient: 85°C  
 Life: 5000 hrs.  
 Environmental MIL-E-5422D  
 Material MIL-E-5400B  
 Class F Insulation



**AIR FLOW—C.F.M.**  
**MODEL**  
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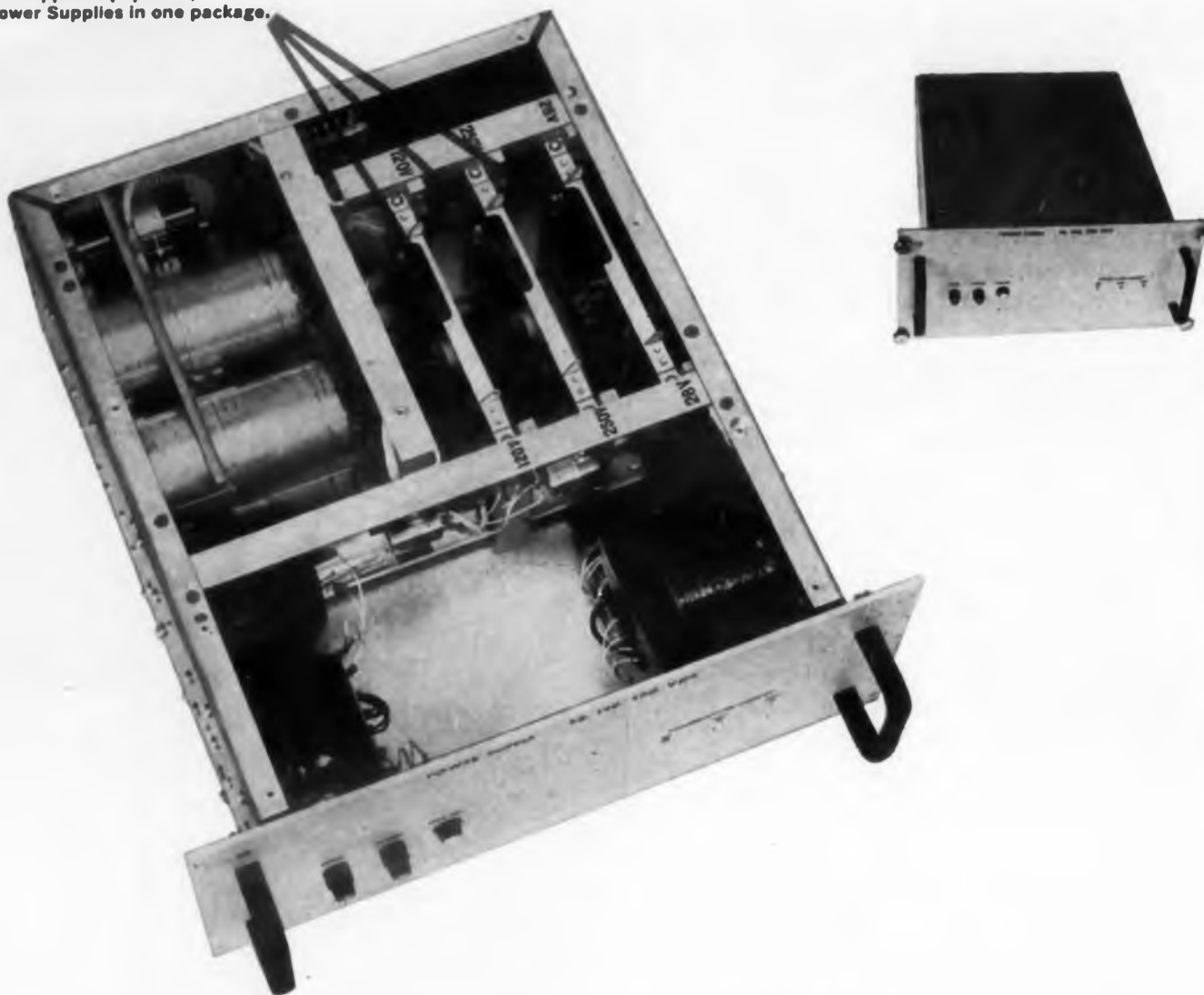


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Los Angeles, California

in Canada AAE Limited, Weston, Ontario  
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CIRCLE 21 ON READER-SERVICE CARD

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



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

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

### Characteristics Model #50-121

Input: 120 ± 5 % VAC

Outputs: 28 VDC @ 2.5 amp; 120 VDC @ 250 ma;

250 VDC @ 500 ma

Regulation: ±0.1% for combined temperature, time and load variations

Temperature: -10°F to +125°F operating; -54°F to +165°F non-operating

Ripple: 5 millivolts RMS (maximum)

Size: 8¾ x 17 x 20 (for 19" rack mounting)

Weight: approximately 70 lbs.

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# HYDRO-AIRE

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Division of CRANE CO.

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

## NEWS

### Computer Simplifies Russian Translation

A Univac computer, using a new technique called predictive analysis, is being used to simplify English translations of Russian scientific articles.

Formerly the computer could produce only rough, word-for-word translations. Predictive analysis permits the machine to approach a sentence as a human does, one word at a time from left to right. The output contains the English translation and the grammatical relation of each word in a sentence. With this information, it is said that a person who knows little or no Russian can prepare a finished translation.

Linguists and mathematicians at the Harvard Computation Laboratory, under the direction of Assistant Professor A. G. Oettinger, developed the process.

#### How Sentences Are Analyzed

Predictive analysis, the laboratory says, is based on a few fundamental concepts. The first is alternative functions, which takes into consideration the fact that a single word may be eligible for several jobs in the sentence being translated. To decide which job the word actually does, the computer makes use of a prediction pool.

The prediction pool enables the computer to decide, for example, if an adjective modifies the subject or object by its position in the sentence. If the subject of the sentence has not yet appeared, the adjective will be held in the computer's memory.

The machine proceeds through the sentence checking one word at a time. Each word determines the most probable grammatical form of the following word. After a sentence, the machine decides whether all requirements for a complete sentence are met. If the sentence cannot be analyzed, the machine notes this too.

#### Automatic Editing Sought

The next step in machine-translation research, the Harvard labora-



tory reports, will be to program a computing machine that will turn out a finished English translation without the need for a human editor.

Originally the Harvard scientists prepared a Russian-English dictionary in the form of magnetic tape in the memory section of the Univac. When translations from this proved unsatisfactory the scientists turned to predictive analysis.

The fundamental work for the new technique was done by Mrs. Ida Rhodes of the Applied Mathematics Div. at the National Bureau of Standards. The Harvard project has been supported by grants from the National Science Foundation and the Rome Air Development Center of the Air Force.

## CHANGES IN . . . PRICES & AVAILABILITY

**CYCOLAC PLASTIC** has been reduced in price by Marbon Chemical, a division of Borg-Warner. Natural CYCOLAC (pellets) have dropped from 58 cents to 49 cents per lb; standard and custom-colored CYCOLAC (pellets) from 58 to 51 cents per lb; natural CYCOLAC (powder) from 53 to 45 cents per lb.

**ELECTRICAL CONNECTORS** have been reduced in price from 4 per cent to 6 per cent by Bendix Aviation Corp. The reductions effect the Bendix Pygmy connector line.

**TV PICTURE TUBE** bulb allowance increases have been announced by Sylvania Electric Products, Inc. The increases range from 50 cents to \$1.25.

**NYLON TUBULAR BARS** have been reduced in price up to 50 per cent by the Polymer Corp. Designated POLYPENCO MC Nylon 901, the bars are available in outside diameters ranging from 2 in. to 15 in. Standard thicknesses are 3/8 in., 1/2 in., 3/4 in. and 1 in. Wall thicknesses up to 2 in. can be made to order. Standard length is 8 in. for inside diameters under 1-1/2 in. and 12 in. for larger sizes.

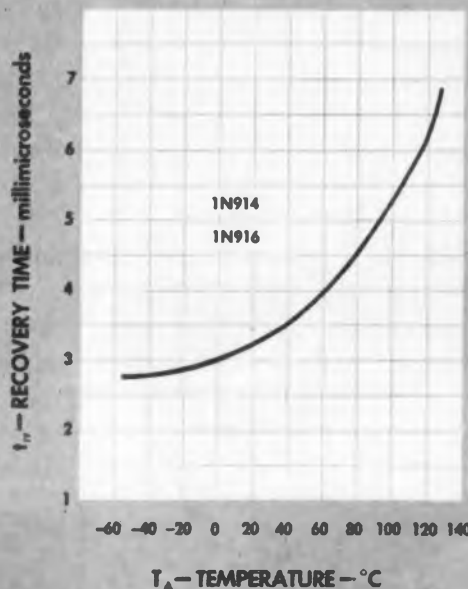
CIRCLE 23 ON READER-SERVICE CARD

## NEW FROM TI . . .

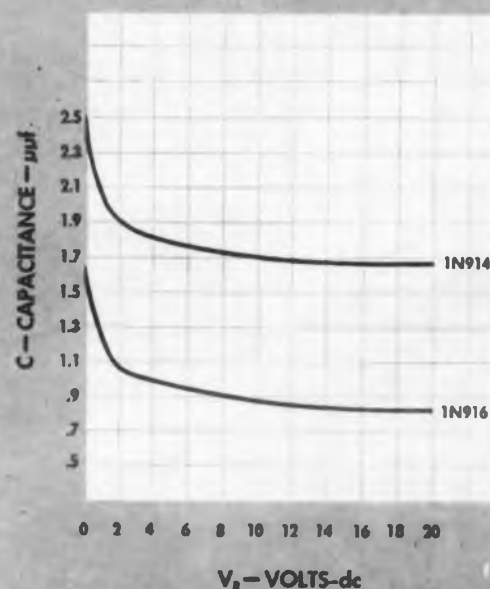
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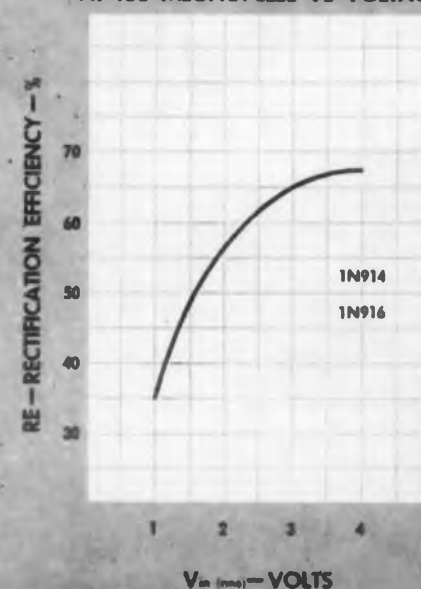
TYPICAL REVERSE RECOVERY TIME VS TEMPERATURE



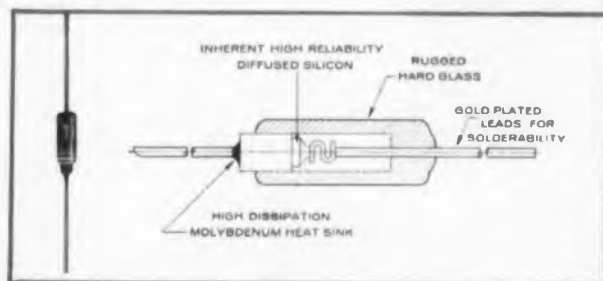
TYPICAL CAPACITANCE VS VOLTAGE



TYPICAL RECTIFICATION EFFICIENCY AT 100 MEGACYCLES VS VOLTAGE



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



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

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

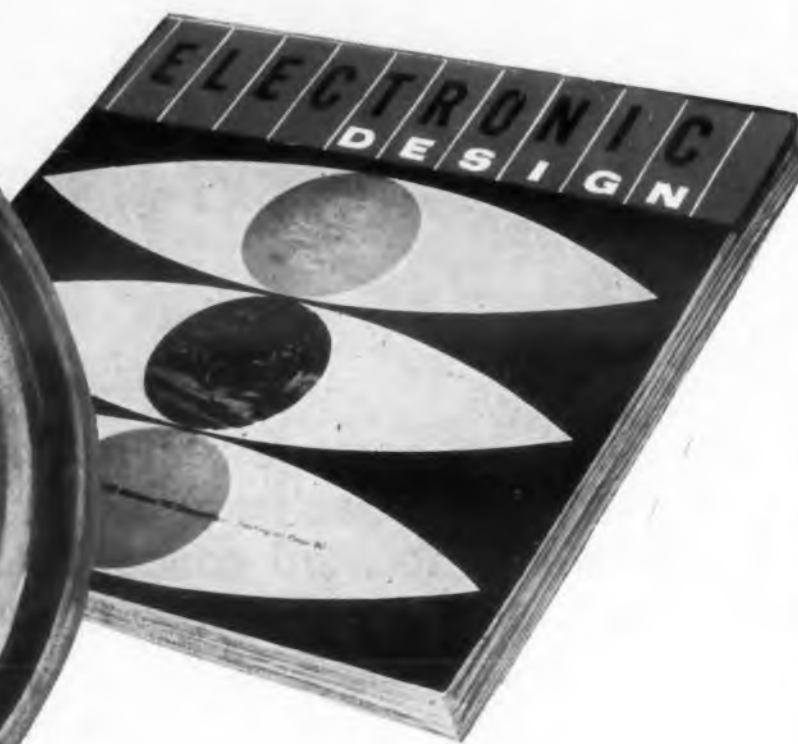
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## NEWS

### New Device Switches Mechanically at Electronic Speeds

Mechanical switching at electronic speeds is reported for the Ferreed, developed at Bell Laboratories, Whippany, N.J.

A bistable magnetic material, such as cobalt ferrite, actuates a metallic reed switch to provide switching times on the order of several hundred microseconds. Control pulses as short as 5  $\mu$ sec switch the ferrite, and the device will maintain its state without a holding current. Typical switching mmf is on the order of 150 amp-turns.

Several new magnetic materials were synthesized for use in developmental models of the Ferreed. Among these are ferrites exhibiting characteristics midway between permanent magnets and computer memory materials.

A typical application for the Ferreed would be as a cross point in telephone switchboards. The device can be adapted for either coincident-current or single-pulse actuation. Switching pulses of a widely varying character could be accommodated for various applications.



**Sub-millisecond mechanical switching** is provided by Bell Laboratories' Ferreed. A 5- $\mu$ sec pulse through the windings switches the ferrite bars to actuate the two reed switches in the center of the device. The Ferreed can be likened to a scaled-up memory core. It requires no holding current.

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ELECTRONIC DESIGN • March 30, 1960



## Industrial Electronics Makers Advised to Stress Systems

Industrial electronics manufacturers have been advised to shun development of isolated components of systems and to concentrate instead on the systems themselves.

The advice came from Patrick Robinson, advanced projects director for John Diebold & Associates, Inc., New York marketing consultants. He spoke at a conference in New York sponsored by the industrial electronics division of the Electronic Industries Association.

Mr. Robinson warned that the "piecemeal approach" to marketing computers and other individual components would create chaos for businesses that wished to automate their operations. He urged instead that manufacturers tailor systems to the needs of individual customers.

He said companies that installed components rather than systems were "building a Tower of Babel" and would be better off throwing out the equipment and returning to their old way of doing business.

Concentrate on the needs of the individual business system, he advised buyers, "and then worry about the equipment to fill those needs."

Mr. Robinson also urged manufacturers to simplify the nomenclature of automation, so that computer operations, for example, could be understood by technicians as well as by engineers and mathematicians.

## 4,000 Line-Per-Min Plotter Produced



Briggs Printer-Plotter System can plot 10 curves simultaneously at 300,000 points per min, or print 4,000 lines per min. The system is designed for use in Atlas missile data processing. On one side of the printing paper are 1,024 stylii, and on the other a metal anode. A pulse injected into a stylus draws metal ions from the bar, causing a black mark to be produced on the paper. Briggs Associates, Inc., designed the system using a printer produced by Hogan Faximile Corp.

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# ACCURACY

## 0.05% DC ...



### FULLY TRANSISTORIZED

No vacuum tubes or batteries.

### ACCURACY

DC  $\pm .05\%$  Absolute from 10 MV to 1 KV.

RANGE DC 0-1 KV.

MODEL DC-100A

**Precision DC Voltmeter**  
**FULLY TRANSISTORIZED**  
**NO EQUAL IN SIMPLICITY**

### MODEL DC-100A

- Built in ultra stable reference supply.
- Highly stable 1 MV null amplifier (No zero controls).
- High resolution readout.
- Portable—9 LBS.

The Model DC-100A DC Voltmeter is a compact potentiometric voltmeter designed to measure DC voltages to an accuracy of better than  $\pm .05\%$  absolute. Below 10 volts the meter has an infinite input resistance at null. Above 10 volts the input resistance is two megohms. A very stable Zener package is used as the reference. The temperature coefficient is better than  $\pm .001\%/^{\circ}\text{C}$  over a range of  $10^{\circ}$  to  $40^{\circ}\text{C}$ . Long term stability is approximately  $\pm .01\%$  / year. INPUT VOLTAGE 117 V.A.C.—60 cps. Input Power less than 3 watts. Size 8" w, 7" h, 6" d.

The null indicator is a stable transistorized chopper amplifier having a full scale deflection of 1 MV. Zero offset is so small that there is no need for a front panel zero control. Large overloads will not damage the amplifier or panel meter. The Kelvin-Varley divider is composed of two switch dividers and a precision 10 turn potentiometer. The resistors in the two dividers are matched to each other and the switches and potentiometer then matched to each other to produce an overall dividing accuracy of better than  $\pm .01\%$ .  
 PRICE \$175.00 F.O.B. POMONA, CALIFORNIA

#### VOLTMETER PRECISION AC/DC MODEL AC-100A

A fully transistorized potentiometric voltmeter capable of precision measurement of both AC and DC voltages. Accuracy of 0.05% DC from 10 MV to 1 KV and 0.2% AC from .5 volts to 1 KV. Frequency range is 30 to 5000 cps. input impedance on AC is 1 megohm on lower ranges and 2 megohms on highest range. Weight and size 10 lbs., 8" w, 7" h, 6" d.

PRICE \$495.00

#### VOLT-AMP METER MODEL VA-100A

A compact potentiometric voltmeter designed to measure DC voltages to accuracy of better than  $\pm .05\%$  absolute and currents to an accuracy of better than  $\pm .1\%$ . This instrument has a 5 digit readout with the last 3 digits readout on a precision 10 turn potentiometer. Weight and size 9 lbs., 8" w, 7" h, 6" d.

PRICE \$545.00

#### WHEATSTONE BRIDGE MODEL WB-100A

A compact electronic package designed to measure resistances from 1 ohm to 100 megohms to an accuracy of better than  $\pm .05\%$ . The instrument is complete in itself and contains no batteries or vacuum tubes, the only active elements are transistors and Zener diodes. Sensitivity 1 MV for full scale, transistorized chopper amplifier. Weight and size 8 lbs., 8" w, 7" h, 6" d.

PRICE \$495.00

#### REGULATION MONITOR MODEL RM-2A

This regulation monitor is a compact electronic instrument designed specifically to measure the stability of any DC voltage from 2.0 volts to 500 volts. The drift is less than .005% for an 8 hour day and its short term drift is less than .002%. At maximum sensitivity the meter gives full scale deflection for a deviation of  $\pm 0.1\%$ . Weight and size 7 lbs., 8" w, 7" h, 6" d.

PRICE \$325.00

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 Electronic Instrumentation for Industry

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## POWER TRANSISTOR SERIES

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Current Gain hFE at Ic = 10 Adc	Maximum Voltage Rating			
	50 Vcb 30 Vce	60 Vcb 40 Vce	90 Vcb 70 Vce	100 Vcb 80 Vce
20—60	2N1031	2N1031A	2N1031B	2N1031C
50—100	2N1032	2N1032A	2N1032B	2N1032C

Ask for complete details on this newly improved Bendix transistor series . . . and on the entire Bendix line of power transistors and power rectifiers. Write SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY, or the nearest sales office. \*TRADEMARK

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LONG BRANCH, N. J.



## NEWS 'Brisk' European For U.S. Tubes,

United States manufacturers of tubes and semi-conductors have established a "brisk" market for their specialized types in most Western European countries, the Dept. of Commerce reports.

The agency's Business and Defense Services Administration has published a survey that shows the volume of imports by nine European countries of U. S. tubes and semiconductors. The survey indicates that American producers are supplementing their home marketing by establishing European outlets either through licensing arrangements or by direct investment.

The administration, in commenting on the report, says that U.S.-made tubes and semiconductors of advanced design hold "further promise" for sale in Europe.

### Nine Countries Surveyed

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

The outlook in the nine countries was given as follows:

**Austria.** The electronic industry is still in early development but represents a potential market for foreign producers of new and technically advanced items. Tubes and semiconductors made in the U.S. are of recognized quality, but American suppliers must compete with low prices and easy credit offered by others. Austria's electronics trade is largely oriented toward The Netherlands.

**Belgium.** The U.S. is expected to continue exporting to Belgium and Luxembourg substantial quantities of transmitting and special-purpose tubes, particularly those of advanced design. Strong price competition is a drawback to increased shipments of receiving and TV picture tubes from the U.S. Comparatively few transistors are reported used in the manufacture of electronic equipment in Belgium.

**Denmark.** Consumption of all categories of tubes and semiconductors is increasing, stimulated in part by expanding output of electronic consumer goods and steady growth in the requirements of communications, broadcasting and industry. About 80 to 85 per cent of Denmark's requirements for transmitting, power and special-purpose tubes are for replacement. Approximately 700 radar transmitters are in use, and annual production of radio transmitters in the 100- to 500-w range is estimated at 400. About 4,500 transmitters of less than 100-w rating are produced yearly. One Danish company is producing germanium diodes, reportedly with the technical cooperation



## Market Found Semiconductors

of a French company, and is planning to make germanium transistors. High prices and lack of interchangeability of many U.S. and European tubes tend to limit the Danish market for U.S. products.

**France.** Tubes and semiconductors are produced in France by 27 companies, which employ about 8,500 persons. French imports of tubes, diodes, transistors and parts in recent years have remained relatively level, but exports of tubes and semiconductors have increased sharply. U.S. producers are expected to retain their strong position in this market, although The Netherlands' share is increasing. The U.S. was France's principal market for transmitting tubes in the first half of 1959, and she supplied a substantial quantity of receiving tubes.

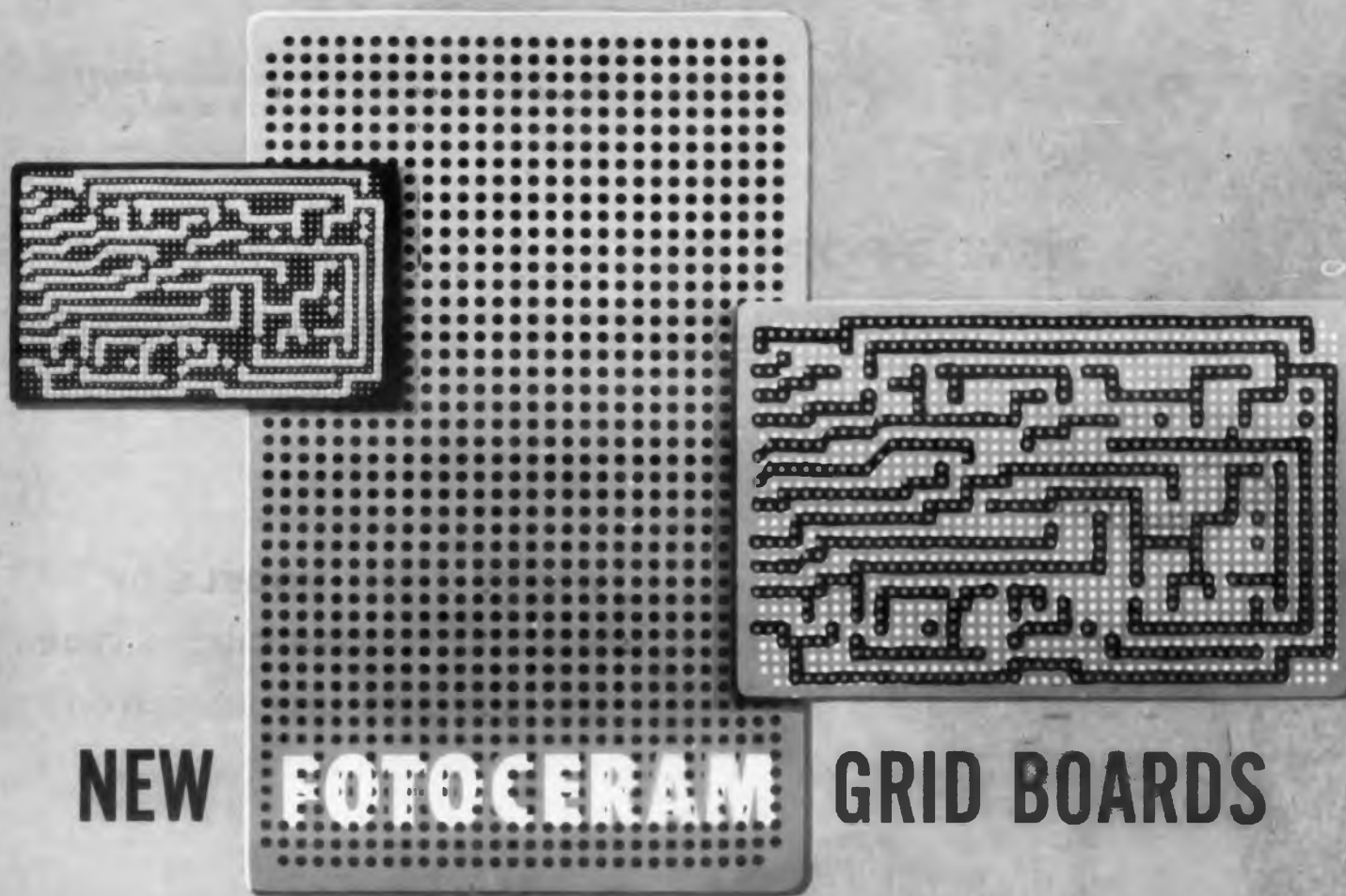
**Italy.** Tubes, transistors and crystal diodes are produced in Italy by at least eight companies, most of which have affiliations and licensing agreements with electronics companies abroad. Most of the large U.S. electronics companies are believed to have surveyed Italy in the last two years for investment and licensing possibilities. One U.S. company has arranged a licensing agreement, two have formed new manufacturing units in association with Italian capital, and a fourth has bought into an Italian company. Strong influences in these developments were apparently the expanding market in Italy for tubes and semiconductors and enlarged opportunity for export to other nearby countries because of the European Common Market. As a result of foreign affiliations, rapid technical developments are expected in the Italian electronics industry. The U.S. is expected to be a leading supplier of new and advanced types of tubes and transistors.

**Norway.** Electron tubes and semiconductors are not produced in Norway. A relatively high

### Imports of U.S.-Made Tubes In Thousands of Dollars

Country	1956	1957	1958	1959
Austria*	22	19	95	3 mo: 55
Belgium	—	1,082	1,097	4 mo: 484
Denmark	—	248	449	7 mo: 489
France	4,099	3,533	2,688	6 mo: 1,167
Italy	4,771	6,872	5,578	—
Norway*	—	289	233	5 mo: 131
Sweden	523	658	1,178	—
Switzerland	344	541	303	—
United Kingdom	1,421	901	746	—

\* Figures include semiconductor devices.



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Now you can produce experimental or small-production-run printed circuits fast and economically in your own lab . . . just 15 minutes of simple processing with this new copper-clad FOTOCERAM grid board from Corning.

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three standard sizes . . .  
3" x 5", 6" x 8", 9" x 12"  
. . . thickness .062"  
component mounting  
holes 0.52" diameter  
± .005" on 0.1" centers.

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## NEW 3-PORT CIRCULATORS FOR MASERS, PARAMETRIC AMPLIFIERS & RADIO ASTRONOMY



### TWENTY EIGHT MODELS OF SMALL LOW-LOSS CIRCULATORS FOR L, S, AND UHF BANDS DOWN TO 350 MC

The unusually compact, low-loss, Raytheon circulator design first introduced for L-band applications last summer is now available in 28 standard models.

The three-port circulators, designed for use with coaxial line, are supplied with fixed permanent magnets or with tunable electromagnets for operation over a broader band. Insertion loss is typically .4 db maximum.† Isolation on all units is 20 db minimum. VSWR is 1.25 maximum. See typical specifications at left.

To learn more about these significant developments or for information about other important Raytheon advances in microwave ferrite devices, please write, stating your particular area of interest, to the address below.

†L&S bands only. UHF insertion loss is typically .5 db.

**RAYTHEON COMPANY**  
**SPECIAL MICROWAVE DEVICES OPERATIONS**  
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*Excellence in Electronics*

### TYPICAL SPECIFICATIONS

	UHF	L & S bands	
		Tunable units	Fixed units
Frequency range	any freq. from 350-800	any freq. from 800-3000	any freq. from 800-3000
Bandwidth	±5 mc	±50 mc above 1000 mc ±40 mc under 1000 mc	±25 mc above 1000 mc ±20 mc under 1000 mc
Isolation	20 db min. 25 db max.	20 db min. 30 db max.	20 db min. 30 db max.
Insertion loss	.4 db min. .6 db max.	.3 db min. .4 db max.	.3 db min. .4 db max.
VSWR	1.08 min. 1.25 max.	1.08 min. 1.25 max.	1.08 min. 1.25 max.
Power (av.)	5 watts	5 watts	5 watts
Power (peak)	5 kw*	5 kw*	5 kw*
Wt. (max.)	10.0 lbs.	10.0 lbs.	9.0 lbs.
Max. diam.	7½ in. excluding arms	7½ in.	7½ in.

\*With type N connector. Powers as high as 90 kw are possible with type HN connector.

CIRCLE 29 ON READER-SERVICE CARD

## NEWS

proportion of Norway's power, special-purpose and transmitting tubes are imported from the U.S., the United Kingdom and Sweden. The Netherlands and West Germany are the principal suppliers of receiving tubes

**Sweden.** About nine Swedish manufacturers produce tubes, transistors and semiconductor rectifiers. Several of these companies are affiliated with Netherlands and U.S. companies. Electronic products of U.S. manufacturers are generally priced about 20 per cent higher than those produced in Sweden and other countries. But tubes of U.S. design made under license in Western Europe are able to compete in the Swedish market. Swedish observers believe that the domestic market could not support substantial production in Sweden of U.S. tubes and semiconductors under license or through direct investment.

**Switzerland.** Five companies produce tubes and semiconductors in Switzerland, which is a growing market. U.S. tubes and semiconductors have a good reputation in Switzerland and should continue to compete successfully.

**United Kingdom.** The tube industry in the United Kingdom comprises about 15 major producers, including subsidiaries of U.S. and Netherlands companies. Their principal foreign markets are in The Netherlands, U.S. Australia, India, West Germany, Sweden and Italy. Exports to the U.S. have climbed rapidly in recent years, particularly tubes rated 50 w or less. The Netherlands and West Germany are the leading sources of imported receiving and TV-picture tubes. U.S. leadership as a supplier of transmitting and special-purpose tubes have been reduced substantially by increasing competition from Continental Europe. Tube imports from the U.S. will probably continue to be of relatively specialized types. Great Britain expects to continue shipping large quantities of receiving and special-purpose tubes to the U.S.

The United Kingdom has more than 20 manufacturers of semiconductor devices, 11 of whom produce transistors. Foreign capital is importantly involved: the leading producer is a Netherlands company, and about six U.S. affiliates are participating. The vigor of the tube and semiconductor industries in the United Kingdom and the extent of British research in this field indicate continuing opportunities for licensing and cross-licensing arrangements.

The 34-page report is available from the Supt. of Documents, U.S. Government Printing Office, Washington 25, D.C. The study is the first in a series of foreign market surveys of tubes and semiconductors being prepared by the Electronics Div. of the Business and Defense Services Administration of the Dept. of Commerce.

ELECTRONIC DESIGN • March 30, 1960



## U.S. Agency Studies EIA Charge Of Japanese Transistor 'Threat'

The alleged threat of Japanese transistors to national defense research may lead to a long, second look as to who should pick up the tab for semiconductor research.

In renewing its call for Government action to curb the import of Japanese transistors, the Electronics Industries Association charged that the undercutting of the commercial transistor market by low-priced Japanese units would limit the industry's capacity for research and expansion to meet defense needs.

The Office of Civil and Defense Mobilization, which has the authority to recommend Government action, has assigned the Commerce Dept. to gather pertinent industry data.

Heretofore unavailable figures of the amounts spent by industry and Government for military semiconductor research should result. A comparison of these figures with those for other sectors of the electronic and aviation industries could lead to a change in funding of research for semiconductors.

### Imports Cut Prices in Half

Japanese semiconductor imports in 1959 topped 25 million units, the EIA reported, at an average price of 60 cents a transistor—about half the going domestic rate for similar types. The Japanese transistors were almost exclusively germanium entertainment units, with the bulk—21 million—imported as components in miniature radios, the EIA said.

In sales, Japanese semiconductors are reported to have captured some 3 per cent of the total U.S. market and about 20 per cent of the commercial market in 1959. Industry leaders foresee the import of 100 million transistors in 1964—accounting for about two-thirds of non-military sales—unless restraints are imposed.

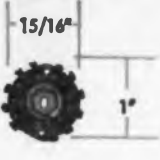
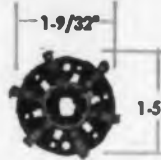
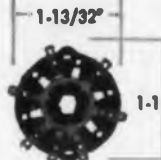



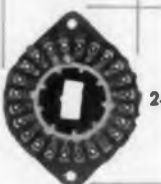

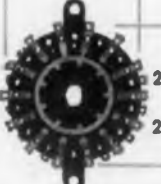

The Japanese reply to the OCDM contends that military demand will be large enough to support expansion and research independently of commercial sales. The reply cites Government figures predicting demand for 100-million units for military transistors in 1964. The production of military transistors, say the Japanese, is beyond the capacity of their research and technology, which they describe as "secondhand" and not in competition with high-quality manufacture of high-frequency, high-quality types.

The growth of the American semiconductor industry (from almost nothing in 1952 to \$370 million in 1959) was held to show that imports are not causing any damage.

### Union Opposes EIA Stand

Surprisingly, opposition to the EIA stand came

# Widest Option in Low-Power Rotary Switches

SECTIONS				
 <p>1-5/16"</p> <p>1"</p> <p>THROW: 30°, 36°, 45° INSULATION: stator glass silicone; rotor, KEL-F</p>	 <p>1-9/32"</p> <p>1-5/16"</p> <p>THROW: 30°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>	 <p>1-13/32"</p> <p>1-17/32"</p> <p>THROW: 25.7°, 30°, 36°, 45°, 60° INSULATION: phenolic, ceramic</p>	 <p>1-5/8"</p> <p>1-7/8"</p> <p>THROW: 18°, 20°, 30°, 36°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>	 <p>1-7/8"</p> <p>1-7/8"</p> <p>THROW: 30°, 36°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>
 <p>1-31/32"</p> <p>2-5/16"</p> <p>THROW: 20°, 40° INSULATION: phenolic</p>	 <p>1-3/4"</p> <p>2-5/16"</p> <p>THROW: 15°, 30° INSULATION: phenolic</p>	 <p>2-5/16"</p> <p>2-5/16"</p> <p>THROW: 20°, 40° INSULATION: phenolic, Mycalex</p>	 <p>1-23/32"</p> <p>2-17/32" or 2-5/16"</p> <p>THROW: 12.85°, 25.7° INSULATION: phenolic</p>	 <p>2-1/32"</p> <p>2-17/32"</p> <p>THROW: 12.85°, 18°, 25.7°, 36° INSULATION: phenolic</p>

### METAL PARTS AND FINISHES

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

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

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

### CONTACTS

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



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

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

**TYPE 3**—Contacts and rotor blades made of Oak alloy

**CMS-202.** This is a special alloy for high temperature operation to 150°C.

**GOLD-PLATED CONTACTS**—Type 1 or 2 contacts may be gold-plated .0002" thick. Not to be confused with gold flash. **FOR PRINTED CIRCUITS**—Standard Oak contacts with a lug extending from the terminal end. Lug inserts in board for dip soldering.

### ACCESSORIES



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

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

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

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

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

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### SEND FOR THIS GUIDE CHART TO OAK SWITCHES

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



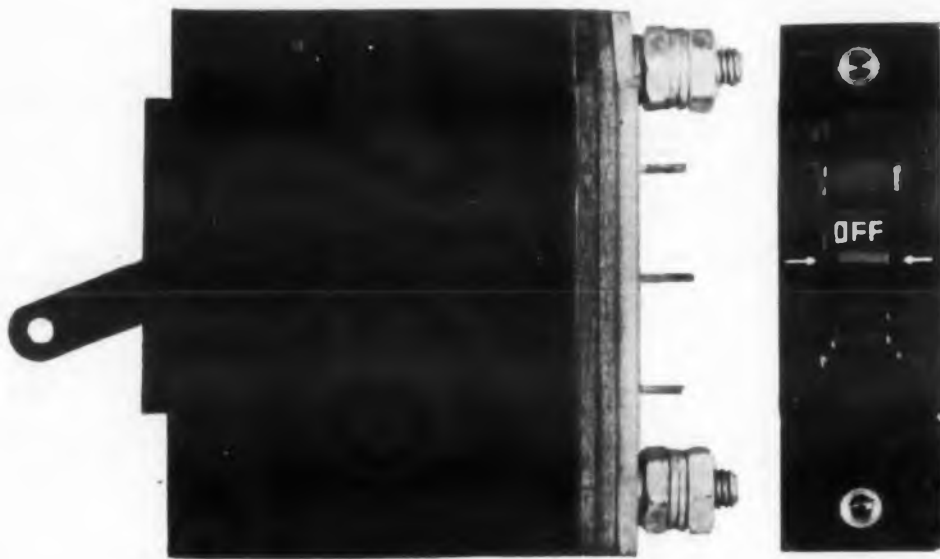
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# TRIPS

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\*Hynetic is the Westinghouse trade-mark for its new hydraulic-magnetic breakers designed specifically for the electronics industry.

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CIRCLE 31 ON READER-SERVICE CARD

## NEWS

from the International Union of Electrical Workers, which filed a petition of its own before the OCDM. The union's brief argues that inability to meet Japanese competition stems from excessive profits rather than from low wages abroad. Announcements by Philco and Texas Instruments of automatic production lines to turn out germanium transistors at prices competitive with imports were cited as proof that American industry could hold its own against foreign products.

In its reply to the Japanese brief, the EIA decried the notion that production of military and commercial transistors could be considered separate industries. Both classes of transistors, said the EIA, come off the same production lines, and volume production methods devised for commercial units are applied with equal success to the manufacture of military transistors at lower cost.

"No industry will continue to expand production facilities or undertake costly research and development programs in the face of inevitable loss of up to two-thirds of its unit markets, the EIA said. "It may shift existing facilities to the production of industrial and military transistors, but it is unlikely to expand facilities when faced with a market of only one-third the size previously envisioned."

### Foreign Ties Complicate Issue

The electronic industry as a whole, however, may not be unanimous in its support of the EIA. Several large U.S. concerns have financial interests in Japanese transistor plants, and considerable royalties are paid to American companies by the Japanese for use of transistor designs and circuits. Emerson, Bulova and Packard-Bell, among others, import large quantities of Japanese radios for resale here, while other companies import transistors and other components for assembly in this country.

Active support of the EIA in the form of briefs to the OCDM has to date come only from Texas Instruments among the larger, multi-plant transistor manufacturers.

Favorable action by the OCDM would probably consist of a recommendation to the President that transistor imports constituted a threat to national defense. The President could then instruct the State Department to negotiate voluntary import quotas with Japan. In any event, OCDM action is not expected until late in the year.

Loose transistors are presently subject to a 12 1/2 per cent import duty and assembled radios to a 15 per cent duty.



## Transistorized Language Lab Can Accommodate 50 Students

A new electronic language laboratory using transistorized components can accommodate up to 50 students at a time, according to its developer.

Equipment for all 50 students need not be installed at the same time, however, because it comes in modular form.

The developer, DuKane Corp. of St. Charles, Ill., said that linguists, educators, school administrators and members of the United States Office of Education were consulted on the specifications for a language laboratory.

Three teaching techniques may be used in the laboratory.

Beginners are acquainted with the sounds of the new language in booths where they listen to master tape recordings. In addition, the instructor may speak to them individually or in groups.

Students at higher levels can respond to the voice on the tape recording and compare their intonations with those of the master.

The third teaching technique requires the students to record their responses along with the master material on their own tape recorders. The student compares the two when he plays the tape back.

The amplifiers in the laboratory have a frequency response of 50 to 20,000 cps; the master tape reproducer, 70 to 15,000 cps, and the students' headsets, 50 to 10,000 cps.

Cross-talk and noise have been reduced to negligible values, according to DuKane.

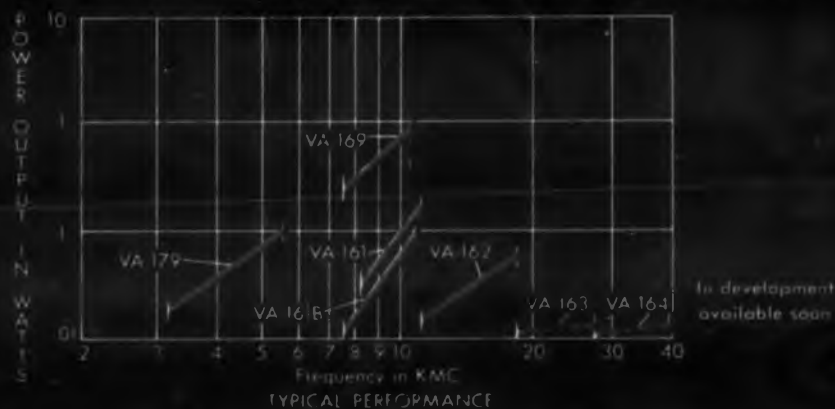
## 240-Line Electronic Telephone



This system is operating in Paris at the Laboratoire Central de Telecommunications, a research company associated with ITT. In the private branch system, mechanical registers are replaced by ferrite cores in transistorized logic circuits. Switching is done by cold-cathode gas tubes capable of 1-msec operation.

ELECTRONIC DESIGN • March 30, 1960

# FROM VARIAN: A LINE OF RUGGED, PM FOCUSED BACKWARD WAVE OSCILLATORS



Varian now offers a line of permanent magnet focused backward wave oscillators in frequency ranges to cover a wide variety of circuit application requirements. All models feature small size, low voltage operation, long life expectancy and rugged construction. These tubes are available either from stock or on short delivery schedules. The metal and ceramic construction offers the most reliable tube at the lowest cost and assures dependability in severe environments. Typical applications for Varian BWO's are: signal generators, electronic countermeasures and systems requiring frequency agility.

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**ROTO-LOCK**—Versatile fastener for butt or right-angle joints in portable shelters, partitions, knock-down shipping boxes, etc. Solidly built, springless.



**CLAMP-LOCK**—A simple and strong, positive-locking clamp for fast assembly (and disassembly) of permanent or temporary rooms and buildings of flanged-panel construction.

## NEWS

### 2 Approaches Pressed to Crack Space Communications Barrier

Space vehicles plunging from great altitudes at searing speed hit a communications barrier when they re-enter the earth's atmosphere. The heat of re-entry ionizes the atmosphere around the vehicle and "blacks out" the signals. To overcome the problem, two remedies are being pressed:

One is development of an ehf transmitter that would be capable of piercing the blackout.

The second is better equipment for in-flight data reduction, with transmission of the data when the communications blackout is ended.

Progress toward successful application of both approaches has been reported.

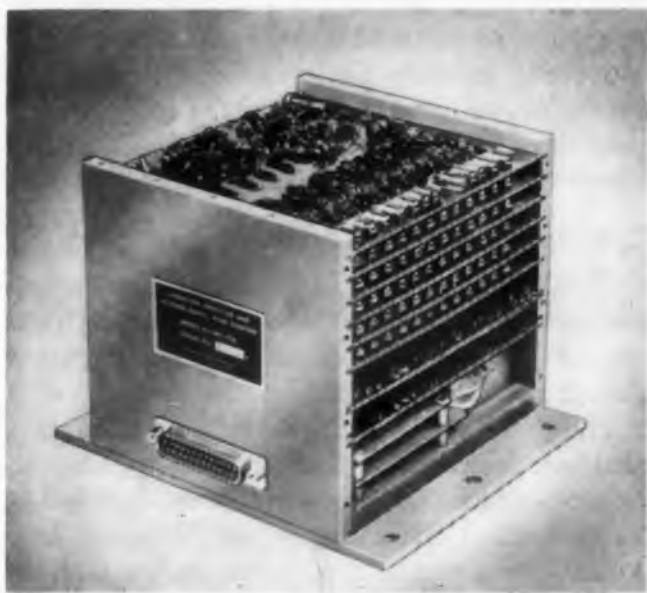
A spokesman for Avco Corp.'s Research and Advanced Development Div. at Wilmington, Mass., confirmed that testing of a new telemetry transmitter in re-entering vehicles had been started for the Air Force. The unit, which operates in the 30-50 kmc freq. range, is designed to penetrate the plasma sheath surrounding a re-entering space vehicle.

Meanwhile Wurlitzer Co.'s Electronic and Defense Dept. at North Tonawanda, N.Y., has developed an analyzer for data reduction and storage within the re-entering space vehicle. Stored information would be transmitted rapidly once the communications blackout ceased.



This receiver, operating in the 30-50-kmc range, is part of Avco telemetry system that may overcome the problem of transmitting through the hot plasma surrounding a re-entering space vehicle. Checking the equipment is Arnold M. Levine, vice-president, missile and space systems, ITT Laboratories, Nutley, N. J. ITT designed the receiver and a transmitter.





**In-flight data reduction** such as that provided by this Wurlitzer airborne vibration frequency analyzer, may be one solution to the problem of transmitting through the plasma sheath around a re-entering space vehicle. Post-blackout transmission is limited to maximum vibration amplitudes at various frequencies, rather than complete data on vibration during re-entry.

#### **EHF Overcomes Signal Attenuation**

In Avco's transmitter ehf is used to overcome signal attenuation. Pulse position modulation is said to provide data bandwidth of 400 cps with synchronization pulses.

Antennas placed around the vehicle are used to provide continuous transmission toward the earth as the vehicle rotates.

A diversity type of receiver that continuously tracks the re-entering object was designed for the project by International Telephone & Telegraph Corp., Nutley, N.J. Basic design of the transmitter was also done by ITT to Avco specifications.

Diversity in the receiver was accomplished by splitting electric and magnetic components in the rf section, according to Walter H. Bonazza, ITT project manager. The two channels must maintain constant gain, Mr. Bonazza said, because, following recombination, the pulse amplitude is measured to generate correction signals used for driving tracking servos. The channels are recombined in the video section.

A spinning dipole on the receiving antenna is used to provide the amplitude variation in the receiver. When the dipole faces the vehicle, received signals have maximum amplitude. If this position in the dipole's spin is off-center, error signals to servos drive the antenna to face the transmitter. The system is said to be accurate within 2 angular mils, or about 0.1 deg.

An MA-200-type magnetron is used to transmit pulses. The system is designed to withstand the high thermal inertia resulting from plasma



**FORD VIBRATION INSTRUMENTATION:** The Ford Motor Company entered the experimental gas turbine engine field in 1952. The Ford Turbo Machines Department is now engaged in research and development of a turbine engine and a working model has been tested in a tilt-cab truck. An obsolete engine, the Ford 702, has developed 160 horsepower at shaft speeds up to 36,000 rpm. ■ A new supercharged 300 horsepower turbine engine was recently announced by Ford Engineers. Known as the "704," the engine weighs 650 pounds installed, compared to 2,700 pounds for a truck diesel engine of comparable horse-

#### **ENDEVCO TRANSDUCERS SOLVE VIBRATION ANALYSIS PROBLEM**

power. The engine has two stages of compression, each operating at a 4:1 pressure ratio. Two burners are used for driving the dual compressors, the low speed wheel turning at 46,500 rpm and the high speed wheel at 91,500 rpm.

**THE PROBLEM:** The Ford Test program requires a wide variety of instruments to measure, control and record performance data of component parts. Measurement of vibration, for example, is a critical factor in this program. Vibrations that may cause metal fatigue, oil film breakdown, overheating, etc., are discovered during tests on individual engine "stands."

**THE SOLUTION:** Ford engineers use a total of six Endevco Series 2200 Accelerometers providing frequency responses up to 6,500 cycles per second. The accelerometers are connected to bearing test rigs, for example (see photo). The accelerometers relay measurements of acceleration movements in turbine shafts from three coordinates (radial vertical, radial horizontal and axial). Temperatures of the metal housings to which the standard Endevco transducers are attached average up to +150°F. Temperatures at which the water-cooled, heat-resistant models are used range up to +1000°F or more. The large self-generated output of the Endevco accelerometers eliminates the need for additional stabilization of a power supply.

**THE RESULTS:** The Endevco transducers are attached with a single-pole threaded bolt. The signal is fed through an Endevco amplifier to an oscilloscope or panoramic analyzer. The analyzer concentrates on a small section of the total signal and may present from 4 to 10 harmonic vibrations of different frequencies being fed from the unit at one time. This analyzer separates the frequency bands into individual bands, which it then sweeps from 20 to 40,000 cycles every second, measuring the frequency and amplitude in millivolts. ■ Ford Technicians convert these vibration records by mathematically integrating acceleration with respect to time to obtain the displacement or housing vibration. Thus, they locate the sources of objectionable resonance and take steps to eliminate or reduce vibration in the overall design. ■ Endevco accelerometers have also served as pickups for determining spring rate and damping characteristics of rubber bonded bearings. • **ENDEVCO CORPORATION** • 161 EAST CALIFORNIA BOULEVARD PASADENA, CALIFORNIA • PHONE SYCAMORE 5-0271



Close-up shows two Endevco Accelerometers on bearing test rig in Ford Instrumentation Section, Dearborn, Michigan. Cable passes to Endevco Amplifier (not shown on right).

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## NEWS

temperatures in the 2,000-to-3,000-F range.

Security prevents disclosure of the initial test results of the transmitter or of the space vehicle used, the Avco spokesman said. He added that the testing program was continuing.

### Data Reduction Gain Reported

The Wurlitzer analyzer is designed to surpass present telemetry units, whose information rates do not permit post-blackout transmission of raw data stored during re-entry.

The Wurlitzer airborne vibration frequency analyzer, providing data reduction as well as storage, can reduce the amount of vibration data to be transmitted, the company says. Filters are used to analyze a complex vibration signal, and the filter outputs are converted to digital form for storage.

During the blackout period the maximum vibration amplitude in each frequency channel is stored in the memory. After blackout the stored data are reconverted back to analog form for rapid telemetry transmission. The data consist of a series of dc voltages representing maximum values of vibration amplitude at each frequency.

The WC-223 analyzer developed by Wurlitzer measures 5 x 5 x 5 in. and weighs 5 lb. Similar equipment has also been developed by the company for multi-axis acceleration analysis.

### Transistor Tester, Classifier Shown

Transistor testing or classification at a rate of 750 per hr is said to be possible with testing equipment displayed at the IRE Convention exhibit at New York's Coliseum by Industro Transistor Corp., New York.

In operation, test conditions and required maximum and minimum values for a test are set on dials by an operator. As each transistor is checked, readout is provided by a meter or by digital voltmeter if desired. Recording of bias conditions, parameter values, and delay between tests with an IBM printing summary punch or punched cards can also be provided, according to Industro. Counters keep track of the number of transistors checked.

The equipment can be used for both go-no-go and direct reading operations.

Dynamic range is said to be sufficient for tests of all types of transistors, and many semiconductor diodes.

Testing units will be designed to customer specifications with about 60-day availability, according to a company spokesman.



## System Now in Test Stage Lands 2 Planes a Minute Automatically

The Federal Aviation Agency is testing an automatic aircraft landing system said to be capable of landing two airplanes a minute. The system, developed by Bell Aircraft Corp., Buffalo, N.Y., uses precision radar to track planes still in level flight and radio to feed instructions to automatic pilots in the planes.

Bell engineers report that no special equipment other than switching gear and a radar reflector need be carried in the aircraft. The airborne receiver in K-band, the transmitter, S-band.

Ground equipment includes twin radars and radios, for tracking and beacon functions, and twin analog computers for processing position data sensed by the radars. Equipment is duplicated to provide high-traffic capacity and system reliability.

Three modes of command are available with the AN/GSN-5 system: beam coded standard ILAS, and voice talkdown. For voice talkdown, plane position is displayed over vhf or uhf link as azimuth, and heading data is computed in a trailer-housed console.

Company spokesmen state that tracking range of the radars used in 4 mi, and touchdown disper-



Monitor at console of Bell automatic landing system observes scope to check glide path (diagonal) and heading (lower horizontal) of plane nearing a landing. Planes can be landed by beam-coded commands to an autopilot, by "talk down" or by standard instrument procedures.



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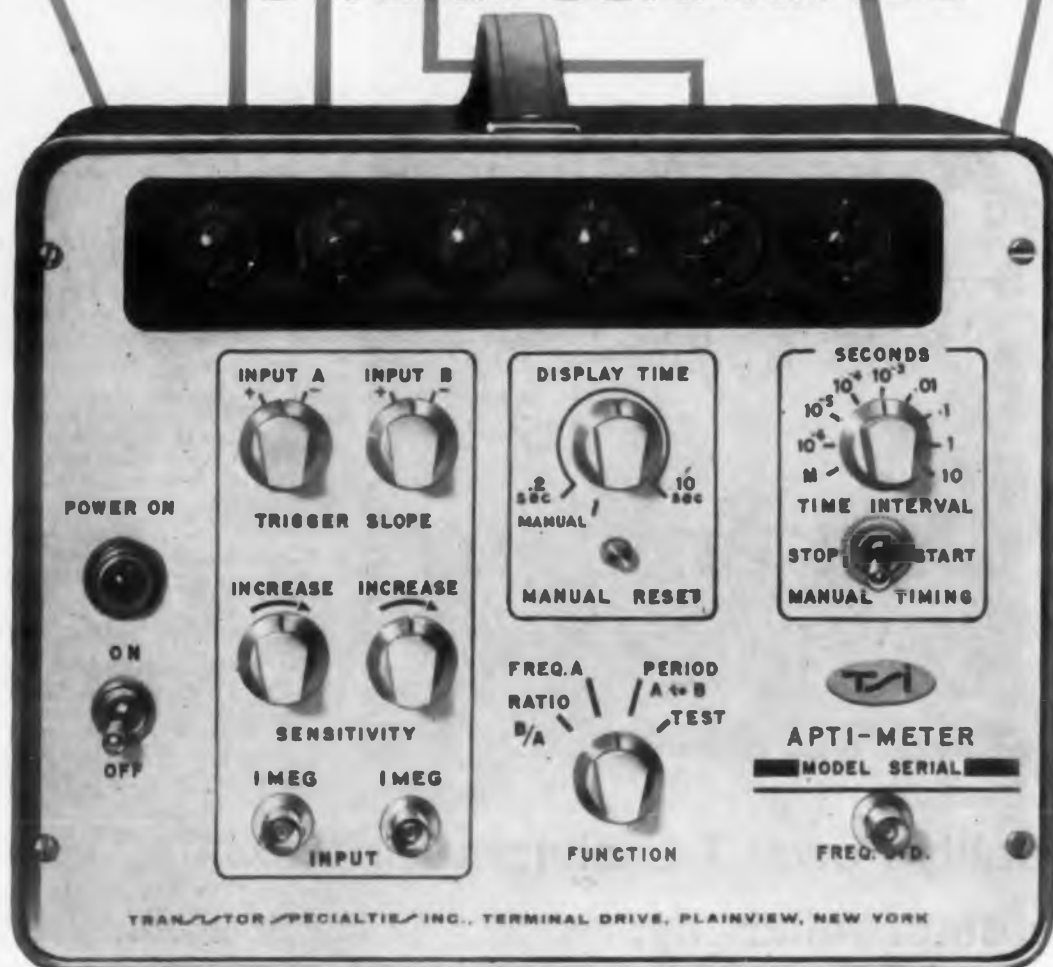
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Here it is—a 1 megacycle fully transistorized counter-timer that gives you all the advantages of solid state circuitry and in-line readout in a versatile, truly portable package! Designed for ultra-reliability in laboratory and plant—and fully environmental tested—the Model 361 APTI-Meter provides all the functions of a precision counter, timer, frequency meter, and ratiometer—meets the most critical standards of accuracy for measurement, calibration, timing, and control. Conservative circuit design and ample component derating assures outstanding reliability under all operating conditions.

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The Model 361 APTI-Meter is one of TSI's family of fully transistorized 100 kc to 10 mc counter-timers for precise laboratory and industrial applications. Write today for complete data.

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CIRCLE 37 ON READER-SERVICE CARD

## NEWS

sion is less than 200 ft longitudinally and less than 15 ft latitudinally.

The system, which has received Air Force support, is designed to be highly mobile. The British-designed Blue system, the only other automatic landing system in operation, according to Bell spokesmen, requires cables to be installed off the ends of runways.

Bell engineers report that the AN/GSN-5 can be installed in about a day and can be moved from one prepared runway to another in minutes.

### Engineers and Medics to Swap Roles in Electronics Study

Electronics and medicine will be combined in a joint graduate study program this year at Drexel Institute of Technology and Philadelphia Presbyterian Hospital.

Engineers will study medicine and MD's will learn about electronics. The goal is to develop new medical electronic apparatus.

This interdisciplinary approach is being supported by industry through fellowship grants administered by the Foundation for Instrument Education and Research. Lloyd Slater, head of the foundation, said:

"In those cases where communication has been established between doctors and engineers, the results have been splendid—so good that doctors got into the habit of taking their instrumentation and measurement problems to engineers first. By establishing this sort of teamwork on a large scale, we should develop many new applications of electronics for diagnosis and treatment."

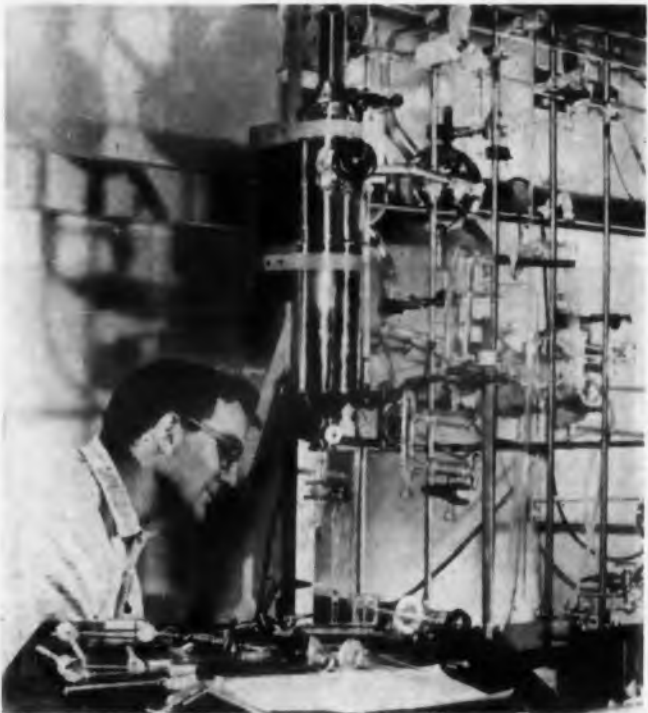
### Tactical Data System to Be Airborne



An airborne tactical data and display system for early warning and weapon control has been developed by Litton Industries and is ready for flight tests. A lighter version is under development for carrier-based aircraft.



## New Helium Dewar Flask Designed



This 1½-liter liquid helium dewar flask has been designed by Hofman Laboratories, Inc., Hillside, N. J. Sixteen hundred cc of liquid helium lasted for almost 20 hours in tests of this type of dewar, according to Hofman.

## Socony Mobil Computers 'Learn' a New Language

Engineers of the Socony Mobil Oil Co., Inc., New York, are "talking" to their computers in a new language.

The company expects the new language, PROLAN (Process Language), to reduce the cost of programming a computer by as much as 80 per cent.

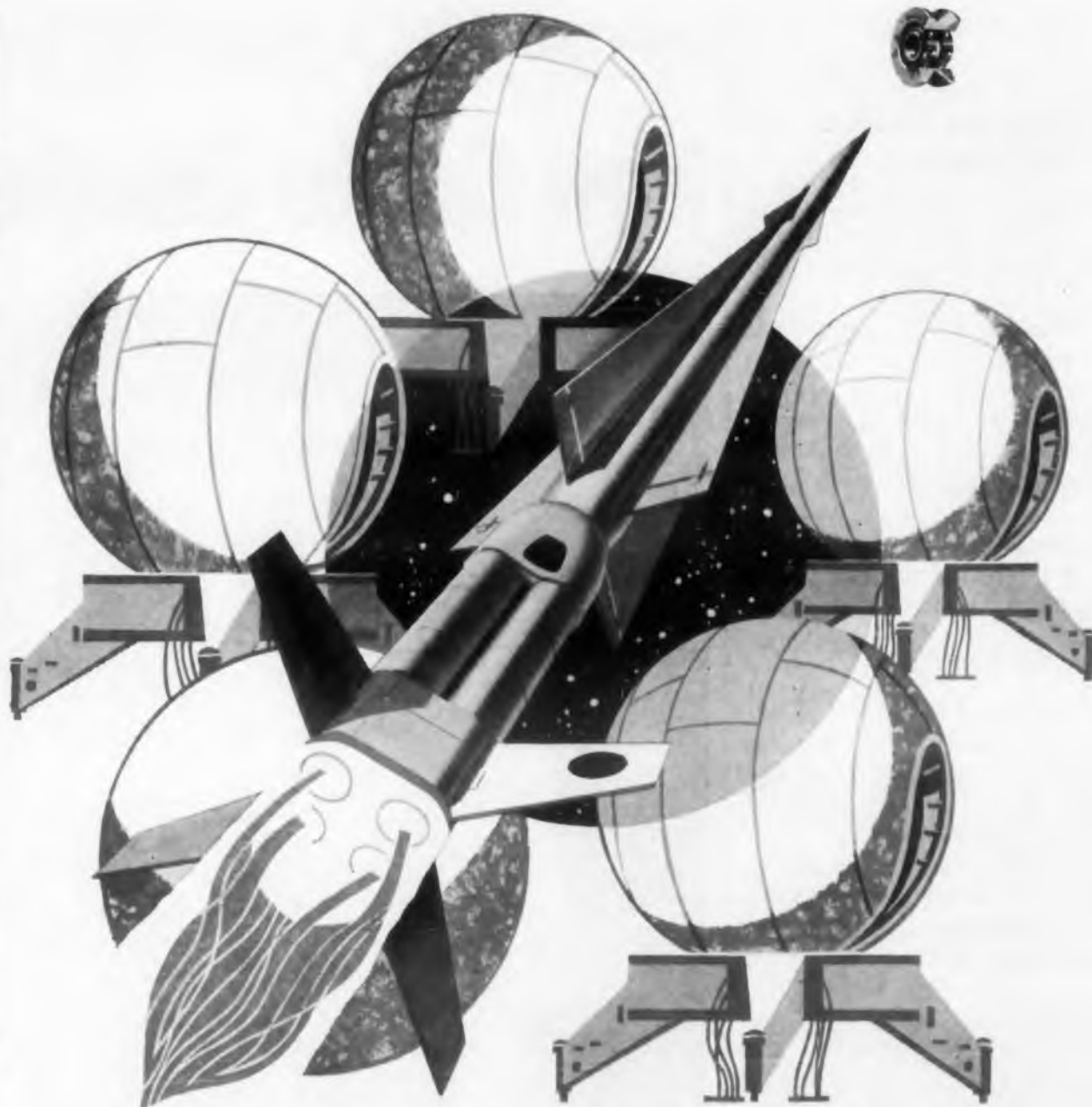
PROLAN is like basic English or Esperanto, but it uses the nomenclature of refinery engineering. The language has cut the training period for persons who work with computers from weeks to days.

Information fed to the computer in PROLAN is converted into language that can be stored on tape and used for computations.

John Hicks, the mathematician who played a major role in developing PROLAN, said, "Computers, like adolescents, have become increasingly difficult to communicate with as they have grown up."

He said it cost as much as \$4 to give one command to a computer. However, he continued, a single command in PROLAN is equivalent to about 100 commands in the basic language of the machine—an IBM 704.

Mr. Hicks said PROLAN was not a substitute for linear programming but was especially effective in testing the feasibility of a new idea for processing petroleum.



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## **N/D** Designs Assembly Savings Into Critical Miniature/Instrument Ball Bearings!

Helping customers *simplify* instrument assembly is a specialty of the N/D engineering group. How? Through *creative* Miniature/Instrument ball bearing application and design. Often, a new ball bearing design will produce assembly savings in excess of its additional costs. Integral ball bearings, too, very often cut down difficult and costly hand assembly of shaft and parts.

A timely example of N/D customer assembly savings can be seen in Nike Ajax and Hercules missile ground support. Here, *special* N/D Instrument ball bearings are now used in precision potentiometers. New Departure engineers recommended eliminating two *single* row instrument bearings, mounted in duplex and requiring precision spacer and separate guide roller. They

replaced this assembly with a *special* N/D *double* row high precision instrument ball bearing with integral outer race guide roller . . . and shaft mounted with a nut. This one recommendation produced cost savings of over 400%! In turn, the customer was able to reduce the potentiometer selling price to the government. What's more, the New Departure Instrument Ball Bearings improved potentiometer reliability!

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MINIATURE & INSTRUMENT BALL BEARINGS  
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## NEWS

### NBS Develops Program Method For Scientific Computation

Omniform I, a new programming method, has been developed to simplify the preparation of scientific computer programs using common mathematical functions.

The information in Omniform I is entered into the computer memory by a deck of 500 binary punched cards. The computer is then ready to interpret the 10 to 30 input cards that direct it to the solution of a problem. Without Omniform I a more intricate program, using many more cards, would be required.

For example, if a scientist wished to substitute a set of numbers in a power series included in Omniform I, he might call for a function of type 1

a power series of the form  $f(x) = \sum_{j=1}^n a_j X^{b_j}$ .

Then he enters the number of terms,  $n$ , and supplies " $n$ " number pairs  $a_j$  and  $b_j$ . He also supplies the arguments desired, instructions concerning further manipulation of the data, if these are necessary, and printing instructions.

This saves much of the effort that would be required to program the power series in terms understandable to the computer.

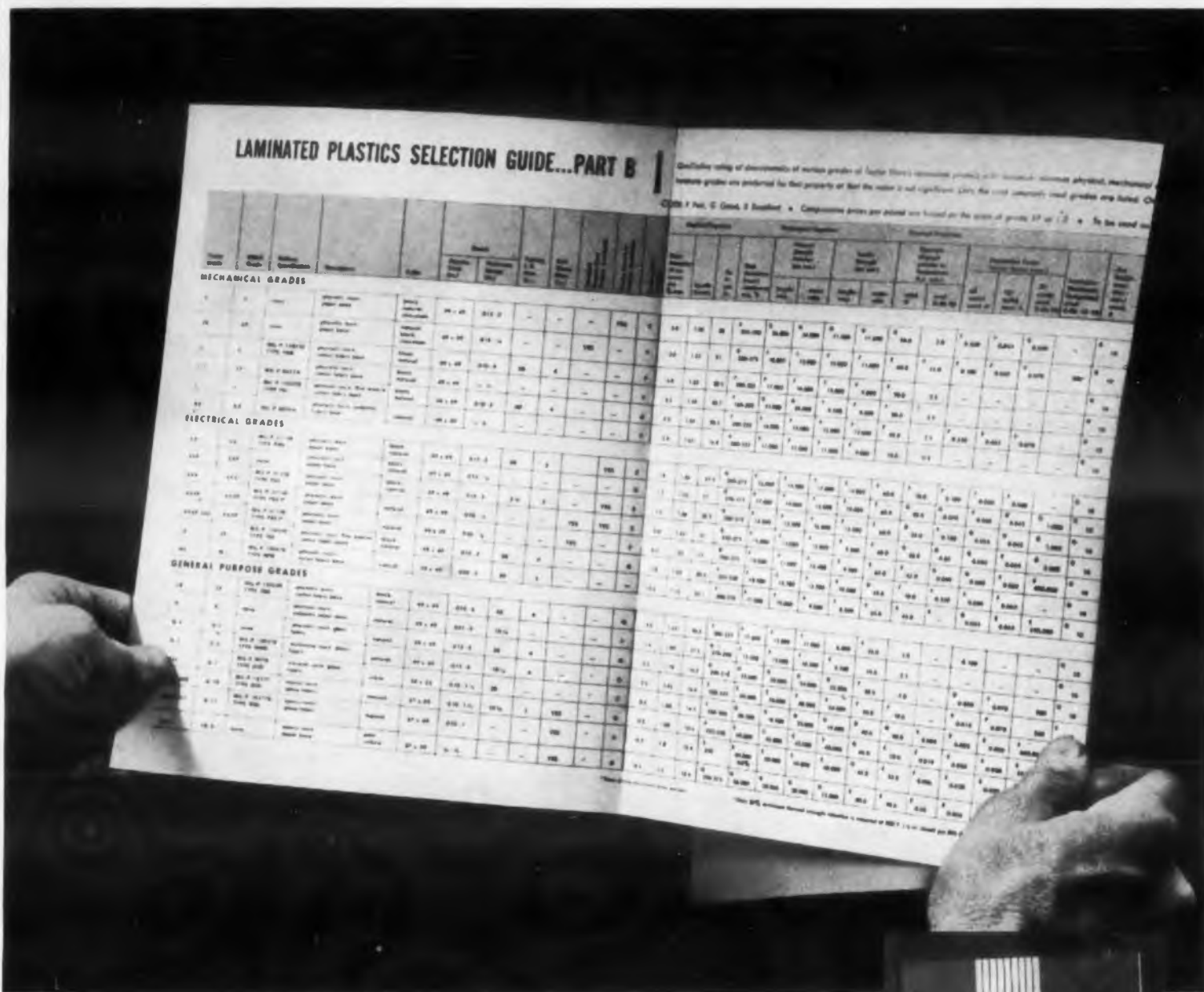
The programming method was developed by the



This is an example of some of the calculations that have been performed so far with the 500-card Omniform I programming system devised by the National Bureau of Standards. Individual programs for these calculations would have required 2,500 cards, NBS says.

## Important facts to know about laminated plastics

# New Guide Developed by Taylor



If you have specialized in metals and are considering industrial laminated plastics as a material for certain components in your design for the first time, this newly devised Taylor Selection Guide will help you evaluate the different grades available. The simplified properties chart lists the various grades now produced and clearly indicates the properties in which they excel. An accompanying booklet gives helpful hints on the selection of laminated plastics for your specific application. Write for your copy of this handy Taylor Laminated Plastics Selection Guide today. Use it to make

tentative selections of the laminated plastics that most nearly fit your requirements. Then consult us on the design and application of laminated plastics and parts fabricated from them before making a final decision. Our application engineers will be glad to discuss them with you. Write Taylor Fibre Co., Norristown 48, Pa.



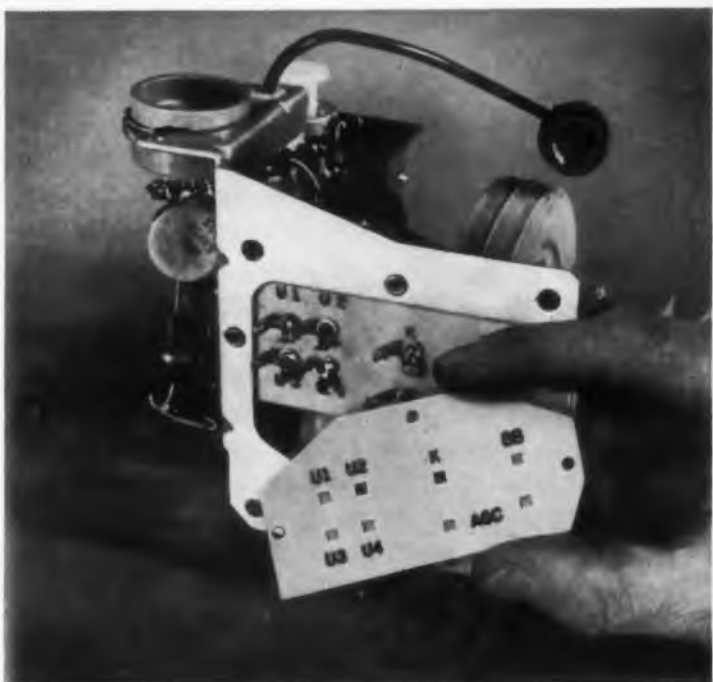


# Simplifies Laminate Selection

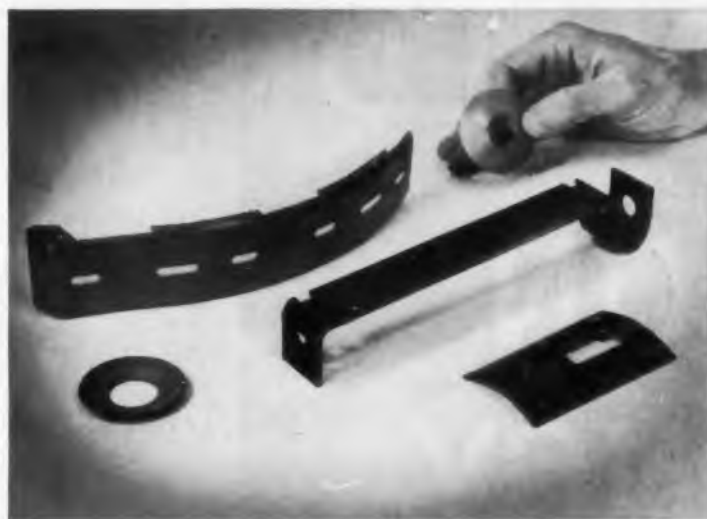
## Suggested applications of different grades of Taylor Laminated Plastics



For the fabrication of springs, silent gears, pinions, cams and bearings: Taylor Grade C—a phenolic resin, cotton fabric base, mechanical grade and Taylor Grade L, a phenolic resin, fine weave cotton fabric base grade.



For high-temperature electrical applications and high-frequency radio equipment: Taylor Grade GSC—a silicone resin, glass fabric base, high-heat-resistant electro-mechanical grade.



For forming into intricate shapes, compound curves, and deep draws: Taylor Grade C-7—a phenolic resin, cotton fabric base, postforming grade. Also Taylor XX-7—a phenolic resin, paper-base postforming grade.



For applications requiring high-strength retention at elevated temperatures: Taylor Grade GEC—an epoxy resin, glass-fabric base grade.

# Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

National Bureau of Standards primarily for work in thermodynamics and molecular physics, but the mathematical operations can also be used in other areas where properties of materials or other data of a tabular nature are required as a function of two variables.

The 16 function types currently included in Omniform I are power series, with positive, negative or fractional powers; natural or common logarithms; exponential terms; six trigonometric functions, and six hyperbolic functions.

NBS is considering expansion of the program to include Bessel functions, and Legendre, Laguerre, Hermite, and Tschebyscheff polynomials.

The programming system was assembled using the basic Fortran programming system. It includes special sub-routines developed by NBS and others from the Fortran library of routines.

It was developed jointly by G. M. Galler of the NBS Computation Laboratory and J. Hilsenrath of the thermodynamics group of the bureau.

## From Diapers to Fire Control Systems

The parts list for the F-105 supersonic fighter aircraft built for the Air Force by Republic Aviation Corp., Farmingdale, L. I., N. Y., runs all the way from \$61,000 fire control systems to babies' diapers.

Republic spent some \$103 million with outside suppliers in 1959 for the aircraft with the fire control systems being the most expensive items purchased.

The diapers were found to be the best lint-free cloths for polishing canopies.

## New Altimeter Measures Radioactive Back-Scatter

A radio-isotope density altimeter developed for missiles and jet aircraft measures radioactive back-scatter, proportional to atmospheric density. The device consists of four major units: probe, radioactive source, detector, and electronic circuits.

Tests indicate, according to the developer, Boeing Airplane Co., that the altimeter can provide dial readings accurate to within 500 ft or less at altitudes above 25,000 ft. Boeing says accuracy depends less on aircraft speed, angle of attack, or structural shape than conventional pressure altimeters.

Use of the density altimeter as a mach indicator is being studied. It is not intended, however, to replace conventional pressure altimeters at low altitudes and within terminal areas.

CIRCLE 39 ON READER-SERVICE CARD

# TUNING FORK CONTROLLED PRECISION FREQUENCY PACKAGES

**FROM 1.0 TO 4,000 CPS.**

Overall accuracies from  $\pm 0.05\%$  to  $\pm 0.01\%$  over  $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  range, and to  $\pm 0.001\%$  from zero  $^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ , without use of ovens.

Silicon and germanium transistorized. Sinewave, squarewave and pulse outputs. 18, 20, 24, and 28 volt DC inputs.

Conservatively designed **reliable** units, potted in silicone rubber and hermetically sealed, for operation under **MIL** environmental conditions.

PHONE EDgewood 3-1700, or TWX WBRY 5103, or write:



**PHILAMON LABORATORIES INC.**

90 HOPPER STREET, WESTBURY, LONG ISLAND, N.Y.

CIRCLE 40 ON READER-SERVICE CARD

## NEWS

### Computer Users Spell (O) Low Cost Machines and

**A**RE COMPUTER designers digitizing themselves into a corner?

What do computer users demand in new hardware?

What is the next big step in data processing equipment?

These and other questions of interest to the designer were explored by over 800 top-level engineers and business men at the American Management Association's three-day Data Processing Conference held recently in New York.

With electronic data processing an accomplished fact, the next few years will likely be devoted to consolidation and refinement of equipment. Forthcoming hardware, the experts agreed, will be derived from existing concepts. "Breakthroughs" in design are several years away.

#### New Hardware Wanted

Computing equipment due in the early 60's may well include:

- Low-priced, multi-purpose data processing systems renting for perhaps \$5000 a month or less. Such systems could economically replace as few as a dozen clerks and extend the use of electronic data processing to tens of thousands of small businesses. The greatest design emphasis in such systems should be upon size reduction, reliability and operating ease. Reasonably low storage capacity and speed would probably suffice.

- Single-purpose, fixed program computers for standardized applications such as payroll and inventory control. Lower cost would result from elimination of the usual provisions for multiple operating functions. Rentals on the order of several hundred dollars per month would make the single-purpose computer attractive both to small business and to small units of larger companies. The one-shot computer could free the larger machine from routine problems and allow its use for the more complex data processing tasks.

- Optical scanning and recognition of alphanumeric symbols (even handwriting) and conversion into machine-useable language. The punched card and paper tape bottlenecks in data conversion are becoming increasingly difficult to live with.

- Improved communication between computers and remote data input stations. Since an arithmetic increase in computer cost tends to give a geometrical increase in computing capacity, central computers serving widely separated

ELECTRONIC DESIGN • March 30, 1960

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## Data Processing Needs: Faster Communication

offices would offer considerable economy. Westinghouse will shortly install a high-speed data link between its Philadelphia offices and a 7090 computer in Pittsburgh on a trial basis. Collins Radio Kinoplex converters at each end will handle up to 2400 bits per sec over conventional phone lines. Microwave data links will ultimately provide much higher transmission capacities and economy. A microwave link recently installed by North American Aviation is indicative of the possibilities here.

■ Film chip data storage which will combine digital control with graphical filing. While essentially an extension of the aperture card approach, the optical recording and sensing of digital information on a film chip offers advantages of convenience in handling and storage, increased digital and graphic storage capacity, ease of duplication, and faster processing by the computer. The recently announced Kodak Minicard system is typical of this approach. Itek and IBM are among others actively developing film chip systems.

### Computers Getting Too Large

Some people attending the conference believed that today's emphasis on ever-faster and bigger digital machines for coping with larger piles of paperwork was a rather sterile approach. Engineers and business were held to be equally shortsighted in this respect, though engineers were criticized for being in the position where "they should have known better."

"We're building bigger and better poles to vault over higher walls of paperwork," said Robert M. Gordon, Associate Director of Stanford University's Computation Center. "Someday soon we may not be able to build bigger poles. Now is the time to find a way around the problem rather than over it." As an example, R. J. O'Keefe, Assistant Vice-President of the Chase Manhattan Bank cited the extremely complex magnetic ink check-marking system recently adopted by American banks. He suggested that one might instead consider the possibility of not returning canceled checks to the customer.

Milton M. Stone of Arthur D. Little, Inc. wanted computers designed to accept graphical inputs and deliver graphical outputs. "A great many problems defy convenient numerical expression," he stated. "We need a computer that could interpret a flow chart, schematic diagram, or graph, and deliver an answer in similar form."

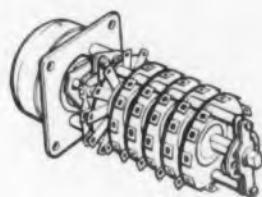
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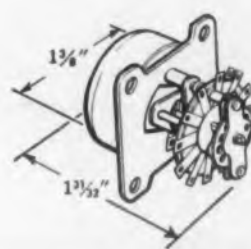
# Ledex

# Rotary Selector Switch

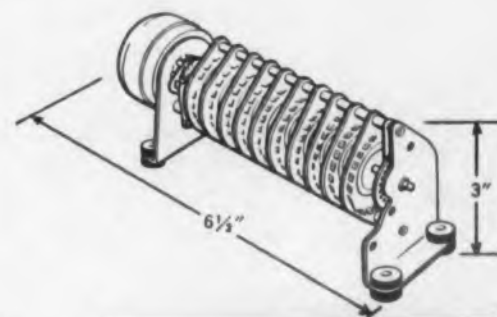
## BASIC INFORMATION



Functions as a power operated remote control circuit selector or stepping switch.



Smallest switch is size 2E with 1 to 4 switch wafers.



Largest standard switch is size 5S with 1 to 10 switch wafers, foot, flange or panel mounting.



8 position



24 position

Switch wafers available with 8, 10, 12, 18, 20 or 24 positions.



1 circuit,  
12 positions

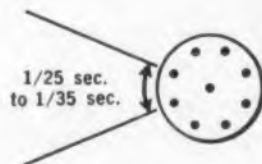


3 circuits,  
4 positions each

Circuitry of wafers is flexible. For example 12 position wafer can be one circuit with 12 positions or 3 circuits with 4 positions each.

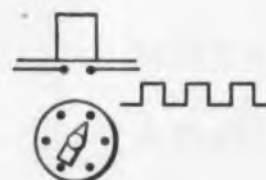


Will self-stop to any pre-selected position.

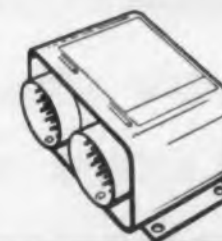


1/25 sec.  
to 1/35 sec.

Self-stepping speed is 25 to 35 steps per second depending on number of positions.



Pushbutton, manual rotary switch, or pulse controlled.



Hermetically sealed switches meet extreme environmental conditions.

The Ledex Rotary Selector Switch is a compact, highly efficient power-operated circuit selector or stepping switch, designed for remote control. Nearly unlimited design combinations permit great variety of applications for stepping, counting, adding, subtracting, programming and sequencing. Many stock models on hand for immediate shipment. Hermetically sealed models also available.

Power source is the Ledex Rotary Solenoid. This unit gives highest-

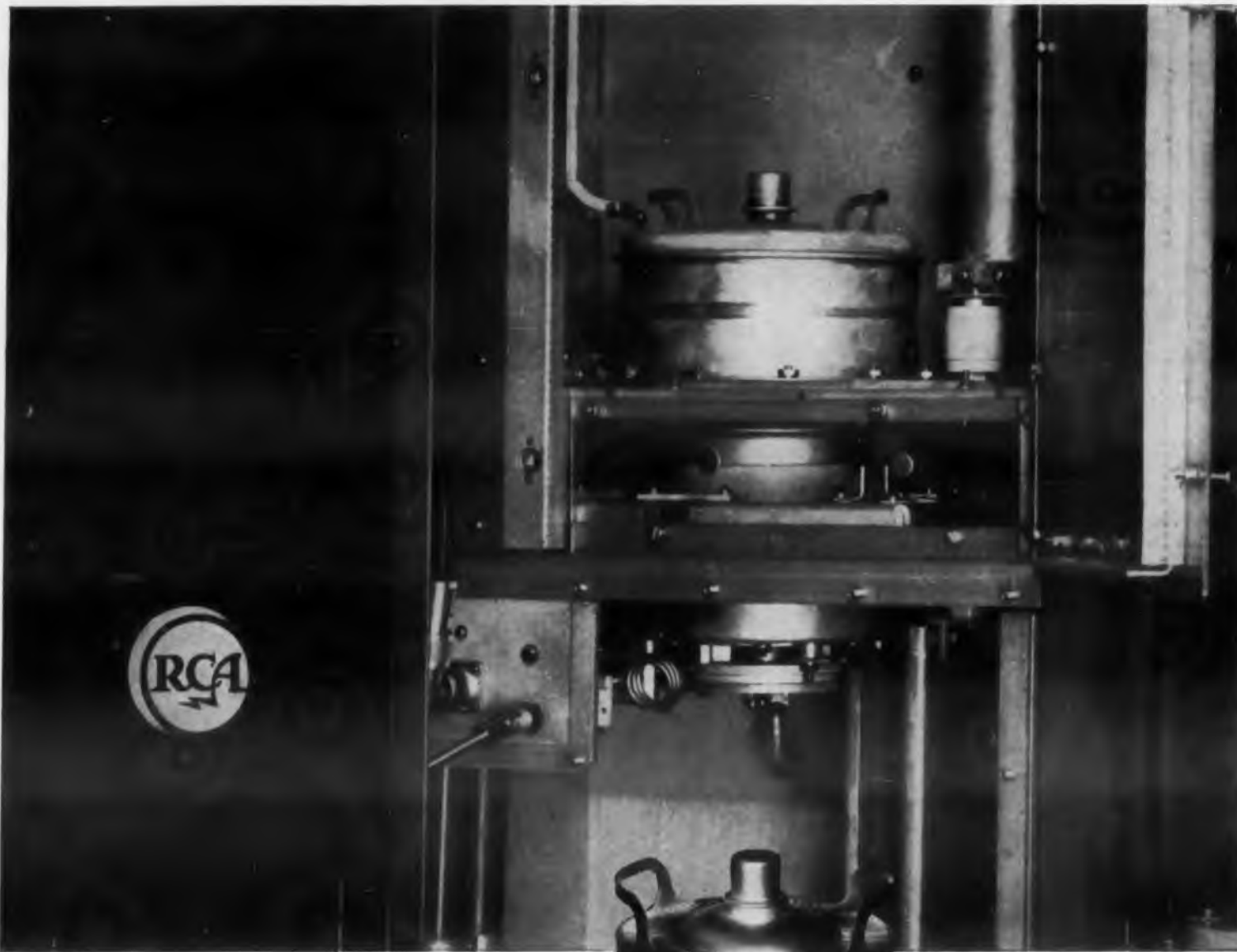


torque-to-size rotary motion. Applications for Rotary Solenoids include actuation of valves, vanes, shafts, and other mechanical loads.

Also Ledex Synchromental Stepping Motors for accurate, reliable shaft indexing.

Write for literature, mentioning application, to Ledex, Inc., Dayton 2, Ohio; Marsland Engineering, Ltd., Kitchener, Ont.; NSF Ltd., 31 Alfred Place, London, Eng.; NSF GmbH, Nurnberg, Germany.

CIRCLE 41 ON READER-SERVICE CARD



**NEW, UNIQUE RCA  
5-KW FM TRANSMITTER  
UTILIZES 4CX5000A  
CERAMIC TETRODE**



RCA has recently developed a unique new 5-KW FM transmitter which utilizes the new technique of multiplexing. This provides simultaneous transmission of two or more program channels on the same RF carrier to meet increased demands of FM stations for additional program services.

The PA stage of the new BTF-5B transmitter is composed of a single Eimac 4CX5000A ceramic tetrode,

which produces the 5000-watt output. This tetrode offers high power gain and excellent stability to assure faithful transmission of the broadband multiplex signals.

That's why the 4CX5000A was the logical choice of discriminating RCA engineers. Its many exclusive ceramic design features help to make possible this conservatively rated, high power, air-cooled transmitter.

CIRCLE 42 ON READER-SERVICE CARD

These ceramic extras are now available in more than forty Eimac tube types—used in many types of communication, pulse and industrial equipment.

**EITEL-McCULLOUGH, INC.**

San Carlos, California



## NEWS

Such a computer, he added, might operate on combined analog-digital principles, or could be entirely non-digital.

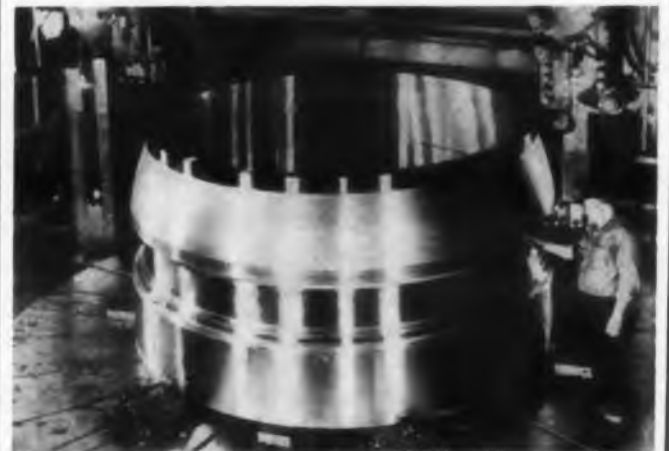
Intelligent machines rather than mere "data massagers" were advocated by Mr. Gordon. Classification, translation, legal problems and other instances where judgement, learning, idea synthesis and decision-making are involved were suggested as possible applications for intelligent machines. Carnegie Tech and the Rand Corporation are among those studying the design feasibility of such computers.

### Standardization Needed

Mr. Stone also stressed the need for standardization among computers, peripheral equipment, and data sensors. "What we need is an industry-wide standard—a common language for computers and associated equipment," he said. "There's a lot of good equipment coming on the market which cannot be used without extensive modification of existing systems or investing in costly anything-to-anything converters." Although the nine or more different tape formats now available were thought to be eight too many, most designers did not feel that standardization, urgently needed, could be sold to industry.

Delegates and speakers generally agreed that the next step forward in computing will consist of imaginative application by business of existing data processing hardware. "Until businessmen learn to trust and exploit data processing within the concept of existing equipment," said the Comptroller of one multimillion-dollar outfit at the conference, "you won't be able to sell us much beyond electronic clerks." ■ ■

### Radio Telescope Bearing Seat Produced



The Navy's planned Sugar Grove, W. Va., radio telescope, expected to be the world's largest, will make use of this 27-ton steel bearing seat, shown at U. S. Steel's Homestead Works.



## New Sylvania CRT Cathode Support Design



This cloverleaf design of ceramic cathode supports for cathode-ray tubes is being used by Sylvania's Electronic Tubes division. It is said to give less heat dissipation and warm-up time than the conventional circular design.

## Nose Cone Impacts in Ocean Pinpointed by Hydrophone Network

Underwater hydrophone networks in the Atlantic and Pacific Oceans are being used to determine the impact points of missile nose cones.

Two types of acoustical systems are used by recovery teams. One detects surface impacts and the other locates the explosion of a bomb ejected from the missile near the point where it enters the ocean.

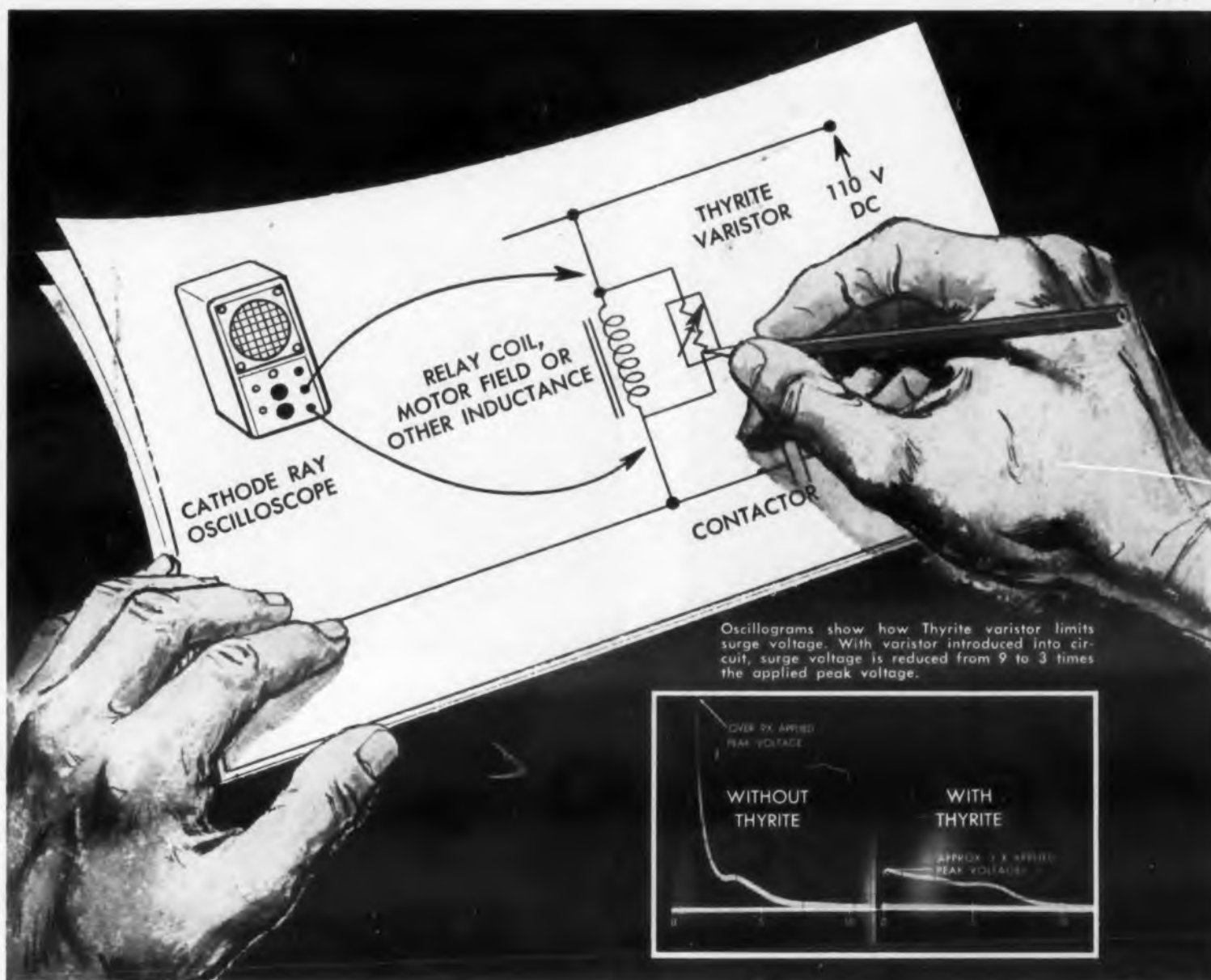
Six hydrophone receivers are used to detect surface impacts. Five are placed on the ocean floor so that hypothetical lines joining them would form a pentagon. The sixth is placed in the center of the pentagon. Underwater cables connect the hydrophones with shore stations. Differences in the time required for the sound of the impact to reach at least three of the receivers give adequate information for accurate fixes in a limited target area.

The bomb method permits detection over several thousand square miles. Known as SOFAR (Sound Fixing and Ranging), the system consists of hydrophone pairs placed at wide intervals on the ocean floor. Cables lead to shore stations. Time differences between the arrival of the exploding bomb sound at various hydrophone pairs are used to obtain fixes on the impact point. Recovery vessels can establish their position with respect to impact points by dropping depth charges and obtaining hydrophone readings.

Because the speed of sound varies with temperature, pressure and salinity at different points in the ocean, a three-month calibration exercise in the Atlantic was conducted by the Navy, Bell Telephone Laboratories and Western Electric Co.

The hydrophone system was developed by the underwater systems development department of Bell at Whippany, N. J. The equipment was produced at Western Electric's Winston-Salem plant.

## Metallurgical Memo from General Electric



## He'll get surge protection results with G-E Thyrite® varistors

TRY IT YOURSELF  
SEND FOR GENERAL ELECTRIC  
ENGINEERING APPRAISAL KITS



Kit #1 (illus.) contains 12 miniature disc varistors, color-coded and with connecting leads. Price: \$5.00. Also, Kit #2 containing 10 color-coded rod varistors with connecting leads. Price: \$5.00. Test their properties; see how they can help you. Send for yours today.

... and so can you with the assistance of a G-E engineer in your circuit planning

Sudden interruption of an inductive current produces high surge voltages which must be limited to a safe value. The engineer who plans his circuit to include a General Electric Thyrite varistor is "buying" the best and lowest cost surge protection available.

Thyrite varistors are voltage-sensitive resistors which limit voltage surges and stabilize current. Available in rods, discs, or washers — with or without leads, and as assemblies ready for installation — Thyrite varistors are made with a wide variety of volt-ampere characteristics for components rated from 6 to 10,000 volts.

For more information on Thyrite varistors — or for the assistance of a G-E engineer to help you with a specific problem — write: Magnetic Materials Section, General Electric Company, 7820 N. Neff Road, Edmore, Michigan.

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CIRCLE 43 ON READER-SERVICE CARD

## NEWS

### Sylvania Expanding EL Output



Expanded production of electroluminescent devices for military and commercial uses is planned by Sylvania Electric Products, Inc. Max Krawitz, left, demonstrates crossed grid suppression panel to Irving Greenberg. Both are with Sylvania's Picture Tube Operations, which will handle production and marketing of the new EL devices.

### Transistorized Carrier System Carries Up to 600 Channels

A new multiplex-carrier system using transistors is said to transmit up to 600 voice frequency channels on a single radio beam.

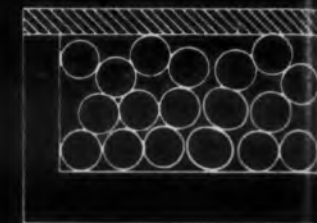
The system utilizes a single-sideband suppressed carrier. Besides voice conversations, it can handle teletype messages and computer information.

Developed by General Electric Co. of Lynchburg, Va., the packaged system is reported one-third the size of conventional equipment using tubes. Equipment for 120 channels can be placed in an 8-ft rack, which previously could accommodate only 24 channels, GE said.

The new system is described as exceptionally reliable. The reliability stems in part, according to the company, from the use of standby components in such common equipment as amplifiers and master oscillators. When a part fails, the standby component allows transmission to continue uninterrupted.

The transistorized system is said to require less power than a conventional one. For example, a 240-channel system using equipment with tubes requires thousands of watts; the transistorized equipment is reported to use less than 700 w.

*Balance your  
insulation  
system with  
the better  
properties of . . .*



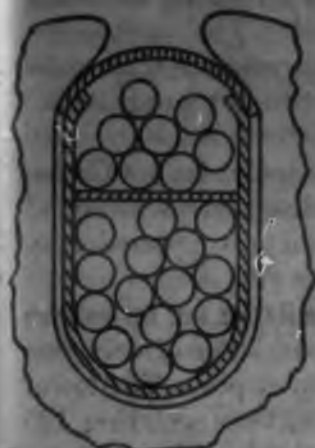
Random Wound Coil

# PHELPS DODGE NYLEZE®

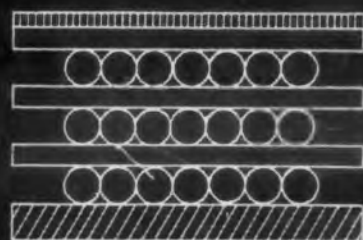
*The extraordinary advanced film magnet wire  
that combines . . . Windability, Varnishability, Solderability,  
Thermal Stability (Class B 130° C.) . . . all in one wire!*

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





Stator Wound Motor



Layer Wound Coil



Wound Rotating Armature

**Remarkable Windability**—slick, hard surface permits wire to wind into space more compactly. Excellent resistance to winding abrasion in automatic equipment.

**Outstanding Varnishability**—withstands wider variety of hot varnish solvents. Ideally suited for *hot dip* in high speed varnishing operations. Excellent for encapsulation or potting.

**Easy Solderability**—solders or dip-tins at 650-750° F. without cleaning or stripping. No damage to copper conductors.

**Unusual Thermal Stability**—rated Class B temperature with a thermal life of 20,000 hours at 135° C. when tested according to AIEE #57 procedures (unvarnished). Provides unusual film “cut-thru” resistance at high temperatures.

**Nyleze®**—with the strongest combination of balanced film wire properties—builds greater strength and reliability into modern insulation systems.

FIRST FOR  
LASTING QUALITY  
—FROM MINE  
TO MARKET!



**PHELPS DODGE COPPER PRODUCTS**  
CORPORATION

**INCA MANUFACTURING DIVISION**  
FORT WAYNE, INDIANA

CIRCLE 44 ON READER-SERVICE CARD

## Polaris Guidance System MIT Design

Successful guidance of the Polaris missile in recent test launches was accomplished with an inertial system developed by Massachusetts Institute of Technology's Instrumentation Laboratory.

Inertial components—gyroscopes and accelerometers—and a computer guide the missile to a certain point in its trajectory. From this point the missile is ballistic, or unguided.

The Polaris system is similar to MIT-designed guidance systems for the Titan and Thor. Accurate submarine position is provided up to launch time by a Ships Inertial Navigation System also designed by MIT's Instrumentation Lab.

Polaris guidance systems are manufactured in a Pittsfield, Mass. plant owned by the Navy and operated by General Electric's Ordnance Department.

## Fully Electronic Switchboard Shipped for Military Field Use

A completely electronic communication switching center, specifically designed and built for the military, has been shipped to the Signal Corps at Ft. Monmouth, N.J.

The AN/TCC-12 local switchboard was developed by Stromberg-Carlson, which reports it requires one-sixth the personnel and logistics support of the conventional 200-line manual switchboard now in use.

The system uses four-wire switching and four-wire transmission throughout, with time-division multiplex. It accommodates 200 lines to individual terminations, has 30 trunks to long-distance switching centers and 50 trunks to other local and tandem switching centers. Up to 60 calls can be handled simultaneously, Stromberg-Carlson reports.



Completely electronic switchboard designed for military field use handles up to 60 calls at a time, accommodates 200 lines to individual terminations.



TR-10 with EAI 1100 E XY Plotter as read-out

## THE *FIRST* ALL TRANSISTORIZED ANALOG COMPUTER

— basic model less than \$4000

**PACE® TR-10 Eliminates Drudgery—Gives New Insight Into Engineering Problems**

This compact unit, 15" x 16" by 24" high, is powered by 115 volts AC and can provide day-in day-out instant solution of your most vexing engineering problems. Even if you have never seen a computer before, you can learn to operate the TR-10 as easily as you learned to use a slide rule.

Simply turn a dial to feed in design parameters, and the computer provides an instant by instant, dynamic picture of the effect of each change. You can study the inter-related effects of heat, pressure, flow, vibration, torque or any variable, and visually compare one with the other. Engineering data comes alive—insight into how new designs will work is obtained easier, faster.

Because of its minimum size and low price, the TR-10 can become your own personal analog computer. You gain first-hand experience with the power of analog techniques, and convert more of your time to *creative engineering*. New ideas that were too costly to try before are now practical.

You can design virtually to perfection and have a permanent, visual record of performance before building pilot models or prototypes. As a result, "cut and try" expense is reduced.

The same quality workmanship and design that has made Electronic Associates the world's leading producer of precision general purpose analog computers will be found in this new unit. Accuracy to  $\pm 1$  per cent. Modular construction allows you to select varying quantities of the following computing functions: summation, integration, multiplication or division, function generation, parameter adjustment, logical comparison.

For complete engineering data, write for Bulletin TR-10 -B

**EAI**

**ELECTRONIC ASSOCIATES, INC.**

Long Branch, New Jersey

CIRCLE 45 ON READER-SERVICE CARD

## NEWS

### 106-Ft Antenna Tower Designed To Be Erected by 6 Men in 4 Hr

A new portable antenna tower, 106-ft high, can be assembled by six men in only 4 hr, according to its manufacturer.

The aluminum tower can support the equivalent of either four 6-ft or two 8-ft parabolic antennas.

Developed by R. D. Werner Co., Inc., of Greenville, Pa., the structure is designed to withstand winds of 100 mph. Antennas are reported fully operational at 70 mph.

The 106-ft design can easily be set up as two 50-ft towers requiring the addition of only one base form and antenna support posts. The tower breaks down into 9-1/2-ft sections weighing 125 lb. For transit packaging and ease of handling, no component weighs more than 90 lb.

Wrought extrusions and stampings are used in the tower instead of castings. This technique is said to more than double the allowable working stress.

Field tests of the tower are being conducted, and production is anticipated. The structure is part of a radio-relay system being developed for the Army Signal Corps by ITT Laboratories of Nutley, N.J.



Portable aluminum antenna tower—106 ft of it—goes up in 4 hr with six men on the job, developer reports. At left, going up. Right, the full tower a few hours later.



## Britain Opens Her First Long-Distance TV Link

A long-distance television circuit reported to be the first in Great Britain has been opened.

The system, linking Birmingham and London, spans 135 mi. It was built by Pye Telecommunications, Ltd., of Cambridge, and will be operated by Associated Television of London.

The circuit, which operates at 7,000 mc per sec, uses passive reflectors instead of the waveguides normally used in such systems.

The signals are passed through four automatic radio repeater stations, which are unattended. Malfunctions at any station are automatically indicated in the London office by a telemetry circuit that operates at 450 mc.

## Data Process System Presents Its Output as a Histogram

A data-processing system that can present its output in the form of a histogram reportedly has been developed by a British concern.

The use of the histogram, a rectangular graph, originally was developed for the United Kingdom Atomic Energy Authority, according to the system's manufacturer, E. M. I. Electronics, Ltd., of Hayes, Middlesex.

The company said the primary input data could come from the continuous scanning of a large number of transducers. The system's output can be in tabular form or can be punched on tape or cards, in addition to being a histogram.

Information that comes in slowly can be stored in unsorted form on magnetic tape and be processed after all the data are obtained.

## Britain Plans 2d Computer Show In London in October, 1961

Great Britain will hold its second Electronic Computer Exhibition in London in October, 1961.

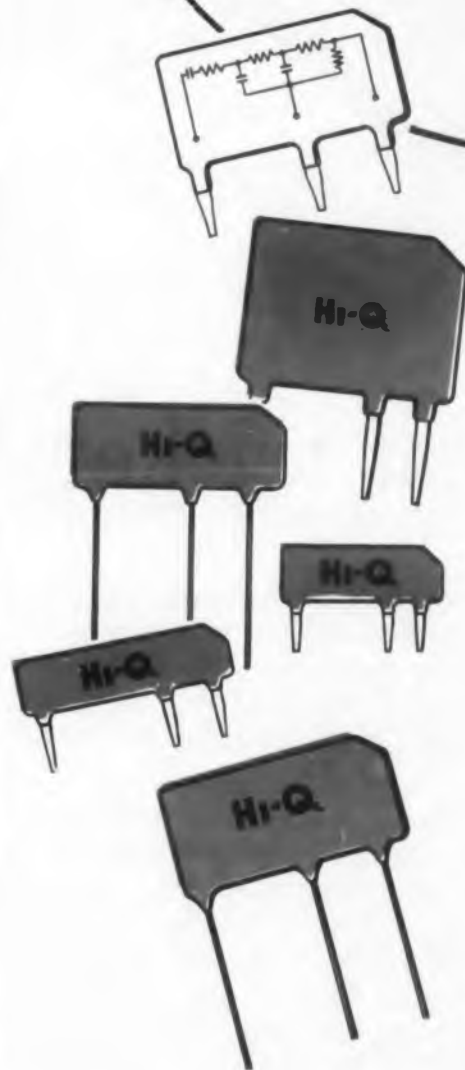
After the first exhibition, in 1958, it was not expected that a second would be held. However, the enthusiasm of foreign manufacturers for British equipment led the joint committee of the Electronic Engineering Assoc. to change its mind, according to Vernon M. Roberts, the chairman.

"Our latest encouragement is that a German mission said that British computers were competitive on the German market, both as regards quality and price," Mr. Roberts said.

A business computer symposium will be held concurrently with the computer exhibition.

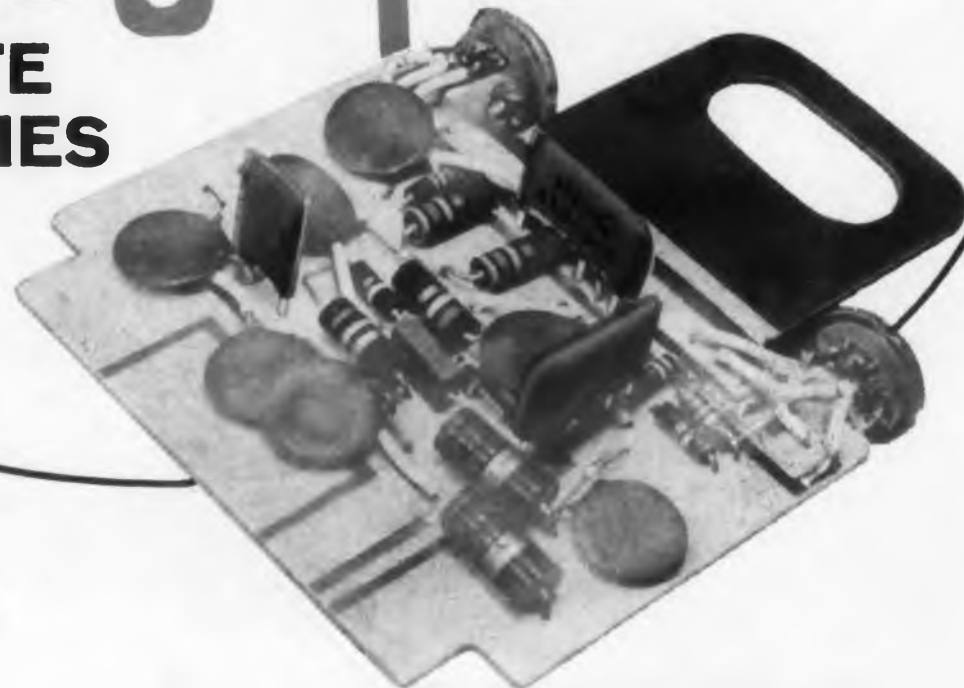
A total of 40,000 persons from 41 countries visited the 1958 exhibition.

# Hi-Q PLATE ASSEMBLIES



**Hi-Q**  
DIVISION

# COMPACT



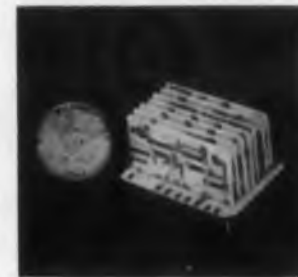
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## NEWS BRIEFS . . .

. . . **FLIGHT SIMULATOR** for jet aircraft has been developed for the Navy by Sylvania Electric Products Inc., New York. The system, essentially a high-speed digital computer, simulates the operation of the Navy F9F-2 or the Air Force F-100A jet aircraft. According to the company, the system may be extended to simulate several aircraft simultaneously.

. . . **A TIME-MULTIPLEX STEREO SYSTEM** developed by Mullard, Ltd., of London requires the addition of no more than two tubes, or one transistor and two diodes, to permit a standard receiver to pick up and shunt stereo signals to a stereo audio stage.

. . . **THE INTER-SYNC**, developed by Ampex Corp., replaces the standard drum servo unit in the Ampex Videotape television recorder. It combines in a precise manner the output of two or more recorders, field by field and line by line. Inter-Sync will also synchronize the playback of one or more recorders with the output of TV camera, film chain, network feed or any other signal source. The unit can be installed on any existing Videotape television recorder or ordered as optional equipment on a new machine. The electronic chassis is the same size as the present drum servo unit (master control) and replaces that unit.

. . . **X-RAYS** as a means of space communication will be investigated by Tracerlab of Waltham, Mass., under a contract from the Air Force. With properties that make them well-suited for communication in outer space, X-rays could supplement conventional rf communications systems, Tracerlab reports.

. . . **THE BERNOULLI DISK** memory system (ED, Jan. 6, 1960, p8) recently developed by the Laboratory for Electronics, Inc., Boston, will be used to store data in a Lockheed satellite system. Lockheed's Missile and Space Div. has awarded a half-million-dollar production contract to Laboratory for Electronics for a number of the lightweight devices.

. . . **ROBOT A-BLAST DETECTORS** are in development at Bell Laboratories and Sandia Corp. The objective is to warn of underground explosions down to 1 kiloton. The State Department is trying to get Russian approval for these monitors in a disarmament inspection system.

ELECTRONIC DESIGN • March 30, 1960



## TO THE ENGINEER who can use a little honest trickery

There's more than one way of skinning a cat—or making ideas *work* automatically. And AE has a bag-full.

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... **MANUFACTURING RIGHTS** for the United States and Canada to the electronic module and capacitor components, developed by ACF Industries, have been purchased for an undisclosed sum, by the Illinois Tool Works, Chicago, for use in radio and TV circuitry and various defense projects.

... **SEMI-AUTOMATIC** ground environment personnel, installation of equipment and maintenance of the Air Force's SAGE program will be provided by Burroughs Corp. of Detroit, Mich., under a \$7,900,000 contract. The company was recently awarded the systems management contract of \$35-million for a seaward extension of the system. (See *ED*, Dec. 9, p 23.)

## QUOTES IN THE NEWS

### On product quality:

"There is virtually no market for the very best product that money can buy. Quality and design represent compromises with expediency."—*Dr. Alfred R. Oxenfeldt, Professor of Marketing, Graduate School of Business, Columbia University, at the American Society of Industrial Engineers Conference.* Professor Oxenfeldt continued: "The problem of design and pricing boils down to being clear and consistent about whom you are trying to sell; getting a clear idea of the extent to which price variations affect sales; learning whether small differences in quality have a major effect on sales; allowing impressions as to elasticity of price and quality to dictate policy; and testing views about price and quality elasticity before proceeding too far, and application of price and quality estimation before going to market."

### On design engineers:

"The engineer, by training, experience and, more than anything else, by mentality is wholly incapable of the type of design that improves form and simplifies production. It is his job to make machines function, to do the work they are supposed to do efficiently and with minimum upkeep. If they are functional, he generally doesn't care too much about what they look like and is extremely bored and inefficient when asked to consider forms and appearance. Then, too, he is usually confined to one field, even though it may be a fairly broad field, and does not have any knowledge or experience in what is being done in other fields."—*M. S. Curtis, vice-president of engineering, Warner & Swasey Co., at the American Society of Industrial Engineers Conference.*



ACTUAL SIZE

**incredible ... but true.** This is a new transistorized voltage controlled subcarrier oscillator, type TS-56. It is 1-3/8" high, 7/8" deep and 1-1/16" wide. The weight is only 1-3/4 oz. The unit has deviation, sensitivity, and output adjustments, and is completely encapsulated. Operational temperatures range from -55°C to +125°C.



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\*T.M.

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# EDITORIAL

## Super-Detection Needed to Ensure Peace

Our first warning of the next war may be enemy nuclear blasts in New York City, Baltimore, Chicago, Los Angeles and three or four military bases. Strategists are optimistic, though, that the U.S. can retaliate, both from remaining State-side bases and overseas bases, with sufficient force to knock out the enemy's striking power before he can destroy us completely.

But if we can get an early warning that nuclear-laden missiles are on their way, we can retaliate faster. More Americans will survive.

Until we improve our retaliatory ability by closing the missile gap and improving our radar net, the danger of near extermination is great. Ideally, to save lives, we need a foolproof, positive detection system that will instantaneously signal the launching of a sneak attack.

The establishment of the multimillion-dollar Project Defender program, which is investigating ways to detect and track space vehicles, is a step in the right direction. The monitor-satellite Midas is certainly a worthy project.

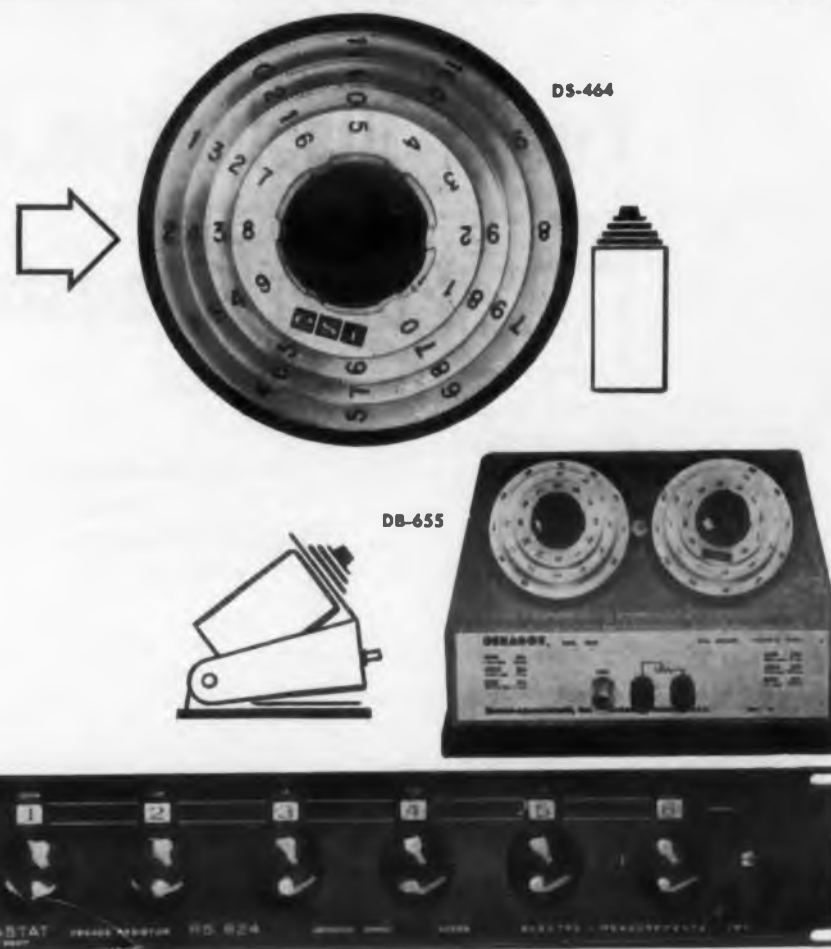
Super-detection devices could do much to guarantee world peace. If, for example, troop movements and aggressive build-up of belligerents could be exposed, enemy subterfuge and propaganda could be vitiated. If we had a reliable nuclear explosion detector today, the Geneva talks on atomic disarmament presumably would lead to the banning of atomic bomb tests. If we could detect all weapons capabilities by surveillance, we could effect disarmament.

Have we exhausted all avenues toward developing super-detectors? Here is a challenge for our profession.

*James G. Kuyper*

**esi**

# DECADE RESISTORS



**MODEL DS SERIES DEKASTAT®**— Precision decade resistors for panel mounting, featuring the exclusive ESI DEKADIAL® concentric dial assembly for convenient straight line readings. Total resistance values available from 1,200 to 120,000 ohms with accuracy of  $\pm 0.05\%$ . Power rating,  $\frac{1}{2}$  watt per step. 3 or 4 decades of resolution. Standard units available from stock. Prices: \$63.00 to \$110.00.

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# Power Dissipation in Class B

## Power Transistors

**Arne Schumacher**  
Senior Engineer  
Hallamore Electronics Co.  
Anaheim, Calif.

**U**SING equations derived from ideal condition assumptions, a simple, straightforward design approach to Class B push-pull transistor amplifiers can be taken. In spite of the departure from ideal conditions experienced in practical applications, the design procedure is quite valid for a first approximation in selection of the proper transistor and output transformer. (The derivation and analysis of the design equations to follow are detailed in the "Equation Derivation" section.)

### Step by Step Design Procedure

1. Determine the dissipation requirement from Eq. 10

$$P_{diss} \geq 0.404 P_{out}$$

where  $P_{diss}$  is the dissipation required of both transistors. In determining  $P_{out}$ , the transformer efficiency, amplifier overload capacity and thermal considerations must be taken into account.

2. Select a supply voltage, or a transistor suitable for operation from an existing supply, from Eq. 1 such that the transistor inverse voltage rating is not exceeded.

$$E_{max} - E_{min} = 2 E_{cc} = \text{Inverse voltage}$$

3. Determine the load impedance  $R_L$  based on the supply voltage  $E_{cc}$  and the required power output from Eq. 3

$$R_L = \frac{E_{cc}^2}{2 P_o}$$

where  $R_L$  is the impedance across one half of the output transformer and  $P_o$  is the output power required of both transistors. It is frequently of interest to determine the minimum value of  $R_L$  permissible consistent with maximum transistor dissipation from Eq. 9

$$R_L = \frac{0.637 E_{cc}^2}{\pi P_{diss(max)}}$$

Hence  $P_{diss(max)}$  would correspond to the total transistor dissipation supplied by the manufacturer. The value of  $R_L$  determined in Eq. 3 will be the maximum  $R_L$  permissible for the required output power while Eq. 9 specifies the minimum value of  $R_L$  based on the maximum dissipation capabilities of the transistors.

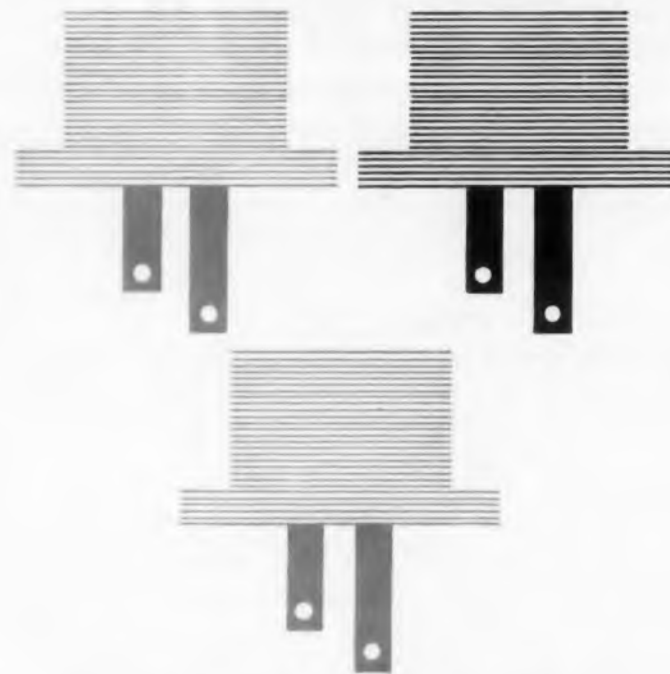
4. Refer to the ( $V_c, I_c$ ) characteristic curves and select a load line based on the calculated value of  $R_L$  from step 3. The actual power output is then determined by Eq. 2a

$$P_o = \frac{(E_{max} - E_{min})(I_{max} - I_{min})}{8}$$

5. Determine the battery power input ( $P_{dc}$ ) from Eq. 5

$$P_{dc} = \frac{2E_{cc} I_{max}}{\pi}$$

where  $I_{max}$  is the peak current swing as determined from the characteristic curve load line in step 4.



*A step-by-step procedure is outlined for the use of ideal equations in practical Class B transistor-amplifier design and a 10-w Class B push-pull amplifier design example is shown. Ideal equations relating to transistor power dissipation requirements in Class B push-pull circuitry are derived.*

6. The collector efficiency can now be found from Eq. 5a

$$\text{Collector Efficiency} = \frac{P_o}{P_{dc}}$$

It is to be noted the collector efficiency of the Class B stage is ideally 78 per cent.

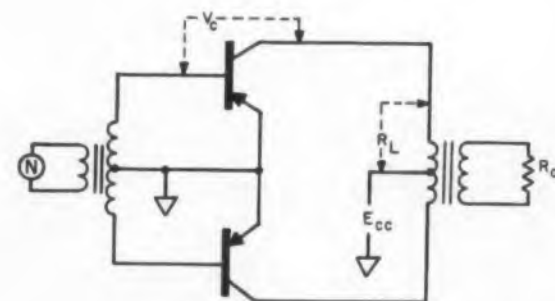
7. The collector dissipation of both transistors can now be calculated from Eq. 5b

$$P_{diss} = P_{dc} - P_o$$

### 10-w Amplifier Design Example

It is desired to design a 10-w Class B push-pull amplifier with an output transformer efficiency of 85 per cent and an available supply voltage of 13 v.

Since the transformer is 85 per cent efficient, the



**Fig. 1.** Basic circuit configuration for a push-pull power amplifier.



power delivery capability of the transistors must be 11.5 w or 5.3 w per transistor.

**From Step 1.** The transistor dissipation requirements are

$$P_{diss} \geq 0.404 P_{out}$$

$$P_{diss} \geq 0.404 (11.5) = 4.65 \text{ w}$$

(for both transistors) or approximately 2.32 w per transistor.

**From Step 2.** The inverse rating on the transistors must be at least

$$E_{max} - E_{min} = 2 E_{cc} = 2 (13) = 26 \text{ v}$$

**From Step 3.** The maximum load impedance usable with the available supply voltage of 13 v and required output of 11.5 w will be

$$R_L = \frac{E_{cc}^2}{2 P_o} = \frac{169}{2 (11.5)} = 7.35 \text{ ohms}$$

Referring to the manufacturer's specifications, select a transistor which, for example, has a collector dissipation rating of 4 w. The total dissipation allowed for both transistors would then be 8 w. The minimum value of load impedance to use will be

$$R_L = \frac{0.637 E_{cc}^2}{\pi P_{diss}} = \frac{(0.637) (169)}{(3.14) (8)} \approx 4.30 \text{ ohms}$$

Therefore the load impedance must lie between 7.35 ohms (maximum) and 4.30 ohms (minimum). (The load impedance, it is remembered, is that which is presented by one half of the output transformer primary.)

**From Step 4.** Referring to the  $V_o, I_o$  characteristic curves (Fig. 2), a load line corresponding to the calculated maximum load impedance is drawn where  $(I_c) = E_{cc}/R_L \approx 1.75$  amp. The maximum and minimum values of the current and voltage swings then determine the actual power output

$$P_o = \frac{(E_{max} - E_{min}) (I_{max} - I_{min})}{8}$$

$$\text{where } (E_{max} - E_{min}) \approx 24 \text{ v}$$

$$(I_{max} - I_{min}) \approx 3.5 \text{ amp}$$

$$P_o = \frac{(24) (3.5)}{8} = 10.5 \text{ w}$$

Since the design specifications require a 11.5-w output, at least one additional watt of output power is required. (The lack of required output power could have been anticipated to some degree since the load impedance determined in step 3 was the maximum load permissible for the required power output.)

The  $I_{max}$  required for the 11.5-w output is determined:

$$P_o = 11.5 = \frac{(24) (I_{max} - I_{min})}{8}$$

and  $(I_{max} - I_{min}) = 4$  amp. Thus  $I_{max} = 2$  amp (as-

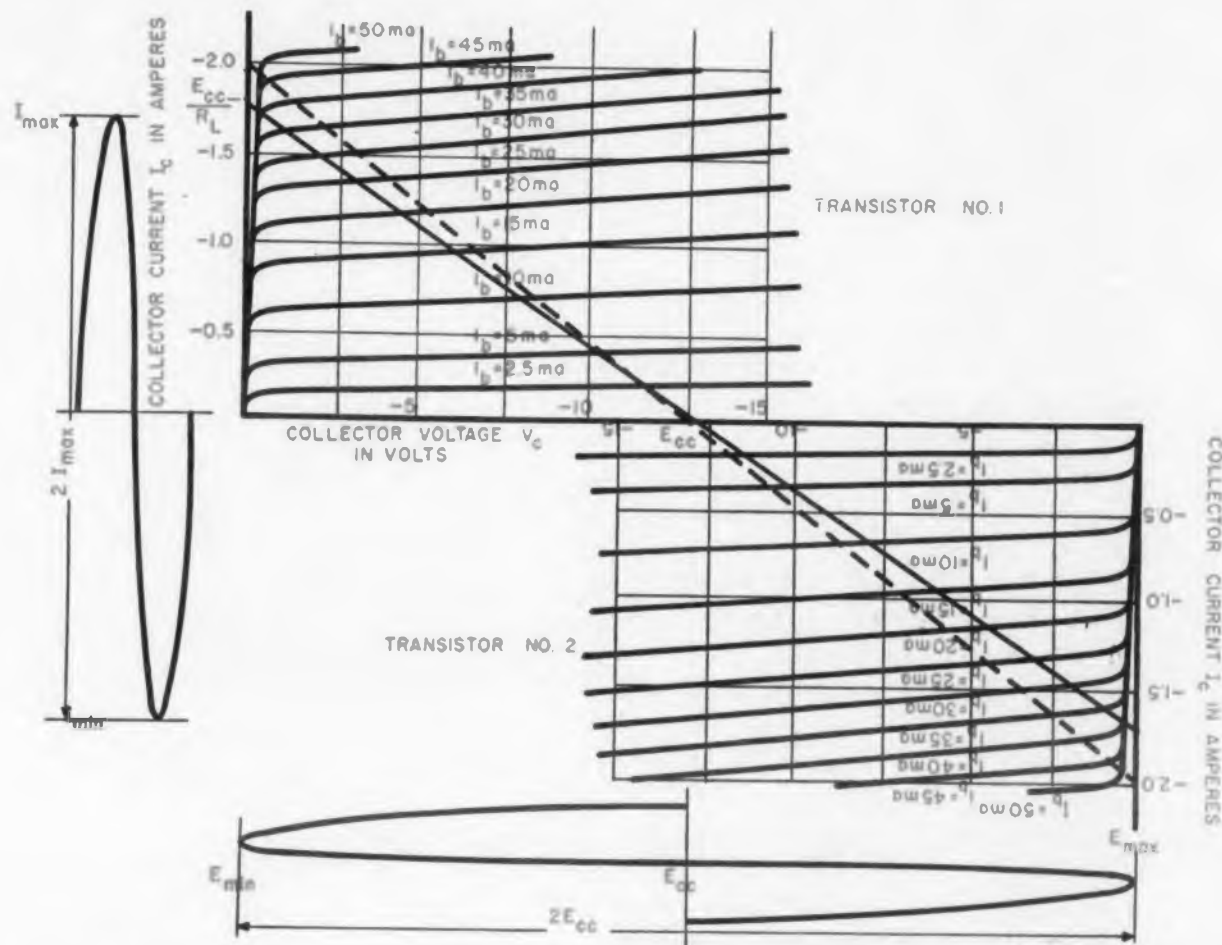


Fig. 2. Individual collector characteristics are drawn back-to-back and joined at their quiescent joint,  $E_{cc}$  in analysis of a Class-B push-pull stage.

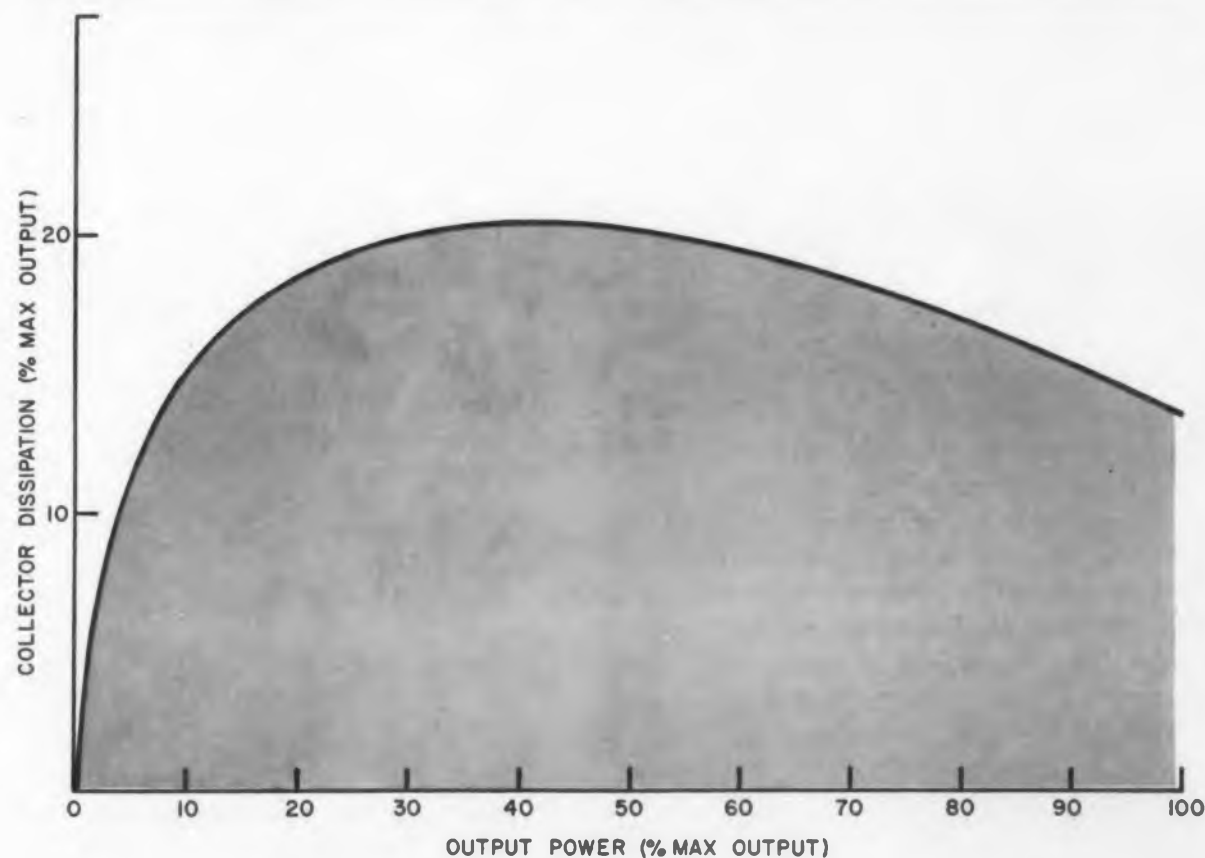


Fig. 3. Variation of collector dissipation with power output for an ideal Class-B push-pull stage.

# EQUATION DERIVATION

In analyzing the mode of transistor operation in Class B circuitry (Fig. 1), the load line is drawn on the  $V_o, I_o$  transistor characteristics as shown in Fig. 2. Since the transistors are placed back-to-back and biased essentially at cut-off corresponding to minimum standby current, the characteristics are drawn back-to-back and joined at this quiescent point, that is, at the supply potential  $E_{cc}$ .

In actual circuit operation, it becomes necessary to arrange the transistor biasing (pre-biasing) in such a manner that each transistor is conducting for slightly more than 180 deg to eliminate crossover distortion. For practical analysis of ideal transistor operation in conjunction with the characteristic curves it can be assumed the transistors are biased exactly at cut-off.

While  $E_{cc}$  is essentially equal to  $V_o$  (assuming no dc drop in the transformer) and considering the instantaneous operating point along the load line, it is found that during the time when one of the transistors is cut-off, the voltage on this transistor rises above the supply voltage  $V_{cc}$  as far as the voltage on the conducting transistor falls below the supply voltage. Under maximum input signal conditions then, each transistor has twice the supply voltage impressed across it while it is cut-off, which the maximum output power (into load) from a Class B push-pull circuit is obtained when each transistor operates into half the load resistance that is optimum for Class A operation.

It would appear that the maximum transistor collector dissipation might occur when the input signal drives the collector to  $I_{max}$  or  $I_{min}$  since the transistor would be driven to maximum operating conditions and the output power would be greatest under these conditions.

While the above assumption is erroneous, the reason for its invalidity is sometimes not too obvious; in the following analysis some of the basic expressions will be derived and transistor dissipation requirements and limits with regard to Class B power transistor operation discussed. Referring to Fig. 2, it is evident that

$$E_{max} - E_{min} = 2E_{cc} = 2I_{max}R_L \quad (1)$$

$$I_{max} - I_{min} = 2I_{max} = \frac{2E_{cc}}{R_L} \quad (2)$$

and Ideal Power Output

$$P_o = \frac{(E_{max} - E_{min})}{2\sqrt{2}} \times \frac{(I_{max} - I_{min})}{2\sqrt{2}} \quad (2a)$$

$$= \frac{(2E_{cc})(2E_{cc}/R_L)}{8}$$

$$P_o = \frac{E_{cc}^2}{2R_L} = \frac{I_{max}^2 R_L}{2} \quad (3)$$

Since the foregoing analysis is based on ideal signal swings, the power output given by Eq. 3 is also ideal.

The dc collector current drawn by one transistor, assuming a sine-wave half cycle of current and neglecting  $I_{oo}$  (reverse current) is

$$i_{dc} = \frac{I_{max}}{\pi} \quad (4)$$

while the total dc collector current drawn by both transistors is  $\frac{2I_{max}}{\pi}$  resulting in a battery power input for both transistors of

$$P_{dc} = \frac{2E_{cc} I_{max}}{\pi} \quad (5)$$

The Collector Efficiency can be written by combining Eqs. 3 and 5

$$\text{Collector Efficiency} = \frac{P_o}{P_{dc}} = \frac{\pi}{4} = 78.5\% \quad (5a)$$

the ideal collector efficiency of the Class B push-pull amplifier.

Assuming zero dc losses in the output transformer wherein the battery power is equal to the transistor input power

$$P_{dc} = P_{in} = P_{out} + P_{diss}$$

hence

$$P_{diss} = P_{dc} - P_{out} \quad (5b)$$

Substituting Eqs. 3 and 5

$$P_{diss} = \frac{2E_{cc} I_{max}}{\pi} - \frac{I_{max}^2 R_L}{2} \quad (6)$$

where  $R_L$  is the impedance across one-half of the output transformer.

Differentiating Eq. 6 with respect to  $I_{max}$  and setting it equal to zero, the value of current is

found which will make the transistor dissipation a maximum, hence

$$\frac{d(P_{diss})}{d(I_{max})} = 0 = \frac{2E_{cc}}{\pi} - I_{max} R_L$$

and solving for  $I_{max}$

$$I_{max} = \frac{2E_{cc}}{\pi R_L} = 0.637 \frac{E_{cc}}{R_L} \quad (7)$$

and since

$$\frac{E_{cc}}{R_L} = I_{max(ideal)}$$

$$I_{max} = 0.637 I_{max(ideal)} \quad (8)$$

Thus, the maximum transistor dissipation occurs when the current swing is 63.7 per cent of the maximum ideal current.

To determine the maximum dissipation which the transistors must be capable of handling, substitute the  $I_{max}$  value of Eq. 7 into Eq. 6 and find

$$P_{diss(max)} = \frac{0.637E_{cc}^2}{\pi R_L} \quad (9)$$

Eq. 9, then, gives the maximum dissipation required of both transistors with a given supply voltage and load impedance.

From Eqs. 3 and 9 the transistor dissipation required for a given power output can be calculated:

$$\frac{P_{diss}}{P_{out}} = \left( \frac{0.637E_{cc}^2}{\pi R_L} \right) \left( \frac{2R_L}{E_{cc}^2} \right) = 0.404$$

hence, in the ideal case, the collector dissipation must be equal to or greater than 40.4 per cent of the required power output

$$\text{(both transistors)} P_{diss} \geq 0.404P_o \quad (10)$$

In terms of an individual transistor then, the power output must be limited to five times the collector dissipation rating

$$\text{(individual transistor)} P_o \leq 5P_{diss}$$

Fig. 3 graphically illustrates the variation of collector dissipation versus power output; it can be seen that maximum collector dissipation occurs at approximately 40 per cent output. Also, the collector dissipation at 8 per cent output is as great as the collector dissipation at 100 per cent output.



suming  $E_{max} - E_{min}$  did not change appreciably.)

**From Step 5.** The battery power is

$$P_{dc} = \frac{2 E_{cc} I_{max}}{\pi} = \frac{2 (13) (2)}{3.14} = 16.5 \text{ w}$$

**From Step 6.** The collector efficiency is calculated as follows:

$$\text{Collector Efficiency} = \frac{P_o}{P_{dc}} = \frac{11.5}{16.5} = 70 \text{ per cent}$$

**From Step 7.** The collector dissipation

**Collector Dissipation** =  $P_{dc} - P_{out} = 16.5 - 11.5$  w or 2.5 w per transistor.

#### Departure from Ideal Conditions

In the foregoing design example, considerations were based entirely on the ideal equations. In the determination of load impedance, the maximum permissible value of load impedance was chosen resulting in insufficient output power. In a practical design situation, since both the maximum and minimum value of permissible load impedances can be determined (Step 3), a load impedance would be selected between the calculated ideal maximum and minimum values which would be consistent with an available output transformer and/or amplifier overload capacity. An additional factor not considered would, of course, be temperature derating. Several factors will cause the collector dissipation to differ from the calculated ideal values, all of which will affect the collector dissipation to some degree.

The effect of transistor input impedance will cause the gain of the Class B amplifier to vary with input signal amplitude resulting in odd-harmonic distortion, thereby altering the dissipation. The variation of input impedance of the Class B stage is greatest near the cut-off region of the transistors due to the effects of  $I_{co}$  at the crossover point on the input and output current waveform. When this condition (crossover distortion) exists in the amplifier, the distortion percentage actually increases with decreasing input signal.

The elimination of crossover distortion is usually accomplished by pre-biasing the amplifier slightly into the Class AB region; this type of biasing of course will have the effect of increasing the collector dissipation slightly.

When temperature stabilization is introduced by the use of an emitter resistor, the available power output (for the same collector dissipation) is reduced, since the load impedance must be reduced when the emitter resistance is added.

The variation in collector dissipation from the ideal calculated case to a practical consideration can be accounted for in the initial design by assuming the maximum collector power dissipation to be approximately 50 per cent greater than the ideally calculated value. ■ ■

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## FCC Control of RFI

**Jules Deitz**

Electronic Engineer  
Federal Communications Commission  
Silver Spring, Md.

*The radio spectrum, bursting at the seams with activity, is additionally burdened by a multitude of extraneous emissions. While the present state of the art is not conducive to FCC control of lightning strokes and stellar emissions, the Commission is intent on thwarting man's contribution to the pollution of the radio spectrum.*

**R**ESTRICTED radiation devices (RRD), incidental radiation devices (IRD) and industrial, scientific and medical (ISM) equipment require special precautions in design and operation in order to prevent radio-frequency interference. To insure that these precautions will be taken, the Federal Communications Commission has issued specific regulations in Part 15 and Part 18 of its rules. Examples of the apparatus covered by these rules are shown in Table I.

### Interference Defined

The FCC's basic requirement is that no harmful interference be caused to the reception of licensed radio stations. Harmful interference is  
*(text continued on p 58)*

**Table 1. Examples of Electronic Devices Regulated by FCC Rules Parts 15 and 18.**

Regulated by Part 18	Regulated by Part 15	
Industrial Scientific & Medical	Restricted Radiation Devices rf energy purposely generated.	Incidental Radiation Devices rf energy unintentionally generated.
1. Industrial Heaters a. Induction b. Dielectric	1. Radio Receivers	1. Fluorescent Lights
2. Medical Diathermy	2. Carrier Current Systems a. Community TV b. "Campus" c. Telephone d. Industrial	2. Electric Appliances
3. Miscellaneous a. Epilators b. Ultrasonic c. Electronic ovens d. Rf neon signs	3. Low Power Communication a. Wireless microphones b. Garage door openers c. Phonograph oscillators	3. Electric Motors
		4. Electric Shavers
		5. Ignition Systems
		6. Defective Insulators

### Previous RFI Articles

*RFI Checklist*—L. W. Thomas, ED, Feb. 3, 1960, p 38.

*Troubleshooting with Clamp-On Devices*—T. H. Herring, ED, Feb. 3, 1960, p 44.

*Optimum Shielding of Equipment Enclosures*—A. L. Albin, ED, Feb. 3, 1960, p 48.

*RFI—An Up-To-Date Survey*—R. Schulz, ED, Feb. 3, 1960, p 24.

*RFI Gasketing*—O. P. Schreiber, ED, Feb. 17, 1960, p 46.

*Dissipative Filters for Switching Circuits*—R. Schulz, ED, Feb. 17, 1960, p 50.



### ISM Frequencies

Frequency	Tolerance	Frequency	Tolerance
13,560 kc	± 6.78 kc	915 mc	± 25 mc
13,560 kc	± 6.78 kc	915 mc	± 25mc
27,120 kc	± 160 kc	2,450 mc	± 50 mc
40,680 kc	± 20 kc	5,850 mc	± 75mc
		18,000 mc	± 150 mc

Note: Radiation in these bands is not limited.

Table 2. Technical Specifications For Part 18 (industrial, scientific and medical services) Devices.

Type of Equipment	Fundamental Frequency of Radiation — (mc)	Field Strength Limit Outside of ISM Bands	Additional Requirements	Refer to Section
<b>Medical Diathermy</b> (Subpart B)	13, 56, 27.12, 40.68	25 uv/m at 1000 ft.		18.11 (b)
	915, 2450, 5850, 18000	Reduce radiation to greatest extent practicable	Reduce bandwidth of emissions to the greatest extent practicable.	18.7
	Any other frequency	15 uv/m at 1000 ft	15 uv/m at 1000 ft limit also applies to radiation at the fundamental frequency.  <u>Applicable To All Medical Diathermy Equipment:</u> Use FCC radiation measurement procedure. Certification. Or type approval. Certificate must be renewed every three years. Equipment operated on off-ISM frequencies requires a rectified and filtered power supply.	18.12 (a)  18.13 18.12 (b) 18.14 18.12 (c)
<b>Ultrasonic</b> (Subpart E)	Up to 0.490	$\frac{2.4}{F_{mc}}$ uv/m at 1000 ft	In predominantly residential areas and on frequencies below 0.490 mc, the radiation limit may be increased as the square root of the generated power to 500 w. The limit, however, is not permitted to exceed 10 uv/m at 1 mile.	18.71
	.490 — 1.6	$\frac{24}{F_{mc}}$ uv/m at 100 ft	<u>Applicable To All Ultrasonic Equipment:</u> Use FCC radiation measurement procedure. Power Line rf Voltage: below 490 mc — 1000 uv above 490 mc — 200 uv	18.77 18.71 (e)
	Over 1.6	15 uv/m at 100 ft	Certification. Or type approval.	18.70 18.72
<b>Industrial Heating</b> (Subpart F)	Below 5775	10 uv/m at 1 mile	Power Line Radiation Limit: 10 uv/m at 50 ft at points 1 mile or more from the equipment. Use FCC radiation measurement procedure.	18.102 18.107
	Above 5775	Reduce radiation to greatest extent practicable	<u>Applicable To All Industrial Heaters:</u> Operation not permitted on — 490-510 kc, 2170-2194 kc, and 8354-8374 kc. Certification. Periodic Inspection.	18.102 (b) 18.103 18.105
<b>RF Stabilized Arc Welders</b>	Any frequency	10 uv/m at 1 mile	Power Line Radiation Limit: 10 uv/m at 50 ft at points 1 mile or more from the equipment. Use FCC radiation measurement procedure. Measure quasi-peak using an instrument equivalent to ASA proposed specification C63.2. Certification. Or type approval.	18.5 18.107 18.5 18.103 18.31 (c)

**Miscellaneous**  
(Subpart C) These rules apply to ISM equipment other than medical diathermy, industrial heating, ultrasonic and RF Stabilized Arc Welders in which rf energy is applied to materials to produce physical, biological or chemical effects such as heating, ionization of gases, mechanical vibrations, hair removal and acceleration of charged particles which do not involve the use of radio receiving equipment.

Requirements are the same as for medical diathermy except that for equipment other than that used in predominantly residential areas, the radiation limit may be increased as the square root of the generated power to 500 w. The limit, however, is not permitted to exceed 10 uv/m at 1 mile.

considered to be "any radiation or induction which endangers the functioning of a radio-navigation service or of a safety service, or obstructs or repeatedly interrupts" any licensed radio service. In order to reduce the probability that harmful

interference will occur, the FCC requires compliance with certain technical specifications. These specifications are outlined in Tables II and III. No license is required to operate a device that complies with Part 15 or Part 18 requirements.

Table 3. Technical Requirements For Part 15 (incidental and restricted radiation) Devices.

Type of Equipment	Frequency of Radiation (mc)	Field Strength Limit (uv/m)	Additional Requirements	Refer to Section	
<b>Radio Receivers (30-890 mc) Subpart C</b> TV broadcast All other	0.45-25	none	Power line rf voltage limitation: 100 uv	15.62	
	0.45-9	none	Power line rf voltage limitation: 100 uv	15.62	
	9-10	none	100-1000 uv*		
	10-25	none	1000 uv		
	25-70	32 at 100 ft	<u>Applicable To All Receivers (that tune 30-890 mc):</u>		
	70-130	50	A certificate is required for each model receiver.	15.64	
	130-174	50-150* (linear interpolation with frequency)	File copy of certificate with FCC.	15.65 (b)	
	174-260	150	Identify each certificated receiver with seal or label.	15.66	
	260-470	150-500*	Any measurement procedure acceptable to the Commission may be used.	15.63 (a)	
	470-1000	1000 (500 after 12/31/60)	The following IRE standards are considered acceptable: Power line rf voltage: 54IRE17S1, 56IRE27S1, 58IRE27S1 Radiation: 51IRE17S1	15.63 (b)	
<b>Community Antenna TV (CatV) Subpart D</b>	Up to 54	15 at 100 ft	<u>Field Strength Limit in Sparsely Inhabited Areas†</u>		
	54-132	20 at 10	15 uv/m at 100 ft †areas within 1000 ft of a CATV	15.161	
	132-216	50 at 10	400 at 10 system where TV signals are		
	Over 216	15 at 100	1000 at 10 being received directly from a 15 at 100 television broadcast station. Use FCC radiation measurement procedure.	15.165	
<b>Low Power Communication Subpart E</b>	Operation under antenna & power limitations	0.16 - 0.19	none	<u>Max. Input To Final</u> 1.0 watt	15.203
		0.51 - 1.6	none	0.1	15.204
		26.97 - 27.27	none	0.1	15.205
	Operating under field strength limitations	0.010 - .490	$\frac{2.4}{F_{mc}}$ at 1000 ft	<u>Max. Antenna Length</u> 50* ft	15.202
		0.510 - 1.6	$\frac{24}{F_{mc}}$	10*	
		70 - 1000	rcvr radiation limit apply.	5 *including transmission line	
above 1000	500 at 100 ft	Limit operation automatically to 1 sec each 30 sec	15.206		
		Limit operation automatically to 1 sec each 30 sec			
		<u>Applicable To All Low Power Communication Devices:</u> A certificate to be attached to each device. Class B emission prohibited.	15.208 15.207		
<b>Incidental Radiation Device* Subpart B</b>	Any frequency	none	In the event that harmful interference is caused, the operator shall promptly take steps to eliminate the harmful interference.	15.31	

\*A device that radiates although it is not intentionally designed to generate rf energy. Examples: Fluorescent lights, electrical appliances, electric motors and ignition systems.



Certification or type approval is, in most cases, a requirement for operating Part 15 and Part 18 devices. A certificate must contain sufficient information and data to demonstrate that the device to which it applies complies with the Commission's technical specifications. Except for industrial heaters, FCC type approval may be requested for all ISM equipment manufactured in quantities of five or more. Type approval tests are performed by the Commission's Laboratory on a prototype unit. If the unit is found to comply with FCC radio-interference specifications, a type-approval number is issued to the manufacturer. He places this number on all units that he sells to indicate that they are identical to the prototype. The type-approval number may be withdrawn if the manufacturer's product is found to deviate from the prototype.

#### Low-Power Transmitters

Special mention is made of the FCC's requirements for operating transmitters of very short range without a license. Developments in transistor circuitry are stimulating wide interest in such devices as wireless microphones. A wireless microphone can be operated under Part 15 as a Low-Power Communication Device but only on the frequencies 10-490 kc, 150-1600 kc and 26.97-27.27 mc. Other technical limitations also apply and they are outlined in Table III. All Low-Power Communication Devices must be certificated.

The Commission expects that the interference from Incidental Radiation Devices will be minimized to the greatest extent practicable at the point of manufacture. In addition, the Commission is encouraging the development of industry standards. Currently, for example, the Automobile Manufacturers Association and the Society of Automotive Engineers are active in developing a radiation limit and measurement procedure to be applied to automotive ignition systems. The almost infinite variety of incidental radiation devices and the yet incomplete knowledge of what standards should apply has not permitted the FCC to adopt radiation limits to date.

Other major sources of RFI, beyond the scope of this article, are interferences between radio stations and spurious and harmonic emissions from licensed transmitters. FCC specifications concerning these matters are contained in the individual rule parts applicable to each of the various radio services regulated by the Commission. ■ ■

Tables II and III contain information in abstract form and should not be used as a substitute for the Rules. Parts 15 and 18 are included in Volume II of the Rules and Regulations of the FCC. Volume II is available from the U. S. Government Printing Office, Washington 25, D. C. at the cost of \$2.00.

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Write for Bulletin 155



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771-2	—	¾	.600	½	¼	251K-400K	350
772-3C	RN65° R192†	¾	1¾/16	¼	1/8	50-125K	300
772-3CJ	R192†	¾	1¾/16	½	¼	50-85K	300
772-1	—	¾	2¼/16	½	¼	25-250K	350
772-1C	—	¾	2¼/16	½	¼	25-250K	350
772-2	RN72° R194†	1¾/16	2¼/16	½	¼	25-400K	350
772-2C	R194†	1¾/16	2¼/16	½	¼	25-400K	350
772-2CS	RN70° R194†	1¾/16	1¾/16	½	¼	25-350K	350
772-2J	R194†	1¾/16	2¼/16	1	—	25-400K	350
		1¾/16	2¼/16	—	½	25-150K	350
772-2CJ	R194†	1¾/16	2¼/16	1	—	25-400K	350
		1¾/16	2¼/16	—	½	25-150K	350
772-8	R196†	1¾/32	1¾/32	1	½	100-1 meg	500
772-8C	RN75° R196†	1¾/32	1¾/32	1	½	100-1 meg	500
772-10	—	2¾/32	2¾/16	2	—	200-2.5 meg	750
772-10C	RN80°	2¾/32	2¾/16	2	—	200-2.5 meg	750

\*MIL-R-10509C †MIL-R-19074B

RHEOSTATS RESISTORS RELAYS TANTALUM CAPACITORS TAP SWITCHES VARIABLE TRANSFORMERS R. F. CHOKES GERMANIUM DIODES

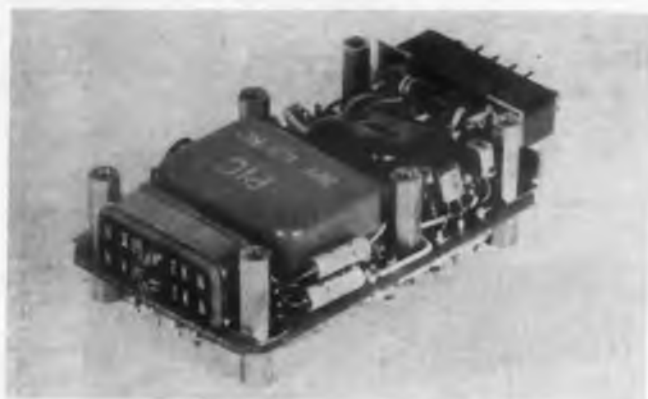
CIRCLE 53 ON READER-SERVICE CARD



## An industrial designer discusses . . .

# CONCEPTS in PACKAGING

*The industrial designer is often asked to contribute proposals on miniaturization and packaging problems. Several approaches to a particular project are outlined. (Knob Design was considered in ELECTRONIC DESIGN, February 17 and Panel Redesign illustrated in the March 2 issue.*



**Fig. 1.** The original package was considered difficult to assemble; weight and size reductions were also deemed necessary.

**T**O CREATE original and constructive concepts in component packaging, the industrial designer must fully exploit his talents of ingenuity and imagination. While the circuit design engineer may apply conventional approaches to the problems of achieving maximum density and assembly efficiency, the industrial designer is often more abstract and prone to delve into fanciful, off-beat suggestions.

### Subcarrier Oscillator Packaging

A typical project involved the preparation of proposals for the packaging of a subcarrier oscillator manufactured by Hoover Electronics Co., Timonium, Md. Simplified assembly plus cost and weight reductions were the prime objectives of the study to redesign the unit shown in Fig. 1.

Three approaches were submitted for solution of the packaging assignment.

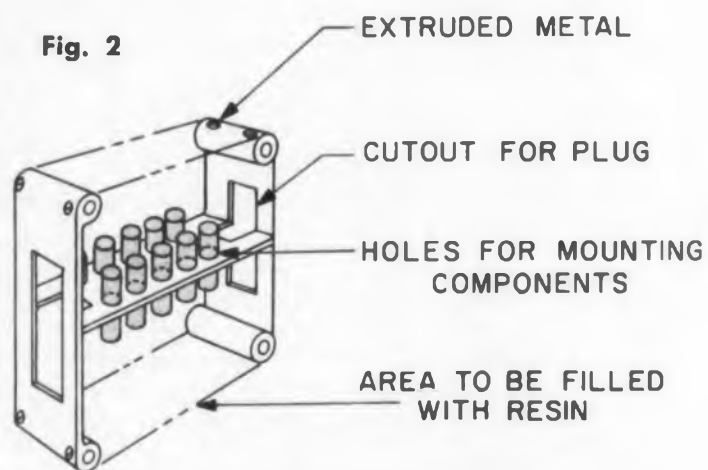
### "H"-Frame Construction

In this assembly, shown in Fig. 2, the bridge or cross member serves as the chassis on which the components are mounted and connected. The open frame construction lends itself to excellent accessibility for wiring with a corresponding decrease in assembly time.

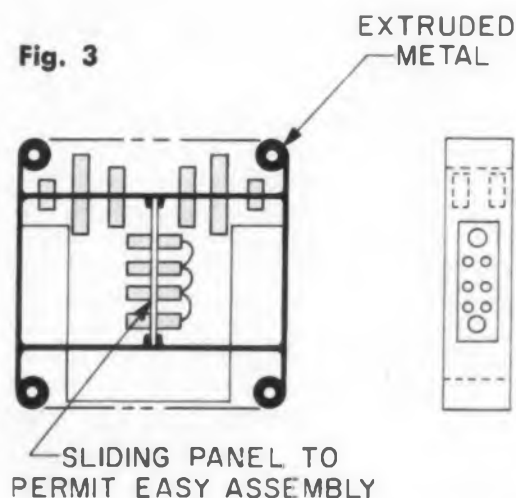
The cavities created by the metal form act as a partial mold into which an appropriate resin material would be poured to rigidize the entire package.

Variations of this proposal, shown in Figs. 3 and 4, include a removable sliding panel for flexibility of subassembly.

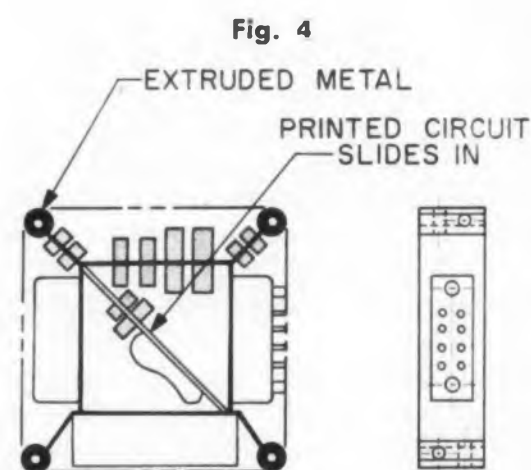
### One approach—and possible modifications



An "H" frame construction offers ease of assembly by virtue of its open areas.



Variations of the "H" frame provide sliding plates which allow separate subassembly.





### Strip Wrap-Around

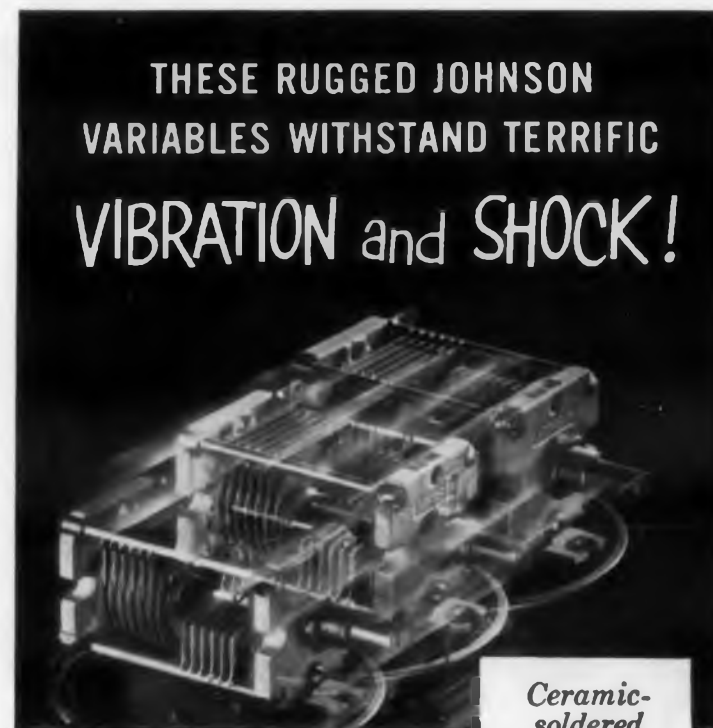
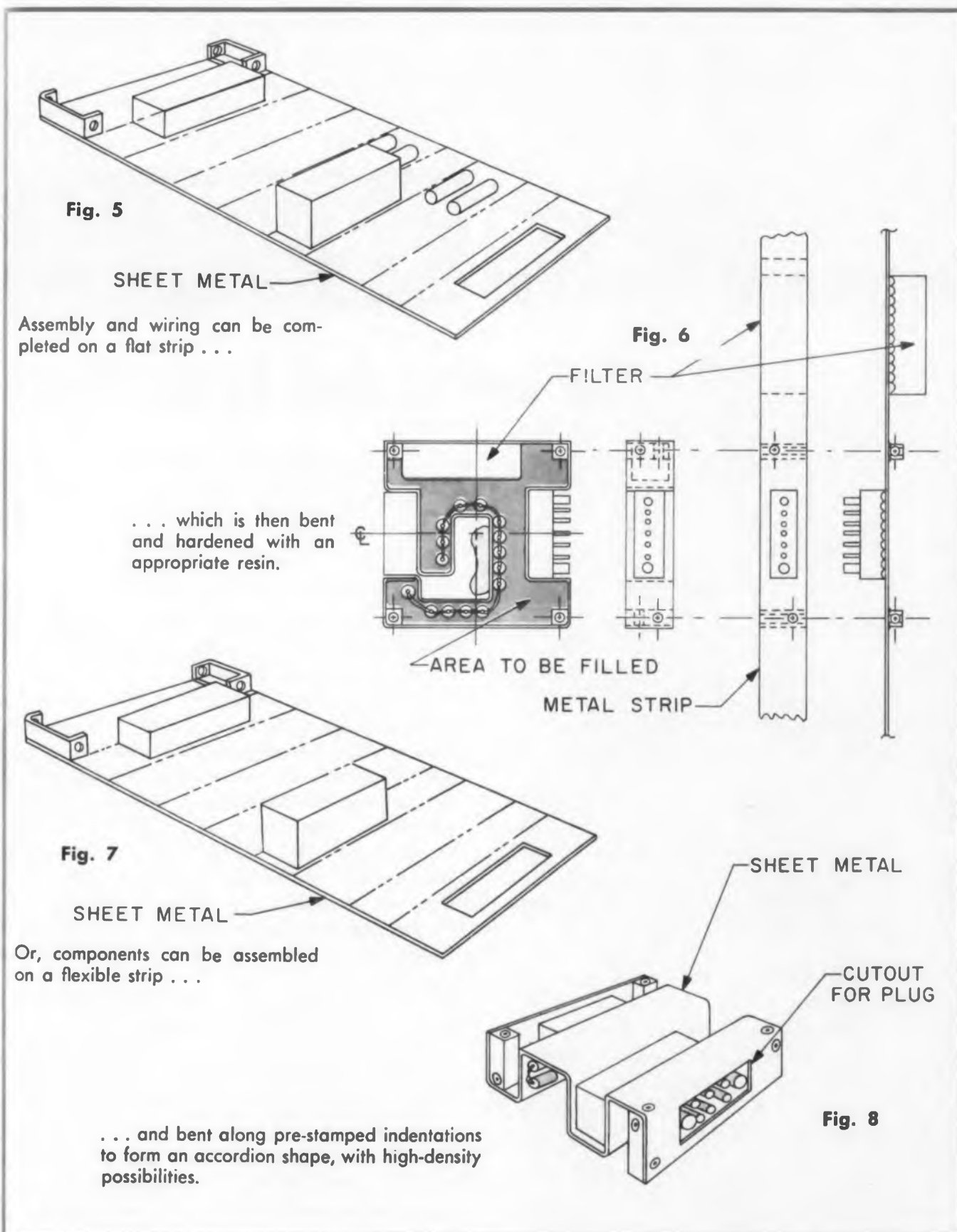
Assembly is greatly simplified by mounting and wiring all components on a flat strip, shown in Fig. 5, and then bending or forming the assembly on a jig; the addition of an appropriate resin would harden the unit to the desired strength.

An alternate suggestion, shown in Fig. 6, involves the extrusion of a maze with the desired contour; specific surfaces would be created for each component.

### Accordion Shape Design

The final scheme, shown in Fig. 7, involves the assembly of components to a flat surface fabricated of a thin flexible metal. By pre-stamping appropriate bends and cutouts, the subassembly can be pushed together into an accordion configuration with an epoxy resin added as a final step.

As an alternate possibility, a square corrugated section could be extruded and components could then be tucked into place, see Fig. 8. ■ ■



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CIRCLE 54 ON READER-SERVICE CARD



*Thomas E. Rounds wrote this article believing that "most bearing problems can be solved at a very early stage in prototype development." He has been associated with the anti-friction bearing industry for over thirty years.*

Data is given on: basic types of bearings; ball retainers; standard sizes; materials; tolerances and radial play; and special bearings.

## Instrument Precision Ball Bearings: How To Select And Apply Them

**Thomas E. Rounds**  
Vice President,  
Chief Consulting Engineer  
The Barden Corp.  
Danbury, Conn.

**K**NOWING how to select and apply instrument precision ball bearings can often accelerate the development of new systems and components, reduce redesign and production costs, and increase a unit's reliability. What electronic design engineers must consider in selecting and applying these bearings is covered in these two articles.

### Basic Types of Bearings

Types or basic designs of instrument ball bearings most frequently used are shown in Fig. 1. The designer's choice is determined chiefly by the character of the load to be supported, how the bearing will be mounted, and shield requirements. Other factors are rotational speed and permissible torque level. The load, mounting and shield requirements determine the bearing type; the torque and speed determine the choice of ball retainer.

While the bearings shown in Fig. 1 are commonly termed radial type, all will support pure end-thrust or thrust combined with radial loads. The deep groove type carries thrust in either direction. Angular contact types will support thrust in only one direction and generally require light axial loading or "take-up" in the same direction.

Bearings with one or two shields are generally available in the deep groove construction, rarely in angular contact. Shields protect bearings against entry of dirt or foreign matter and loss of lubricant. Shielded bearings, generally, are wider than open or unshielded versions, although there are some exceptions.

Flanges, which simplify mounting and enclosure designs by permitting through-boring, usually are available only in the deep-groove types. Flanged, and single or double-shielded bearings are also supplied in this type, the single-shield version having the shield on the flange side.

### Ball Retainers: High And Low-Speed Types Available

Ball retainers are now used in all sizes of instrument precision ball bearings. They space the balls and thus reduce by one-half the rubbing speed that would occur if the balls rotated against each other. Three commonly used types appear in Fig. 2.

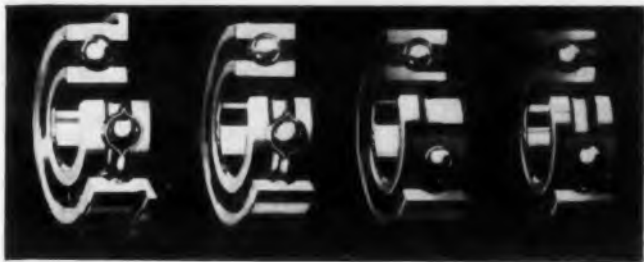
Retainers for deep-groove bearings are predominantly made of pressed steel, usually stainless steel. Bearings with these retainers are best

for sensitive low-torque, low-speed applications (gyro gimbals and synchros) and lowest in cost of the standard sizes now produced in quantity.

Spring separators for deep-groove bearings are intended for very low-speed work only (such as gyro gimbals) where their chief virtue is to prevent "hang-up" or retainer lock which sometimes occurs under certain misalignment, combined load or vibratory conditions. Improved pressed-steel retainers that accommodate these adverse conditions are now available from some manufacturers; they are gradually superseding the spring separators because of their superior characteristics of uniformly low restraining torque and better load capacity.

The machined-phenolic retainer is used in the greatest number, by far, of angular contact bearings, both non-separable and separable. Chief virtues include: light weight, good wear resistance, and ability to absorb a minute oil film on its surfaces—a distinct advantage for high-speed work in prolonging useful life with minimum lubrication. Most predominant applications are in gyro rotors, motors, generators, and other very high-speed devices.





**Fig. 1.** Basic types of instrument bearings are, left to right: deep groove—flanged and unflanged; angular contact—separable and non-separable. Character of load and mounting arrangement are chief factors in choice of bearing type.



**Fig. 2.** Three widely used ball retainer types are, left to right: two-piece pressed steel spring separator, and one-piece phenolic. Torque and speed requirements are major factors in choice of retainer type.

#### Standard Sizes: Two Series Commonly Used

While there are some metric-dimension bearings in the instrument's size range (which is generally considered as below 1 in. outside diameter) the greatest number of sizes, by far, are made to inch standards. Two series are commonly used: one an intermediate series made in sizes from 0.375 to 0.875 in. OD, and the other a miniature series from 0.156 to 0.500 in. OD.

These series have recently been accepted by the American Standards Association as American standards. (American Standard Requirements for Instrument Precision Ball Bearings—B3.10—1959.) Since they are now standard and obtainable from several sources, these sizes should constitute the electronic designer's first choice for lowest cost and best availability. Many of these sizes are available in the non-separable and separable angular contact types, as well as the deep-groove types.

#### Materials: Steel Plays Major Role

Major materials used for instrument precision balls and bearing rings are SAE 52100 chrome-



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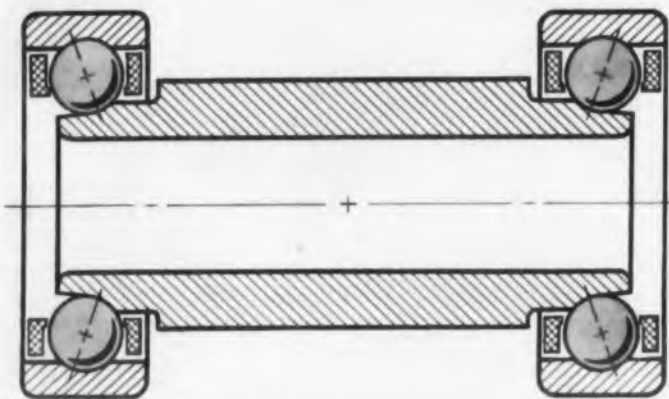
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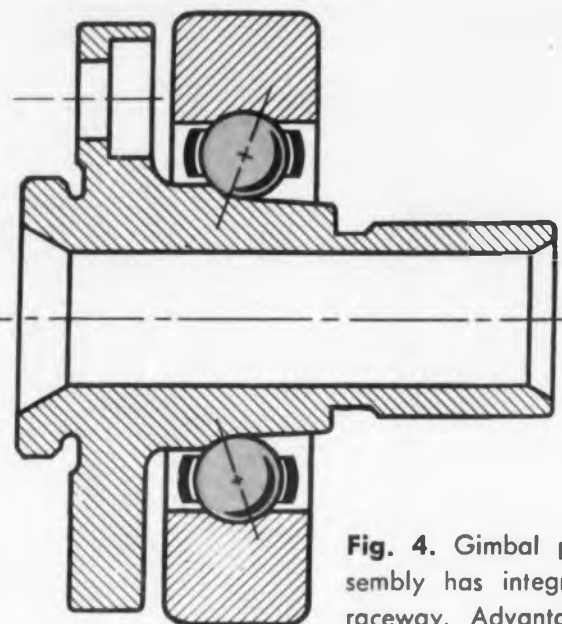


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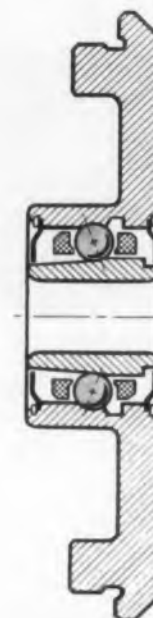
CIRCLE 55 ON READER-SERVICE CARD



**Fig. 3.** Special design bearing for gyro spin axis has inner raceways ground on shaft and separable outer ring assemblies. Integrally ground shaft raceways reduce mounting errors and improve accuracy and rigidity.



**Fig. 4.** Gimbal pivot assembly has integral inner raceway. Advantages are low runout errors and high rigidity and accuracy; cost, like other specials, is higher than for standard bearings.



**Fig. 5.** End bell type, specially designed for gyro use, features outer raceway integral with flanged member which forms a part of the spin mass assembly.

bearing steel, and AISI 440C stainless steel. While some instrument bearings have been produced in beryllium copper for antimagnetic applications, its low hardness and poor surface-finishing qualities make it unattractive for general use in electronic systems. Type 440C is increasingly specified by designers because of its resistance to corrosion and, when suitably heat treated, its superior high-temperature dimensional stability. Improvements made in surface finishing techniques have made 440C stainless bearings practically equal in low-torque performance to 52100 steel, although their load capacity is slightly lower. The lower load capacity, however, seldom is a disadvantage in instrument or electronic applications.

#### Tolerances And Radial Play: Some Misunderstandings Cleared Up

Tolerances of instrument grade or "super precision" ball bearings are generally in the ABEC 5 to ABEC 7 range. The tolerances conform to those of the ABEC (Annular Bearing Engineers' Committee of the Anti-Friction Bearing Manufacturers Association) for all dimensions except for width, which is  $+0.000$  to  $-0.005$  in. in the basic ABEC system.

These tolerances define, in specific terms, certain dimensional qualities of ball bearings generally characterized as instrument grade. The tolerances, however, do not define performance qualities of torque and bearing induced, vibration (or noise), nor design characteristics of yield, preload or iso-elasticity. Nor do they provide specific values of axial or radial play, as these are customarily varied by specifications to suit different application requirements.

A common error in specifying radial play of instrument bearings is assuming that a relationship exists between low values of radial play and a high degree of precision. Some applications require very close radial play values; others, for good and sufficient reasons, quite loose. A computer gear train with close backlash requirements may need radial play not exceeding 0.003 in. maximum. Servomotors may require radial play of 0.0005 to 0.0008 in. to prevent internal radial in-

terferences caused by thermal differentials at operating temperatures.

A generalized guide to selection of radial play ranges, all of which are available with bearings of exactly the same degree of precision, is shown in Table 1. The ranges shown conform to American Standard B3.10-1959 for instrument bearings. Radial play values should always be a part of the designer's bearing specifications; if there is a doubt as to the range, ask the bearing manufac-

**Table 1. Guide to selection of radial play range.**

Typical applications	Radial play	Limitations
Precision gear trains, servomechanisms and other similar low-speed applications	0.0001" to 0.0003" (tight)	High torque under thrust Low-thrust capacity Interference shaft or housing fits must not be used
Synchro repeaters, radially loaded gyro gimbals and other low to moderate speed, moderate temperature applications	0.0002" to 0.0005" (standard)	May require axial adjustment or spring preloading for control of play Interference shaft or housing fits not recommended
Gyro rotors, thrust loaded gyro gimbals, motors, generators and other high speed, high temperature applications	0.0005" to 0.0008" (loose)	Axial adjustment or spring preloading usually required Light interference shaft or housing fits may be used



turer for recommendations based on the needs of the specific application. Axial play, to the contrary, should not be specified without prior consultation with the supplier because of the many variables involved.

#### Special Bearings: They're Not Always Needed

When faced with unusual bearing requirements, designers are often tempted to think that only a bearing of special design or configuration can meet the need. Often, consultation with the bearing manufacturer will show that an existing standard bearing, or a slight modification, will fully answer the requirements. Sometimes, as a result of such consultation, a slight design change in the component will permit use of a standard bearing, with obvious benefits in costs, multiple sources of supply and shorter delivery date for bearings.

Yet there are times, particularly when an entirely new order of component performance or reliability is demanded, that only a special bearing can do the job. Fairly often in such cases the highly specialized solution is to combine a shaft member with the inner ring of the bearing or a housing member with the outer ring.

An example of such a design is shown in Fig. 3. Here a shaft is machined and precision-ground with a raceway at each end and a conventional outer ring, retainer and ball assembly are applied for each end support. Such an assembly with integral inner raceway grooves can be made with extremely low runout errors between raceways and outer diameter—often below 0.00005 in. Although cost is necessarily higher than with conventional bearings, this type is quite commonly used for gyroscope spin axis support in high performance gyros.

Another type is the integral inner raceway gimbal pivot assembly shown in Fig. 4. Here, again, the inner member is removable and total runout errors from the mounting hub to raceway can be held to similarly low values. Cost is also higher than regular cataloged sizes, but rigidity and accuracy of pivot attachment to gimbal are beyond the performance to be obtained from conventional bearings.

Still another integral raceway type gyro bearing, sometimes called an end bell type, is shown in Fig. 5. Here the outer raceway is a part of a flanged member which forms the end shield of an inverted motor. The motor has a stationary shaft with the outer rotating assembly functioning as part of the spin mass assembly of the gyro. Again, the cost of this special bearing is higher than that of standard items, but extremely high performance, rather than low cost, dictates its use. ■ ■

Part 2 of this article will appear in the next issue.



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D4075A	D4110A	30	3.0	2.0
D4075B	D4110B	40	2.0	3.0
D4075C	D4110C	50	1.8	4.0
D4075D	D4110D	60	1.4	5.0
D4075E	D4110E	70	1.0	6.0
D4075F	D4110F	80	1.0	7.0
D4075G	D4110G	90	1.0	8.0
D4075H	D4110H	100	1.0	9.0

Breakdown voltages are  $-6$  volts min. at  $I_n=200 \mu\text{a}$ .  
 †Calculated from  $f_{co}=(Q \text{ at } 10 \text{ kmc and measured at BV}) \times 10 \text{ kmc}$ .  
 ‡Net junction capacitance measured at  $f=100 \text{ kc}$ ,  $V_n=-6\text{V}$ .  
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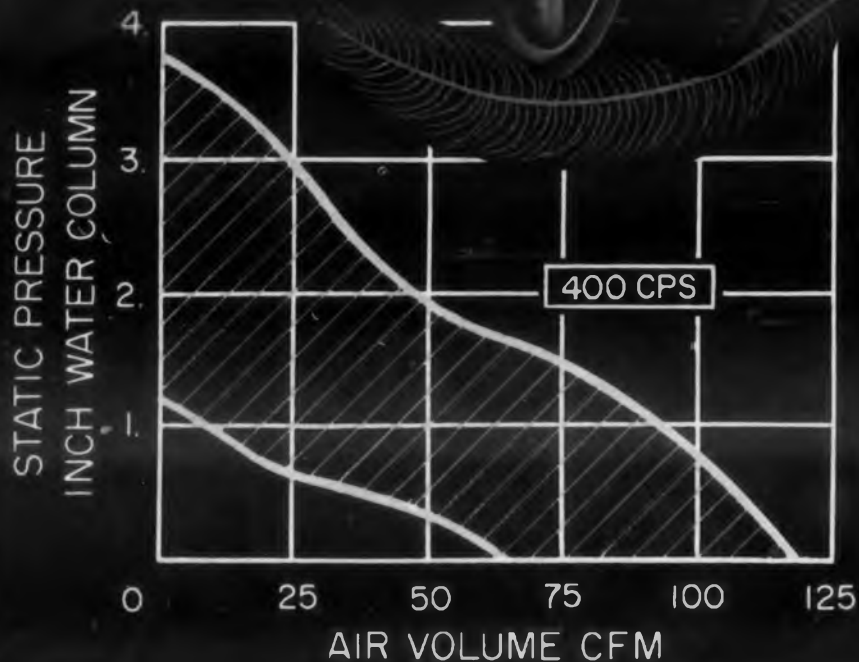
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## Selecting an IR Radiation Detector



**R. A. Harber**

Engineering Physicist

ITT Laboratories

International Telephone & Telegraph Corp.

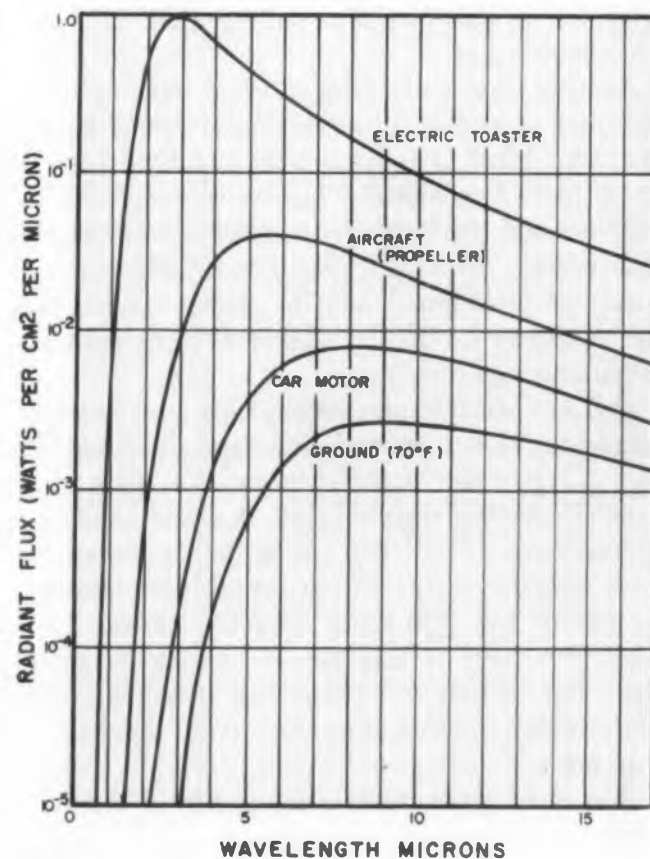
Fort Wayne, Ind.

The most critical component in an infrared system is the detector, a device which transforms the infrared radiation into an electrical signal. Because of the function that it performs, the detector must be very carefully selected. The factors involved in this selection are discussed in this article.

SPECTRAL response of the infrared detector and how it is related to the detection of the incoming radiation is important in the design of infrared systems. This article is concerned only with that aspect of infrared technology.

There are essentially five different factors having a spectral variation (that is, quantities that vary with the radiation wavelength) that influence the choice of detector. These are:

1. Radiation from the target or object to be sensed.
2. Transmission of the intervening atmosphere.
3. Background radiation.
4. Transmission of any optical elements such as



ELECTRONIC DESIGN • March 30, 1960



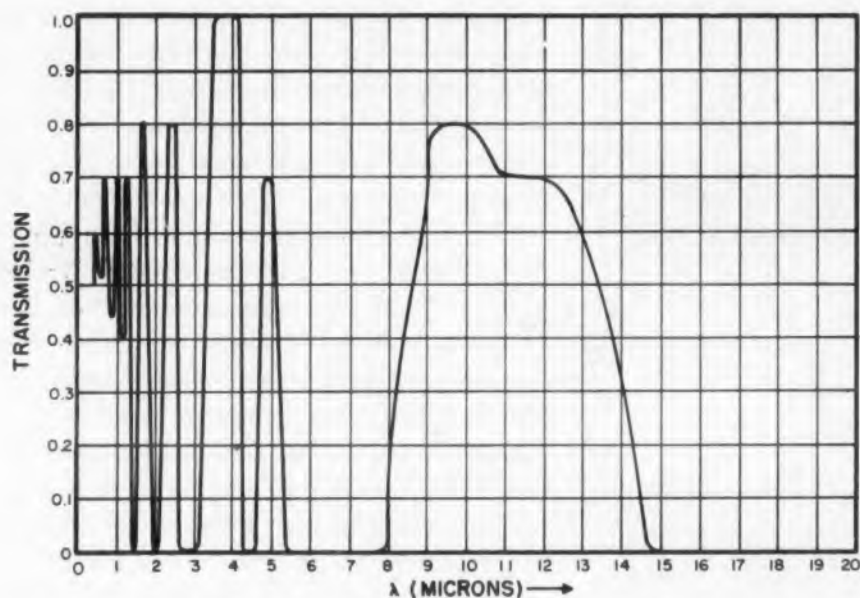


Fig. 2. Smoothed transmission curve of the atmosphere through a 2000-yd path.

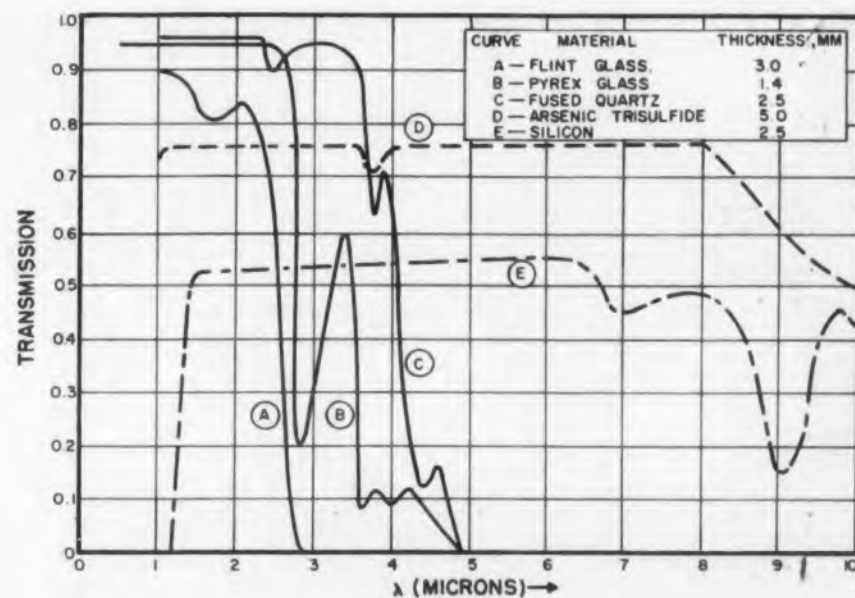


Fig. 3. Transmission of some uncoated optical materials.

lenses, domes, reticles, filters, etc.

#### 5. Detector response.

In most applications, the designer has no control over the first three. He has only the transmission of the optics and the detector response as parameters. Nevertheless, knowledge of the first three factors is indispensable because of the manner in which they affect the overall design.

In order to detect the presence of some radiating object, the signal generated by the infrared equipment must be greater than the "noise" which is present with it. This noise comes from many sources but can be referred to as system noise and background noise.

System noise is that electrical noise generated within the equipment by such sources as the detector, resistors, tubes, etc.

Background noise is the unwanted electrical signal generated by the detector due to incoming radiation from sources other than the desired signal such as clouds, stars, spatial variations in atmospheric radiation, etc.

Since system noise has been treated in previous articles, and is independent of radiation wavelength, it will not be considered here. It should be mentioned however that the combination of system noise and background noise ultimately limits the performance of the system. In a well-designed equipment, both types of noise are properly balanced so that the system will have the best performance under average background conditions.

The signal-to-background noise ratio,  $S/N_b$  is given by:

$$\frac{S}{N_b} = K \frac{\int_0^{\infty} \phi_s T_a T_o E_c d\lambda}{\int_0^{\infty} \phi_b T_a T_o E_c d\lambda}$$

where

$K$  = proportionality constant independent of wavelength

$\phi_s$  = radiation from the object to be sensed

$\phi_b$  = radiation from background

$T_a$  = transmission through the intervening atmosphere

$T_o$  = transmission of optical elements

$E_c$  = detector cell response

The quantities inside the integrals are all dependent upon wavelength and are normalized by the factor  $K$ . This constant can be determined from given detector specifications and known source and background radiation information.

It is well known that all objects radiate energy in accordance with their temperature and emissivity. (Emissivity is the ratio of the amount of radi-

ation actually radiated by an object to the maximum amount that any object at the same temperature could possibly radiate.) The spectral variation of radiation from several objects is given in Fig. 1. It is readily apparent that the peak of the radiation occurs at shorter wavelengths for hotter objects. Since the area under the curve represents the total amount of radiation, it can be seen that hotter objects tend to radiate considerably more energy; although this is true for any given object, it does depend upon the emissivity of the object.

Atmospheric transmission varies considerably according to the length of the intervening path between source and receiver, humidity, haze conditions, altitude, etc. A representative curve is shown in Fig. 2. It can be seen that the atmosphere has fairly good transmission over several different wavelength regions which are called "windows". It is, of course, desirable to have high transmission in those regions where the source to be sensed radiates the most energy. The same is true of the transmission of the optical elements. Besides having high transmission, the optical elements must be capable of withstanding the environment in which they will be used, must have the proper index of refraction and dispersion characteristic, and should not be unduly expensive. Transmission curves of some typical optical materials are shown in Fig. 3.

In addition to these materials it is also possible to fabricate optical filters which will reject radiation at certain wavelengths and transmit (with a small loss) the desired wavelengths.

The most commonly used types of infrared radiation detectors make use of the photoconductive or photovoltaic property of certain materials. These include lead sulfide, lead selenide, lead



Fig. 4. A typical lead telluride cell.

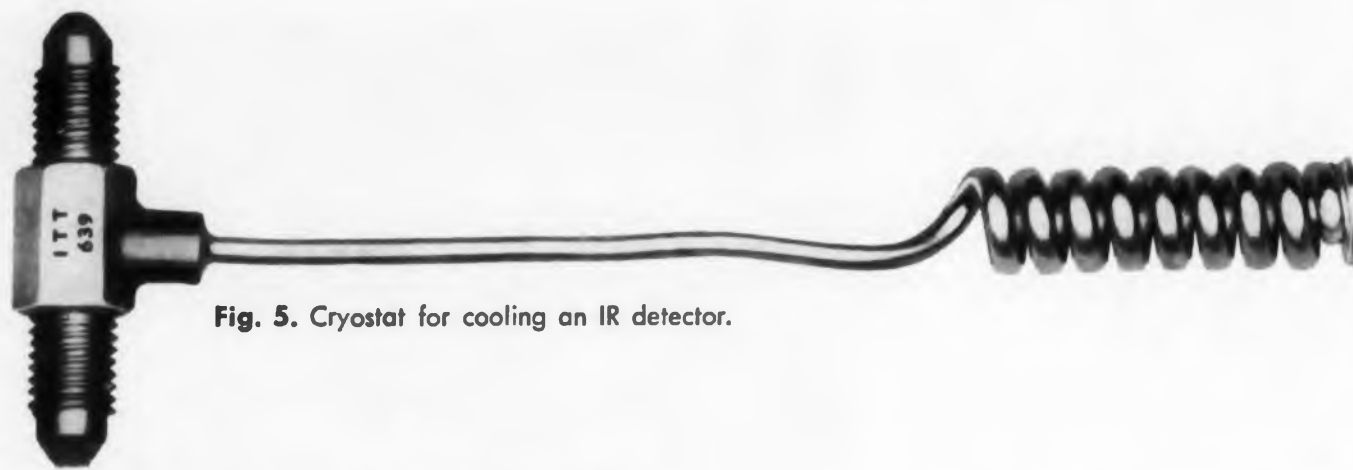


Fig. 5. Cryostat for cooling an IR detector.

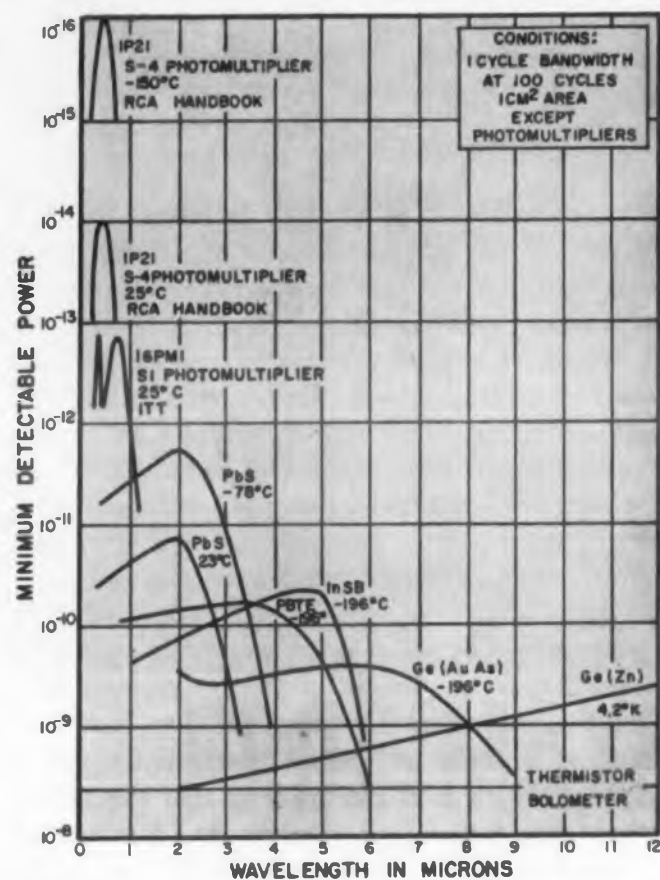


Fig. 6. Spectral response of some IR detectors.

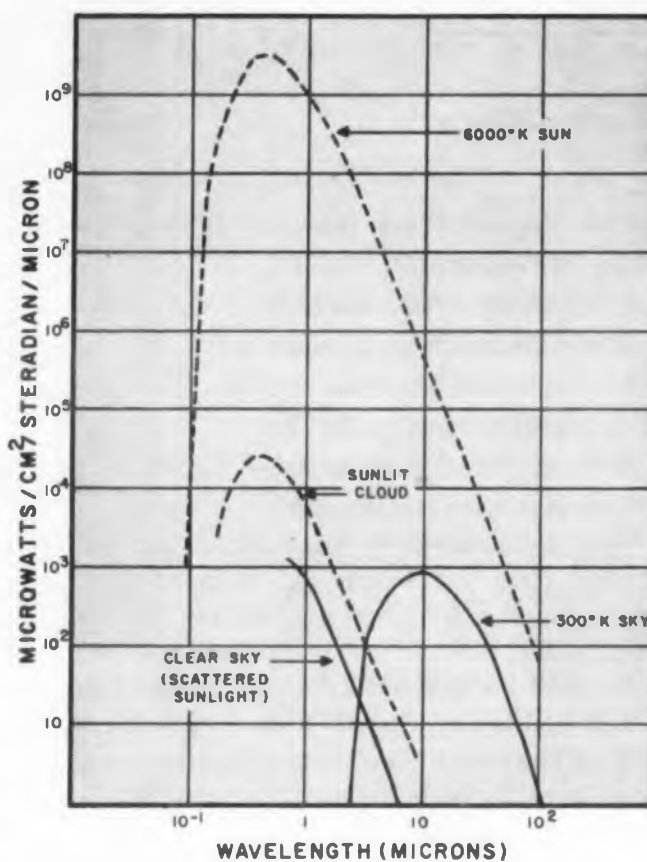


Fig. 7. Sky background radiation.

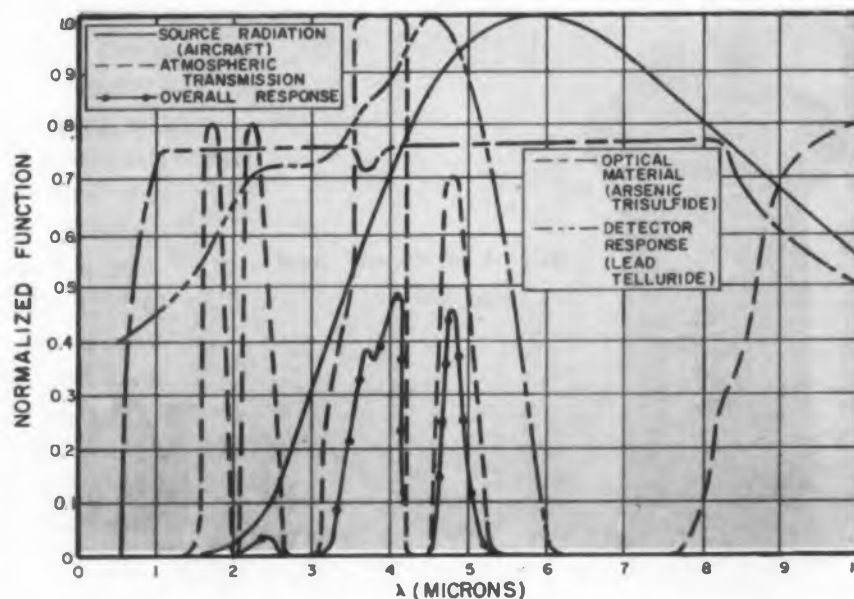


Fig. 8. Integration of signal radiation flux.

telluride, indium antimonide, and germanium. These detectors differ in spectral sensitivity, speed of response, noise characteristics, etc. The first three are usually prepared by a chemical or evaporation technique while the latter two are grown crystals.

Fig. 4 shows a typical lead telluride detector. The sensitive area of the detector is placed inside a double-walled Dewar container (similar to a Thermos bottle) because it must be cooled to a very low temperature ( $-320$  F). One end of this flask is fitted with a sapphire window in order to transmit the infrared radiation to the sensitive element. One method of cooling a detector to such a low temperature is by means of a cryostat such as the one shown in Fig. 5.

This device is supplied with high pressure nitrogen gas from a storage bottle or suitable compressor. The gas expands inside the cryostat and is cooled by the Joule-Thompson effect. The cooled gas then flows through a heat exchanger which cools the incoming high-pressure gas. This cooling continues until the expanding gas becomes so cool that it begins to liquefy—this occurs at  $-320$  F. By efficient design this temperature is attained in approximately one minute.

Obviously, cooling the detector is somewhat of an inconvenience because of the added complexity of the equipment. It is, however, the only workable solution at the present time to obtain the required performance in most systems.

Spectral response curves of several detectors are shown in Fig. 6. Each curve represents the response of a better-than-average detector. While the sensitivity of individual detectors will vary considerably above and below these values, the shape of the curve does not change appreciably. It is readily apparent that lead sulfide is much more sensitive to infrared radiation between 2 and 10 microns than are the other detectors at wavelengths less than 3 microns. It has the added advantage that it has appreciable sensitivity without cooling. With cooling, the sensitivity increases but the time constant also increases which usually limits the use of this detector to designs where the speed of response need not be too rapid. Lead sulfide is particularly suited to the detection of relatively hot objects. A disadvantage of lead sulfide is that it is also sensitive to reflected sunlight, as will be shown later. This detector is therefore not too well suited for systems that must operate in the daytime when the presence of such sources is objectionable.

The relative merits of some of the other detectors (lead telluride, lead selenide and indium antimonide) are not as readily apparent. There are "cross-over temperatures" where two different detectors will give equal response to the same source. In these cases, a more detailed analysis



of the signal-to-noise ratio is required to obtain the correct solution.

The radiation from some typical backgrounds is shown in Fig. 7. Here again the magnitude of the curves will vary considerably with temperature, type of cloud or ground, etc, but the general shape will remain essentially the same. If the magnitude of these backgrounds did not vary, then electronic cancellation techniques could be employed to eliminate the background in a system intended to detect either moving objects or sources of radiation that vary rapidly in the amount of energy radiated. Since most systems employ some type of scanning, radiation from the background does vary. It is therefore desirable to utilize those wavelengths where there is a minimum amount of background radiation but still an appreciable amount of energy from the object to be sensed.

Fig. 8 illustrates how the value of the integrated signal response is determined for a particular detector for the specified conditions. The area under the product curves can be easily measured with a planimeter. The system response to the background radiation is determined in the same manner except that the background radiation curve is substituted for the source radiation. The signal-to-noise ratio is then the quotient of these two values.

It is evident from Fig. 8 that only a small percentage of the radiation from the source is effective at the detector. Atmospheric absorption between 5.2 and 7.6 microns accounts for a large portion of this loss. Above 8 microns the detector will respond more to background radiation than to signal radiation. Consequently, little can be done to improve the system's over-all spectral response to the source radiation.

This process is then repeated for other detectors, using the same values of the other parameters. The detector which yields the largest value of signal-to-noise ratio is then the best detector for those conditions when considering only this aspect of the problem. The actual choice of the detector is made after considering the electrical characteristics also.<sup>1</sup>

The analysis used here indicates how a detector is selected for sensing particular sources of radiation. The same type of study can be made to select the best optical material or, in fact, the best detector-optical material combination. In some active systems (for example, communication) the source of radiation is also a parameter and an optimum selection can be made according to the techniques outlined. ■■

#### References

1. "Evaluating Infrared Photon Detector" by Fred Rosell, ELECTRONIC DESIGN, May 27, 1959.

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Fig. 1. Stripes on the probe's handle make locating it easy against a background of varicolored elements.

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By rotating the probe slightly in either direction, however, the jaws open up and disengage the notches from the wire—permitting quick and easy removal of the probe. The tip is effective over the complete range of wire sizes and terminal pins up to 3/32 in. The tip will also securely lock on to flat chassis elements.

A series of three white stripes are molded into the probe handle. They





**Fig. 2.** The probe is pressed on to engage it. By rotating the probe in either direction, the jaws open up permitting it to be removed.



**Fig. 3.** Pins in this connector have an OD of 0.06 in. and are on 1/4-in. centers.

make it possible to locate the probe quickly when positioned among varicolored circuit elements.

The Grip-Tip series includes, in addition to the test probes, jumpers and other accessories. Special adaptations to fit various engineering requirements may also be provided. Minimum orders of six pairs of test probes will be accepted on normal billing at \$2.00 per pair. Sample orders of two pairs or less must be prepaid.

For more information on these test probes, turn to the Reader-Service Card and circle number 100.



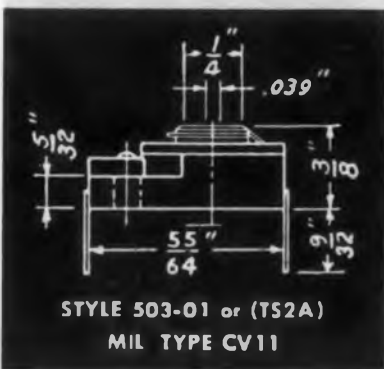
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## DESIGN FORUM

# Automatic System Finds Taped Data



Fig. 1. Mechanism of automatic tape indexer.

**A**UTOMATIC indexing of magnetic tape enables the operator to locate vital parts of recorded data in a hurry. Mylar "flags", applied to the tape during recording, mark the point at which this important data is recorded. The flags can be applied at recording speeds up to 120 in. per sec without affecting the tape travel or the magnetic recording. Scanning to locate the proper flag can be at 40 to 50 ft per sec.

All operations are performed automatically by this device designed by Miller, Myers & D'Arcy, Inc., 150 Roxbury Road, Garden City, L. I., N. Y. Work was performed under contract to Datrel Inc., Hempstead, N. Y.

Layout of the mechanism is shown in Fig. 1. Pregummed flags are applied by energizing the solenoid shown in the assembly at the upper left. Flags are mounted on a parchment paper strip wound around one of the plastic reels in the center of the panel. The other reel takes up the paper strip. Setting the numbered dial selects the desired flag on playback.

### Apply Function

Operation of the "apply" function can be traced from the schematic of Fig. 2. Assume that switch  $S_2$  is in the "apply" position and that all the other

switches and relays are in the normal or unoperated position. None of the motors or relays have voltage applied, so none will operate. Now assume that switch  $S_4$  (the station motor switch) is closed.

The station motor  $M_2$  will now operate, bringing a flag into position between the photocell and its light. (This motor drives a reel of semi-adhesive tape to which the flags are attached.) When the light is interrupted, a sequence similar to the count sequence occurs, and a ground is put on the arm of  $S_{2a}$  for a short time. With  $S_2$  in the apply position, relay  $R_3$  will be operated and will lock on its own normally open contacts. This operation removes the voltage from  $M_2$ , which thus stops with the flag in the apply station, ready to be applied by the action of a solenoid.

Now assume that the "apply" pushbutton  $S_5$  is pushed. Relay  $R_4$  will be activated and will lock on its own normally open contacts. The delay timer ( $M_1$ ) will now be activated. After some preset interval, the  $M_1$  switch will be thrown momentarily. This will put a ground on the "apply" solenoid, which fires and pushes the magnetic tape against the flag. The flag has now been applied to the tape, which carries it off.

When  $M_1$  closes momentarily, it also removes the ground from both relays  $R_3$  and  $R_4$ . When the



ground is removed from  $R_4$ , this relay opens and consequently the timer motor stops. (The path through the locking contact on  $R_4$  is broken.) When the ground is removed from  $R_3$ , it no longer operates and the path through its locking contact is broken. This will allow a new flag to be brought up into position by closing switch  $S_4$ .

Thus far, manual operation of the station motor  $M_2$  has been described. If switch  $S_3$  is closed (the "automatic" position), motor  $M_2$  will operate immediately following the firing of the solenoid. Thus, each time the "apply" button  $S_5$  is pushed, the timer motor switch will close at the end of a preset period. This will, as previously described, fire the solenoid and release relay  $R_3$ , which in turn will activate the station motor until a new flag is brought up into position.

#### Counting Function

A flag, having already been applied on the magnetic tape, is carried along by the tape and

passes between the photocell and the station light. When it does so, the photocell generates a positive electrical pulse, which is amplified by the 12AX7 and fed to the starter electrode on the 5823 cold cathode thyatron. The starter voltage, whose bias was previously set by the 5-meg potentiometer, is now sufficient to fire the thyatron. The thyatron now charges the capacitor to a point at which the relay  $R_1$  is operated. The normally closed contact on  $R_1$  is broken, which extinguishes the thyatron. Relay  $R_1$  continues to be activated until the capacitor is discharged to the relay drop-out voltage. The normally open contact on  $R_1$  is thus closed for a length of time dependent on the pull-in and drop-out voltages of the relay.

Relay  $R_2$  is thus activated for this time, and applies a ground to the arm of switch  $S_{2a}$  momentarily, for each time a flag interrupts the light to the photocell. Assume now that the switch  $S_2$  is in the count position. The momentary ground

on the arm of  $S_{2a}$  will allow the stepper to advance one position. The stepper, advancing one position for each flag, can be preset to operate some external device after the  $n^{\text{th}}$  flag has passed the photocell station.

There are two power supplies, one for the solenoid ("A" in Fig. 2), and one for the amplifier ("B" and "C"). These are necessary to prevent transient disturbance from the solenoid activation from re-firing the thyatron. Such operation could otherwise cause a continuous self-triggering oscillation. The remaining components are the series RC circuits across the relays and the diode across the solenoid, which are for the purpose of arc suppression.

Applications include any situation where the operator wishes to identify a portion of recorded data. For example, during rocket-flight, the operator may flag each instant when various stages fire. Then, these points would be found automatically during scanning. ■ ■

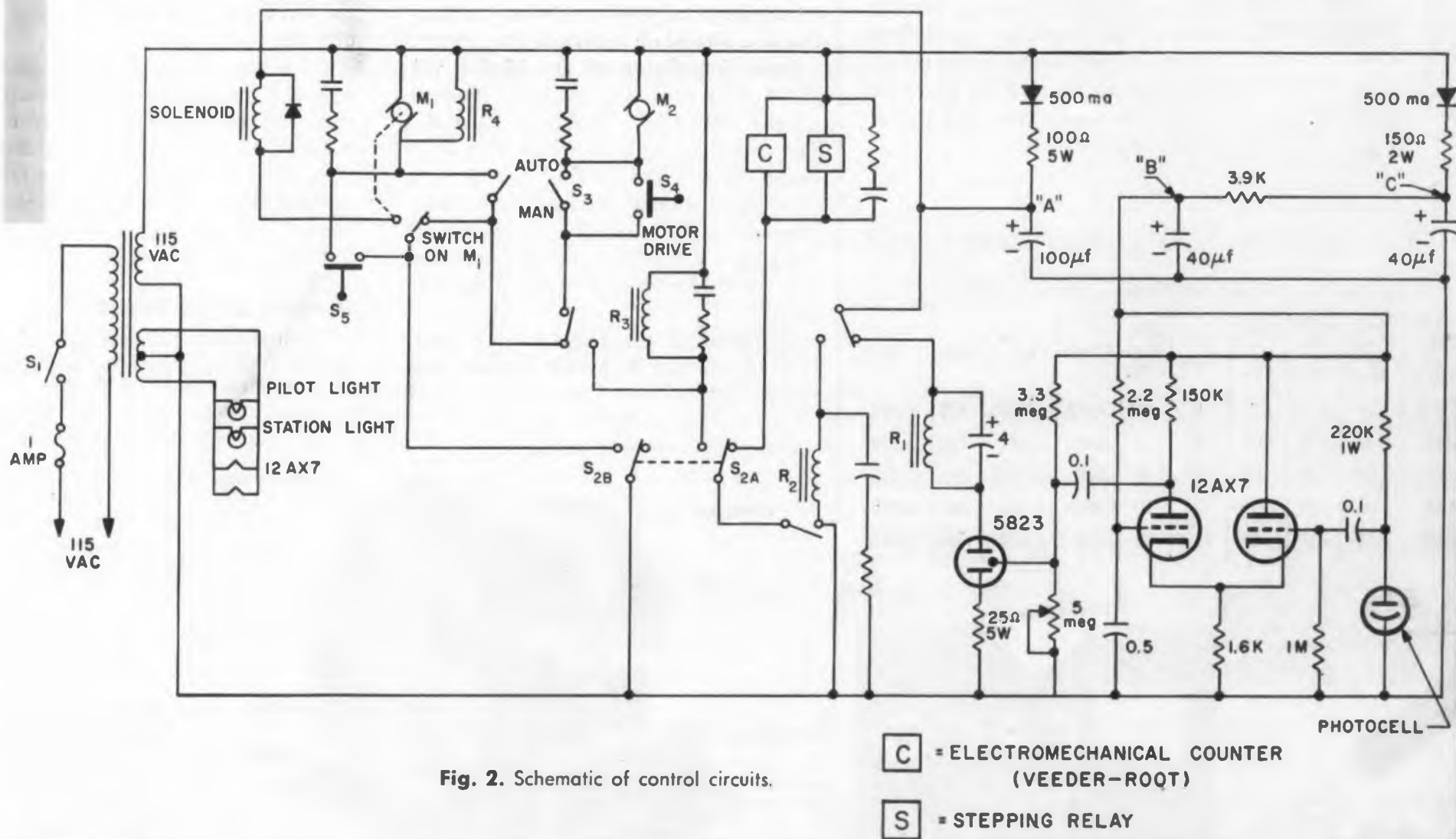
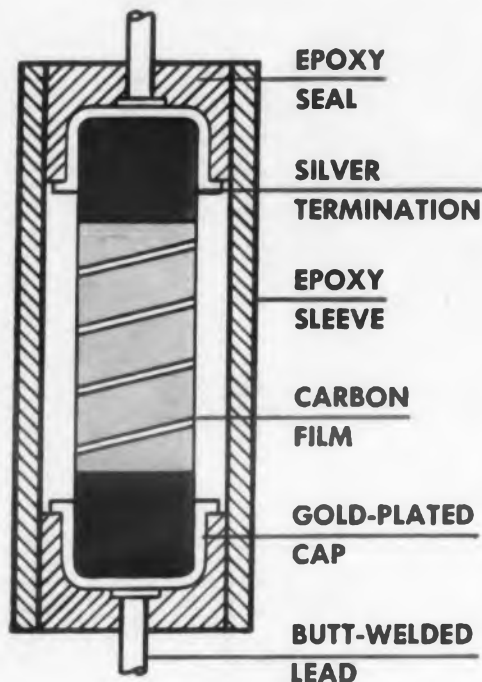


Fig. 2. Schematic of control circuits.

- C = ELECTROMECHANICAL COUNTER (VEEDER-ROOT)  
S = STEPPING RELAY

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	EP-012	RN60B	0.125	0.25	0.125	250	5	1	.4335	±.0035	.156	±.010
	EP-025	RN65B	0.25	0.50	0.25	300	10	2	.640	±.015	.240	±.010
	EP-050	RN70B	0.50	1.00	0.50	350	10	5	.830	±.015	.240	±.010
	EP-100	RN75B	1.00	1.00	1.00	500	10	10	1.093	±.020	.395	±.010
	EP-200	RN80B	2.00	2.00	2.00	750	50	20	2.230	±.020	.395	±.010



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## Digital Voltmeter's Low Cost Result of Stroboscopic Design

**B**Y USING stroboscopic techniques, Electro-Logic Corp. has developed a digital voltmeter that is priced at \$295. Accuracy of the unit is 0.5 per cent—good enough for most industrial and laboratory applications. The numbers to be read are enlarged optically and projected in a fraction of a second on a ground-glass screen.

Input impedance of the Model V-1 DVM is 1 meg on the three voltage ranges: 000 to 2.50, 25.0, and 250 v dc. The manufacturer (located at 1515 Boccaccio Ave., Venice, Calif.) can provide an optional internal amplifier (\$50 extra). This adds a 0000 to 0.250-v dc range, and the accuracy is held to 0.5 per cent, except for the lower 20 per cent of the new range.

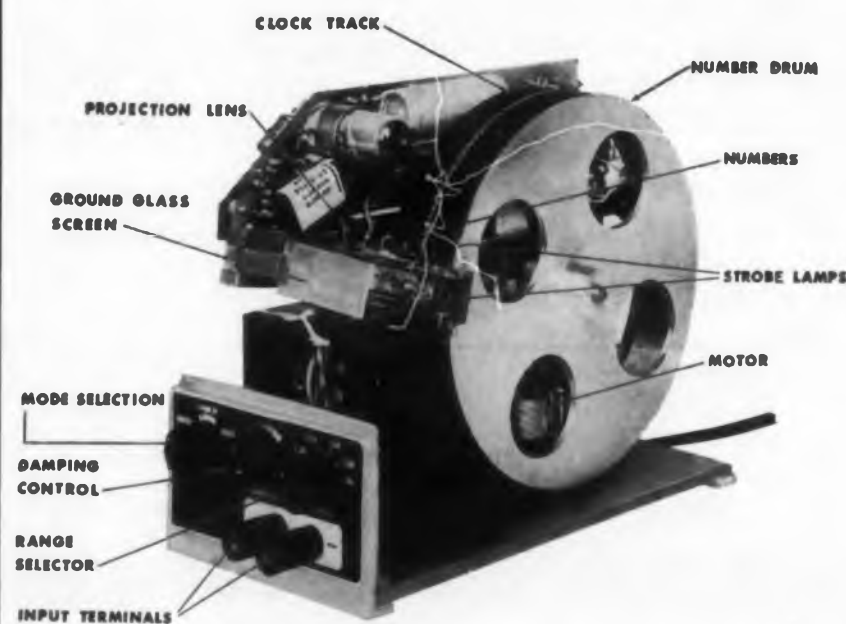
Response of the readout to a step-function voltage is "within human per-

ception," according to Electro-Logic. When the probes are placed on the test points, the digital number is there "as fast as the human eye can read it"—in about 1/30 sec. There is no waiting for the unit to clatter from, say, zero to full scale. In operation, the DVM hums quietly, blinking to a new reading whenever the test probes are moved.

For observing trends in changing voltages and for interpolating between numbers, the readout presentation can be changed to quasi-digital. In this mode, the numbers roll smoothly across the readout screen instead of snapping into view. The operation is controlled by a front-panel knob.

### Damping Can Be Added

To discriminate against noise, the operator can add damping by another front-



Numbered drum rotates at 1500 rpm in synchronism with linear potentiometer. As potentiometer-generated sweep meets the values of the known voltage, a pair of stroboscopes are lighted.





The digital voltmeter has 0.5 per cent accuracy, instantaneous readout, and is priced at \$295. The simplicity of the control panel makes the unit useful for production-line use.

panel control. Since, very often, there is some ac floating in a dc signal to be measured, electronic sampling techniques sometimes sample on the noise peaks and give erroneous readings. With a d'Arsonval type of meter there is enough damping to reduce the possibility of error. The new DVM imitates this desirable feature. At the highest damping level, readout response is reduced to only 0.1 sec.

Stability of the meter is "good enough"—so the *zero adjust* and *calibrate* controls have been taken off the front panel and put inside. Entry is gained through a small access port. This leaves only three controls for the unskilled operator to adjust.

Design of the DVM is such that unskilled manipulation of the controls can do no more than turn the unit off. For this reason, the unit is well-adapted to production-line use.

The unit measures 6-3/4 x 4-3/8 x 9 in. and weighs 9 lb. It requires 105 to 125 v ac, 60 cps.

Electro-Logic promises delivery within 60 days of receipt of order.

For more information on this unit, turn to the Reader Service Card and circle number 101.

## AMP taper technique points the way to greater reliability

**Magnetic Amplifiers, Inc.** of New York carefully manufactures its Static Inverters with a step-by-step quality control and testing program to build in the reliability required for aircraft and missile applications.

It found that AMP Taper Technique simplified this procedure. A high speed AMP Automachine pre-terminates circuit leads with crimp-type, pre-insulated solid Taper Pins. Components are then easily tested in the modular stage before final assembly. Crimping eliminates difficult soldering operations and the danger of burning wound components while Taper Technique permits checking and trouble shooting without destroying the main cable. After final assembly, when the Pins are inserted into the Blocks, this Technique provides rugged vibration resistance and operational reliability.

AMP solderless Taper Pins are made in formed and solid types, with or without pre-insulation and mate with a wide range of one or two piece stackable Taper Blocks. You'll find that AMP Taper Technique is ideal for your quality control or circuit density problems too.

Write for our new Taper Technique brochure.

# AMP INCORPORATED

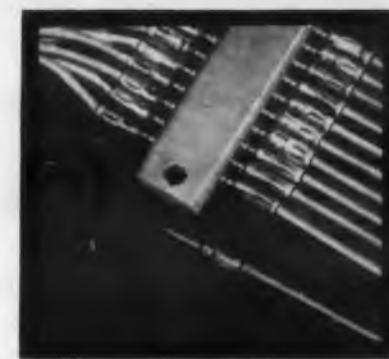
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • West Germany

CIRCLE 62 ON READER-SERVICE CARD



Magnetic Amplifiers' 250VA Static Inverter Model SIS-425041



AMP Pre-Insulated Taper Pins and stackable Taper Blocks

# new... TRIMMING POTENTIOMETERS

Tiniest on the Market...

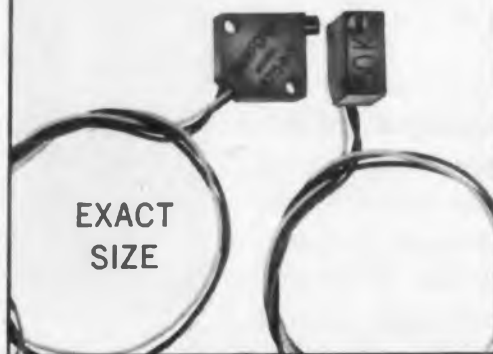
(smaller than  
an aspirin  
tablet)



## FEATURES

Unsurpassed accuracy and reliability, higher power rating, superior resolution, inherent stability, dual contact wiper, moisture resistance, teflon insulated lead wires, sealed for reliability under environmental extremes, precision machined aluminum case, 25-turn "0" ring sealed adjustment, meet or surpass requirements of MIL specifications.

## MIRACLE IN MINIATURIZATION



## CHARACTERISTICS



**375 SERIES (all models) —**  
Power rating 1 watt  
Resistance range 10 to 50K ohms  
Dimensions 0.375x0.375x0.175"  
Weight less than 1 gram



**500 SERIES (all models) —**  
Power rating 2 watts  
Resistance range 10 to 100K ohms  
Dimensions 0.500x0.500x0.175"  
Weight less than 2 grams

Compact, square design unexcelled for stacking arrangements.

### PATENT PENDING

Engineers should investigate the outstanding advantages of these wire-wound trimming potentiometers...call or write for Brochure containing complete specifications.  
A FEW SELECT TERRITORIES ARE STILL AVAILABLE TO PROGRESSIVE REPRESENTATIVES



Potentiometer Division

**BAMFORD CORPORATION**

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CIRCLE 63 ON READER-SERVICE CARD



## Transistor's Planar Structure Reduces Reverse Leakage Current

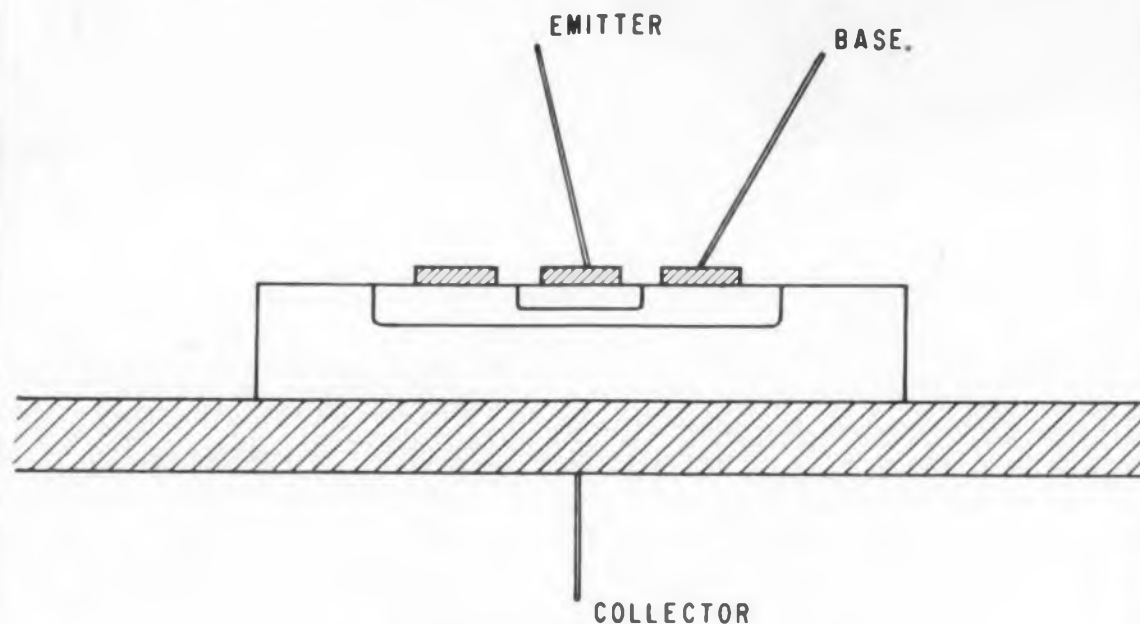


Fig. 1. The planar structure transistor is different from mesa types in that both the collector to base and base to emitter junctions are embedded in the top surface.

**L**OW REVERSE leakage current, high-voltage operation, high power dissipation—these are some of the outstanding characteristics claimed for the type 2N1613 transistor. The features result from the silicon unit's construction: both the collector-to-base and base-to-emitter junctions are embedded in the top surface of the planar structure (see the drawing). In the mesa structure, the collector-to-base junction is on the side of the device.

Made by Fairchild Semiconductor Corp. (545 Whisman Road, Mountain View, Calif.), the diffused-planar-structure transistor's reported advantages are:

- A typical  $I_{CBO}$  of 0.0005  $\mu$ amp at 60 v. This compares with 0.02  $\mu$ amp at 60 v for a typical mesa unit.

- A useful beta over a range of collector currents from 100  $\mu$ amp to 0.5 amp. Guaranteed minimum betas are: 15 at 100  $\mu$ amp; 30 at 150 ma; and 15 at 500 ma. The typical gain-bandwidth product is 100 mc.

- A high-voltage operating capability. Its  $V_{CBO}$  is 75 v. This compares with 40 to 60 v for a general-purpose, mesa transistor.

- A dissipation rating of 3 w in a JEDEC TO-5 package at 25 C case temperature. This compares with a 2-w dissipation for most mesa transistors in the same package.

- Physical ruggedness. The planar structure makes the device "more resistant to thermal and mechanical shock and vibration than previous types."



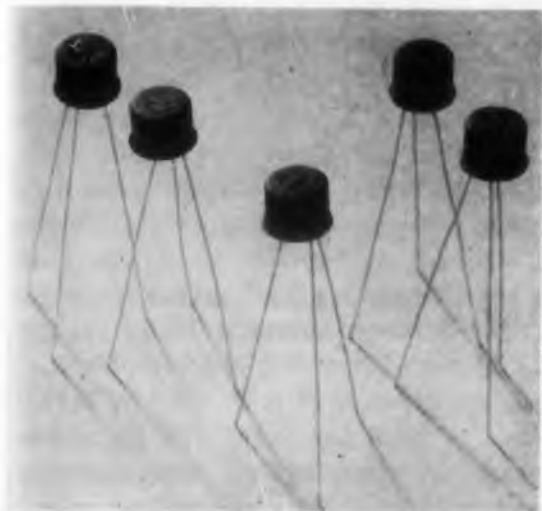


Fig. 2. Reverse leakage current in the 2N1613 diffused silicon planar transistor is 0.0005  $\mu$ amp at 60 v.

- High reliability. All transistors are pre-aged for 60 hr at 300 C. They have a 0.65 per cent AQL on significant parameters after 1000 hr, 200 C storage.
- Low-noise operation. The unit's typical noise figure is 7 db, which permits it to be designed into infrared amplifiers, character recognition preamplifiers, and low-noise video amplifiers. By comparison, a mesa transistor has a typical 12-db noise figure.

Why have both diffused junctions in the top surface of the device? Because, the manufacturer says, the top surface of the silicon chip has a better "finish" to it than the side surfaces. This leads to less surface sensitivity and better characteristics.

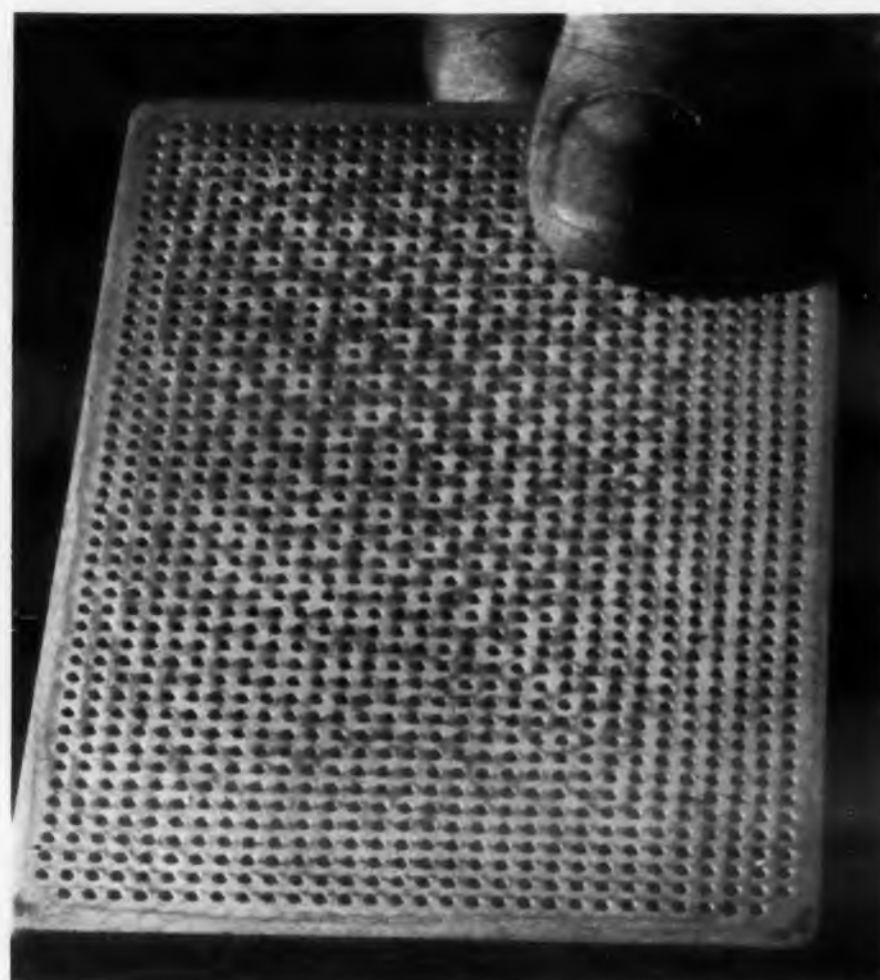
The type 2N1613 transistor is now available in production quantities.

The planar device structure is also used in the firm's new silicon diode line. Type FD100, the first in the line, was designed for switching applications and has a reverse recovery time of 0.004  $\mu$ sec. This is the time required to recover to 1 ma reverse current, when switching from 10 ma forward current to 10 ma initial reverse current. The unit has a maximum forward voltage of 1 v at 10 ma and a capacitance of 2  $\mu$ mf at 0 v. It is sold in the subminiature, axial-lead, glass package. Price is \$6.50 in quantities of 1 to 99.

For more information on these products, turn to the Reader-Service Card and circle number 103.

# NOW BUILD A PRINTED CIRCUIT IN YOUR LAB IN 15 MINUTES

... you simply mask, etch, and  
rinse new Corning FOTOCERAM\*  
grid boards for perfect circuits



1. New Corning grid boards are already holed and coppered to give you maximum design flexibility.



2. Lay out the circuit run you want on one or both sides with tape or chemical resist.



3. Immerse in a copper etchant to remove excess copper.



4. Rinse. That's all there is to making a board ready for use.

Take a new Corning FOTOCERAM copper-plated grid board. Apply a tape or chemical resist of your circuit pattern. Etch away the excess copper. Rinse the board, and strip the resist. You're ready to add components.

**No adhesives are used.** The board has 0.052 inch holes spaced 0.1 inch apart on centers. The holes, too, are already plated.

The base is FOTOCERAM, a glass-ceramic, a proved production material that's used widely in printed circuits which demand high strength, temperature resistance to 250°C., zero moisture absorption, nonflammability, and rigid dimensional stability.

**Excellent through-hole plating.** Hole plating is done with the same material used for circuit-run conductors. This provides exceptional thermal and electrical conductivity and negates the need for eyelets.

We have soldered, removed, and resoldered components to

these boards as many as fifty times without circuit-run failure.

**No bending, bowing, delaminating.** The FOTOCERAM base is a solid piece. There are no laminations which might bend, twist, or warp under high temperatures.

**Three sizes.** There are currently three boards, all  $\frac{1}{16}$ " thick: 3" x 5", 6" x 8", 9" x 12". They can be trimmed to any shape with a simple glass cutter.

**Small production runs.** Some of our customers are using these boards for small production runs as well as R&D work.

**Data sheets.** Write to Corning Glass Works, 540 High Street, Bradford, Pa., for data sheets on the grid boards and FOTOCERAM printed circuit boards. For orders of 1000 or less, contact your distributor serviced by Erie Distributor Division.

\*Trademark



## CORNING ELECTRONIC COMPONENTS

CORNING GLASS WORKS, BRADFORD, PA.

CIRCLE 64 ON READER-SERVICE CARD



## VERSATILE EYE FOR ASW

### AN/APS-88 RADAR

by Bendix-Pacific

Bendix-Pacific Radar Set AN/APS-88 is a lightweight, high sensitivity, multiple function radar for ASW and allied functions.

**FOR ASW** — Used in conjunction with IFF and sonobuoy systems the AN/APS-88 integrates signals into an overall PPI display which shows the presence of unfriendly aircraft, submarines and marine objects.

**FOR WEATHER WARNING** — Detection of cloud formations and mapping of storm fronts.

**FOR SEARCH** — Indicates even small objects — life rafts, life boats, and trawlers—as well as shore lines, islands and other marine topography.

**AN/APS-88**, developed by Bendix-Pacific for use on the U.S. Navy S2F-3, provides ranges from 3 to 240 miles and is operable to 30,000 feet. Maximum weight is 215 pounds. The set's unique sensitivity is achieved by varying pulse lengths and repetition rates for each selected target. Bendix-Pacific engineers are always available to discuss your airborne radar problems with you.

MORE PERFORMANCE PER POUND



AZIMUTH AND RANGE INDICATOR



ANTENNA



RECEIVER-TRANSMITTER

We invite your inquiry regarding the excellent opportunities for engineers now available. Write Ralph Lamm, Director of Engineering.



NORTH HOLLYWOOD, CALIFORNIA

CIRCLE 65 ON READER-SERVICE CARD

## Zener Package Provides TVM with Better than $\pm 0.05$ Per Cent Accuracy

**A**N ACCURACY of better than  $\pm 0.05$  per cent absolute from 0.01 to 1000 v dc is achieved in the model DC-100A transistorized voltmeter (TVM) by use of a stable Zener package. The unit is priced at \$4.75, which is claimed to be a fraction of the cost for comparable voltmeters. For a line change of from 100 to 130 v ac, the stability of the meter is  $\pm 0.005$  per cent.

Requiring only 10 min to warmup, the instrument weighs 9 lb and measures 8 x 7 x 6 in. Below 10 v the meter has an "infinite" (at null) input resistance; above 10 v the input resistance is 2 meg. The meter is made by Calibration Standards Corp., 1130 W. Fifth St., Pomona, Calif.

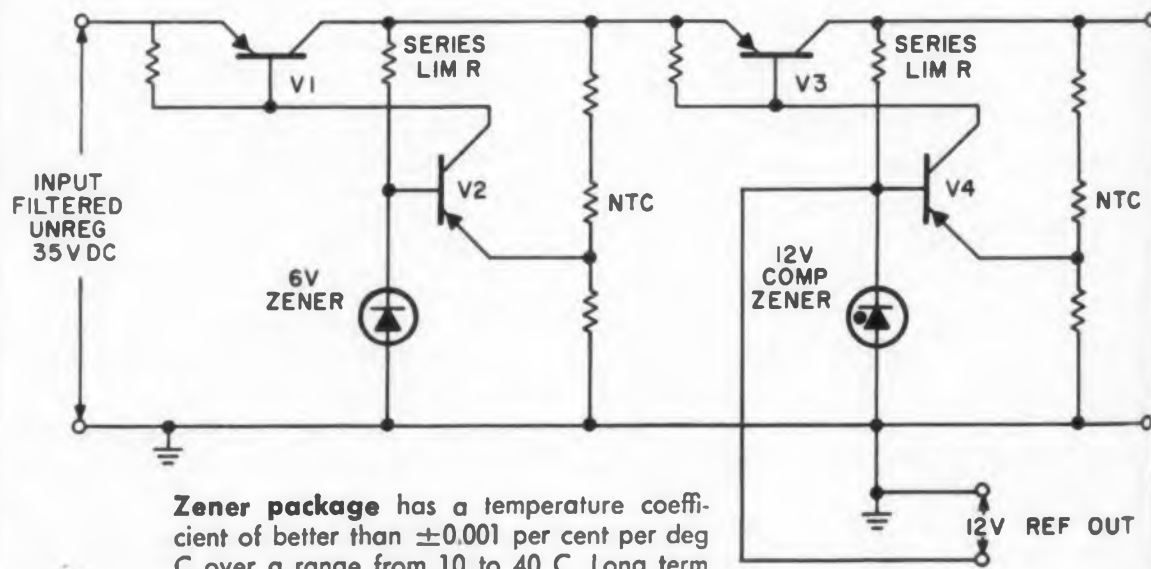
How is a TVM of this range and accuracy possible at the \$475 price? Designer Ed Zimmer, vice-president of Calibration Standards, says it is due mainly to the instrument's "integrated design." Simplicity of design and use of relatively inexpensive circuits keeps production costs down.

The voltage-reference package is responsible for the high order of accuracy possible. Instead of using an internal standard cell, the DC-100A is provided with an "ultrastable, temperature-compensated, transistor power supply that powers a compensated, Zener reference element." (See circuit drawing.) The first stage of the reference package consists of

two transistors and a 6-v Zener diode. This diode has a zero temperature coefficient, so long as the voltage across it remains in the neighborhood of 6 v. Current through it is controlled by adjusting the series limiting resistor between it and the series transistor collector.  $I_{CO}$  of the amplifying transistor, V2, is no trouble since the transistor base is at the low impedance of the Zener diode. The linear temperature effect of the base-to-emitter voltage change is compensated with a thermistor (NTC on drawing).

Total regulation of the first stage from collector-to-ground is 1 per cent. Temperature stability is 0.05 per cent per deg C. In the second stage, all elements are the same except that a 12-v, compensated, Zener reference is used instead of the 6-v uncompensated unit. Overall temperature stability before the Zener is 0.002 per cent per deg C; after the Zener (third stage) it is guaranteed to be 0.001 per cent per deg C, but is typically "two or three parts per million," says Ed Zimmer. The series limiting resistor is "carefully" adjusted during testing for the exact current that produces the best temperature coefficient.

All reference packages are checked in an environment ranging from 0 to 50 C before using them in the meter. Although the guaranteed regulation is  $\pm 0.005$  per cent for a line change of from 100 to 130



Zener package has a temperature coefficient of better than  $\pm 0.001$  per cent per deg C over a range from 10 to 40 C. Long term stability is about  $\pm 0.01$  per cent per yr.





The dc voltmeter has a  $\pm 0.05$  per cent accuracy from 0.01 to 1000 v. Plug-in units are a null amplifier and a Zener reference package.

v, it is typically 0.002 per cent, says Zimmer.

The rest of the circuitry is straightforward. The reference voltage from the Zener package is divided in a range selector network to provide 10 v, 1 v, etc, to a Kelvin-Varley divider, which is composed of two switch-dividers and a precision, 10-turn pot.

The resistor in the first deck of the divider are matched to  $\pm 0.0025$  per cent; in the second deck to  $\pm 0.005$  per cent; to produce an overall dividing accuracy of better than  $\pm 0.01$  per cent.

Since the reference supply to the K-V divider is 10 v, the resistance values can be low—"experience shows that low resistances tend to be more stable than higher ones." Resistance stability is further helped by winding wire on cards of bobbins—less strain on the wire.

The null detector is a stable, transistorized amplifier using an electro-mechanical chopper and has a full-scale deflection of 1 mv. Zero offset is so small there is no need for a front panel zero control—calibration can be handled by the meter screwdriver adjustment. Large overloads will not damage the amplifier or panel meter.

The circuitry used in the meter has given rise to other products in the CSC line with comparable accuracy and price: VA-100A, a precision volt-ammeter; RM-2A, a regulation monitor; and WB-100A, a Wheatstone bridge.

The meter can be delivered in two weeks.

For more information, turn to the Reader Service Card and circle 102.

# 100,000,000 MILLION

actual size

**Phono Cartridge Compensating Circuit**

Contains 6 fixed resistors. Component Density 1510/in.<sup>2</sup> (2,610,000/ft.<sup>2</sup>)

**Telephone Line Detector**

Contains 6 resistors and 5 capacitors. Component Density 46/in.<sup>2</sup> (80,000/ft.<sup>2</sup>)

1/2 actual

**Computer Arc Suppressor**

Contains 4 resistors and 4 capacitors. Component Density 8.3/in.<sup>2</sup> (14,350/ft.<sup>2</sup>)

1/4 actual

**TV-Height, Linearity and AGC Control Unit**

Contains 3 variable and 4 fixed resistors. Component Density 70/in.<sup>2</sup> (121,000/ft.<sup>2</sup>)

1/2 actual

**3-stage Transistor Amplifier**

Contains 3 transistors, 5 resistors and 5 capacitors. Component Density 321/in.<sup>2</sup> (555,000/ft.<sup>2</sup>)

1/2 actual

Centralab **PEC**\* circuits have filled the bill!

**Proof of Design Flexibility:** in hearing aids, guided missiles, appliances, jet aircraft, tv sets, electronic organs, and countless other applications.

CENTRALAB PEC\* circuits—combining capacitors, resistors, transistors, and wiring in one compact sub-assembly—have stood the test of time. Since their development during World War II, more than 100,000,000 of them have been used to guarantee circuit performance in a multitude of electronic projects.

During these fifteen years, CENTRALAB has continued to refine and improve its PEC\* circuits, giving them even longer life and broader application. The basic concept, however, has remained intact: a packaged circuit adapted to *your* shape and contour requirements, offering you flexibility, versatility, and reliability. PEC\* packaged circuit combinations can be designed in an infinite number of sizes and shapes, and special circuits can be produced to meet your requirements and any applicable military specifications.

Consult the CENTRALAB engineering department for further information.

# Centralab<sup>®</sup>

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.  
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VARIABLE RESISTORS • SWITCHES • PACKAGED ELECTRONIC CIRCUITS • CERAMIC CAPACITORS • ENGINEERED CERAMICS  
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$$E = \frac{mc}{2}$$

## Or How To Find New Leisure Even Though You're An Engineer

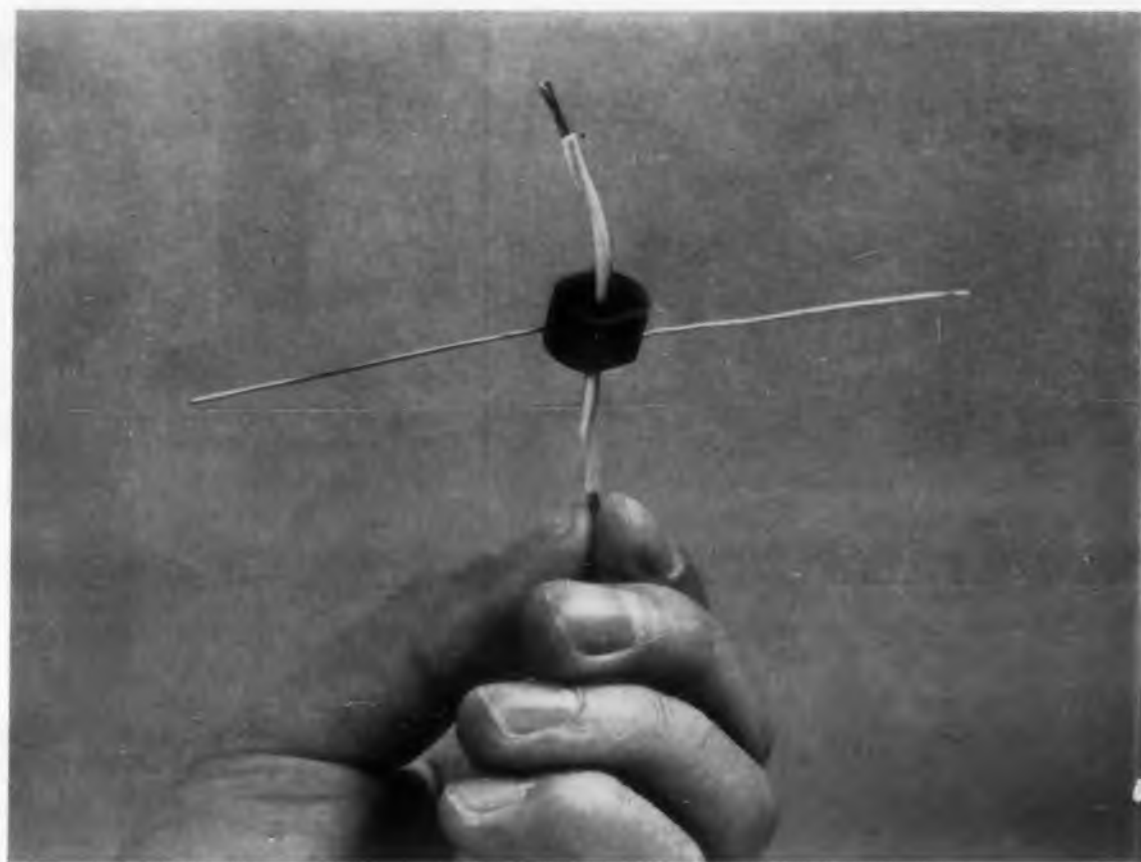
IT seems you can't begin to please everybody these days — particularly if they're all marketing people. Ours were happy enough when we discovered the new physical law embodied in  $E = mc/2$ \* and then built the FR-600 analog recorder that embodied the principle. They grouched a bit when it took us two years to finish it, but relations were still on a gentlemanly level. Then we published the Ips Corollary and they flew off the handle because this showed that the FR-600 could record the same bandwidth at half the usual speed. (125 kc at 30 ips, giving 48 minutes recording time on a 14-inch reel of tape.) They pointed out that this meant people wouldn't need a second stand-by machine to switch over to on most data runs. They wrung their hands and mumbled about the market being cut in half with one stroke. Things got even worse when it leaked out that the FR-600 made this same doubled recording time possible on every one of our analog recorders ever built. (The new engineer says this is because bandwidth is determined by the reproduce head rather than the record head.) So everyone who had an FR-600 to reproduce on could record the same bandwidths at half the usual speed on our other equipment and get double the usual recording time. We had a hard time explaining *that* away. They threw some nasty phrases at us like 'planned obsolescence' and 'market saturation,' but there was no changing the facts.

Now it seems that instead of plunging down as they predicted, the sales curve is inching up, and they want more of the same kind of information we have published before. We will supply it, but it is not without some misgiving as to how fate may twist it and make it work against us. Perhaps this time the Labor Board will complain. Nevertheless, here it is in one flat unequivocal statement: The FR-600 will work twice as many hours in every working day. This is not to say, mind you, that *you* have to work twice as many hours — just the machine. In fact, you may find new leisure — as they say in the ads. The new engineer says it's because the FR-600 spends more time recording and less being adjusted and maintained. He says—and you might well have a chance at *being* the new engineer if it's not true—that the solid-state circuitry warms up in less than 10 minutes, and maintains FM calibration within 1% for more than 24 hours. That means one calibration a day instead of 3 or 4. We've also eliminated a lot of adjustments by leaving out a lot of parts. Our motives in bringing you these benefits are completely altruistic but you can return the favor by helping to hold up your end of the sales curve.

\*We'll never get rid of all the reprints of our earlier papers on  $E = mc/2$ , the Ips Corollary, etc. unless you write for them in your new-found leisure.

**AMPEX**

AMPEX DATA PRODUCTS CO., 934 CHARTER ST., REDWOOD CITY, CALIF.



The current-sampling transformer measures  $\frac{9}{16} \times \frac{1}{2} \times \frac{3}{8}$  in. and weighs  $\frac{1}{8}$  oz.

## Current-Sampling Transformers Can Replace Bulky Resistor Networks

**F**EED-THROUGH transformers for replacing bulky resistor networks that have been used to deliver synchronizing, voltage pulses are now available to designers. Used in radar transmitters or other high-pulse current devices, the new current-sampling transformers deliver a low-voltage pulse with the same shape as the high-current pulse.

Designed to avoid cutting heavy-duty conductor and to take up less space than resistor networks, the transformers consist of a single, potted, toroidal coil with an axial hole for passing through the current-carrying conductor. Manufacturer of the units is Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif.

Effective resistance added to the conductor is on the order of 0.005 ohms,

when part of the pulse energy is tapped off. Size of the transformers is  $\frac{9}{16} \times \frac{1}{2} \times \frac{3}{8}$  in.; they weigh  $\frac{1}{8}$  oz. Ratios run from 20-to-1 to 150-to-1. Pulse widths at 50 v are 0.4 to 3  $\mu$ sec; ET product is from 25 to 186; inductance is from 0.12 to 6 mh; optimum loads range from 50 to 500 ohms. The toroidal core must be tightly coupled to the connecting wire, otherwise it will saturate; coupling load is important.

Price of the current sampling transformers is \$7.70 each in quantities of one to four; \$4.60 each for 100. Delivery is typically, from stock, with a two-week minimum.

For more information, turn to the Reader Service-Card and circle number 104.





New potting compound washes away so rapidly that individual parts can be exposed for replacement.

## Reversible Potting Compound Dissolves in Liquid Solvent

A REVERSIBLE potting compound that dissolves when placed in a liquid solvent is now available to design engineers. The action is so rapid that a stream of solvent will dissolve a specific area without dissolving the entire unit.

Called Vicap by the manufacturer, Video Instruments Co., Inc. (3002 Pennsylvania Ave., Santa Monica, Calif.), the potting compound cures at room temperature. When cured, it has the appearance of plaster of Paris. Designed for missile use, the compound's thermal conductivity is 0.0008 calories per cm<sup>2</sup> per cm per deg C per sec. The compound's volume resistivity is 10<sup>12</sup> ohm-cm; specific gravity is 1.2. And the temperature range is from -65 to +250 F.

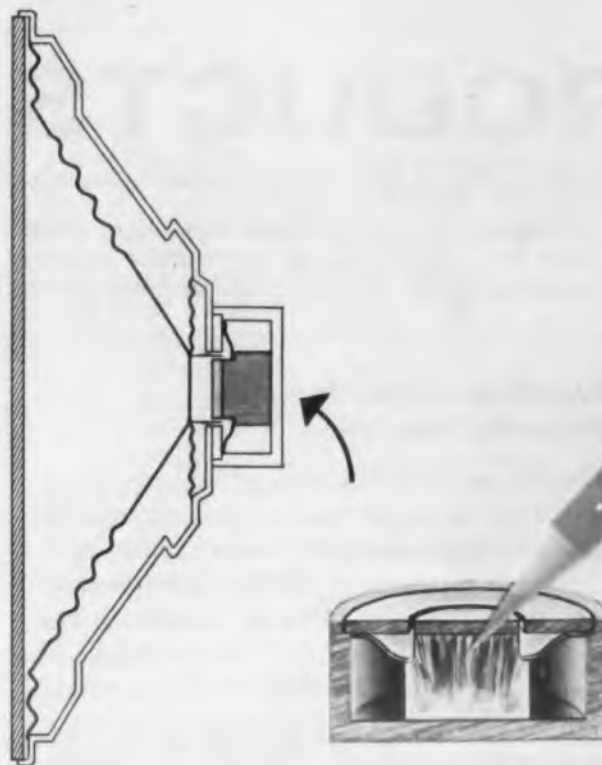
Since epoxy compounds are messy and difficult to dissolve, potted circuits in the past have been thrown away when one part failed. With the new compound, the manufacturer points out, an individual part that has failed can be washed out of the potted unit and replaced.

Development of the compound was Video Instrument's solution to the replacement problem in the manufacture of matchbox-size, strain-gage amplifiers for missiles.

Sample kits, containing 2 lb of Vicap and solvent, are available off-the-shelf for \$6.00.

For more information, turn to the Reader-Service Card and circle number 105

## Magnetic Materials from General Electric



## Compact G-E dual-diameter d.g. magnets give you a free hand in speaker design

General Electric dual-diameter, directional grain magnets clearly demonstrate that magnet size and weight are no longer any criterion of speaker performance. And, the reason is simple.

G-E engineers have purposely designed weight and size out of dual-diameter, directional grain Alnico 5 magnets by concentrating magnetic field energy within the area of voice coil travel. By combining the outstanding properties resulting from the G-E patented d.g. process with a design integrated to use these properties, a new level of efficiency at the higher levels of gap energy has been achieved.

In addition, smaller, lower cost pole pieces and return paths of powdered iron are now feasible in larger speaker sizes. Send for full technical information on G-E directional grain Alnico 5. And, for a freer hand on any magnetic design, turn first to: *Magnetic Materials Section, General Electric Company, 7820 N. Neff Road, Edmore, Michigan.*



Compare these two Alnico 5 magnets for size. The smaller G-E directional grain Alnico 5 magnet at the right establishes air gap energy equal to that produced by the conventional Alnico 5 magnet at the left. Note the crystal orientation over the dual-diameter magnet volume.

MAGNETIC MATERIALS SECTION

**GENERAL ELECTRIC**

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • MAGNETIC MATERIALS • THERMISTORS • THYRITE® • VACUUM-MELTED ALLOYS  
CIRCLE 68 ON READER-SERVICE CARD

# NEW PRODUCTS

*Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.*

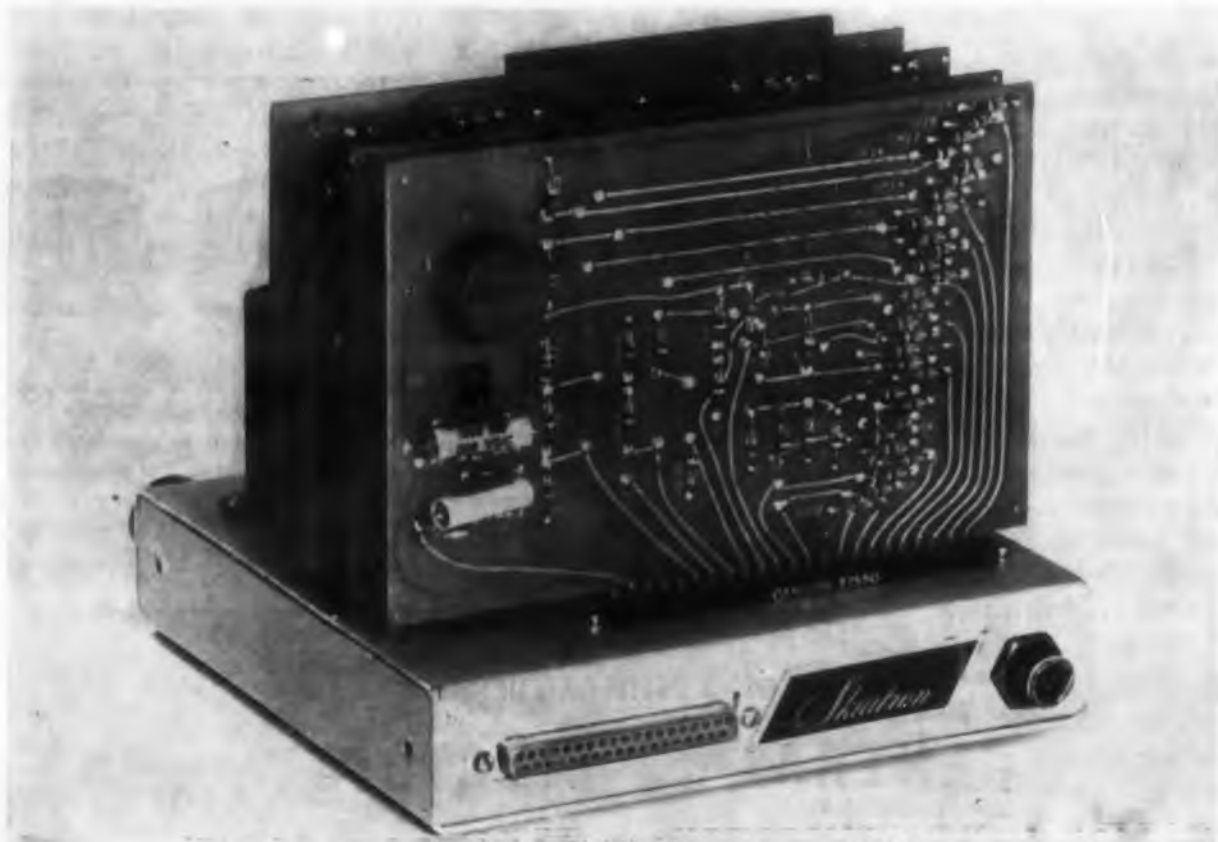


## Switch Operates On Magnetic Principle 545

The hermetically-sealed FluxLink switch is actuated by a permanent magnet circuit. The switch element is the only moving part; there are no coils or springs. Designed to operate on 15 amp, 115 v ac, the switch has a temperature range of  $-85$  to  $+900$  F, and it can withstand 10 to 3000 cps vibration and 50 g shock. It is made of stainless steel with a ceramic header. The micro-miniature switch can also be actuated by various manual or machine motions.

Space Components, Inc., Dept. ED, 1048 Potomac St. N. W., Washington, D. C.

**Price & Availability:** Made on order only. Lower temperature models available from stock. According to type of actuation, prices may vary from \$4 to \$70 for the simpler forms.



## Two Character Generators Are Transistorized 541

The Series 2000 Alphadyne character generator supplies all 10 digits, 9 letters and 3 symbols. All transistorized, the unit measures about 6 x 6 x 6 in. and consumes less than 5 w. Characters can be written as fast as 40,000 per sec. The Series 3000 Alphadyne generator provides full alpha-numeric characters: all 10 digits, all 26 letters, and 4 symbols. This series is also completely transistorized. It measures about 6 x 6 x 8 in. and consumes less than 5 w. Characters can be written as fast as 17,000 per sec.

Skiatron Electronics and Television Corp., Dept. ED, 180 Varick St., New York 14, N. Y.

**Price & Availability:** Series 2000 are \$3000 each and Series 3000 are \$5000 each for 1 to 5 units. Delivery is 30 to 60 days.



## Camera Processor Provides Film Record in Minimum Of 20 Sec 542

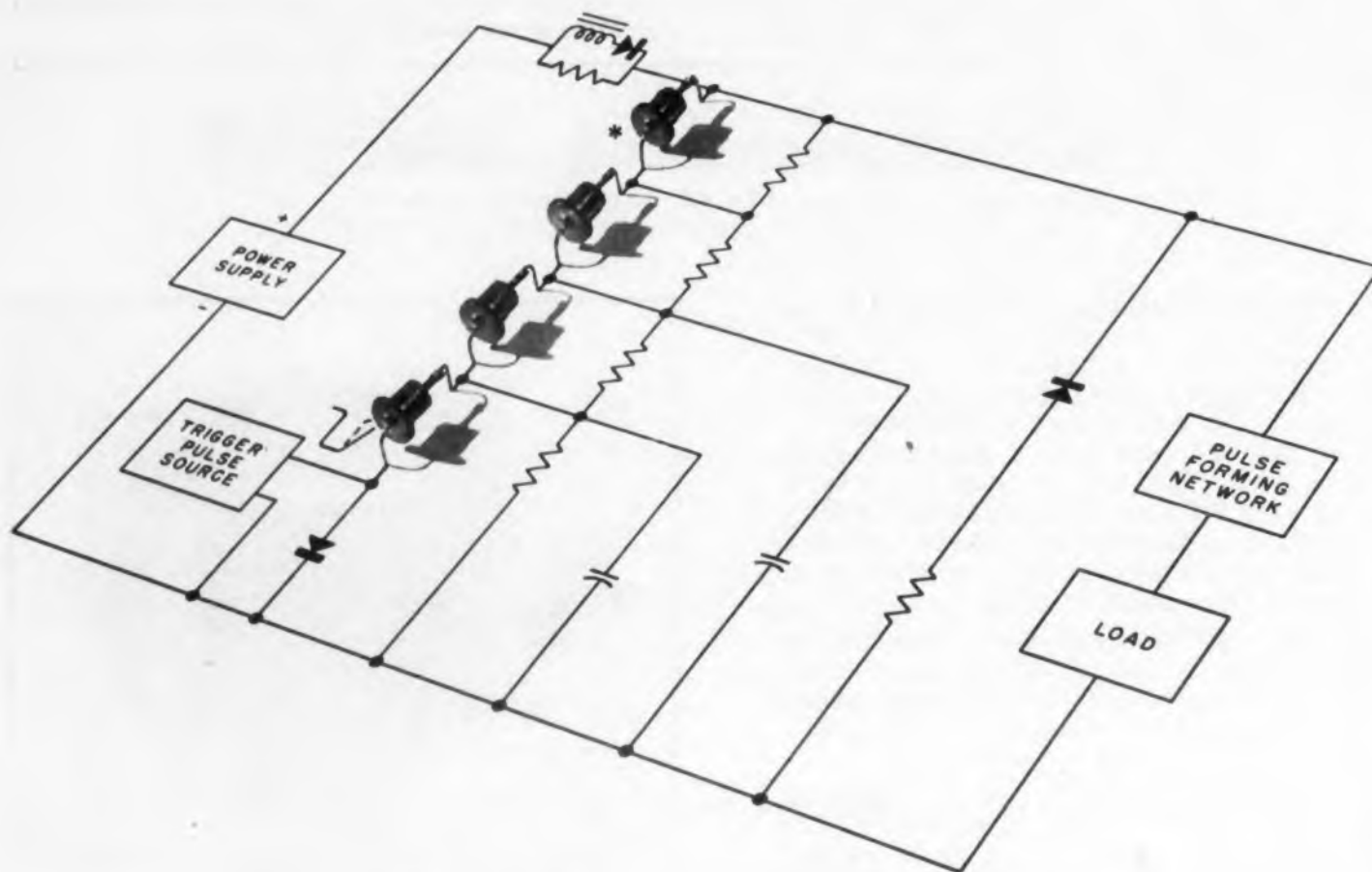
Having many electronic, data recording applications, the Model 414 Rapidata Photo-Processor permits film viewing with a minimum delay of about 20 sec; the actual delay depends on the type of event and the device's mode of operation. It is designed to expose and process films that are suited to line, and blue-phosphor cathode-ray-tube recordings. The Rapidata has an f:1.9, 75 mm objective lens mounted in a shutter, which is manually tripped. The unit may be operated (1) on command, to move a single exposed frame through the processing area to the viewer, (2) with continuous film drive to provide programmed, frame-by-frame exposures, and (3) to provide one scanning dimension for an oscillograph trace.

Photomechanisms, Inc., Dept. ED, 6 W. 18th St., Huntington Sta., N. Y.

**Price & Availability:** Price, in quantity, is \$2995 per unit. It is available 12 weeks after order.







\*SHOCKLEY 4-LAYER DIODES used in series to reach voltages of 1000 or 1500 volts in medium power modulator circuit. Jitter: less than 6 milli-micro seconds. Turn on time: 0.1  $\mu$ s.

## A NEW PULSE MODULATOR

Solid state reliability...drastically reduced power consumption...small size...light weight...and speed—all these are yours when your pulse modulator circuit includes Shockley 4-layer diodes.

These are *important* considerations no matter what your pulse modulator applications may be...whether you're working with modulators for driving sonar oscillators, modulators for driving magnetrons and klystrons, modulators for driving triodes or pentodes.

And, they are *critical* considerations where space

and weight are limited, where the size of the power supply must be reduced, where maximum reliability is a must...as in missile work.

Pulse Modulator applications, using 4-layer diodes, are described in a new data sheet, just released. Or, are you interested in how 4-layer diodes can solve circuit problems in counters, flip-flops, alarm circuits, magnetic memory driving, d-c to a-c inverters, oscillators, detonators, pulse amplifiers, or just plain switching? If so, call or write your local Shockley field representative or write Dept. 8-2.

**Shockley TRANSISTOR CORPORATION**

Stanford Industrial Park, Palo Alto, Calif.

A SUBSIDIARY OF BECKMAN INSTRUMENTS, INC.



CIRCLE 71 ON READER-SERVICE CARD

## NEW PRODUCTS

### FM Receiver

518

Sensitivity is  $-30$  dbm



Model R-25 fm receiver has a nominal sensitivity of  $-30$  dbm. Discriminator linearity is  $\pm 5\%$  or better and discriminator output is at least  $\pm 12$  mc. A 50-ohm input attenuator continuously covers the range of 0 to 30 db with an accuracy of  $\pm 20\%$ . The input signal is combined in a crystal mixer with the output of the local oscillator to produce an if frequency of 100 mc. The local oscillator, a reflex klystron, is mounted in an oven, temperature controlled to 140 F, and has a repeller voltage of nominally 150 v, adjustable to  $\pm 10$  v. Inherent drift of the oscillator is less than 100 kc per min. The video amplifier output is 1 v peak-to-peak min across a 75-ohm resistive load for a deviation of  $\pm 10$  mc. Its response is within 3 db from 40 cps to 6 mc.

Alto Scientific Co., Inc., Dept. ED, 855 Commercial St., Palo Alto, Calif.

*Price & Availability:* Price range is \$8000 to \$11,000. Units can be delivered in 75 to 90 days.

### Traveling Wave Tube

521

CW output is to 4 w



Model X778 ceramic-metal, traveling-wave tube, with a small signal-gain of at least 60 db over the range of 5 to 11 kmc, has an output of 1 to 4 w. Beam focusing is by means of temperature-compensated permanent magnets which allow operation from  $-65$  to  $+150$  F. Noise figure is 25 to 34 db. The tube can be used where two tubes would normally be required to cover the C and X-bands. Applications include electronic counter-measures, missile and aircraft instrumentation, amplifier drivers, microwave communications and test



equipment. The unit weighs 5 lb and measures 16.5 in. in length and 3 in. in diameter.

Eitel-McCullough, Inc., Dept. ED, San Carlos, Calif.

**Price & Availability:** Sample quantities are available at a price of \$3800 ea. Units will be in stock by December 1960.

### Ammeter

533

Measures up to 3 ma dc



Model 1811 millimicroammeter measures dc currents from less than 1  $\mu$ a to 3 ma. The feedback amplifier design with chopper stabilization gives a full scale voltage drop of 10 mv, and eliminates the need for a zero adjustment. Built-in current shunts withstand overloads of 60,000 times full-scale current at the lowest current range. Accuracy is 3% of full scale.

Dynatran Electronics Corp., Dept. ED, 178 Herricks Road, Mineola, N.Y.

**Price & Availability:** Available from stock to 30 days. Unit is priced at \$149.

### AC-AC Converter

519

Output is up to 1500 w



These two series of ac-dc converters have up to 1500 w output at variable and fixed frequencies from 50 to 20 kc. The 100 series is designed for applications where 24-hr operation is needed and where regulation, frequency, and wave shape are not critical. The 200 series is for applications where regulation, frequency, and wave shape are important.

Digitrols, Inc., Dept. ED, 8223 Old Philadelphia Road, Baltimore 6, Md.

**Price & Availability:** Price of standard 150 va unit is \$189. Delivery time is 10 days.

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## NEW PRODUCTS

### DC Voltage Standard

528

Provides regulation of 0.001%



This solid-state voltage-reference standard, model 210, operates directly on 115 v, 60 cps lines and delivers 10 ma into a load. Regulation of 0.001% of output voltage is achieved over a  $\pm 10\%$  line variation. The unit has a temperature-compensated current generator which maintains a constant current through Zener references over an ambient temperature range of  $-25$  to  $+75$  C. Units in the line come with 1, 5.6, 6.8, 8.5, 11, or 13.6 v dc output.

Viking Industries, Inc., Dept. ED, 21343 Roscoe Blvd., Canoga Park, Calif.

### Voltage Standard

520

Full scale is  $\pm 11.111$  v in 1-mv steps



This four-decade, direct-reading voltage standard has a full scale of  $\pm 11.111$  v in 1-mv steps. For use in telemetry, data reduction, and laboratory equipment, the unit uses solid state circuitry throughout and weighs 8 lb. Inherent noise, drift, and ripple are below 100 mv. The output impedance is less than 50 milliohms. The maximum output current is preset. Both a portable unit measuring 7 x 7.5 x 8.5 in. and a rack-mounted unit measuring 3.5 x 19 x 7 in. can be furnished.

Electronic Development Corp., Dept. ED, 423 W. Broadway, Boston 27, Mass.

Price: \$555 *job factory*.





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NEW ... FROM INDUSTRY'S BROADEST RECTIFIER LINE

# SILICON CARBIDE RECTIFIERS

## FEATURES

- IMPROVED RELIABILITY AT ELEVATED TEMPERATURES
- HIGHER TEMPERATURE PERFORMANCE TO 500°C
- EXCELLENT RADIATION RESISTANCE

Silicon carbide rectifiers are now available for production requirements. Their inherent higher temperature capabilities (to 500°C) provide greater reliability in existing circuitry subject to high ambient temperatures. Resistance to radiation is up to 100 times greater than previously available in any semiconductor rectifiers.

Type	SPECIFICATIONS @ 500°C			RATINGS @ 500°C	
	Peak Inverse Voltage (volts)	Maximum Inverse Current $I_b$ ( $\mu$ a)	Maximum Forward Voltage @ Specified Current (volts @ mA)	Maximum Average Forward Current $I_o$ (mA)	Maximum Peak Inverse Voltage (volts)
TCS10	100	500	6 @ 100	100	100
TCS5	50	500	4 @ 100	100	50

Type	SPECIFICATIONS @ 25°C		
	Peak Inverse Voltage (volts)	Maximum Inverse Current $I_b$ ( $\mu$ a)	Maximum Forward Voltage @ Specified Current (volts @ mA)
TCS10	100	10	12 @ 100
TCS5	50	10	8 @ 100



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## PUNCH IT... FORM IT... SHEAR IT... SOLDER IT!

New G-E CLAD-MOLY SHEET won't blister, flake or peel even if you heat it to 950°C

G-E Clad-Moly is molybdenum sheet clad in either nickel or copper, developed by General Electric. It meets the needs of the electronic industry for a molybdenum sheet with good soldering characteristics. What's more, this cladding really sticks! Won't delaminate! Bonds like a single piece of metal!

Base material is General Electric HD Moly Sheet, a new, high ductility sheet of pure molybdenum. The G-E Clad-Moly Sheet retains all the favorable properties of molybdenum—like its coefficient of thermal expansion that's similar to silicon, and its high electrical conductivity.

Order G-E Clad-Moly Sheet in thicknesses of from 0.010 to 0.080 inches—in widths up to 4 inches. Specify copper or nickel cladding on one or both sides. (Cladding will be between 0.0005 and 0.001 inches thick.) Or you can special

order the *cladding thickness* up to 10% of *total sheet thickness*.

**WIDEST USE AT PRESENT**—G-E Clad-Moly is ideal for disks in silicon power rectifiers (see disks in photo above). It gives them excellent soldering properties. But there's no limit to the possible uses of this new material. We'd like to work with you in tailoring just the right G-E Clad-Moly to your specific needs. General Electric Co., Lamp Metals and Components Dept-ED, 30, 21800 Tungsten Road, Cleveland 17, Ohio.

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

CIRCLE 75 ON READER-SERVICE CARD

## NEW PRODUCTS

### Electroluminescent Display 449

**Operates from data transmitters**

This electroluminescent display is designed to operate from most data transmitters, such as tape, punched-card, or manual switching devices. The unit accepts low dc voltages in three-decade order and uses a transistorized digital decoder to provide energizing signals for illuminating the in-line display. There are no tubes or moving parts. Applications are in military and industrial systems.

Magnetic Amplifiers, Inc., Dept. ED, 632 Tinton Ave., New York 55, N.Y.

### Coaxial Attenuators 415

**Have vswr rating of 1.25**

Series RDA-1 dc coaxial attenuators, having attenuation values of 3, 6, 15, and 20 db, now hold a vswr of 1.25 max. Their frequency sensitivity is 0.05 db per db max through 7000 mc. The units use mounted type N connectors and have precious metal resistors which are evaporated on rugged mica bases. Over-all length is 3 in.

Radar Design Corp., Dept. ED, 1002 Pickard Drive, Syracuse 11, N.Y.

**Price & Availability:** Price ranges from \$65 to \$75 ea. Units are available from stock.

### Speed Detecting Governors 424

**Detect 500 to 4000 rpm**

Able to detect from 500 to 4000 rpm, the Synprotex speed detecting switches have an accuracy of 1%. They are furnished in a stamped steel box, complete with wiring knock-outs and flange for external mounting. The housing measures 2.75 x 4.5 x 3 in. Units are rated for over 1,000,000 cycles of uniform operation. Uses include overspeed and under speed detection, signaling, and sequencing.

Torq Engineered Products, Inc., Dept. ED, 32 W. Monroe St., Bedford, Ohio.



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**PSI microdiode**  
SUPER-MINIATURIZED SILICON DIODES

**NEW SPECIFICATIONS**

*on the world's*

**SMALLEST DIODES**

**IN897 • IN898 • IN899 • IN900 • IN901 • IN902**

**VERY LOW LEAKAGE • 250 mW DISSIPATION •  
RELIABILITY  $\geq$  CONVENTIONAL DIODES**

ACTUAL SIZE

**ELECTRICAL SPECIFICATIONS**

Type No.	Min. Sat. Voltage @ 100 $\mu$ A (V)	Min. Fwd. Current @ +1.0 V (mA)	Maximum Reverse Current ( $\mu$ A)		Reverse Recovery Characteristics	
			25°C	100°C	Reverse Res. (Ohms)	Max. Recov. Time ( $\mu$ S)
1N897	50	5	.025 (10V) .1 (40V)	5 (10V) 20 (40V)	100K	1.0
1N898	50	100	.025 (10V) .5 (40V)	5 (10V) 20 (40V)	100K	0.3
1N899	100	5	.025 (10V) .1 (80V)	5 (10V) 20 (80V)	100K	0.3
1N900	100	50	.025 (10V) .1 (80V)	5 (10V) 20 (80V)	100K	0.3
1N901	100	100	.025 (10V) .5 (80V)	5 (10V) 20 (80V)	100K	0.3
1N902	200	10	.025 (10V) 1.0 (100V)	5 (10V) 15 (100V)	200K	0.3

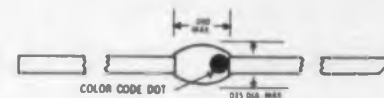
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PSI Authorized Distributors from coast-to-coast can deliver Micro-Diodes in quantities to 999 at factory prices. See listing.



ENLARGED VIEW

Announcement of these new low leakage Micro-Diode types coincides with a general price reduction of up to 20% on the current PD-100 Micro-Diode series.

Excellent delivery is being made on both the original PD-100 series and this new EIA series of Micro-Diodes. A large number of manufacturers are already designing Micro-Diodes into highly advanced micro-miniaturized systems.

Exhaustive reliability and life tests have been completed on the PSI Micro-Diode. Write for this valuable new information!



**Pacific Semiconductors, Inc.**

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE, INC.

12955 Chadron Avenue, Hawthorne, California

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# IDEA

**Problem: SATELLITE TRACKING BEYOND SKIN RANGE.** Create a solid-state uhf transponder that can be included in the payload of a space probe without usurping valuable instrumentation space. TI Apparatus division engineers gained the highest component densities ever achieved in a transponder by designing entirely new circuits with TI mesa uhf transistors, recently developed by the TI Semiconductor-Components division, and packaging them in individually shielded modules.

**Result:** In a missile shot just 2½ months after the start of this program, the transponder made possible tracking beyond the skin range with absolute reliability, and helped tracking site personnel predict final trajectory early in flight without the usual wait for down-range reports.



Actual size of transponder  
0.058 cubic feet. 6.3 pounds.

design, manufacturing and quality control engineers — 3-10 years experience

## ORIGINAL IDEAS BECOME REALITIES AT TI

The development of this new transponder is only one example of how TI's engineering activities are combined in an atmosphere of intellectual freedom, to transform original ideas into product realities.

Here at TI's Apparatus division, it's easier to put your ideas into space... you have the opportunity to call on TI's Central Research Laboratory for basic research, the Semiconductor-Components division for the latest component advances, the GeoSciences and Instrumentation division for world-wide facilities and new knowledge in geophysics, and Apparatus division's own R & D department for product application development.

Men with the qualifications specified here are invited to write to John R. Pinkston, Professional Placement, Dept. 120, Apparatus division. To learn more about us, write for a copy of "We Can Tell You This Much About Apparatus Division."

### selected current career opportunities

**SENIOR ELECTRONICS ENGINEER:** Apply signal detection theory to advanced radar receiver design. (5 years' experience with advanced EE or Physics degree preferred.)

**SENIOR DESIGN ENGINEER:** Advanced missile system digital computer design with solid-state circuits, logic and memory. (5 years' experience with MS in EE or Physics.)

**DESIGN ENGINEER:** Microwave R & D with parametric amplifiers, tunnel diode devices, and other advanced components. (3 years' experience with BS in EE or Physics.)

**MANUFACTURING ENGINEERS:** Complete manufacturing planning and coordination of electronic and electro-mechanical equipment. (3 years' experience with BS in EE, ME, or IE.)

**METHODS ENGINEERS:** Producibility design, tooling, estimating, and production methods for electronic and electro-mechanical equipment. (4 years' experience with BS in ME.)

**QUALITY CONTROL ENGINEER:** Establish and maintain quality standards and inspection methods. (3 years' experience with BS in IE, ME, or EE.)

PROFESSIONAL  
PLACEMENT

APPARATUS  
DIVISION

TEXAS  INSTRUMENTS  
INCORPORATED  
6000 LEMMON AVENUE • DALLAS 9, TEXAS

## NEW PRODUCTS

### Teletypewriters 538

Can print on 11/16-in. punched tape

T2PN teletypewriter can print on a standard 11/16-in. punched tape for use with electronic readers and integrated data processing systems. About the same size and weight as an electric typewriter, the unit can deliver 60- or 75-wpm operation. Almost 20 different keyboard options are available. The T2PN comes in two variations: The T2PR, an on-line machine for receiving only, and the T2PL, for off-line use in tape preparation.

TELaughtograph Corp., Dept. ED, 8700 Bellanca Ave., Los Angeles 45, Calif.

**Price & Availability:** Machines are available on either a rental or direct sale basis. The T2PN rents for \$37 per month, sells for \$1900. The T2PR is \$30 per month or \$1555. The T2PL is \$25 per month or \$1620.

### Camera 535

Magnifies time by 100,000

This movie camera takes from 480 to 1,600,000 pictures per sec on 35-mm film and stretches an event lasting 1 sec to 28 hr. Equipped with its own lighting system, the camera produces 400,000,000 lumens with 3-msec duration. Typical applications are recording arc discharges, studies of vibration patterns, and wire explosions. When the camera is operated at low speeds, motion is stopped in the recording of such mechanisms as cams, relays, springs, and breaker points. Three separate units are furnished: the camera, the control unit, and the light control unit.

Benson-Lehner Corp., Dept. ED, 1860 Franklin St., Santa Monica, Calif.

### Miniature Neon Lamps 414

Have extra brilliance

Types LNE 45, 47, and 48 miniature glow lamps are five times brighter than the firm's previous neon lamps. They operate at 0.5 w

◀ CIRCLE 77 ON READER-SERVICE CARD



on 105 to 125 v ac and have a series resistance of 12,000 ohms, internal for the LNE 45 and external for the other two types.

Signalite, Inc., Dept. ED, Neptune, N.J.

**Price & Availability:** The LNE 45 and 47 are priced at \$0.528 ea for less than 5000 units. The LNE 48 is priced at \$0.431 ea. Small quantities are available from stock; large quantities can be delivered in 20 to 30 days.

## Receiving Tube 422

For TV applications

Intended for use in the majority of TV receivers using a single-ended, octal-base damper diode, type 6DA4A tube is designed for trouble-free operation. The cathode used reduces the possibility of voltage break-down between heater and cathode. The plate design uses a copper core which distributes the heat evenly over the large plate area, eliminating the possibility of back emission. The plate configuration provides the lowest possible tube drip consistent with the limitations imposed by the hazard of arcing. The tube uses a 6.3-v, 1.2-amp heater. It replaces type 6DE4 and can be used in type 6AX4GT and 6AU4GTA sockets.

Tung-Sol Electric Inc., Dept. ED, 1 Summer Ave., Newark 4, N.J.  
**Availability:** From stock.

## Insulation Material 411

Ceramic

This ceramic insulation is offered in different types. Dielectric strength is 230 v per mil per 1/8-in. thickness for types B890 and B890-2 and 275 v per mil per 1/8-in. thickness for type P3142-1. The volume resistivity at 500 C is  $6 \times 10^{10}$  ohms per  $\text{cm}^3$  for types B890 and B890-2 and  $1.2 \times 10^{10}$  ohms per  $\text{cm}^3$  for type P3142-1. The product meets Mil specs.

Diamonite Products Mfg. Co., Dept. ED, 1232 Cleveland Ave., N.W., Canton 3, Ohio.

**Availability:** Made on order, the product can be delivered in 42 to 60 days.

CIRCLE 78 ON READER-SERVICE CARD ►

SILICON



TRANSISTOR CORPORATION

SILICON GLASS DIODES

JAN  
TYPES

1N457  
1N458  
1N459

SIG.C.  
TYPES

1N643  
1N658  
1N662  
1N663

Silicon Transistor Corporation manufactures three general purpose and four fast switching silicon glass diodes designed to meet latest military specifications. STC's silicon diodes and silicon high power transistors are unique due to a continual program of "built-in" reliability. Write for engineering bulletins on STC's silicon diodes and power transistors.



**FOR IMMEDIATE DELIVERY, CONTACT THESE STC AUTHORIZED DISTRIBUTORS:** Ala.: M. G. Electrical Equipment Co., Birmingham. Conn.: Brill Semiconductor Corp., Oakland; Hollywood Radio Supply, Inc., Hollywood; Peninsula Electronic Supply, San Jose; San Delco, San Diego; Shelley Radio Co., Inc., Los Angeles; Wesco Electronics, Pasadena. Conn.: Bond Radio Supply, Inc., Waterbury. Fla.: Leader Distributors, Inc., Tampa. Maryland: Valley Electronics, Inc., Tampa. Mass.: Durtell Distributors, Inc., Waltham. New York: Arrow Electronics, Inc., Mineola, L. I. Penna.: Philadelphia Electronics, Inc., Phila. Texas: Lenert Company, Houston.

CARLE PLACE, L. I., NEW YORK - PIONEER 2-4100

SILICON TRANSISTOR CORPORATION

# IDEA

**Problem: SATELLITE TRACKING BEYOND SKIN RANGE.** Create a solid-state uhf transponder that can be included in the payload of a space probe without usurping valuable instrumentation space. TI Apparatus division engineers gained the highest component densities ever achieved in a transponder by designing entirely new circuits with TI mesa uhf transistors, recently developed by the TI Semiconductor-Components division, and packaging them in individually shielded modules.

**Result:** In a missile shot just 2½ months after the start of this program, the transponder made possible tracking beyond the skin range with absolute reliability, and helped tracking site personnel predict final trajectory early in flight without the usual wait for down-range reports.



Actual size of transponder  
0.058 cubic feet. 6.3 pounds.

design, manufacturing and quality control engineers—3-10 years experience

## ORIGINAL IDEAS BECOME REALITIES AT TI

The development of this new transponder is only one example of how TI's engineering activities are combined in an atmosphere of intellectual freedom, to transform original ideas into product realities.

Here at TI's Apparatus division, it's easier to put your ideas into space... you have the opportunity to call on TI's Central Research Laboratory for basic research, the Semiconductor-Components division for the latest component advances, the GeoSciences and Instrumentation division for world-wide facilities and new knowledge in geophysics, and Apparatus division's own R & D department for product application development.

Men with the qualifications specified here are invited to write to John R. Pinkston, Professional Placement, Dept. 120, Apparatus division. To learn more about us, write for a copy of "We Can Tell You This Much About Apparatus Division."

### selected current career opportunities

**SENIOR ELECTRONICS ENGINEER:** Apply signal detection theory to advanced radar receiver design. (5 years' experience with advanced EE or Physics degree preferred.)

**SENIOR DESIGN ENGINEER:** Advanced missile system digital computer design with solid-state circuits, logic and memory. (5 years' experience with MS in EE or Physics.)

**DESIGN ENGINEER:** Microwave R & D with parametric amplifiers, tunnel diode devices, and other advanced components. (3 years' experience with BS in EE or Physics.)

**MANUFACTURING ENGINEERS:** Complete manufacturing planning and coordination of electronic and electro-mechanical equipment. (3 years' experience with BS in EE, ME, or IE.)

**METHODS ENGINEERS:** Producibility design, tooling, estimating, and production methods for electronic and electro-mechanical equipment. (4 years' experience with BS in ME.)

**QUALITY CONTROL ENGINEER:** Establish and maintain quality standards and inspection methods. (3 years' experience with BS in IE, ME, or EE.)

PROFESSIONAL  
PLACEMENT

APPARATUS  
DIVISION

TEXAS  INSTRUMENTS  
INCORPORATED  
6000 LEMMON AVENUE • DALLAS 9, TEXAS

## NEW PRODUCTS

### Teletypewriters 538

Can print on 11/16-in. punched tape

T2PN teletypewriter can print on a standard 11/16-in. punched tape for use with electronic readers and integrated data processing systems. About the same size and weight as an electric typewriter, the unit can deliver 60- or 75-wpm operation. Almost 20 different keyboard options are available. The T2PN comes in two variations: The T2PR, an on-line machine for receiving only, and the T2PL, for off-line use in tape preparation.

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Diamonite Products Mfg. Co., Dept. ED, 1232 Cleveland Ave., N.W., Canton 3, Ohio.

**Availability:** Made on order, the product can be delivered in 42 to 60 days.

CIRCLE 78 ON READER-SERVICE CARD >

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CARLE PLACE, L. I., NEW YORK • PIONEER 2-4100

SILICON TRANSISTOR CORPORATION

## ABOUT WATERLOO . . .

Shortly after Waterloo, the Duke of Wellington received a letter, postmarked St. Helena. It was from Napoleon. It read: "Excellency: I was amused to hear your recent remark that 'The Battle of Waterloo was won on the playing fields of Eton.' To have won an engagement in Belgium from a field in England, you must have been further back of the battle lines than I thought.

"The real reasons for my defeat were two, and Eton was neither. In the first place, the radar broke down for two hours in the heat of

battle. Not even a Napoleon can be expected to make radar work without Bomac tubes.\*

"But I might easily have defeated you, faulty tubes and all, had I not been persuaded to partake of a bottle of Scotch on the evening before the battle. I have reason to suspect my drink was tainted. At any rate, on the day of Waterloo, I did not display my usual energy and decisiveness.

"It appears, in short, that you owe the battle to a bottle. (Signed,) N."

The Emperor received a brief reply by re-

turn boat. It read: "Excellency: In view of the fact that your loss at Waterloo appears to have been less a matter of Eton than of Drinking, I am withdrawing my original statement. I have released the following in its place, which I here submit for your approval:

"You can mix Scotch and Water  
And Water and Scotch  
But don't whatever you do  
Make the mistake Napoleon did,  
And mix Scotch and Waterloo."

(Signed,) Wellington."

## No. 19 of a series . . . BOMAC LOOKS AT RADAR THROUGH THE AGES



\* Bomac makes the finest microwave tubes and components this side of Waterloo

**BOMAC** laboratories, Inc.



Leaders in the design, development and manufacture of TR, ATR, Pre-TR tubes; shutters; reference cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; surge protectors.

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Offices in major cities—Chicago • Kansas City • Los Angeles • Dallas • Dayton • Washington • Seattle • San Francisco • Canada: R-O-R Associates Limited, 1470 Don Mills Road, Don Mills, Ontario • Export: Maurice I. Parisier, 741-745 Washington St., N. Y. C. 14, N. Y.

## NEW PRODUCTS

### Molding Machine 534

Mold capacity is 4 to 6 oz

Model 12 plastic injection molding machine has a mold capacity of 4 to 6 oz. It provides heavy-duty electrical cord plugs, axial switches, condensers, wiring harnesses, strain reliefs, and grommets. The self-compensating feed mechanism includes an aluminum hopper with a 75-lb capacity. A built-in water cooling system is included for the injection piston and feed sleeve. The machine needs only one operator.

Moslo Machinery Co., Dept. ED, 2458 Prospect Ave., Cleveland 15, Ohio.

### Potentiometer 539

Has a range up to 100 K

Model 260 Trimpot potentiometer has a range up to and including 100 K. Designed primarily for applications requiring continuous operation at 125 to 175 C, the component weighs 0.1 oz and has a resolution as low as 0.17%. It has multi-turn screwdriver adjustment, and idling wiper assembly to prevent damage from forced adjustment. It comes with three terminal configurations: insulated stranded leads, solder lugs, or printed circuit pins.

Bourms, Inc., Dept. ED, Box 2112, Riverside, Calif.

### Time Standard 425

Portable

This portable time standard can be used for on-off control of recording instruments, telemetering transmitters, and other devices located in remote locations. It operates with an accuracy of  $\pm 16$  sec per yr. Completely transistorized, the unit measures 7 x 11 x 7 in. and weighs 9 lb. It is self-powered.

Zenith Radio Corp., Dept. ED, 6001 W. Dickens Ave., Chicago 39, Ill.



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OF  
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- WASHINGTON, D. C.**  
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HUdson 3-5200



SEE PAGES 37 & 81 - MOTOROLA ZENER DIODE HANDBOOK

CIRCLE 80 ON READER-SERVICE CARD

NEW  
MOTOROLA

1/4 WATT  
diffused-junction  
ZENER DIODES

Voltages from 6.8 to 200  
Tolerances of 20%, 10%, & 5%

Motorola 1/4 watt silicon zener diodes provide the following reliability and application features:

- Unique diffused-junction process for —  
Excellent parameter uniformity  
Low temperature coefficients  
Low dynamic impedance  
High surge current capability
- Widest selection of voltages—43 basic types from 6.8 to 200 volts. Test currents selected approximate those found in actual circuit designs.
- Electrical stability and reliability assured by 200°C aging.
- Excellent selection of tolerances — 10% and 5% — plus 20% tolerances for "lowest cost" applications
- Sharp knees are assured by 100% scope testing
- All units readily identifiable by type number
- Forward current ratings specified and guaranteed

SPECIFICATIONS

D. C. Power Dissipation	1/4 watt
Nominal Zener Voltage Range	6.8 to 200 volts
Maximum Forward Voltage @ 100 ma	1.5 volts
Junction & Storage Temperature	-65°C to +175°C

IMMEDIATELY AVAILABLE from your Motorola Semiconductor distributor.

FOR COMPLETE TECHNICAL INFORMATION write or phone your Motorola Semiconductor district office:

CLIFTON, NEW JERSEY  
1051 Bloomfield Avenue  
GRegory 2-5300  
from New York WI 7-2980

DETROIT 27, MICHIGAN  
13131 Lyndon Avenue  
BRoadway 3-7171

MINNEAPOLIS 27, MINNESOTA  
7731 6th Avenue North  
LIBerty 5-2198

BELMONT 76, MASSACHUSETTS  
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## AMPHENOL LEADS IN RF COMPONENTS

- 1 BROAD AVAILABILITY from a single source. All popular RF Series. In addition to those illustrated above, series UHF, BN, Adapters and Specials are also manufactured by AMPHENOL.
- 2 SERVICE & ASSISTANCE based on the experience of over twenty years of designing and manufacturing RF connectors.
- 3 ENGINEERING facilities are the finest of any components manufacturer. AMPHENOL has the know-how and the equipment to assist you in "problem areas" and in special designs.

\*PATENT PENDING

**AMPHENOL CONNECTOR DIVISION**

1830 S. 54TH AVENUE, CHICAGO 50, ILLINOIS  
Amphenol-Borg Electronics Corporation

## NEW PRODUCTS

### DC Power Supply

526

Provides three outputs



The AGA PS/T-525 power supply is a transistorized dc-to-dc converter that operates from 7 to 10 v. It provides these outputs: 6.3 v at 2.6 amp; 150 v at 0.035 amp; and -22.5 v at 0.01 amp. The unit includes a solenoid-actuated switch for remote selection of external or internal primary power. The 7 to 10 v primary battery input is regulated by a series transistor and applied to a dc-to-dc switching converter. Packaged in a cylindrical container, the unit weighs 19 oz.

Aero Geo Astro Corp., Dept. ED, 1200 Duke St., Alexandria, Va.

**Price & Availability:** Delivery in 30 days. Unit price is \$825.

### Static Inverter

530

Has an efficiency of 85%



This static inverter, which converts 28 v dc to 115 v ac at 400 cps, weighs less than 5 lb and has a voltage regulation accuracy of  $\pm 0.87\%$  and an efficiency of 85%. The unit operates over a temperature range from  $-55$  to  $+125$  C. Frequency accuracy of  $\pm 1/4$  cps has been achieved by the use of a stable frequency reference which, in conjunction with a logic circuit, also controls the phase relationship.

United Aircraft Corp., Hamilton Standard Div., Electronics Dept., Dept. ED, Main St., Broad Brook, Conn.

◀ CIRCLE 70 ON READER-SERVICE CARD

## new, low-cost micro- microammeter



Model 414 offers high performance over 17 ranges for just \$280.00!

● The Keithley 414 Micro-microammeter is today's lowest-cost instrument for low current measurements in production tests, monitoring installations and experiments in the range of  $10^{-2}$  to  $10^{-11}$  ampere. The 414 can be used as the amplifier element in systems, such as reactor controls, thickness gauges, ionization gauge control in high-vacuum equipment. Contact meter models are available for go, no-go production tests, alarm and control systems.

#### SPECIFICATIONS

**Ranges:** 17 ranges in 1x and 3x steps, from 10 ma to 0.1  $\mu\text{m}$ a f.s.

**Accuracy:** Within  $\pm 3\%$  of f.s. to 10  $\mu\text{m}$ a;  $\pm 4\%$  on lower ranges.

**Input Voltage Drop:** Below 5 mv all ranges with full-scale signals.

**Response Time:** Below 0.5 sec. all ranges, for any input capacitance to 5000  $\mu\text{m}$ f.

**Zero Drift:** Below 2% of f.s. per day.

**Recorder Output:** 5 volts with a 1 ma capability.

**Price:** Model 414 . . . . . \$280.00

For full details, write:



**KEITHLEY  
INSTRUMENTS**

12415 EUCLID AVENUE  
CLEVELAND 6, OHIO

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## Wattmeter

523

Indicates and controls power



This ac-dc contact-making wattmeter is capable of indicating and controlling power in the lower milliwatt range. Standard full scale sensitivity is 500 mw ac or dc; with modifications dc ranges with a sensitivity to 100 mw can be obtained. The instrument operates on any frequency to 1000 cps. The instrument consists of a locking contact meter-relay and a magnetic circuit built around a Hall-effect solid state device. The panel-mounting package has a 4.5-in. meter and a barrel less than 5 in. long. Primarily intended for measuring power, the unit is also available in modified form as a true rms voltmeter, an ammeter, or a variometer. It can monitor the product of up to four variables.

Assembly Products, Inc., Dept. ED, Chesterland, Ohio.

**Price & Availability:** Price ranges from \$160 to \$200, depending on special features required. Delivery time is four weeks.

## AC Supply Kit

525

Provides 0 to 150 v



Model T-266 ac supply provides a variable source of 0 to 150 v and is rated at 300 w. It consists of a variable-voltage auto transformer, a voltmeter, fuse, switch, light and two receptacles. Required input is 110 to 120 v. The unit is housed in an aluminum cabinet measuring 8 x 4 5/8 x 4-1/2 in.

Olson Radio Corp., Dept. ED, 260 S. Forge St., Akron, Ohio.


**Price:** \$15.95.




Which of these



# APPLICATION NOTES

can help you?

- #16 WAVES ON TRANSMISSION LINES
- #17 SQUARE WAVE AND PULSE TESTING
- #18 INTRODUCTION TO SOLID STATE DEVICES
- #21 MICROWAVE STANDARDS PROSPECTUS
- #27 BASIC MICROWAVE MEASUREMENTS
- #29 CONVENIENT METHOD FOR MEASURING PHASE SHIFT
- #30 MEASUREMENT OF CABLE CHARACTERISTICS
- #34 AC CURRENT MEASUREMENTS
- #36 SAMPLING OSCILLOGRAPHY
- #37 MONITORING A RADIO TRANSMITTER SIGNAL WITH AN  120A OR 130B OSCILLOSCOPE
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- #40 HEWLETT-PACKARD ELECTRONICS INSTRUMENTATION FOR TRANSDUCER APPLICATIONS

The above involve both theoretical and "how to do it" information, illustrated, complete, designed for swift practical application to your problem. These and all other  APPLICATION NOTES are available by calling your  representative, or writing  direct. No charge, no obligation.

### HEWLETT-PACKARD COMPANY

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instruments measure more swiftly, surely

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10  
WATTS  
OF  
POWER...  
from

dc to 1 megacycle!

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

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

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

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

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



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

CIRCLE 83 ON READER-SERVICE CARD

## NEW PRODUCTS

### Silver-Zinc Battery

531

Delivers 420 w for 19 min



In a typical application, model PN-5522 primary silver-zinc battery is operated at 15 amp, delivering 420 w for 19 min. It consists of 19 cells of 3 amp-hr nominal capacity and has a volume of 214 cu in. Operating temperature range is 32 to 160 F. The 28 v battery was designed for guidance systems, telemetering, and radio beacons and strobe lights in missile nosecones. Weight, including case, heaters, activation mechanism, and other hardware is 11.4 lb.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York, N.Y.

### Transformer

529

Covers 15 to 1000 mc range



Capable of covering the range from 15 to 1000 mc, this BPC series transformer has an insertion loss of less than approximately 1 db point over the 20 to 500 mc range, and 3 db at 15 and 1000 mc. It comes in a 200-ohm balanced, to 50-ohm unbalanced, transformation ratio. The hermetically sealed can measures 1-15/16 x 2-1/4 x 1-3/16 in. Soldering lugs are mounted in one end of the can for connecting balanced input leads, and a BNC connector is located at the other end for the unbalanced output.

CGS Laboratories, Inc., Magnetic Components Div., Dept. ED, 49 Danbury Road, Wilton, Conn.

# D-C POWER

Precisely Regulated for  
Missile Testing, Battery  
Charging and General Use



## SILICON POWER SUPPLIES

Over 200 standardized and militarized models up to 1500 amps... 6 to 135 volts. CHRISTIE'S QUALITY CONTROL is approved by the leading aircraft and missile manufacturers.

Write for  
Power Supply Bulletin AC-60  
Battery Charger Bulletin BC-60

**CHRISTIE  
ELECTRIC CORP.**  
3416 W. 67th Street  
Los Angeles 43, Calif.

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MRC proudly presents another series of quality products equally recognized for dependability, and performance. The Micromag, a low-level drift-free magnetic DC amplifier, completely solid state...ideally suited for instrumentation applications where temperature, strain and pressure are to be measured. DC signals in the millivolt region are amplified to the 0 to 5 volts DC range required for telemetering and recording systems.

**Typical Specifications:**

- Power / 26-31 volts DC, 10 milliamps
- Input Signal / 0-10 millivolts DC
- Voltage Gain / 500  $\pm$  10%
- Output Load / 100 K ohms
- Linearity /  $\pm$  2%
- Gain Stability /  $\pm$  3% from 0°C to +65°C
- Common Mode Rejection / At DC, 10'
- At 60 cps, 10'
- At 400 cps, 10'

For additional information on MRC's complete line of Micromags, write for Data File No. MA1001.



**MAGNETIC RESEARCH CORP.**  
3160 West El Segundo Blvd.  
Hawthorne, California  
CIRCLE 85 ON READER-SERVICE CARD

◀ CIRCLE 228 ON READER-SERVICE CARD

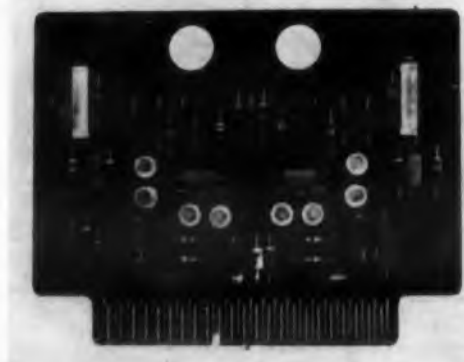
ELECTRONIC DESIGN • March 30, 1960

**NEW PRODUCTS**

**Modules**

581

Operate as multivibrators



These plug-in modules operate as either free-running or one-shot multivibrators. Combinations of generators can be formed to produce arbitrary pulse trains with variable pulse widths and variable frequencies. Rise-time is 0.5  $\mu$ sec or less. Output current is 75 ma for 7 v output pulse amplitude. Adjustable range of frequency is from 1 to 100 kc. Pulse widths are independently variable from 4  $\mu$ sec to 100  $\mu$ sec.

Abacus, Inc., Dept. ED, 3040 Overland Ave., Los Angeles 34, Calif.

*Price & Availability:* Available from stock. Prices range from \$120 to \$165 per unit for various models. Quantity discounts available.

**Power Supply**

580

Ripple is 1 mv rms



Model PS102M power supply, delivering an output of 6 to 30 v dc at 0.5 amp, has 1 mv rms typical ripple and 5 mv line regulation. The input is 105 to 125 v at 60 to 400 cps. The load regulation for a 0 to 0.5 amp load change is 50 mv and the output impedance is 0.08 ohms. A variable supply, it is equipped with double regulation and is especially designed for transistor circuit applications.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

*Price & Availability:* The unit is available for immediate delivery from stock; price is \$235.

**THE MAGIC ALPHABET**



Students of alphabetology will recognize these letters to be "M.R.C." written in the magic alphabet. Engineers everywhere recognize MRC for quality, reliability and outstanding performance.

The airborne power supply shown below is one of a series of highly reliable stable power sources de-

signed to operate from a 115 volt, 400 cycle line and supply well regulated and filtered DC power. Dual magnetic regulation, an exclusive feature of this series, suppresses line transients and compensates for changes in load.

The use of magnetic amplifier circuitry with tantalum capacitors, silicon diodes and rectifiers...coupled with inherent short circuit protection...combine to achieve a degree of reliability unattainable in other types of circuits.

**SPECIFICATIONS:**

Model 40-103-0 is a typical 5 watt supply used extensively in missile instrumentation:

- Input / 95-125 V; 380-420 cps
- Output / 4.75 to 5.25 V DC (Adjustable), 0 to 1 amp
- Regulation /  $\pm$  0.1%
- Ripple / 0.5% rms max. at full load

For additional information on MRC's complete line of airborne power supplies, write for Data File PS 1000.

**MAGNETIC RESEARCH CORPORATION**  
3160 West El Segundo Boulevard, Hawthorne, California  
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# JACKPOT...

**for circuits needing  
compensation**

This is the day to *hit the jackpot* — piled high with practical solutions to problems arising from the use of complex circuits to compensate for temperature and voltage. FXC Thermistors and Varistors not only outmode the use of complex circuits, but make possible a *more precise control* of both temperature and voltage.

**FXC Thermistors** — available in a full complement of values in miniature, bead, rod, vacuum and disc types — provide ideal resistors, having a negative temperature coefficient of resistance for almost any application.

**FXC Varistors**, including rod and disc types, have a negative voltage coefficient of resistance that decreases as applied voltage increases.

*Both* can be used not only as the basis for controllers of temperature and voltage, but for compensation in any electronic circuit requiring precise control. Complete technical and sample kit information supplied on request.

Say ferroxcube  
when you need  
thermistors and  
varistors.



## FERROXCUBE

CORPORATION OF AMERICA

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## NEW PRODUCTS

### Low Capacity Bridge

577

Range is 0.002 to 1000  $\mu\text{f}$



Three terminal capacity measurements from 0.002 to 1000  $\mu\text{f}$  can be made with model 1342 bridge. Accuracy of the instrument is  $\pm 0.2\%$ . Completely self-contained, the instrument is used for measuring tube inter-electrode capacity, circuit strays, and rf network components. Operation is based on a transformer bridge operation at 1 kc.

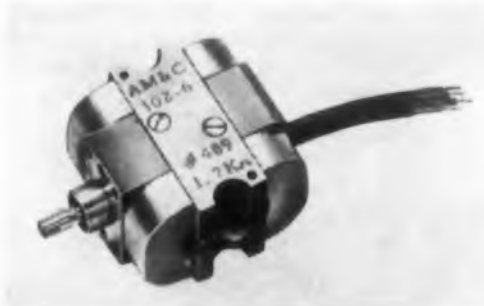
Marconi Instruments, Inc., Dept. ED, 111 Cedar Lane, Englewood, N.J.

**Price & Availability:** Units are available from stock at the price of \$555 ea.

### Rotary Output Torque Motor

578

Has no back-lash, end-play, or radial play



In this rotary output torque motor, the output is in the form of an output shaft rotation. The motor has no back-lash, end-play, or radial play. The output rotation is  $\pm 12$  milli-radians, the torque sensitivity is very high, and the hysteresis is about 1%. The unit operates at temperatures to 650 F. A pressureproof O-ring seal may be used around the output shaft to isolate the torque motor from the controlled medium.

American Measurement & Control, Inc., Dept. ED, 240 Calvary St., Waltham 54, Mass.

**Price & Availability:** Units can be delivered in 45 to 60 days. Prices are quoted on request.

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button  
button  
who's  
got  
the  
button?

Push-button frequency selection is one reason why the **TO-258 Telemetry Test Oscillator** is a standard in several major missile programs. This standout performer provides extremely accurate, convenient calibration of sub-carrier units in FM/FM telemetering systems. The unique deviation control is calibrated directly in percent doing away with "slipstick" manipulation. High frequency stability makes the instrument ideal for production testing and other applications utilizing standard FM/FM test frequencies.



**Model TO-258  
Crosby-Teletronics  
Telemetry Test Oscillator**

Housed in a gray steel cabinet (17 $\frac{1}{4}$ " x 8 $\frac{3}{4}$ " x 9"), the unit is a full size module in Crosby-Teletronics' Modular Instrumentation System. Rack-adaptor RA-81 available. (Bulletin 249)

Model TO-258 — \$425. Special models can be supplied at extra cost with any 20 frequencies from 20 cycles to 100 KC.

For complete information and specifications, write:

**Crosby-Teletronics  
Corporation**

Sales Office:

54 Kinkel Street, Westbury 4, L.I., N.Y.

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## Digital Printer 358

Has an 11-column capacity

Capable of printing at speeds to 5 lines per sec, model DP-834 digital printer has a capacity of 11 columns. It accepts decimal data for six columns from measuring instruments, prints function and polarity as well as decimal point location, and provides three columns of test number identification. The solid-state unit can be connected to the outputs of AD converters, dvom's, dvm's, timer-counters, and digital data logging systems, among others. It meets the requirements of MIL-E-4158B and is completely automatic in operation.

Epsco, Inc., Equipment Div., Dept. ED, 275 Massachusetts Ave., Cambridge, Mass.

*Availability: Made on order only and delivered 21 days after order received.*

## Push-Button Generator 400

For use in digital control systems



For use in digital control systems, this push-button generator can start, trigger, or gate a logic unit or system. Consisting of a miniature mercury switch and two differentiating output circuits, it provides two pulses at separate outputs. One output occurs when the switch is depressed; the other occurs when the switch is released. The output is a  $-4$  v,  $1/10$   $\mu$ sec pulse. A supply of  $-4$  v at 1 ma plus 10 v at 50 ma is required.

Harvey Wells Electronics, Inc., Dept. ED, East Natick Industrial Park, East Natick, Mass.

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# FXR'S ENGINEERING KNOW-HOW!



Control room of a 50 million watt transmitter created to better man's understanding of the atmosphere and ionosphere—The complete transmitter developed and manufactured by FXR.

Details on Request

FXR's precision microwave equipment, high-power pulse modulators and high-voltage power supplies have prominent roles in such leading scientific programs as this 50 million watt transmitter, thermonuclear control research, communication and ballistic missiles systems and similar astronomical, aeronautical and electronic developments.

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## FXR, Inc.

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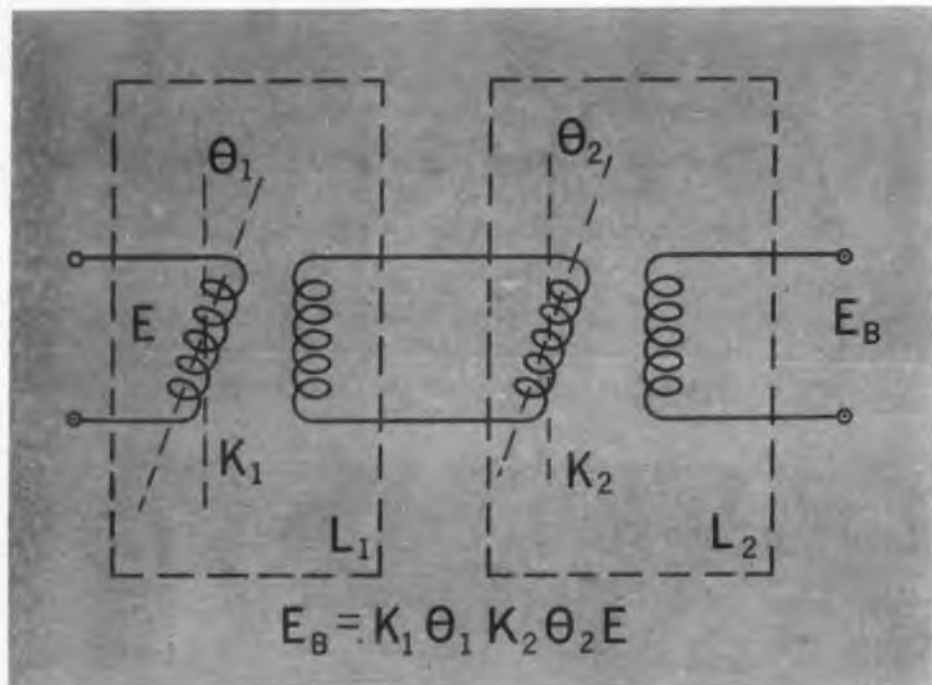
ENGINEERING  
**REPORT**  
ON BENDIX COMPONENTS

## LINEAR FUNCTION GENERATORS FOR COMPUTER APPLICATIONS

THREE BASIC TYPES MEET SPECIFIC LOAD CONDITIONS

As a result of research, development and production of computers, Eclipse-Pioneer can make available performance-proved components. For example, these three basic types of linear function generators:

- Linears that give optimum performance under no-load conditions.
- Linears that operate best under a specific load.
- Linears compensated to operate independently of the magnitude of the load.



### TYPICAL APPLICATION

To achieve linearity at output  $E_B$ , since  $K_2$  a variable function of  $\theta_1$ , linear function generator  $L_1$  must be carefully chosen in conjunction with other system components. In the above application, either a fixed load or a compensated linear function generator can be used for  $L_1$ , compensating for the loading due to  $L_2$  and the changes in  $K_2$  with  $\theta_1$ .  $L_2$  may be a no-load linear. Both fixed load and compensated linear

function generators will give linearities of 7 minutes for  $\pm 60^\circ$  rotation. Other generators are available for tangent, versine and log functions, in various frame sizes and with accuracies to  $\pm 7$  minutes over range of  $\pm 15^\circ$ . Units are now being developed with ranges to  $\pm 30^\circ$  while maintaining the same accuracies. For design assistance, or for further details on computer components, 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.

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## NEW PRODUCTS

### Power Supply

579

Regulation is 0.01%



Adjustable in 1- $\mu$ a increments, model 351A power supply delivers 0 to 100 ma at a maximum of 100 v. Regulation is better than 0.01% and calibration of current measuring is performed at an accuracy of 0.05%. Applications include the calibration and testing of instruments, meters, semiconductors, torque motors, bolometers, and other constant current applications.

John Fluke Manufacturing Co., Inc., Dept. ED, P.O. Box 7161, Seattle 33, Wash.

**Price & Availability:** Price is \$845 ea. Delivery time is 45 days.

### Potentiometers

366

Are conductive plastic types



Conductive plastic potentiometers models 78P and 156P measure 7/8 and 1-5/16 in. OD, respectively. They are available in multigang units with a maximum of six gangs per assembly. Standard units come in 100-ohm to 10-meg resistance values; standard linearity is 0.5%, with closer linearities supplied on special order. The potentiometers have infinite resolution, and can be had in servo or bushing mounts.

New England Instrument Co., Dept. ED, 1334 Main St., Waltham, Mass.

**Price & Availability:** Made on order only and delivered 30 days after order received. Price is between \$120 and \$140 when ordered in small quantities.

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ENGINEERING  
**REPORT**  
ON OTHER BENDIX  
COMPONENT PACKAGES



### OMNI-BEARING CONVERTER

Modular package permits smaller, lighter navigation receiver design



Compass heading and VOR signals are computed and converted by this radio receiver component into signals that position the displays in the Radio Magnetic Indicator of an aircraft radio navigation system. In a package measuring only 3 5/8" x 2 1/8" x 1 1/2", the module comprises a size 11 resolver, differential, motor-generator, gear train assembly and indicator dial. Write today for complete information.

### SYNCHRO SLIP RINGS

Autosyn\* provides electrical contact with both rotor and stator



In the compact Autosyn design, both housing and shaft can be rotated, permitting introduction of another variable into the system. Electrical contact with both elements is made through external slip rings, which replace the usual fixed leads or terminals. Slip ring location and configuration can be varied to meet specific mechanical or electrical needs. Precious metals are used in the rings to minimize contact resistance and insure maximum reliability. Write for details.

\*REG. U.S. PAT. OFF.

Manufacturers of

GYROS • ROTATING COMPONENTS  
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PACKAGED COMPONENTS

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Teterboro, N. J.

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## Integrator

Is a computing component



Model ARPI-7 integrator, an electromechanical analog-computing component, provides a shaft position which is proportional to the integral with respect to time of a dc input signal. Its input range is  $\pm 25$  v; the output range is limited only by the readout device. Some of its uses are: inertial platforms, astro-trackers, flight control systems, and doppler radar. The unit measures 5.2 x 5.5 x 3.3 in., and weighs 7 lb.

Aeroflex Corp., Aeroflex Labs Div., Dept. ED, 34-06 Skillman Ave., Long Island City 1, N.Y.

**Price & Availability:** Made on order only and delivered in 120 days. Price is \$4800 per unit.

## Uhf Mixer Diodes

Come in five types



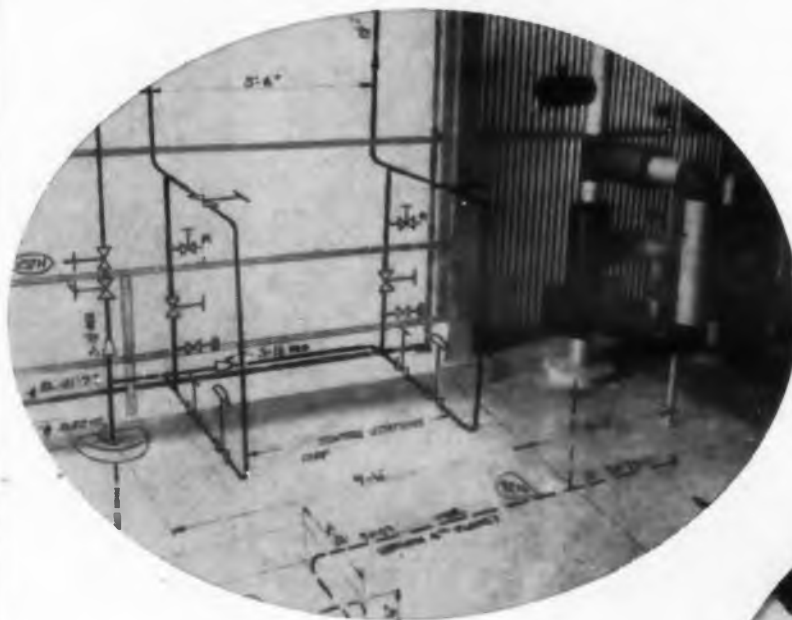
Designed for mixer applications in the 1000 mc range, these diodes come in five types: DC 7, DC 7A, DC 7B, DC 7C, and DC 7D. The maximum dc current average is 25 ma; maximum dc current peak is 75 ma. Operating temperature range for the diodes is from  $-50$  to  $+75$  C, and maximum dissipation is 250 mw.

Semi-Elements, Inc., Semiconductor Div., Dept. ED, Saxonburg Blvd., Saxonburg, Pa.

**Price & Availability:** Available from stock and delivered 7 days after order received. In quantities of 1 to 99, prices are: DC 7, \$0.85; DC 7A, \$1.15; DC 7B, \$1.65; DC 7C, \$2.45; DC 7D, \$3.55. In quantities of 100 to 999, prices are: \$0.65, \$0.85, \$1.25, \$1.75, \$3.95, respectively.

368

# CRONAFLEX®: best engineering films you can use



### CRONAFLEX: Photographic versatility

CRONAFLEX plus photography plus drafting equals the best combination for photo-drafting techniques.

### CRONAFLEX: Durability of CRONAR® base

CRONAFLEX copies are free of kinks and tears. Its rugged and flexible base adds years of life to your drawings.



### CRONAFLEX: Superb drafting surface

Matted on both sides, CRONAFLEX accepts pencil and ink, erases easily without ghosting or affecting the surface.

CRONAFLEX Engineering Reproduction Films are now being used to make outstanding reproductions of engineering drawings in shops everywhere. Shown here are three major reasons that help explain its success. There are more.

ALL CRONAFLEX films are on rugged CRONAR\* polyester base. This means they are dimensionally stable... so stable that many companies use them for exacting template work. CRONAFLEX intermediates provide faster print-through speeds and better resolution of detail because of the optical clarity of the base.

CRONAFLEX films are now available in four types: (1) Direct Positive Film; (2) Contact Film; (3) Projection Film; (4) CRONAFLEX Drafting Films. It's the most complete versatile line of engineering reproduction films you can use. For more information, contact your Du Pont Technical Representative, or write: E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, Wilmington 98, Delaware. In Canada: Du Pont of Canada Limited, Toronto.

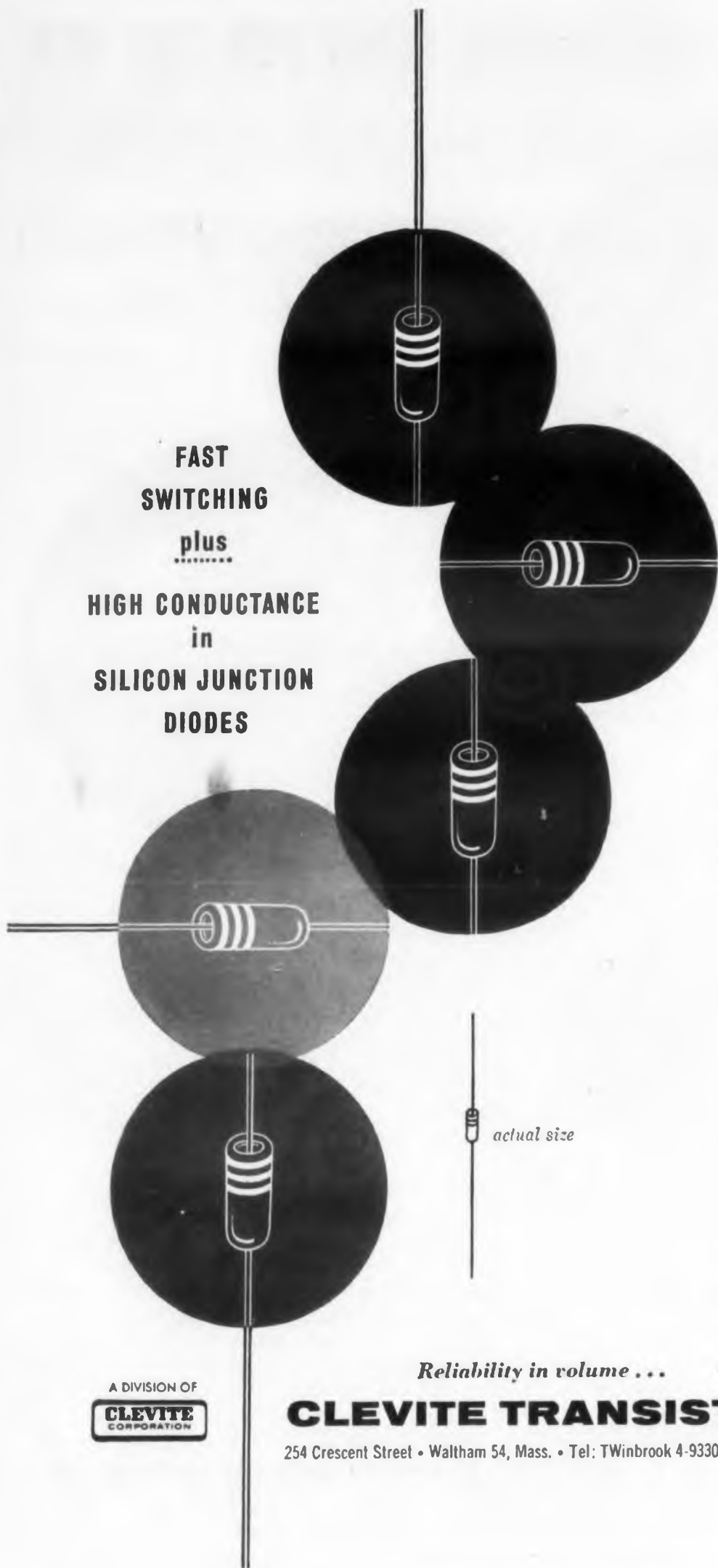
\* Du Pont's trademark for its polyester photographic film base.



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**FAST  
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**HIGH CONDUCTANCE  
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DIODES**



actual size

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#### SWITCHING TYPES

New circuit possibilities for low impedance, high current applications are opened up by Clevite's switching diodes. Type CSD-2542, for example, switches from 30 ma to -35v. in 0.5 microseconds in a modified IBM Y circuit and has a forward conductance of 100 ma minimum at 1 volt.

*Combining high reverse voltage, high forward conductance, fast switching and high temperature operation, these diodes approach the ideal multi-purpose device sought by designers.*

#### GENERAL PURPOSE TYPES

Optimum rectification efficiency rather than rate of switching has been built into these silicon diodes. They feature very high forward conductance and low reverse current. These diodes find their principal use in various instrumentation applications where the accuracy or reproducibility of performance of the circuit requires a diode of negligible reverse current. In this line of general purpose types Clevite has available, in addition to the JAN types listed below, commercial diodes of the 1N482 series.

#### MILITARY TYPES

##### JAN

1N457	MIL-E-1/1026
1N458	MIL-E-1/1027
1N459	MIL-E-1/1028

##### Signal Corps

1N662	MIL-E-1/1139
1N663	MIL-E-1/1140
1N658	MIL-E-1/1160
1N643	MIL-E-1/1171

*All these diodes are available for immediate delivery. Write now for Bulletins B217A-1, B217A-2, and B217-4.*

*Phone for data and prices.*

## NEW PRODUCTS

### Testing System

372

For crystal video receivers



This automatic testing system includes a circularly polarized horn, a high-pass filter, a band-pass Waffle Iron filter, and a waveguide switch. The filters present less than a 1/2-db insertion loss over the pass-band and greater than 50-db suppression of the second harmonic. The horns are made of cast aluminum and come in X, Ku, K, and Ka bands. It presents an axial ratio of better than 1.5 to 1 and a vswr better than 1.3 to 1 over most of the bands.

American Electronic Labs, Inc., Dept. ED, 121 N. Seventh St., Philadelphia 6, Pa.

*Price: High-pass filter, all models, \$70; Waffle-Iron Filter, \$455, Ka-band model, \$460; Circularly polarized horns, \$95. All prices fob Colmar, Pa.*

### Noise Sources

367

For the 200 to 250 mc range



Available as the T44V series, these noise sources cover the 200 to 250-mc range. Models in the line include: the T44V1C, providing an excess noise ration of  $18.5 \pm 0.3$  db; T44V2C, which has a replaceable, gas-tube element as well as a noise output of 21 db; and the T44V3C, which also has the replaceable, gas-tube element, and a noise output of 18.5 db. Coaxial versions of the series are available at frequencies up to 1000 mc.

Tucor, Inc., Dept. ED, 18 Marshall St., S. Norwalk, Conn.

*Price & Availability: Delivered in 30 days. Prices range from \$150 to \$500 for components when ordered in quantities of 10 to 100.*

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ELECTRONIC DESIGN • March 30, 1960



# EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY IN COMPUTER DEVELOPMENT

**Space Vehicle Command** — An important advance in the control of space vehicles has been accomplished with the development by Lockheed scientists of space-borne, command decoders and sequence programmers. Basically, the programmers store information and, at a predetermined time when the vehicle is out of contact with ground stations, cause commands to be executed by the various subsystems. In this way, versatility of vehicle missions can be markedly expanded.

In addition, when the vehicle comes in range of ground command stations, the programmer can be given new instructions for either future or immediate action. All of the programmer's components are solid state devices. There are no moving parts nor vacuum tubes. The ferrite core memory in which information is stored is a two core-per-bit matrix.

A primary design goal was to reduce power requirements. Although the Lockheed programmer is highly complex and employs over 600 transistors, the average power consumption is only 3.5 watts, less than a Christmas tree light bulb. The development of such complex circuitry that will withstand the shock, vibration and a temperature range from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  is in itself a significant achievement.

The highly precise timing necessary for the execution of the various programmed assignments is accomplished by means of a crystal oscillator — maintained at an exact temperature by means of a two phase mixture of solid and liquid inert chemical.

**Engineers and Scientists:** Lockheed's capability in design and development of computers is contributing to the advancement of the state of the art in a number of areas. Work is being carried on in research and development of ultra reliable digital circuitry, ferrite logic systems, and millimicrosecond switching techniques; radically new devices for pattern recognition operations; high speed digital plotters; self-organizing systems; large scale systems for the automatic storage and retrieval of information; microminiature packaging techniques; and systems research and engineering of large scale information handling complexes.

If you are experienced in work related to logic design or computer development, you are invited to inquire into the interesting work being conducted and planned at Lockheed. Write: Research and Development Staff, Dept. C-21, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense clearance required.

## *Lockheed*

### MISSILES AND SPACE DIVISION

*Systems Manager for the Navy POLARIS FBM;  
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# Announcing ... SILICON RECTIFIERS



from  
**DELCO RADIO**

**High Quality  
High Performance  
Extreme Reliability**

From the leading manufacturer of power transistors, new Silicon Power Rectifiers to meet your most exacting requirements. Even under conditions of extreme temperatures, humidity and mechanical shock, these diffused junction rectifiers continue to function at maximum capacity! Thoroughly dependable, completely reliable—new Delco Rectifiers are an important addition to Delco Radio's high quality semiconductor line.

**Conservatively rated at 40 and 22 amperes  
for continuous duty up to case temperatures of 150°C.**

TYPE	AVG. DC CURRENT	PIV	NORMAL MAX. TEMP.	MAX. FORWARD DROP	MAX. REVERSE CURRENT
1N1191A	22A	50V	150°C	1.2V at 60 amps.	5.0 MA
1N1192A	22A	100V	150°C	1.2V at 60 amps.	5.0 MA
1N1193A	22A	150V	150°C	1.2V at 60 amps.	5.0 MA
1N1194A	22A	200V	150°C	1.2V at 60 amps.	5.0 MA
1N1183A	40A	50V	150°C	1.1V at 100 amps.	5.0 MA
1N1184A	40A	100V	150°C	1.1V at 100 amps.	5.0 MA
1N1185A	40A	150V	150°C	1.1V at 100 amps.	5.0 MA
1N1186A	40A	200V	150°C	1.1V at 100 amps.	5.0 MA

at 150°C case temperature and rated PIV

For full information and applications assistance, contact your Delco Radio representative.

Newark, New Jersey  
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Tel: Mitchell 2-6165

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5750 West 51st Street  
Tel: Portsmouth 7-3500

Santa Monica, California  
726 Santa Monica Boulevard  
Tel: Exbrook 3-1465

Division of General Motors • Kokomo, Indiana

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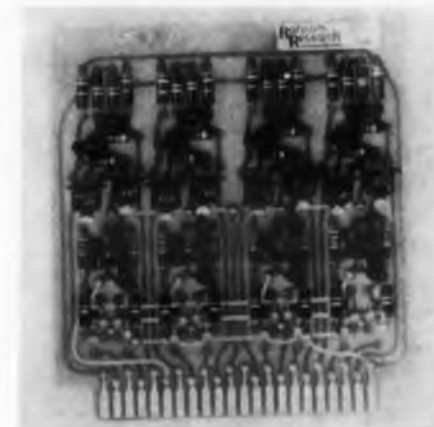
**DELCO**  
DEPENDABILITY  
**RADIO**  
RELIABILITY

## NEW PRODUCTS

### Computer Pack

370

Consists of 4 flip-flops



Type 4XA storage unit is a plug-in, solid-state, high-speed, computer element consisting of 4 independent flip flops, each of which has a set 0 and set 1 input. A set gate enables all diode gate inputs as well as a reset line to reset all flip-flops to the 0 condition. It is intended for use as an output storage for holding data in parallel, and as a buffer storage for holding data for parallel or serial shift from one part of a system to another. The unit is assembled on a standard 4-1/2 x 5 in. printed-circuit card which has a 22-pin PC connector.

Ransom Research, Dept. ED, 323 W. 7th St., San Pedro, Calif.

**Price & Availability:** Available from stock. Prices are: \$55 per unit when ordered in quantities of 1 to 9; \$46.75 when ordered in quantities of 100 and up.

### Cathode Follower Circuit

380

Used in low-level signal work

Designed for matching a low-level high-frequency source to a low-impedance line, model 53-A is a plug-in package containing two independent cathode followers. The operating levels are 1 v output for an input of 2.2 v; maximum levels are 4.2 v input and 2 v output. The package has two 5670 tubes, and requires +150 v dc at 40 ma, -150 v dc at 2 ma, or 6.3 v ac at 350 ma.

Altron Electronics, Dept. ED, 409 E. Seventh St., Chester, Pa.

**Price & Availability:** Made on order only. Can be delivered 20 days after receipt of order. Price is \$27 per unit; \$25 when ordered in quantities of 25 to 50.

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# DAVEN

Offers off-the-shelf  
distribution of  
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## Daven precision wire wound resistor...

Type 1282

actual size

makes other miniatures  
look like giants!

**DOWN, DOWN, DOWN** go the dimensions of Daven precision wire wound resistors. The latest: a micro-miniature resistor that is the **smallest ever made!** Developed for a major missile program to meet stringent space requirements without sacrificing reliability, this Type 1282 meets all specifications of MIL-R-93B, Amendment 3, except physical size.

Specify Type 1282, or other units in the Daven micro-

miniature family, for all of your small-size, high-reliability wire wound resistor requirements. Available in all tolerances and temperature coefficients.

Type	Diam	Length	Max Watts	Max Ohms
1250	1/4	1/2	.33	1 megohm
1273	1/4	5/16	.25	400K
1274	3/16	3/8	.25	250K
1282	1/8	1/5	.05	100K
1284	1/4	27/64	.25	1 megohm

Write today for complete information!

THE **DAVEN** CO.



LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY



## DEAD END FOR STRAY POWER...

*New rotary shutter for S-Band  
extends reliable standby protection to RG 48/U  
waveguide systems.*

Microwave Associates' new MA-788 rotary shutter puts up an effective secondary barrier to high level signals... forms an important element in the guaranteed crystal protection offered by Microwave's complete duplexing units.

#### NOW — SIX SHUTTERS AVAILABLE

Six magnetically operated rotary shutters for S, X, Ku and Ka bands are now in our line and are charted below. They form the best-yet supplementary protection against crystal damage when radar

system is inoperative. They may also be used as on-off waveguide switches for low power applications. In the closed position they create a dead end short circuit across the waveguide, reflecting essentially all the incident power.

#### COMPLETE DUPLEXERS OR SEPARATE SHUTTERS

They're available as separate units supplied to fit your system or as components in complete duplexers carrying *guaranteed crystal protection for life... at full rated power and elevated temperatures.*

#### SPECIFICATIONS

Band	Type	Frequency kMc	Isolation (Closed position)	Insertion Loss (Open position)	VSWR (Open position)
S	MA-788	2.7-3.1 kMc	25 db min.	0.2 db max.	1.10 max.
X	MA-710	8.5-9.6 kMc	30 db min.	0.2 db max.	1.10 max.
X	MA-750*	8.5-9.6 kMc	30 db min.	0.2 db max.	1.10 max.
Ku	MA-760	16.0-17.0 kMc	30 db min.	0.2 db max.	1.10 max.
Ku	MA-776**	16.0-17.0 kMc	75 db min.	0.2 db max.	1.10 max.
Ka	MA-761	33.0-36.0 kMc	28 db min.	0.2 db max.	1.10 max.

\*Dual \*\*Tandem

Write or call for complete data and prices to:



**MICROWAVE ASSOCIATES, INC.**  
BURLINGTON, MASSACHUSETTS • BR0WNING 2-3000 TWX 942

CIRCLE 97 ON READER-SERVICE CARD

## NEW PRODUCTS Oscilloscope

374

Provides records in less than 1 sec



Type 5-123 modular oscilloscope uses a technique that provides latensified oscillograph records in less than 1 sec. The technique, called Dataflash, involves raising the temperature of the oscillogram by passing it over a heated platen as the latent image is latensified by a high-energy light. It is interchangeable with the standard, record-drive module of the oscilloscope. No chemicals are used in this process.

Consolidated Electrodynamics Corp., Electro Mechanical Instrument Div., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

## Power Resistor

369

Is rated at 100 w



Having a resistance range from 5 ohms to 20 K, type NH-100 noninductive power resistor is rated at up to 100 w. The resistance element is sealed in silicone and inserted into the aluminum housing, offering protection from shock, vibration, moisture, and salt spray. Temperature coefficient is 0.00002 per deg C. Length of the housing, not including leads, is 3-1/2 in.; width, not including mounting lugs, is 2-1/4 in.

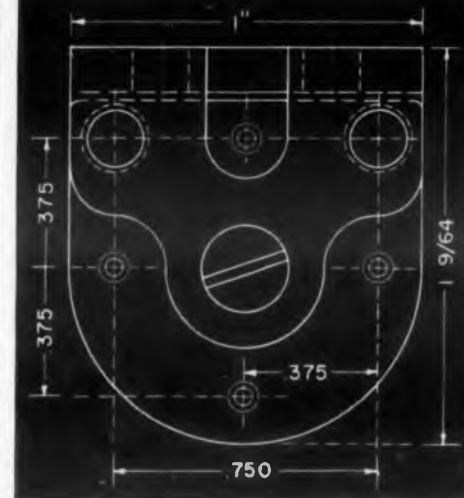
Dale Products, Inc., Dept. ED, Columbus, Nebr.

*Price & Availability: Limited quantity of standard values are available from stock. Delivery is 14 days. Price is between \$1.78 and \$3.29 when ordered in quantities of 500 to 999.*



## Telephone Relay

interchangeable with  
many other makes



Stromberg-Carlson's type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the drawing above shows, universal frame mounting holes and coil terminal spacing allow you to specify these relays—of "telephone quality"—interchangeable with the brands you have been using. Costs are competitive and expanded production means *prompt delivery.*

Welcome engineering features of the telephone type "E" relay are—**Contact spring assembly:** maximum of 20 Form A, 18 B, 10 C per relay.

**Coil:** single or double wound, with taper tab or solder type terminals at back of relay.

**Operating voltage:** 200 volts DC maximum.

You may order individual can covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

*For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R2. Write to Telecommunication Industrial Sales, 116 Carlson Road, Rochester 3, New York.*

**STROMBERG-CARLSON**  
A DIVISION OF  
**GENERAL DYNAMICS**

CIRCLE 98 ON READER-SERVICE CARD



## Continuity Tester 537

Has a 400-wire circuit capacity

Normally testing at a rate of 10 circuits per sec, model ACT-2 continuity tester is an automatic device with a circuit capacity of 400 wires or 800 ends. Its uses include: hipot checks; tests for leakage resistance; tests for presence of capacitors; and tests for value of series resistance in harness situations. Readout is accomplished by Good and Reject lamps, and a 4-in. panel meter that is labeled to indicate the condition of a conductor under test.

Briggs Assoc., Inc., Dept. ED, 10 De Kalb St., Norristown, Pa.

**Price & Availability:** Made to customer specifications. Delivery made 120 days after receipt of order. Prices range from \$8000 to \$10,000, depending on number of wires to be tested.

## Waveguide Stand 576

For waveguide sizes in the 2.6 to 40 kmc range



Model PRD 370 universal waveguide stand accommodates all waveguide sizes used in the frequency range of 2.6 to 40 kmc. It has a continuously adjustable set of jaws which firmly grip the sidewalls of the waveguide and simultaneously locate the transmission line center plane three inches above bench level.

Polytechnic Research & Development Co., Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N.Y.

**Price & Availability:** Available from stock. Price is \$7.50 per unit.

Don't miss an issue of **ELECTRONIC DESIGN**; return your renewal card today.

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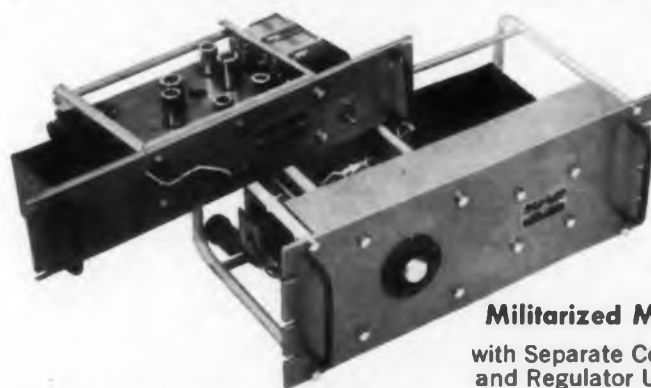
# SERVO-OPERATED Line-Voltage Regulator

50-Ampere, 6-KVA Capacity in a One Cubic-Foot Package



Oscillogram shows peaks of 60-cycle line voltage with sudden 2% change, and subsequent correction by regulator. Change is corrected in 12 cycles (0.2 sec.).

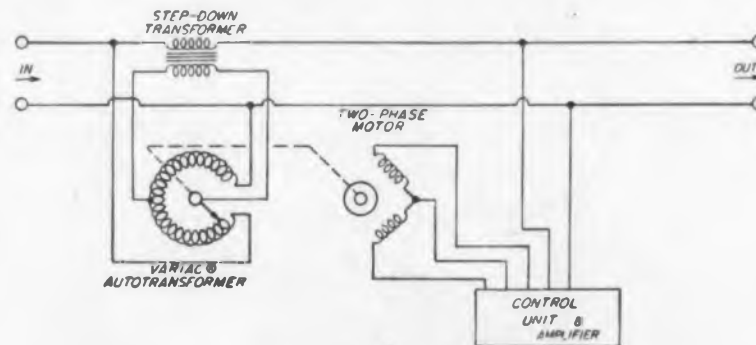
- ★ Handles up to 500 Amperes on Short-Period Overload
- ★ Holds Line Voltage Constant to  $\pm 0.25\%$
- ★ NO Waveform Distortion
- ★ NO Power Factor Restrictions
- ★ NO Relays to Cause Transient Pulses or Chattering
- ★ NO Dead Zones
- ★ Can Be Connected to Handle 10% or 20% Line-Voltage Variations
- ★ Output Voltage Can be Varied  $\pm 10\%$  from Nominal Voltage



**Militarized Model**  
with Separate Control and Regulator Units.

Meets requirements of MIL-E-4158B and MIL-E-16400B  
for 115-volt, 45-55- and 55-65-cycle lines, **Type 1570-ALS15** . . \$670  
for 230-volt, 45-55- and 55-65-cycle lines, **Type 1570-AHS15** . . \$690

**Two other models available** — A three-phase militarized model for regulation of balanced systems.  
A regulator for control of 150- to 500-cycle lines (requires 50- or 60-cycle power).



**How it works.**— Any deviation from normal line voltage is sensed by the control unit. The resulting error voltage, amplified by a two-stage balanced amplifier, changes the firing angle of a push-pull thyatron circuit which in turn controls a low-inertia, two-phase servo motor. The motor adjusts a Variac<sup>®</sup> autotransformer which delivers a correction to the input line voltage through a buck-or-boost transformer.

The control-circuit thyatrons operate continuously and produce two, equal, in-phase motor voltages. Any line-voltage variation causes a proportionate change in phase angle between these two voltages. This change of phase produces a corresponding motor torque, causing correction to take place. Thus, smooth, truly proportional control is achieved, with consequent better accuracy, faster response, and less overshoot (see oscillogram) than is found in regulators using on-off methods.



**Standard Model**

Available in table, rack, or wall models  
for 115-volt, 60-cycle lines, **Type 1570-AL** . . . . . \$490  
for 230-volt, 60-cycle lines, **Type 1570-AH** . . . . . \$510  
50-cycle models also available

Write for Complete Information

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## NEW MINIATURE A.C. MOTOR

*high output for commercial use*

This a.c. synchronous motor costs you only about half as much as its miniature precision counterpart for military applications. In production quantities it is so economical that you can design it into good quality products that now use induction motors. And because you can put this bigger performance motor in smaller spaces, it gives you a head start in miniaturizing your design at the same time you improve product quality.

Vital statistics: This Type CMC motor has a starting torque of .7 oz. in. and a continuous duty torque of .7 oz. in. at synchronous speed. It is 1 1/4" in diameter by 2 5/8" long, and weighs 6 1/2 oz. The shaft is precision ground stainless steel, supported by ball bearings. The epoxy-sealed design provides good resistance to normal environmental conditions.

If you have hesitated to design with precision miniature motors in the past, now's your chance!

The Globe motor line includes both a.c. and d.c. models. Globe is pleased to work with you to provide the exact motor you need for your commercial, competitive product. Please write for Bulletin CMC. Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio. BALdwin 2-3741.

**GLOBE INDUSTRIES, INC.**

PRECISION MINIATURE A.C. & D.C. MOTORS. ACTUATORS,  
TIMERS, STEPPERS, BLOWERS & FANS MOTORIZED DEVICES

**GLOBE**

CIRCLE 106 ON READER-SERVICE CARD

## NEW PRODUCTS

### Tape Recorder

373

Operates for over 4 hr



This seven-channel, portable, magnetic-tape recorder, model 1855 R, operates for 4 hr and 15 min on 4800 ft of 1/2-in. tape. With tape speed of 3.75 ips, the recorder starts up in about 0.1 sec and stops in 0.2 sec. Wind and rewind time is less than 2 min for the entire 4800-ft length of tape on a 10-1/2-in. reel. The amplifiers are modular, plug-in types. Power requirements are: 260 w at 117 v ac, 60 cps, single phase; and 1.2 amp at 50 v dc. Harmonic distortion is less than 3% at normal playback level; wow and flutter are below 0.5% rms 0 to 300 cps.

Telecto Industries Corp., Dept. ED, 35-16 37th St., Long Island City 1, N.Y.

*Availability: Immediately available.*

### Preamplifier

583

Operates in 250 to 500 mc range



Designed for use in the 250 to 500 mc range, model 1002 preamplifier has a gain of 20 db with noise figures of better than 5 db at 250 mc, and 6 db at 500 mc. The unit is fixed tuned to the required frequency with a bandwidth of 10 mc. Screw-driver adjustments are provided for independent tuning of cavities. Input and output impedance is 50 ohms; connectors are standard N type.

Community Engineering Corp., Dept. ED, Box 824, State College, Pa.

*Price & Availability: Approximately 45 day delivery. Price is about \$395.*

**Have you sent us your subscription renewal form?**

ELECTRONIC DESIGN • March 30, 1960





The following Fairchild transistors are available from stock for same day shipment in quantities up to

**1000**  
pieces per type.

Standard NPN: 2N696, 2N697. High Voltage NPN: 2N699. High Beta NPN: 2N1420. Low Storage NPN: 2N1252, 2N1253. Standard PNP: 2N1131, 2N1132. Mesa: 2N706.



60 HERRICKS ROAD, MINEOLA, L. I., N. Y.  
TWX G-CY-NY-580U PIONEER 6-6520

At factory prices of course!

CIRCLE 107 ON READER-SERVICE CARD

## DIFFUSED SILICON DIODES FROM FAIRCHILD

### THE FIRST — An ultra-fast computer diode:

Four millimicrosecond maximum reverse recovery time of this new FD 100 overcomes the diode-caused speed limitations in computer circuits. Capacitance is only  $2\mu\text{f}$  at zero volts bias.

### THE REASON — A need and the technology

to serve it: Fairchild's diffused silicon transistors have achieved heretofore unattainable performance. Application of these transistors has in turn created the need for silicon diodes of similarly outstanding performance.

### THE FOLLOW UP — A broad line of high reliability diodes:

This Fairchild FD 100 diode is being followed by others providing industry-leading standards in reliability and uniformity — backed by a continuing accumulation of statistical data on a large scale.

4300 REDWOOD HIGHWAY • SAN RAFAEL, CALIFORNIA • GLENWOOD 6-1130 • TWX SRF 26

New York Area: Pioneer 1-4770 • Syracuse: Granite 2-3391 • Philadelphia Area: Turner 6-6623  
Washington, D. C.: National 8-7770 • Chicago: Browning 9-5680 • Los Angeles: OLeander 5-6058

*It was inevitable*

TENTATIVE SPECIFICATIONS — FAIRCHILD FD 100  
25°C Except As Noted

Symbol	Characteristic	Min.	Max.	Conditions
$B_V$	Breakdown Voltage	40 volts		@ $I_R = 100 \mu\text{A}$
$I_R$	Reverse Current		.100 $\mu\text{A}$	@ $V_R = 30\text{v}$ , 25°C
$V_F$	Forward Voltage Drop	1 v		@ $I_F = 10 \text{mA}$
C.	Capacitance	2 $\mu\text{f}$		@ $V_R = 0\text{v}$
$t_{rr}$	Reverse Recovery Time To $I_r = 1 \text{ma}$		4 $\mu\text{s}$	@ $I_f = I_r = 10 \text{ma}$
	Maximum Power Dissipation		200 mw.	
	Temp. Range Operating	-65°C to 175°C		
	Storage	-65°C to 200°C		

For full specifications, write Dept. B-3



CIRCLE 225 ON READER-SERVICE CARD

BECAUSE  
IT'S DIGITALLY  
PROGRAMMABLE—  
NEW  
CON AVIONICS  
DC POWER  
SOURCE...



...INSTANTLY PROVIDES ON COMMAND ANY VOLTAGE  
FROM 0.1 TO 50 VOLTS DC—UP TO 15 AMPERES

Another first by Con Avionics, this digitally programmable power source translates manual push-button setting or output of your program device into the selected voltage. It can be made to respond to any digital code from sources such as paper or magnetic tape readers, punched card readers, or keyboards. Voltages may be changed from any setting to any other within 300 milliseconds. Voltage is stable and accurate within  $\pm 0.1\%$  of the selected value. Ripple is less than 0.05% rms.

The completely self-contained design of the Con Avionics DC Power Source eliminates external rheostats, step switches and other devices. This unit reduces equipment complexity in data systems, automatic checkout equipment or precision testing applications. Outstanding results are obtained both in the lab and on production work.

### CONSOLIDATED AVIONICS CORPORATION

A SUBSIDIARY OF CONSOLIDATED DIESEL ELECTRIC CORPORATION

800 Shames Drive • Westbury, L. I. • EDgewood 4-8400

CIRCLE 108 ON READER-SERVICE CARD

## NEW PRODUCTS

### Snap-Acting Switch

371

Provides split contact, spdt operation



Type BK-1 switch can be wired as: a spdt switch with series contacts that break each circuit in two places at once; a conventional spdt switch with contacts paralleled; or it can provide spst double-break action in two separate circuits operating alternately. It is sealed within a cast-aluminum housing and actuated through a high-pressure, spring plunger. The switch is 2-1/8 x 13/16 x 2-11/32 in. over-all and weighs 3 oz. Mounting is by two No. 6 screws on 1-in. centers.

W. L. Maxson Corp., Unimax Switch Div., Dept. ED, Ives Road, Wallingford, Conn.  
*Price & Availability: Made on order only; delivered 5 to 6 weeks after order received. For quantities of 1 to 1999, price is \$27.75; \$25.35 for 2000 to 4999.*

### Silicon Resistors

383

Available in three types

Sensistor silicon resistors are available in three types: the TM 1/4 and TM 1/8 axial lead molded units, and the TC 1/8 in the standard JEDEC TO-5 round welded case. They have values extending from 68 ohms to 1.8 K, with  $\pm 10\%$  tolerance. Special values from 62 ohms to 2 K with tolerances of  $\pm 5\%$  and  $\pm 10\%$  are also available. These solid-state devices have a positive temperature coefficient of 0.7% per deg C, and a constant predictable rate of resistance change with temperature.

Texas Instruments, Inc., Dept. ED, Box 312, Dallas, Tex.

*Availability: Standard values available from stock. Special values made on order.*

Don't forget to mail your renewal form  
to continue receiving  
**ELECTRONIC DESIGN.**

## FULL SCALE BALANCE IN

**1/4**  
**second!**



### WITH L&N's HIGH SPEED SPEEDOMAX® RECORDER

Need to follow extremely fast-changing d-c millivolt signals... get detailed records for test analysis? Then you'll want this Speedomax instrument, widely-used for rocket testing, radiation monitoring of nuclear reactors, and other data-gathering applications.

The pen speeds across the 9 1/2" chart and balances in 0.25 second or less without overshoot. Even when loaded with an alarm contact, a retransmitting slidewire and a digital encoder, it balances in 0.4 sec. or less.

**LIST NO.—69801-E2-N3-P28-742**  
**SPEEDOMAX G RECORDER**, normally available for delivery from stock.

**Record**—Single-point continuous line.

**Measuring Circuit**—D-c potentiometer.

**Electrical Range**—0 to 10 mv.

**Accuracy Rating**— $\pm 0.3\%$  of range.

**Dead Band**—0.15% of range.

**Span Step Response Time Rating**—With unloaded slidewire shaft, 0.25 sec.; with loaded shaft, 0.4 sec. or less.

**Chart Speed**—1800" per hour, exact. Chart and balancing motor switching provided.

**Chart Number**—742, 100 uniform div. in 9 1/2" with 3/16" overtravel at each end.

**Standardization**—Semi-automatic.

**Power Supply**—Operates on 120v, 60-

**Price**—\$1186.00 f.o.b. Phila. or North Wales, Pa. (subject to change without notice). Use List No. 69801-E2-N3-P28-742 when ordering from L&N, 4908 Stenton Ave., Phila. 44, Pa.

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**NEW SERIES of  
Antenna SLIP RING  
Assemblies**

**12 to  
500 RINGS**

A standardized line of large Slip Ring assemblies, designed for a multiplicity of instrumentation, control and power circuit applications. First production assemblies are in use on radio telescopes, radar and tracking antennas and human centrifuge installations.

Assemblies vary from 12" to 72" in length, are either shaft or flange ball-bearing mounted and may be specified with hermetically sealed housings. Noise levels are held to a minimum. So are intercircuit losses, cross-talk and radiation, through proper shielding.

For complete information, write:



**SLIP RING COMPANY  
of AMERICA**

3612 West Jefferson Blvd., Los Angeles 16, Calif.

**Solid State Relay**

**375**

For pulse circuit applications

Engineered to operate with a 28-v, positive-pulse trigger, model SSR-200S is a solid-state relay containing transistors, diodes, and resistors. The unit has a pick-up time of 10  $\mu$ sec and a drop-out time of 10  $\mu$ sec. High-temperature characteristics permit adaptation of missile and aircraft control and instrumentation, and other standard relay control applications.

Curtiss-Wright Corp., Electronic Div., Dept. ED, Box 8324, Albuquerque, N. Mex.

**Price & Availability:** Can be delivered 30 to 45 days after receipt of order. Price is \$112, fob Albuquerque, N. Mex.

**Potentiometer**

**582**

Comes with nylon or steel shaft



Available with either a nylon or steel shaft, type MLC carbon film potentiometer measures 1/2 in. in diameter. It can be supplied with a full-rated switch for 2 amp, 125 v ac service. Applications of this miniature component are expected to be in portable communication equipment and test equipment.

P. R. Mallory & Co. Inc., Mallory Control Div., Dept. ED, 3029 E. Washington St., Indianapolis 6, Ind.

**Price & Availability:** Available in sample quantities only. Price not yet determined.

**Video Limiter Circuit**

**379**

Is a 3 x 5-in. plug-in package

Model 710 plug-in package contains two independent video limiters designed for quick changes in complex system designs. It measures 3 x 5 in. with a standard 11-pin plug for input, output, and power. The output level is 2.2 v for an input level of 0.6 v; limiting level is 4.2 v. Rise time is 0.035  $\mu$ sec and drop is 3.5% for a 500  $\mu$ sec pulse. Power requirements are 150 v dc at 15 ma, and 6.3 v ac at 175 ma.

Altron Electronics, Dept. ED, 409 E. Seventh St., Chester, Pa.

**Price & Availability:** Delivered 20 days after order received. Price is \$22.45 per unit.

**SAGE** Announces  
**A NEW LINE OF NON-INDUCTIVELY  
WOUND RESISTORS**



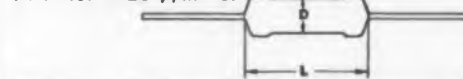
SAGE "Silicohm" wirewound Resistors . . . outstanding and versatile Type "S" and chassis mount Type "M" are now matched by companion styles of non-inductively wound units. These resistors, designated Types "NS" and "NM," are designed for pulse or other radio frequency power circuits demanding negligible inductive reactance. They are precision made to rigid requirements of stability and reliable service life which Sage customers expect.

**Check your requirements against these SAGE "Silicohm" Resistors**

**TYPE "NS" SILICONE COATED RESISTORS**



Sage "Silicohm" Type "NS" units are compact, light weight. Exclusive insulation for extreme combinations of moisture and temperature environment (-65°C to 350°C) . . . dielectric strength-1000 volts RMS . . . precision to .05% . . . T.C.  $\pm 20$  ppm/°C.



Style	ratings, WATTS	dimensions	
		L	D
NSA2W	2	.500	.187
NSB2W	2	.812	.187
NS2W	2	.625	.250
NS3W	3	.750	.250
NSS5W	5	.875	.312
NSR5W	5	1.000	.312
NSL5W	5	1.125	.312
NSS7W	7	1.250	.312
NSR7W	8	1.375	.375
NSS10W	10	1.812	.375
NS10W	10	1.937	.375

**TYPE "NM" METAL CLAD  
CHASSIS MOUNTED  
RESISTORS**



Aluminum housed resistors for heat sink mounting, Type "NM" units feature considerably less heat rise than any other resistors of comparable size and wattage. Lower hot spot means longer service life, near perfect stability—(Average resistance shift is only 0.4% after 1000 cycled hours at recommended loads), and exceptional reliability under extreme conditions. Dielectric strength: 1000 volts RMS to 2500 volts RMS, equal or exceeding Mil requirements . . . precision to .05%.

Style	ratings, WATTS	Nominal Mounting Dimensions, inches	
		A	B
NM10W	10	.562	.625
NM25W	20	.719	.781
NM50W	40	1.562	.844

Write for samples and complete specifications.

**SAGE**

**ELECTRONICS CORPORATION**

COUNTRY CLUB ROAD • EAST ROCHESTER, N. Y.

CIRCLE 111 ON READER-SERVICE CARD

CIRCLE 110 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • March 30, 1960

# SYNTRON SELENIUM POWER RECTIFIERS

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Milliwatts



to  
Megawatts

A choice of 355,000 stack combinations available in each of our 20 different cell sizes.

We can supply selenium stacks for any d-c requirements—in production quantities.

Call on your SYNTRON Rectifier Engineer or write

## SYNTRON RECTIFIER DIVISION

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CIRCLE 112 ON READER-SERVICE CARD

## NEW PRODUCTS

### Binary Counter

387

Operates to 300 kc



Model 310 binary counter is a five-stage unit capable of operating to 300 kc. A transistorized plug-in module, it is fabricated on a glass-epoxy, printed-circuit card measuring 5 x 6 x 1/16 in. It is used with an 18-pin PC receptacle. Required voltage is -12v. Standard output levels are -6.8 for the one-output and -0.2 v for the zero-output.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.

**Price & Availability:** Price is \$135. Delivery is in three weeks.

Booth 3223.

### Transistor Tester

386

Beta ranges are 0 to 100 and 0 to 300



Model 870 dynamic transistor tester has beta ranges of 0 to 100 and 0 to 300 and  $I_{CBO}$  ranges of 0 to 100  $\mu$ a, 0 to 1 ma, and 0 to 10 ma. The beta ranges permit half-calibration which increases the upper range to 600. The tester operates according to the manufacturer's specifications. Collector current and voltage can be varied. The instrument measures large signal dc beta on power transistors as well as small signal ac beta on low and medium power transistors.

The Hickok Electrical Instrument Co., Dept. ED, 10514 Dupont Ave., Cleveland 8, Ohio.

**Price & Availability:** The unit will be available from stock April 15, 1960. Price is \$298.

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## Relay

376

Used in squib firing circuitry

Capable of delivering 50 amp of load current for 50 msec, model SSR-28-50SM squib-firing relay is a solid-state device for high-temperature, high-current requirements in missile and aircraft applications. It operates on 28 v dc. Pick-up time is 4  $\mu$ sec; drop-out time, after squib has fired open, is 20  $\mu$ sec. Input noise peaks of less than 7-v amplitude will not cause false triggering.

Curtiss-Wright Corp., Electronics Div., Dept. ED, Box 8324, Albuquerque, N. Mex.

*Price & Availability: Delivered 30 to 45 days after order received. Price is \$135; quantity discounts available.*

## DC Relay

385

Is 6 pdt type



Rated at 5 amp, series 2505 miniature dc relay has 6 dpt contact combinations. All contacts are stacked instead of welded. Standard terminals are solder-hook type; plug-in terminals or potted leads can also be furnished. The units meet or exceed MIL-R-6106, class B-8, including minimum current requirements, and MIL-R-5757-C, class A and B. They stand vibration of 20 g for 2000 cps. Hermetically sealed in metal enclosures, the units weigh a maximum of 0.23 lb and measure 1-21/64 x 1-7/32 x 1-7/32 in.

Guardian Electric Manufacturing Co., Dept. ED, 1621 W. Walnut St., Chicago 12, Ill.

## Dual Channel Amplifier

382

Has 1.5 to 30 gain variation

Used to supply a variable gain output voltage, model S3108-01 dual-channel amplifier has a gain variation of 1.5 to 30. Power input is 28 v dc  $\pm$  10 v dc, 0.05 v rms maximum ripple. The control signal input is 6 v rms max to 0.0 v rms, 400 cps; output voltage is 6 v rms max, 400 cps. The self-contained unit meets the environmental requirements of MIL-E-5272.

Kearfott Div. of General Precision Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

# HONEYWELL MOTORS

... for chart drives, servos, balancing circuits



## STACK-TYPE MOTORS

These newly designed motors have such maintenance saving features as: sectional housing . . . wick-type lubrication . . . printed circuits . . . ball bearings . . . shock absorbers . . . alignment keying rings. Any major part replaceable in two minutes.



## OIL-SEALED MOTORS

These field-proven motors feature self-lubrication, have shock absorbers, are totally enclosed and oil sealed.



## MILITARY MOTORS

These are oil-sealed-type motors, modified to comply with MIL-M-17059. Housing is treated as specified in MIL-C-5541, and leads are fungus resistant as per MIL-V-173.

... All motors are available in two phase and synchronous models

### SPECIFICATIONS (applicable to all motors described above)

#### Two-Phase Induction Motor

Nominal No Load R.P.M.*	Gear Ratio	Intermittent Rated Load (oz.-in.)	Minimum Starting Torque (oz.-in.)	†Power (Watts) Loaded	Current (amp) Loaded	Temp. Rise °F
330	4.4:1	4	10	11.5	0.11	70
144	10:1	5	23	11.5	0.11	70
48	30:1	15	56	11.5	0.11	70
23	60:1	30	105	11.5	0.11	70

#### Synchronous

R.P.M.*	Gear Ratio	Pull-In Torque Minimum (oz.-in.)	Continuous Torque (oz.-in.)	Power (Watts) Loaded	Current (amps.) Loaded	Temp. Rise °F
180	10:1	12	12	24.0	0.21	100
180	10:1	2	2	11.5	0.11	65
90	20:1	14	12	11.5	0.11	65
60	30:1	21	18	11.5	0.11	65
30	60:1	42	36	11.5	0.11	65

\*1/6 less at 50 cycles

†Field winding 11.0 watts, balance in amplifier winding

Note: Some speeds available at 25 cycles

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

# Honeywell

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Here is important news for designers in the appliance, aircraft, electronics and other industries! A unique process developed by The Stalwart Rubber Company now enables silicone rubber to be extruded and sponged in complex configurations or calendered to close tolerances to meet customer specifications. Here are the facts . . . Stalwart extrudes silicone sponge parts in 1/16 to 8-inch dimensions in lengths up to 300 feet. Calendered sheets are produced in widths up to 36 inches. These silicone sponge parts resist sunlight, ozone, and aging as well as temperatures ranging from  $-160^{\circ}$  to  $+500^{\circ}$  F. Stalwart also mass-produces all types of precision parts from natural and synthetic rubbers.

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Cell sizes range from very coarse to fine with open or closed cell-structures.



Silicone sponge extrusions can be combined with solid silicone rubber extrusions.



Calendered and extruded silicone sponge shapes can be covered with heat-resistant fabric.

CIRCLE 115 ON READER-SERVICE CARD

## NEW PRODUCTS

### Transmission Unit

377

Measures 3/4 in. in length

Designed to increase or decrease the speed of servo motors, this transmission unit weighs a few grams and measures 1/2 in. in diameter and 3/4 in. in length. It is capable of producing step-up or step-down ratios from 10:1 to 2025:1. The unit was developed to meet the minimum space and weight requirements of electromechanical systems in satellites two or three years from now.

Bowmar Instrument Corp., Dept. ED, 8000 Bluffton Road, Fort Wayne, Ind.

*Availability: Made on order only. Can be delivered 10 to 12 weeks after order received.*

### Control Transformers

378

Come in voltages from 50 va to 5 kva

The line of Red H control transformers is available in all standard sizes and voltages from 50 va to 5 kva. They are supplied with screw-type terminals, constructed of heavy nickel plated brass, to which is riveted a heavy section of rag paper. Both core and coil are varnish dipped and baked. Connecting links are supplied for series-parallel connections on primary.

Hindle Transformer Co., Inc., Dept. ED, Flemington, N.J.

*Availability: Available from stock. Delivered 2 days after order received.*

### Solar Cells

381

Have 10% minimum conversion efficiency

Type 120C solar cells come with 10% minimum conversion efficiency. They measure 1 x 2 cm (0.4 x 0.8 in.), and have a spectral response ranging from 4000 to 11,500 A. Their operating temperature range is from  $-65$  to  $+175$  C.

Hoffman Electronics Corp., Dept. ED, 3761 S. Hill St., Los Angeles 7, Calif.

*Price: Price for the cell is \$8.25 each in quantities from 100 to 999. In shingled assemblies, they are priced at \$6.75 per cell in quantities from 100 to 999.*

### Cable Adapter

633

For 50-ohm connectors

This cable adapter accommodates all 50-ohm ConheX connectors to BNC panel fittings. It also permits the use of subminiature cables with existing larger cables and connectors in ground control equipment, radar and test equipment.

Sealectro Corp., Dept. ED, 139 Hoyt St., Maroneck, N.Y.

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It's no accident that Gudelage is the best lacing tape you can buy. Excellence is engineered into Gudelage. A sturdy nylon mesh is meticulously combined with the optimum amount of special microcrystalline wax. Careful selection of raw materials and superior methods of combining them give Gudelage outstanding strength, toughness, and stability. Gudelage is the original flat lacing tape which distributes stress evenly over a wide area. It is engineered to stay flat; it will not stretch out of shape when pulled. Gudelage's nonskid surface prevents slipping, eliminating the too-tight pull that causes strangulation and cold flow. Durability and dependability make Gudelage your most economic buy—with no cut insulation, fingers, or feelings.

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### Midget Pliers

362

These midget, chain-nose pliers are designed primarily for work on electronic, subminiature assemblies. As an addition to the company's midget line, these pliers offer a thin-nose construction for use in confined working spaces. They come in three sizes: 4, 4-1/2, and 5 in.

Kelsey Hayes Co., Utica Drop Forge & Tool Div., Dept. ED, Utica, N.Y.

**Price & Availability:** Available from stock. Prices are: \$2.70, \$2.84, and \$2.94 for the 4, 4½, and 5 in. units, respectively.

### Tube Shields

363

The company's 7-pin miniature full-contact tube shield has been redesigned to conform to standard socket dimensions. The full-contact line exceeds the shock and vibration requirements of MIL-19786 A, paragraph 3.6. In addition, these shields offer maximum cooling of tube envelopes.

Atlee Corp., Dept. ED, 47 Prospect St., Woburn, Mass.

**Price & Availability:** Available from stock. Prices per hundred range from \$71 to \$98, depending upon quantity ordered. All prices job Woburn, Mass.

### Wire Wrapping Tape

364

This wrapping tape, called Rulon Abrasion Barrier, is used with TFE insulated wires rated for 500 F and higher. The tape, a skived form of Rulon (reinforced TFE resin) is available in thicknesses from 0.004 in. up, and in widths from 1/4 to 12 in.

Dixon Corp., Dept. ED, Bristol, R.I.

**Price & Availability:** Made on order only and delivered 7 to 10 days after order received. Price is \$10.45 per lb in 100 lb quantity.

### Round Drawn Cases

436

Designed to house electronic components, these round-drawn cases include more than 200 standard sizes made from aluminum, copper, steel, brass, and mu metal. They range in size from 1/2 to 3 in. in diam, and lengths up to 4 in.

Olympic Products Co., Inc., Dept. ED, Alpha, N.J.

**Availability:** From stock.

### Silicone Dielectric Fluid

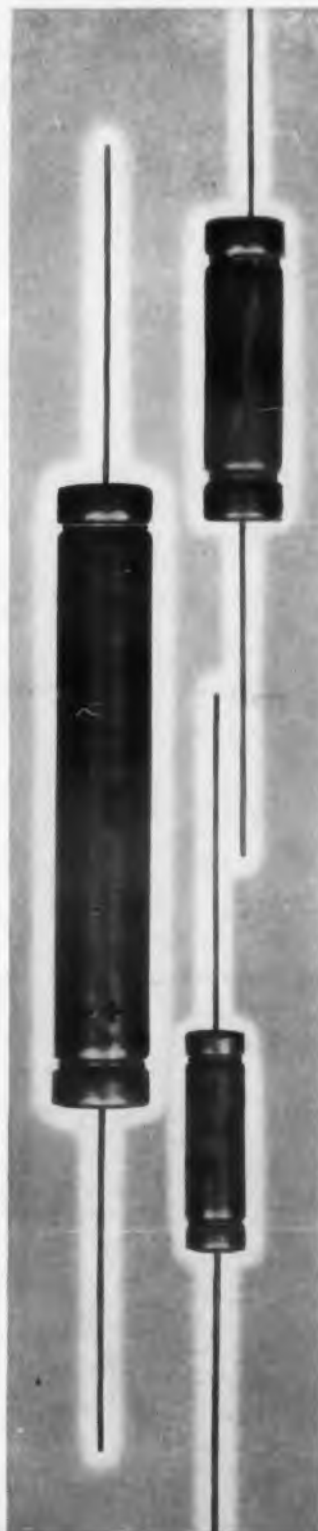
524

Type SF-85(50) has a pour-point below -120 F, making it suitable for low temperature uses. Applications are in transformers, capacitors, fluid-filled components, and fluid-cooled assemblies.

General Electric Co., Silicone Products Dept., Dept. ED, Waterford, N.Y.

**This is the time of our annual subscription renewal.**

# NEW General Electric High-voltage Tantalytic\* Capacitors RATINGS TO 300 VOLTS



General Electric announces a new high-voltage foil Tantalytic capacitor—rated to 300 volts at 85C and to 250 volts at 125C—in both polar and non-polar designs.

**SMALLER IN SIZE** than any previously available capacitor with similar voltage ratings, these new General Electric capacitors also provide size advantages over series arrangements of lower voltage units.

**GREATER CAPACITANCE STABILITY**, achieved over the entire temperature range, is provided by these new high-voltage Tantalytic capacitors. An 8 percent maximum capacitance increase at high temperatures and a 20 percent maximum capacitance loss at -55C are specified.

**CLOSER CAPACITANCE TOLERANCE** of ±15 percent is standard. This represents a significant improvement over the ±20 percent or -15 +75 percent initial tolerances characteristic of lower voltage capacitors.

**SUPERIOR LIFE PERFORMANCE** during 2000 hours under maximum rated conditions is realized, with a maximum capacitance change not exceeding 10 percent.

**FOR COMPLETE INFORMATION** on this significant breakthrough in Tantalytic capacitor design, contact your General Electric Sales Representative, or write Section 449-15, General Electric Co., Schenectady 5, N. Y.

\*Registered trademark of General Electric Co.

#### TYPICAL OF THE WIDE RANGE OF RATINGS AVAILABLE WITH THE NEW G-E HIGH-VOLTAGE FOIL TANTALYTIC CAPACITORS

Cat. No.	Volts	Temp.	Capacitance (uf)	Polarity	Max. Leakage at Rated Temp. (ua)	Max. Imp. -55C 120 CPS (Ohms)	Diam.	Length
29F2200	200	85C	0.35	P	32	5715	3/16"	1 1/8"
29F2105	300	85C	25.0	P	500	82	1 1/2"	2 3/4"
29F2108	300	85C	2.0	NP	150	1010	3/8"	2 1/8"
29F2207	200	85C	0.15	NP	32	13330	1/8"	1 1/8"
29F2161	250	125C	2.5	P	100	830	3/8"	1 1/4"
29F2164	250	125C	13.0	P	325	160	1 1/4"	2 3/4"

These units are supplied in tubular form, in lightweight aluminum cases, with axial leads, and are available with insulating sleeve in 7 case sizes.

**GENERAL ELECTRIC**

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**George Rose just won't sit still.** As head of Receiving Tube Advanced Development, it is George

Rose's job to direct the exciting activities of one of the most imaginative research teams at RCA. He is an able and dynamic chap: always on the move. So it's not surprising to find him not at his desk, but back in the lab pursuing his first love: the practice of shirtsleeve science.

George's multiple abilities guide the work of a group which fairly pops with new ideas. Recently he turned his staff loose on the problem of developing a modulator tube with exceptional isolation between inputs, good linearity, and high sensitivity. What emerged was an innovation in tube geometry: our new 7360 Beam Deflection Tube, one of the most significant contributions to single-sideband operation in many years. With the 7360, engineers can now design more efficient SSB circuits with fewer components.

The work of George's group, which has also been responsible for such electronic milestones as the nuvistor and the ceramic metal pencil tube, is another phase of RCA's broad continuing quest for finer, more reliable tube products for you.



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 LOS ANGELES 22, CALIF.: 6355 E. Washington Blvd.  
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**NEW PRODUCTS**

**Impulse Relay 384**

Life is over 1,000,000 steps



Series 670 impulse relay is designed to have a life in excess of 1,000,000 steps. The unit can have up to 10 steps per sec. Each impulse causes the relay to reverse the cam-actuated contacts. Contact arrangement is dpdt, with ratings up to 1500 w, non-inductive, or up to 20 amp locked motor current. Coil voltages are up to 230 v ac or 110 v dc.

Guardian Electric Manufacturing Co., Dept. ED, 1621 W. Walnut St., Chicago 12, Ill.

**Digital Logic Blocks 488**

Come in computer and panel type mountings

Available with either computer or panel type mountings, this line of compatible transistorized digital logic blocks can be used for adding functions to new or existing systems and equipment. Each of the blocks is designed to perform a major digital operation. When used with existing systems, units can be added by selecting the blocks which meet operational requirements. Applications include: digital systems, timing and control, data processing, instrumentation, and test equipment.

Control Equipment Corp., Dept. ED, 19 Kearney Road, Needham Heights 94, Mass.

*Price & Availability: Made to customer specifications. Small quantities delivered in 30 days; large quantities delivered in 90 days.*

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## Pulse Sampling System 612

Displays sweep times down to 1  $\mu$ sec



Consisting of the type N sampling plug-in unit, type 110 pulse generator and trigger take-off, and the type 113 delay line, this pulse-sampling system provides displays with apparent sweep times of as little as 1  $\mu$ sec. The system also investigates risetimes to approximately 0.6  $\mu$ sec with bandwidth to 600 mc. Designed for use with the company's plug-in oscilloscopes, the system provides general purpose medium and low-speed service.

Tektronix, Inc., Dept. ED, Box 831, Portland 7, Ore.

**Price:** Prices are \$600 for the type N sampling plug-in unit, \$650 for type 110 pulse generator and trigger take-off, and \$200 for type 113 delay line. All prices job factory.

## Overtemperature Protector 361

For motors, solenoids, and transformers

Designed specifically for subfractional hp motors 1-in. in diameter and larger, the Klixon 5891 over-temperature protector is equally suitable for small solenoids and transformers. Temperature levels of protection are 150, 175, and 200 C. Maximum contact capacity is 5 amp at 27 v dc or 120 v ac. Envelope dimensions are 0.28 x 0.2 x 0.6 in.; weight, excluding leads, is 1 g. The units conform to MIL-M-7969 and MIL-M-8609, and when mounted in equipment they comply with MIL-E-5272.

Texas Instruments, Inc., Metals & Controls Div., Dept. ED, 34 Forest St., Attleboro, Mass.

**Availability:** Now available in sample quantities only. Full production in three months—on order only. Can be delivered 4 weeks after order received.

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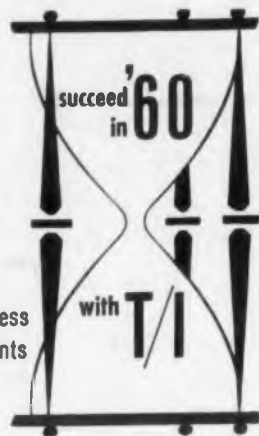
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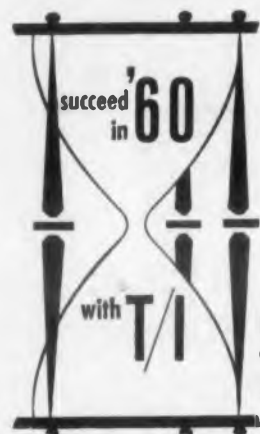
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Gasaccumulator Co., (Canada) Ltd., 12 Gower Street, Toronto 16, Ontario

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## NEW PRODUCTS

### Diode Test Set

For fast switching diodes



Model 510 diode test-set generates and displays the recovery characteristics of fast-switching diodes. The unit includes a fixture for manual insertion of coaxial lead diodes, a regulated power supply, a mercury, switching-type pulse generator, a side-band delay unit, and a  $\mu$ sec sampling converter. The power supply delivers currents to 20 ma at 15 v. The pulse generator provides precisely adjustable pulse amplitude and a rise time of less than 0.3  $\mu$ sec. The sampling converter has a rise time of 0.6  $\mu$ sec, sweep speeds to 0.5

388

$\mu$ sec per cm, and a sensitivity of 10 mv per cm. The unit is of modular construction, weighs about 40 lb, and measures 13-7/8 x 10-1/2 x 18-1/2 in.

Lumatron Electronics, Inc., Dept. ED, 68 Urban Ave., Westbury, L.I., N.Y.

**Price & Availability:** Price is \$1920. Delivery is in 90 days or less.

### Microvoltmeter

590

Measures from 10 v to 1  $\mu$ v

Model 951 transistorized microvoltmeter is a differential voltmeter which compares a precise internal voltage with the unknown voltage to be measured. It measures from 10 v to 1  $\mu$ v. The reference voltage to the precision voltage divider covers four ranges: 10 v, 1 v, 100 mv, and 10 mv. The divider is a four-dial device reading from 0 to 9 on the three outer dials, and 0 to 10 on the inner dial. Accuracy is 0.01%  $\pm$  0.5  $\mu$ v in differential mode, input impedance at null is infinite, and drift is less than 0.5  $\mu$ v on the null indicator.

Smith-Florence, Inc., Dept. ED, 4228-23rd Ave., W., Seattle 99, Wash.

**Price & Availability:** Price is \$1350. Delivery time is 45 to 60 days.

## SPECTROL PRECISION POTENTIOMETERS

Two valid reasons why **SPECTROL**  
delivers better non-linear pots *faster!*

REASON

1

COMPUTER DESIGNED



Spectrol uses an IBM 610 computer to turn out complex non-linear precision pots in record time, both single-turn and multi-turn. This in itself saves weeks of time, assures more accurate performance. Spectrol alone maintains a computer on the premises for this purpose.

**How It Works.** Design information in the form of X and Y coordinates or mathematical equations describing the particular parameters of a given non-linear function is entered in the computer. Previously programmed general equations automatically compute from these data points manufacturing directions in terms of winding equipment settings, cam angle and radii. An electric typewriter prints out winding machine set-up information on a form which is sent to production. Simultaneously, a punched tape is made to store data for repeat requirements.



## Beam Power Tube 502

For audio amplifier uses

Beam power tube 6L6-GC is a glass-octal type designed for use in the output stage of audio amplifiers and radio receivers. In push-pull class AB<sub>1</sub> af power amplifier service, two of these tubes can deliver a maximum signal power output of 55 w with a total harmonic distortion of 1.8%.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N.J.

5272B, NAS 710, and applicable portions of JAN R-19 standards.

New England Instrument Co., Dept. ED, 1334 Main St., Waltham, Mass.

**Price & Availability:** Samples are available for 15 to 30-day delivery at a price of about \$60.

## Ball Bearings 504

Two series offered

Series R and series 30 ball bearings have inch and metric dimensions, respectively. Series R comes in 15 sizes for shafts from 1/8 to 1-1/2 in. in diameter. For use with shafts having small diameters, series 30 has bores ranging from 4 to 9 mm in diameter and may be equipped with a single or double seal. Both series offer open or shielded configurations.

Hoover Ball and Bearing Co., Dept. ED, 5400 S. State Road, Ann Arbor, Mich.

**Availability:** Delivery can be made in 60 to 90 days.

## Wirewound Potentiometer 503

Comes with up to 75 K resistance

Model 78 wirewound potentiometer is supplied with resistances up to 75 K. Standard tolerance is  $\pm 5\%$ ; a tolerance of  $\pm 1\%$  can be furnished on special units. Having less than 0.5 oz-in. torque per section, the unit will take up to 2.5-w continuous power over the temperature range of  $-55$  to  $+150$  C. It has low noise characteristics. The insulation resistance is rated at 100 meg. Linearities down to 0.25% are available. The unit meets MIL-

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REASON

2

## LIBRARY OF TAPES

Spectrol also maintains an extensive library of tapes with programs for the solution of general non-linear potentiometer design equations, saving hours of calculation time and providing error free results. Again, you receive a superior product sooner.

Let us know your design requirements. With Spectrol's time-saving techniques, you can expect a quote within a few days.

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\$184<sup>95</sup>

### PROFESSIONAL 5" DC OSCILLOSCOPE KIT (OP-1)

Distinguished quality, coupled with traditional Heathkit savings, highlight the OP-1 as one of the most unusual values in the test equipment field! Designed as a professional caliber research tool, the OP-1 meets critical quality standards demanded in industrial, educational or medical applications. Features include; 5ADP2 CRT; DC coupled amplifiers and CR tube unblanking. Triggered sweep circuit operates on int. or ext. signals, AC or DC coupled. Send for FREE Heathkit catalog today describing this and many other money saving kits or see your nearest Heathkit dealer.



HEATH COMPANY  
Benton Harbor 60, Mich.

Please send Free Heathkit Catalog.

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Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

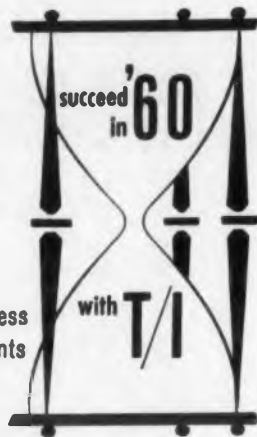
NOTE: Prices and spec. subject to change without notice. Dealer and Export prices slightly higher.

CIRCLE 124 ON READER-SERVICE CARD

circuit  
development  
engineer



professional progress  
exciting assignments  
liberal company  
benefits



see full-page ad between 144 & 145



device  
development  
engineer



professional progress  
exciting assignments  
liberal company  
benefits

CIRCLE 900 ON CAREER INQUIRY FORM, P. 143



"because every  
assembly job is  
different, only  
**CUSTOMED**  
preforms perform  
correctly."

Hamburg Fang,  
Chief Metallurgist  
ALLOYS UNLIMITED

## NEW CUSTOMED SOLDER PREFORMS IMPROVE AUTOMATIC SOLDERING

New customed preforms consist of an accurately predetermined amount of a specific alloy. The proper melting temperature and correct volume of solder are assured. Labor costs are lowered. Production increases. Scrap is eliminated. Get the facts today! Write for 8 page Guide to Preform Soldering.

21-01 43rd Ave., Long Island City 1, N. Y.

CIRCLE 126 ON READER-SERVICE CARD

## NEW PRODUCTS

### Potting Compound 568

For electronic hardware use, type 0308 stands 4500 F for 5000 hr, 5000 F for 1 hr, and 4000 F continuously. Types 0307 and 0306 stand a maximum of 3000 F and 2000 F respectively.

Technical Industries Corp., Dept. ED, 389 Fair Oaks Ave., Pasadena, Calif.

**Price & Availability:** Available from stock, types 0306, 0307, and 0308 are priced at \$11.25, \$47.50, \$95 per lb. Prices are \$8, \$32.25, and \$62 per lb. when quantities of 25 lb. or more are ordered.

### Piezoelectric Ceramics 569

This insulation material, designated SS101, has a Curie Temperature of 275 C min, a planar coupling coefficient of 0.52 at room temperature, and a dielectric constant of 1180. Dissipation factor is 0.006. Diameters are from 1/8 to 2 in. and thicknesses are 1/16 to 1/2 in.

Solar Manufacturing Corp., Dept. ED, 4553 Seville Ave., Los Angeles 58, Calif.

**Price & Availability:** Price, which varies with size and quantity, will be quoted on request. Delivery in 21 to 30 days.

### Fans and Blowers 570

The 2.5-in. diameter motors used to drive the firm's small axial fans and centrifugal blowers now have a terminal block which permits hook-up cables to be run directly to the terminals of the motor.

Rotron Manufacturing Co., Dept. ED, Woodstock, N.Y.

### Phenolic Laminates 571

Firebran 321-R and 321-E flame retardant, copper-clad laminates are offered in sheets 36 x 48 in., in thicknesses of 0.02 to 0.25 in.

Taylor Fibre Co., Dept. ED, Norristown, Pa.

### Jack 572

Type SKT-30 jack, which also serves as a test point, accepts a probe 0.04 in. in diameter. Contacts are gold-flashed beryllium-copper; insulation is Teflon.

Sealectro Corp., Dept. ED, 139 Hoyt St., Maroneck, N.Y.

### Microwave Switch 437

Model V-FSW 2 reciprocal ferrite rotator has a switching time of 1 to 2 usec. Peak power is at least 10 kw, unpressured.

T. R. G., Inc., Microwave Component and Antenna Dept., Dept. ED, 9 Union Square, Somerville 43, Mass.

**Price & Availability:** Price is \$2100 per unit. The unit is made on order and is delivered in 60 to 90 days.

NEW!



### SPRING & FUSE CLIPS, LOCK WASHER TERMINALS

Order from Zierick stocks for quick delivery. New terminals with #4, 6, 8 holes, spring and fuse clips made from .018 brass or phosphor bronze, hot tinned. Special parts quoted from sketches or blueprints. Production on our upright presses or multi-slide machines. Over 500 stampings and wire forms to choose from.

STANDARD  
ELECTRICAL  
PARTS delivered  
**FAST!**

Lugs • Clips • Terminals  
Wire Forms from Stock

Send for your copy of the new  
Zierick catalog No. 22 TODAY!

ZIERICK MANUFACTURING CORP.

96 Beechwood Ave., New Rochelle, N. Y. • NEw Rochelle 6-8520

CIRCLE 127 ON READER-SERVICE CARD

## New Metron Miniature Speed Changers

Ready-to-go  
in your product

- Complete
- Compact
- Adaptable



Save design, production, and assembly costs

### ...USE METRON SPEED CHANGERS AS COMPONENTS IN YOUR PRODUCT

- Over 400 different standard ratios! 10:9 to 531,441:1
- Small! 1.062" diameter. Overall lengths: Class A, 2-11/16"; Class B, 3-1/2"; Class C, 4-5/16"
- Transmit power either way to 100:1 ratios
- All aluminum housing
- Servo or foot mounted
- Concentric ball-bearing input and output shafts
- Hardened steel spur gears
- Permanent lubrication
- Prompt delivery on production or experimental models

ONE WEEK DELIVERY

Write for Bulletin 97

Metron

INSTRUMENT COMPANY

460 Lincoln St., Denver 3, Colo.

• NEW YORK • CHICAGO • DETROIT  
• LOS ANGELES • CLEVELAND

CIRCLE 128 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • March 30, 1960



Save Time—half your present cost  
with **SELF-ADHERING E-Z-CODE**

## MARKERS

for small gauge wires.



THOUSANDS OF STOCK ITEMS in letters, numbers, sequence, combination numbers and letters, N.E.M.A. Colors, etc. Stock materials in Vari-Temp Cloth, flame-proof Aluminum-foil, oil resistant vinyl-plastic, super-thin polyester-film in 1 1/2" and 3/4" lengths. Also available are miniature and sub-miniature stock markers. Special Markers made to requirements.

**\*To get a more permanent adhesive bond use-E-Z-CODES...you grab the tab...not the adhesive!**

Westline E-Z-CODE markers give sure, foolproof, lasting identification to wires of any size. Self-adhering numbered or lettered strips, quickly and easily applied by fingertip pressure. You make no mistake with E-Z-CODES.

WRITE FOR FREE SAMPLES AND LOCAL DISTRIBUTOR

### WESTLINE PRODUCTS

A Division of Western Lithograph Company  
676 E. 2ND STREET, LOS ANGELES 54, CALIF.

CIRCLE 129 ON READER-SERVICE CARD

## Octave Band Couplers 410

For use up to 4000 mc

These octave band couplers, available in several models, cover frequencies from 125 to 4000 mc. Coupling can be  $3 \pm 0.5$  db,  $6 \pm 0.75$  db, or  $10 \pm 1$  db. Directivity is a minimum of 17 db. The vswr is 1.25:1 max. Various mounting provisions can be supplied.

Sage Laboratories, Inc., Dept. ED, 3 Huron Drive, Natick, Mass.

**Price & Availability:** After April, 1960, units will be available for 30-day delivery. Price is \$235 ea.

## Tape Recorder 483

For airborne operation



Designed for military aircraft service, model TR555 tape recorder has four channels and stores up to two hours of information at 3-3/8-ips tape speed. It employs a tape cartridge loaded from the front which eliminates the need for tape threading. Signal-to-noise ratio is -40 db with a normal signal applied to the tape at 400 cps. The unit operates from a 28-v dc aircraft supply with less than 3-amp drain. Weight, including transistorized amplifier, power supply, and remote control unit, is less than 17 lb.

Telectro Industries Corp., Dept. ED, 35-16 37th St., Long Island City 1, N.Y.

**Price & Availability:** Available from stock by July, 1960. Price is \$1750.

## Radio Field Indicator 459

Measures the rf field from 100 kc to 250 mc

Model TM-14 radio field indicator is a portable unit requiring no electricity, batteries, or transmitter connection. It provides a continuous performance check by measuring the rf field generated by any marine, mobile, or fixed transmitter between 100 kc and 250 mc regardless of power. The unit has a 200- $\mu$ a meter movement with a variable sensitivity control. The antenna extends from 3.25 to 10.75 in. Dimensions, not including the antenna, are 3.125 x 2.25 in.

Lafayette Radio, Dept. ED, 165-08 Liberty Ave., Jamaica 33, N.Y.

**Price:** \$7.95.

# LERMER PLASTIC CONTAINERS



## Exceptional printing makes the difference...

### Helps make the sale!

- Printed or decorated up to 4 colors on crystal clear, transparent or opaque colors
- Largest line of **RIGID** plastic containers
- 1/5 the weight of glass—greatly reducing ever-increasing shipping and handling costs
- Lightweight and shatterproof—with rigid wall protection
- Economical—with customer re-use value
- Also made of new high density polyethylene—Poly-Opal\*. Are chemically inert, stain resistant and have lower permeability to moisture and gases than conventional polyethylene.

\*T. M.

Write for full-color catalog, samples and prices.

## LERMER PLASTICS, INC.



572 South Avenue  
Garwood, New Jersey

PIONEERS AND SPECIALISTS IN  
PLASTIC CONTAINERS SINCE 1919

CIRCLE 131 ON READER-SERVICE CARD

## KESTER SOLDERFORMS®

**BIG STEP** in

**PRODUCTION COST-CUTTING!**

Preformed solder, all shapes and sizes engineered to your needs; rings, washers, discs, coils, pellets, others. Flux filled or solid types, all alloys including rare metals.

Write for free sample assortment and engineering detail.

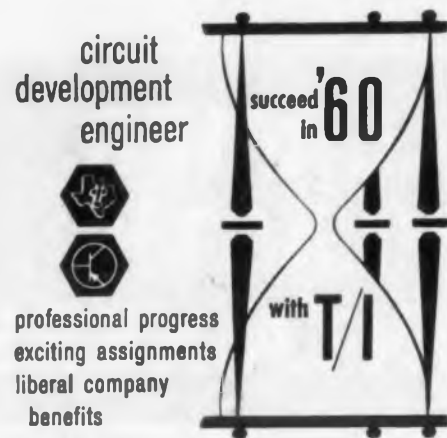
**KESTER SOLDER COMPANY**

4266 Wrightwood Avenue  
Chicago 39, Illinois  
Newark 5, New Jersey  
Anaheim, California  
Branford, Canada

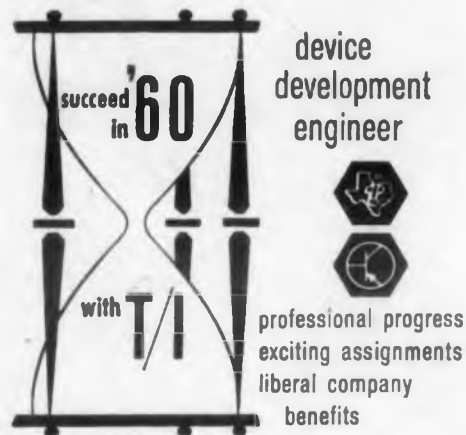
OVER 61 YEARS' EXPERIENCE

CIRCLE 130 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 30, 1960

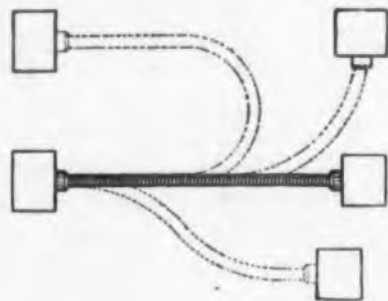


see full page ad between 144 & 145



CIRCLE 900 ON CAREER INQUIRY FORM, P. 143

## FLEXIBLE SHAFTING OFFERS NEW FREEDOM OF DESIGN



Before the innovation of Flexible Shafting, it was necessary to transmit power from a drive unit to its driven unit by means of a solid shaft which utilized expensive and cumbersome gearing. Today the Flexible Shaft alone provides a means of transferring this power from one unit to another by going around, over, and under obstacles. This allows you more space in your design, and eliminates the age old problem of having to have perfect alignment of the shaft and its drive or driven unit in order to make a connection. Flexible Shafts are simply curved towards the unit and connected by means of a ferrule, or an end fitting. If you have any application, now or in the future, which will require control from remote places, you owe it to yourself to write F. W. Stewart Corporation, 4311 Ravenswood Ave., Chicago 13, Illinois, for complete information on Circle Ess Flexible Shafting.

CIRCLE 133 ON READER-SERVICE CARD

## NEW PRODUCTS

### Time-Delay Generator

485

Operates from 0.1 to 10,000  $\mu$ sec



Operable over five ranges from 0.1 to 10,000  $\mu$ sec, this time-delay generator may be triggered by a periodic wave of 15 v peak-to-peak amplitude, or an 8-v peak negative or positive pulse of noncritical shape. Delay is presented as the time between two pulses, approximately triangular and of at least 20-v amplitude; rise time is less than 0.05  $\mu$ sec. A gate of positive and negative polarity, and a recurrent sweep are also available as outputs.

BJ Electronics, Borg-Warner Corp., Dept. ED, 3300 Newport Blvd., Santa Ana, Calif.

**Price & Availability:** Made on order only and delivered 30 to 60 days after order received. Price is \$585; \$555 when ordered in quantities of 10. Other quantity discounts available.

### Antenna Coupler

484

Covers a range of 1000 to 11,000 mc



Designed to fasten over the radome of a radar system and operate as a preflight checker, this antenna coupler, model 9322, covers the range of 1000 to 11,000 mc. It provides a calibrated signal of 40 db,  $\pm 2.5$  db. The variation in vswr from free space to antenna coupler is less than 0.12 over a 200% bandwidth. It can also match out counter-measure antennas of all types including helix, spiral, and scimitar.

Bogart Manufacturing Corp., Dept. ED, 315 Seigel St., Brooklyn 6, N.Y.

**Price & Availability:** Made on order only. Price is \$1000 per unit when ordered in quantities of 1 to 10.

## PRECISION ANGULAR DIVIDER

positions synchros and resolvers  
with less than 20 sec. error



AVAILABLE FROM STOCK

Accepted and utilized for 3 years by the major synchro quality control facilities, the Theta Angular Divider has become a standard of the industry. It is the only positioning mechanism which guarantees less than a 20 sec.-of-arc composite error at the point of contact with the synchro shaft. Ready to use—additional fixturing is not required. Adapters to accommodate Size 8 through Size 37 are stocked. A complete Technical Bulletin is available.



INSTRUMENT CORP.

520 Victor Street, Saddle Brook, N.J.  
Hubbard 7-3508, TWX: HKK 952 U.

CIRCLE 134 ON READER-SERVICE CARD



## Symbol of Hope and Opportunity

Thousands of crippled children and adults—almost 250,000 last year—pass under signs that identify nearly 1,400 Easter Seal centers and programs. Regardless of race, religion or cause of crippling, they find here skilled care and treatment, help along the road to rehabilitation and independence.

Have you shared in this important humanitarian effort? Mail a generous contribution TODAY.



National Society for  
Crippled Children and Adults  
2023 W. Ogden Ave.  
Chicago 12, Ill.



## Wedge Lock Band Clamp

399

Has separate mounting tab



This nylon wedge lock band clamp, designed for permanent, vibration-resistant use, has a separate mounting tab. The tab can be pre-mounted or it can be slipped on its clamp when the cables are bundled. Before locking, the tab slides around the clamp to any useful position.

Weckesser Co., Dept. ED, 5701 Northwest Highway, Chicago 46, Ill.

## Sliderule

460

Solves resonant circuit problems

Called the Calculaide Frequency Computer, this sliderule correlates the natural frequency and wave length of a circuit comprising a coil and condenser with the physical dimensions of the coil and the capacity of the condenser. All answers are given at one setting.

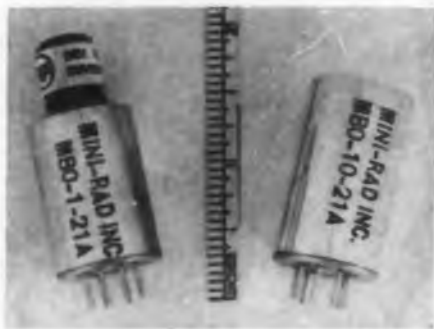
American Hydromath Corp., Dept. ED, 24-20 Jackson Ave., Long Island City 1, N.Y.

Price: \$4.95.

## Blocking Oscillators

481

Come in three series



These blocking oscillators come in three series: the MBO series that provides rectangular output pulses between 0.05 and 25  $\mu$ sec wide; the ABO series that provides rectangular pulses at any repetition rate between 1 and 100,000 pps; and the CBO series that provides countdown ratios of 2 to 1, up to 10 to 1. All units weigh less than 1 oz, and measure 0.75 x 1.3 in.

Mini-Rad, Inc., Dept. ED, 7416-E Varna Ave., N. Hollywood, Calif.



FABRICATED



ELECTRO-PLATED



MOLDED

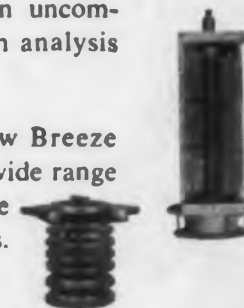
# No Compromise

## IN THE DESIGN OR PRODUCTION OF CUSTOM SLIP RING ASSEMBLIES...

... at Breeze. With the depth of design and production capabilities and facilities at Breeze Corporations, your slip ring requirements are met without compromise. Breeze produces custom slip ring assemblies by *all* of the reliable methods and techniques, thus assuring you of a unit tailored to meet your unique requirement.

Let Breeze provide you with an uncompromised design and production analysis before you buy.

You'll want a copy of the new Breeze catalog 66SR which describes a wide range of custom units as well as Breeze standard slip ring assemblies.



## BREEZE CORPORATIONS, INC.

700 Liberty Avenue, Union, New Jersey • Telephone: MUrdock 6-4000

Manufacturers of electrical, electro-mechanical and hydro-mechanical components and systems and fabricated metal products.

CIRCLE 136 ON READER-SERVICE CARD

# NOW! ALL YOUR FUSED QUARTZ REQUIREMENTS FROM 1 SOURCE

We manufacture and stock a complete range of:

STANDARD TAPER JOINTS • BALL AND SOCKET JOINTS  
CAPILLARY TUBING • COMBUSTION TUBES • DOUBLE BORE TUBING  
PRECISION BORE TUBING • LABORATORY QUARTZWARE



## CLEAR TUBING AND ROD

Can be secured from stock in a complete range of sizes—special sizes also available to meet your exact specifications.



## TRANSLUCENT TUBING AND ROD

In stock for immediate delivery in a wide range of sizes. Available in random or cut lengths to fit your requirements.



## INGOTS, PLATES AND DISCS

Rough cut or ground and polished in diameters up to 18½". Lenses, windows, prisms supplied in a wide range of sizes—or finished to your needs.



## FUSED QUARTZ COMPONENTS

High purity—in stock in a wide variety of semi-conductor grade crucibles, boats, test tubes and furnace tubes.

**FREE BROCHURE.** Yours for the asking. Illustrated . . . contains data on physical properties and transmission characteristics, plus complete prices on G-E Fused Quartz. Write: General Electric Co., Willoughby Quartz Plant, Dept. ED-30, Willoughby, Ohio.

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

CIRCLE 140 ON READER-SERVICE CARD

## NEW LITERATURE

### Insulating Materials 141

This 12-page book, No. GET 2929A, describes the characteristics and applications of the firm's complete line of insulating materials for electrical equipment. Technical data and suggested uses are given. The products available include mica mat, built-up mica, coated materials, varnishes, paints, adhesives, compounds, thinners, irradiated materials, wire enamels and permafils. General Electric Co., Schenectady 5, N.Y.

### Input Switches 143

Data sheet 170 describes a new line of rotary switches for use on computer control consoles to introduce information by converting decimal constants to a positional number code. The sheet describes various types and styles with illustrations and charts. Micro Switch, Division of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

### RF Connector Chart 144

This four-page, two-color brochure serves as a guide to the selection of rf connectors by rg cable types. It includes a cross-reference of cables versus applicable connectors and a guide for adapters between series. Category definitions indicate current preferences over obsolete types and their preferred replacement in rf transmission line applications. Schweber Electronics, 60 Herricks Road, Mineola, L.I., N.Y.

### Gyro Data Sheets 142

Information on three gyros is given in these three data sheets. No. B2115 describes a vertical gyro, No. A2215 describes a directional gyro and No. Q2315 describes a free gyro. All have similar external appearance. External dimension drawings are given. All have 23,000 rpm, 115 v, 400 cps motors. Kearfott Co., Inc., Little Falls, N.J.



CIRCLE 145 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 30, 1960 E.E.C



### Breadboard Components 151

Booklet No. 4 describes mechanical breadboard components. Various features of the system and its application to design problems are covered. This 24-page, compact booklet offers numerous design hints and recommendations for instrument engineers and designers. PIC Design Corp., 477 Atlantic Ave., East Rockaway, L.I., N.Y.

### Trimmer Pot Booklet 152

This booklet thoroughly covers the construction and desirable features of trimmer potentiometers for solving miniaturization and environmental problems in circuit design. Send 50 cents to: Dale Products, Inc., Dept. ED, Columbus, Nebr.

### Solid-state Commutators 153

Two-color, 12-page, illustrated brochure No. 937 describes solid-state elec-

tronic commutators for PAM, PDM, and PCM airborne telemetry systems. Electrical, environmental, physical and installation informations are given for these ruggedized units. Tele-dynamics, Inc., 5000 Parkside Ave., Philadelphia 31, Pa.

### Mica Paper 154

This eight-page brochure describes the characteristics, available forms and typical applications of mica paper. Photos and graphs of the products are included. Mica Insulator, Division of Minnesota Mining and Manufacturing Co., Schenectady 1, N.Y.

### Thermocouple Adapter 155

This two-page bulletin describes adapters which convert any 1/16-in. or 1/8-in. metal-sheathed thermocouple to a bayonet-lock spring-loaded type. A photo and application chart are included. Thermo Electric Co., Inc., Saddle Brook, N.J.



### Polaroid® Slides or Prints in Minutes!

This ONE new Beattie Oscillotron answers your every need in oscilloscope photography. Project new Polaroid® transparent slides minutes after recording or have prints in 60 secs. with new 3000 Speed Film. Object to image ratio - 1 to 0.9. Record up to 9 traces on a single frame. 75mm f/2.8 Wollensak lens. Instantly converted for a wide range of instrumentation photography.


"Polaroid" ® by Polaroid Corp. \*Trade Mark

1000 NORTH OLIVE STREET, ANAHEIM, CALIFORNIA • BRANCH: 437 FIFTH AVENUE, NEW YORK, N. Y.

CIRCLE 150 ON READER-SERVICE CARD

**\$250** Basic Camera

ACCESSORIES: Binocular viewing hood; Data card to record in frame; Data chamber; f/1.9 lens; Electric remote shutter control.



atlee clips increase their grip under

# VIBRATION and SHOCK

**TESTS PROVE IT . . . tests conducted independently by some of the nation's most critical users of component holders.\***

*the TESTS:*

- vibration at 500 cps with 90 g peak acceleration, and at 2,000 cps with 60 g peak acceleration, for one minute
- 1,750 impact shocks at 200 g, at right angles to and also along the axis of the holder
- 100 complete cycles of component insertion and withdrawal
- all tests repeated after 15 minutes exposure to 500° F.

*the RESULTS:*

- no visible shifting of the component in the holder
- no resonant frequencies developing under vibration
- dynamic holding power unchanged by heat
- dynamic holding power unchanged by use
- force needed to dislodge component *increased* during tests

*the REASONS:*

- severe vibration and shock cause the material of the holder to flex slightly, producing a closer "set" of the holder surfaces to the actual contours of the held component

**atlee** component holders *start out* with a tighter-than-usual grip, because of proper contours, construction and materials. As environmental stresses increase, this holding power automatically increases to meet the greater demand . . . because the holders actually mold themselves to the components. Here is an equipment designer's dream come true: the greater the stress, the *greater* the security.

**DESIGN FOR RELIABILITY WITH atlee** — a complete line of superior heat-dissipating holders and shields of all types, plus the experience and skill to help you solve unusual problems of holding and cooling electronic components.

\*Names on request



CIRCLE 156 ON READER-SERVICE CARD



SS-5  
DP-DT spring return  
0.5 amp @ 125v ac/dc  
U.L. Inspected

SS-15  
SP-ST pushbutton, momentary  
contact 1 amp @ 125v ac  
U.L. Inspected

SS-16  
3-position special  
0.5 amp @ 125v ac/dc

## THINK HOW YOU CAN



SS-31  
3-Position 3 amps  
@ 125v ac  
U.L. Inspected

SS-32  
SP-DT 1 amp  
@ 125v ac/dc  
U.L. Inspected

SS-33  
DP-DT 3 amps  
@ 125v ac  
U.L. Inspected

## IMPROVE YOUR PRODUCT



SS-50  
DP-DT miniature  
0.5 amp @ 125v ac/dc  
U.L. Inspected

SS-8  
JP-DT optional  
detent 1 amp @ 125v ac

SS-27  
SP-DT spring return  
3-amps @ 125v ac  
U.L. Inspected

## WITH THESE LOW COST



SS-26-1  
SP-DT 3-amps  
@ 125v ac  
U.L. Inspected

SS-9  
SP-DT spring return  
3 amps @ 125v ac  
U.L. Inspected

SS-18  
4-position special  
0.5 amp @ 125v ac  
for 10,000 cycles

## STACKPOLE SWITCHES!

### Get This GUIDE TO MODERN SWITCHING

Ask for 8-page Switch Bulletin RC-11D  
World's largest slide switch line—over 12 low cost  
standard types—dozens of economical adapta-  
tions. NEW colored knobs. Special conventional and  
miniaturized switches designed and produced for  
large quantity users. Electronic Components Division,  
STACKPOLE CARBON COMPANY, St. Marys, Pa.



CIRCLE 160 ON READER-SERVICE CARD

## NEW LITERATURE

### Electrical Connectors 161

This four-page bulletin, No. B 77, discusses the design of the company's electrical connectors. Special designs for special applications are illustrated and described. Also described are styles such as oval and round, push-ball, straight-pin bigun, change out and quik-loc designs. Joy Manufacturing Co., Electrical Products Div., 1201 Macklind, St. Louis, Mo.

### Resistor Booklet 162

This booklet by Bernard Hay surveys the field of precision resistors. Definition of resistor terms, construction and utilization of precision resistors are important areas covered. Send 50 cents to: Dale Products, Dept. ED, Columbus, Nebr.

### Silicone Product Guide 163

Listing major uses and benefits, this

eight-page guide contains data on the following silicone products: lubricants, release agents, electrical insulation, ceramics and glass fabrics, and silicone rubber. The illustrated bulletin, No. CDS-129B, also contains information for obtaining additional detailed information on specific silicone products. General Electric, Silicone Products Dept., Waterford, N.Y.

### Precious Metals 164

Entitled "Precious Metals and High Purity Nickel as used in Temperature Measurement," this eight-page brochure discusses the advantages of using platinum and platinum alloys as both resistance thermometer elements and as thermocouples in the measurement of high temperatures. The booklet covers platinum vs platinum rhodium thermocouple wire, iridium vs iridium rhodium, and gold-cobalt vs silver-gold. Sigmund Cohn Corp., 121 S. Columbus Ave., Mount Vernon, N.Y.

## PROTECT & CONTROL

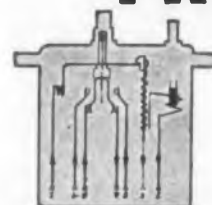
YOUR PRODUCT WITH

# E-T-A

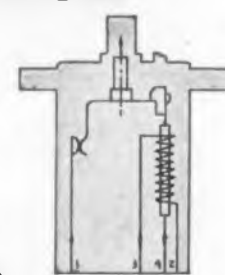
## CIRCUIT BREAKERS

Evaluate how E-T-A can economically simplify your design—

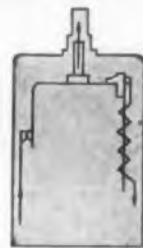
- Control of several component functions with one breaker
- Starting as low as 50 milliamp
- Also performs as On-Off Switch
- Miniature size
- Low cost per unit



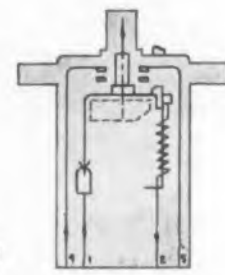
Two auxiliary circuits N.C., N.O., Shunt—Thermal Magnetic Circuit Breaker



Control of two circuits — Over-current Circuit Breaker



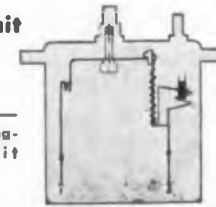
Series trip — Overcurrent Circuit Breaker



Auxiliary Circuits N.O.—Over-current Circuit Breaker



Series trip — Overload Relay



Series trip — Thermal Magnetic Circuit Breaker

For engineering assistance call or write to—

**E-T-A PRODUCTS COMPANY of AMERICA**

6284 N. Cicero Ave.

Phone: Kildare 5-1554

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IN CANADA: E-T-A Products of Canada Ltd.

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CIRCLE 165 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 30, 1960



## Laboratory Standards 170

Published primarily for those who recommend, specify, and buy instruments of laboratory standard quality, this 23-page brochure details and diagrams electrical instruments used for the calibration of working equipment. Instruments described include dc voltmeters and ammeters; ac or ac and dc voltmeters, ammeters, and watt-meters; current transformers; low voltage standardizing potential transformers, and high voltage potential transformers. Daystrom, Inc., Weston Instruments Div., 614 Frelinghuysen Ave., Newark 12, N.J.

## Cable Fault Finder 229

This illustrated brochure describes the operation and uses of the model 722 cable fault finder. Complete technical specifications are included. Smith-Florence, Inc., 4338 23rd Ave. W., Seattle 99, Wash.

## High Temperature Wire 171

Types E and EE teflon high temperature lead wire are described in this five-page brochure. Included are a table of

properties, suggested applications, thermal characteristics, and construction data. L. Frank Markel & Sons, Norristown, Pa.

## Toggle Switches 172

Toggle switches and toggle switch assemblies for use in airborne, mobile, marine, electronic, and commercial applications, are illustrated and described in this 32-page catalog. The switches include military versions that have been tested and approved under MIL-S-3950A, as well as pull-to-unlock, hermetically sealed, electrical memory, rocker actuated, and miniaturized designs. The catalog contains photographs, diagrams, dimensional drawings, and specification tables. Micro Switch, Freeport, Ill.

## Microwave Components 173

The company is currently engaged in the issuance of approximately sixty technical data sheets covering over 1000 coaxial and microwave test components available from stock. Some of the components described are 45 and 90 deg bends, directional couplers and terminations. Omega Labs Inc., Haverhill St., Rowley, Mass.



## Miniaturized POWER SUPPLIES FOR WIDE LOAD AND LINE VARIATIONS

Designed and manufactured to operate from an auxiliary power source such as an unmanned microwave station, these power supplies provide a wide input frequency range, offer transient and short-term short-circuit protection, and are complete with terminals for external output fusing.

### SPECIFICATIONS Model No. PAI-040

#### ELECTRICAL CHARACTERISTICS:

INPUT: 108 to 132 V, 47 to 420 cycles  
 OUTPUT: 200V<sub>DC</sub> ± 1% at any load between 100 to 200 MA and at any input between 108 to 132 V, 47 to 420 cycles  
 RIPPLE: (Max) 300MV<sub>RMS</sub> @ 47 cycle  
 — 200MV<sub>RMS</sub> @ 60 cycle — 10MV<sub>RMS</sub> @ 400 cycle

#### ENVIRONMENT CONDITIONS:

AMBIENT TEMPERATURE: Operating — 40°C to + 30°C  
 — 30°C to + 55°C with forced air cooling  
 ALTITUDE: Operating 10,000 ft. Non-Operating 40,000 ft.  
 HUMIDITY: 95% RH 40°C 240 HR (Mil-Std-202 Method 103)  
 SHOCK: 30 g's (Mil-S-4456)  
 VIBRATION: .060" Total Excursion 10-55 cycles (Mil-Std-202 Method 201A)

#### MECHANICAL CHARACTERISTICS:

SIZE: 4 1/4" x 5" x 4 3/4" WEIGHT: Less than 13 lbs. MOUNTING: Four # 1/4-20 Studs

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Aluminum-case Hiperomag cores are tested in accordance with EIA standards and are available in EIA standard sizes. Special tests and sizes can be secured. These cores, as well as polyclad hermetically sealed Hiperomag cores, are available in Hiper-nik®V (50% oriented nickel-iron) and 4-79 Permalloy (square loop) in a variety of thicknesses.

For complete information, call your Westinghouse representative or write Specialty Transformer Department, Westinghouse Electric Corporation, P.O. Box 231, Greenville, Pennsylvania.

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CIRCLE 180 ON READER-SERVICE CARD

## NEW LITERATURE

### Printed Circuits 181

Bulletin No. P-5a, entitled "Miniaturized Printed Circuits," contains information on how the elimination of lands or pads around plated-through holes permits substantial size reduction of printed circuit boards. It describes how the barrels of the holes are used for solder joints without sacrifice to reliability, repairability, pull strength, or insulation resistance. Photocircuits Corp., 31 Sea Cliff Ave., Glen Cove, N.Y.

### Silicon Components 182

This four-page illustrated folder contains data on a voltage reference diode, a voltage reference diode with a silicon amplifying transistor, a core switch, a silicon transistor, and a logic transistor. Specifications for each component are included. Transitron Electronic Corp., 168 Albion St., Wakefield, Mass.

### Tellurium Copper 183

This technical data sheet discusses physical, mechanical, and fabrication properties of tellurium copper. Principal uses of the alloy include torch tips for oxyacetylene assemblies and soldering iron tips. Other uses are in electrical switches, transformers, and circuit breakers. Bridgeport Brass Co., Bridgeport 2, Conn.

### Transistors 184

Complete application and performance characteristics for Fairchild's diffused-silicon mesa transistors are outlined in this two-color, four-page folder. High voltage, switching, and low storage transistors are included. Schweber Electronics, 60 Herricks Road, Mineola, L.I., N.Y.

### Battery Chargers 185

Silicon rectifier chargers for stationary-type batteries are described in a 20-page folder that includes curves and statistics on charger performance at various electrical loads. Exide Industrial Div., Electric Storage Battery Co., Rising Sun & Adams Aves., Philadelphia 20, Pa.

### Punching and Notching Units 186

Catalog B, 16 pages, illustrates and describes the series B hole punching and notching units. Included are round and shaped hole units, and corner, vee, and edge notching units. The catalog contains specifications and outline drawings. Punch Products Corp., 3800 Highland Ave., Niagara Falls, N.Y.



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CIRCLE 190 ON READER-SERVICE CARD

## Power Supply 191

Model R-100B compound regulated, dual power supply is described in this two-page data sheet. Characteristics, a general description, installation notes, operation data, and maintenance procedure data are included. George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 10, Mass.

## Retainer Bearing 192

This four-page data brochure on the W retainer bearing gives engineering information on performance, dimensions, load capacity, tolerances, calibration, and radial play. The bearing is designed to provide low torque reliability for gyros, synchros, small motors, and potentiometers. The Barden Corp., 200 Park Ave., Danbury, Conn.

## Microwave Components 193

This short form catalog lists over 85 models of microwave ferrite components. The components shown include the small size Y, T, and cross-type circulators, in addition to waveguide and coaxial isolators, modulators, circulator switches, and phase shifters. Monogram Precision Industries, Inc., Cascade Research Div., 5245 San Fernando Road W., Los Angeles 39, Calif.

## Recording Oscillograph 194

Type 5-114 recording oscillograph is described in this illustrated 16-page brochure. In addition to specifications, an evaluation of the instrument and a description of accessories are included. Bulletin No. 1500E contains complete specifications for series 7-300 galvanometers. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

## Shock Testing Machines 195

Four shock testing machines that are engineered to reproduce the entire spectrum of all significant shock waves appear in a four-page bulletin, No. 135. They range from bench-size models to a 12-ft model capable of testing objects up to 200 lb. Specifications and performance data for all models are included. Jan Hardware Manufacturing Co., Inc., Dept. ED-2, 38-01 Queens Blvd., Long Island City 1, N.Y.

## Space Chambers 196

Walk-in space chambers, suitable for military and industrial applications, are described in this illustrated four-page bulletin. The chambers include a variety of specifications for the simulation of extreme conditions of space. Tenney Engineering, Inc., 1090 Springfield Road, Union, N.J.

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100 feet of cable in seconds with the new  
**ALPHLEX® CLOSING TOOL**  
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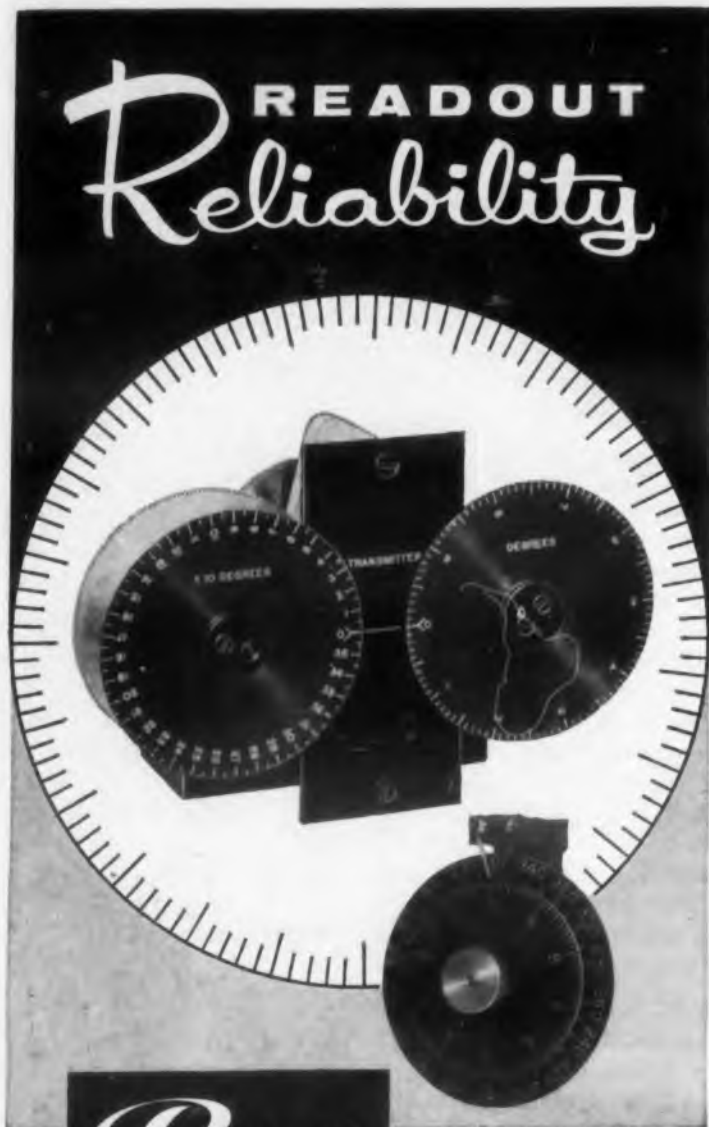
For your every harnessing, cabling and jacketing need, the complete line of Alphlex Zipper Tubing comprises 6 types and 17 sizes each, from 1/4" to 4" I.D.—and is used by such leaders as IBM, IT&T, Lockheed, Martin, Sperry Rand, U.S. Government agencies, etc.



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**Concentric Dial Assembly** — A miniaturized assembly for two-speed applications. Maximum precision with extremely low backlash. Available from stock in gear ratios of 10:1 and 36:1, with or without hand-input knob.

Both models supplied with dial engravings shown. Available on special order: etched dials and anti-backlash gearing which provide readout accuracies to 1 minute of arc.

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2RV60

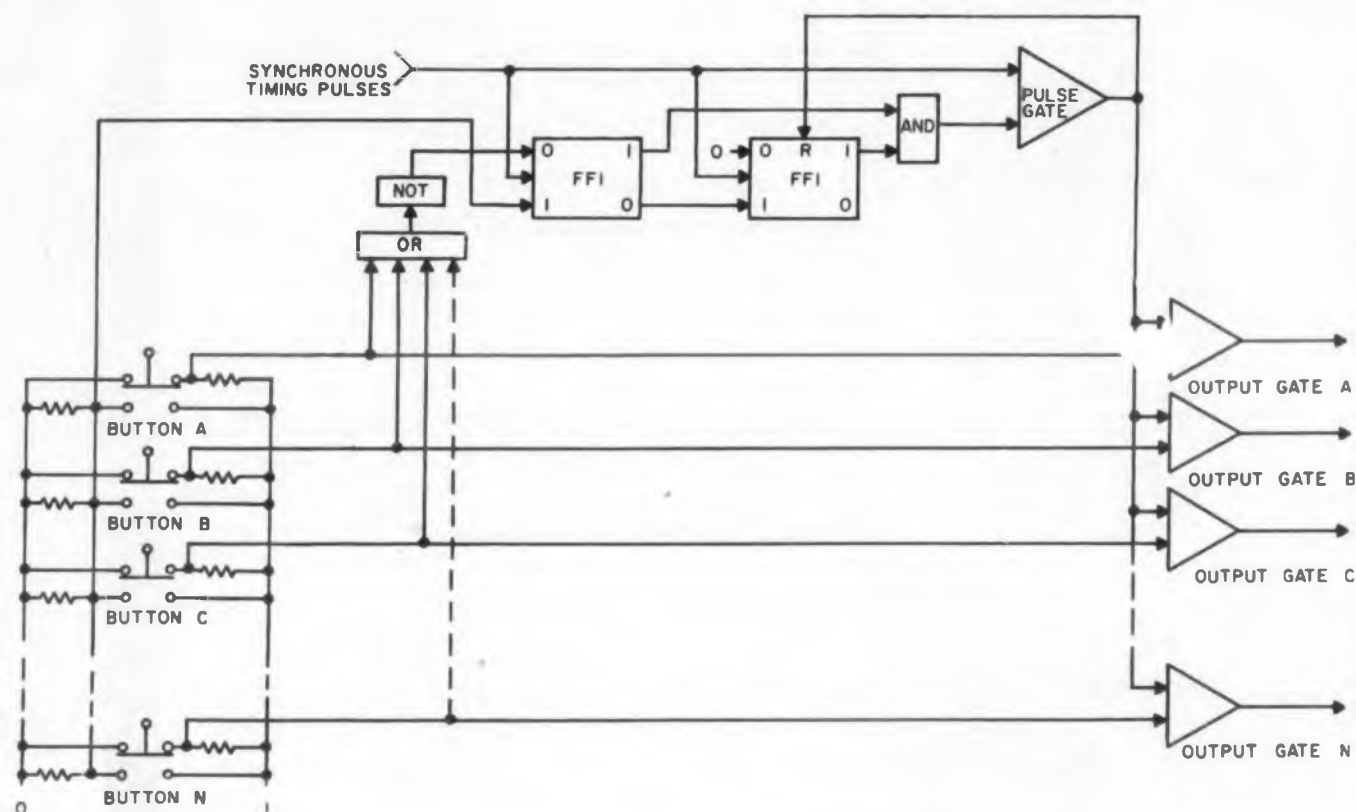
REEVES INSTRUMENT CORPORATION

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CIRCLE 200 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Pushbutton Gates Single, Synchronous Pulse



Pushbutton gating circuit requires only two flip-flops, but can pass a single synchronous pulse over any one of  $n$  output lines.

**S**INGLE, synchronous pulses, stripped from a train of synchronous timing pulses can be used to perform control functions such as start, stop or reset. A pushbutton-actuated circuit for obtaining this single pulse is shown here. The circuit uses only standard logical elements, is self-resetting and can handle any number of pushbuttons and their corresponding single-pulse output lines.

In referring to the figure, note the following logic convention:

1. A timing pulse sets the flip-flop to a state determined by the gating levels. For example, a binary 1 at the I input enables the timing pulse to set the flip-flop to the 1 state.
2. A pulse applied to the R input unconditionally resets the flip-flop to the 0 state.
3. A pulse gate passes pulses when binary 1's are present at the gating input.

4. The necessary circuit delays are built into the level-carrying lines of the flip-flops and pulse gates.

Initially, none of the buttons are depressed. Therefore, the output of the NOT is high and a timing pulse sets FF-1 in the 0 state. With FF-1 in the 0 state, a timing pulse sets FF-2 in the 1 state. The master gate is held closed because FF-1 is in the 0 state; the output gates are closed because of the 0 applied through the associated pushbuttons. The circuit is now in the quiescent state and remains there until a button is pushed.

When a pushbutton is depressed, FF-1 is set to the 1 state. The output of the AND gate goes high and a pulse passes through the master gate. The output gate associated with the depressed pushbutton passes this pulse.

The output of the master gate is also applied to



the reset input of *FF-2*. *FF-2* is set to the 0 state, disabling the AND gate. Hence, the master gate is closed and no more timing pulses can pass through. The circuit remains in this condition as long as the pushbutton is depressed.

When the pushbutton is released, the next timing pulse again sets *FF-1* to the 0 state. This enables the *FF-2* 1 input and the next timing pulse sets *FF-2* to the 1 state. The circuit is now reset to its initial state, and the cycle is complete.

It is apparent that one and only one synchronous timing pulse will be generated each time a pushbutton is depressed. Another pulse will not be generated until the button is completely released and then depressed again.

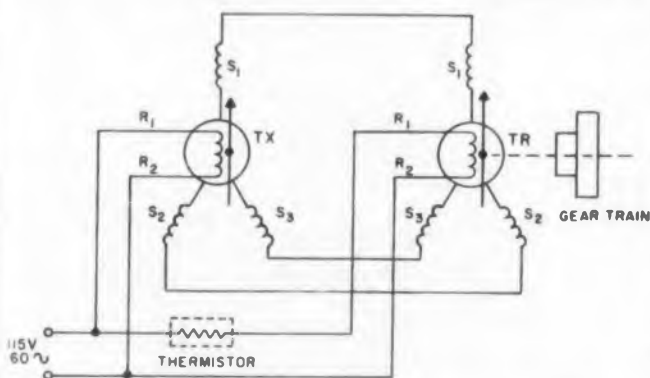
*Joseph Friedman, Principal Engineer, Budd-Lewyt Electronics, Inc., Long Island City, N.Y.*

### Tiny Thermistor Protects Gear Train From Transient Damage

A pair of synchros was used to transmit azimuth data for a special purpose analog computer. If the synchros were off null in their de-energized state and excitation was applied to the rotors, a large shock load was transmitted to the output gear train. This was causing excessive damage to the gears.

A mechanical solution to this problem would place a slip clutch in front of the output gear head. However, this would have required a complete mechanical redesign.

A simpler and more economical solution is shown in the figure. A thermistor was placed in



**Thermistor inserted** in series with synchro rotor prevents transient alignment torque from suddenly being applied to gear train.

the rotor leads of the torque receiver. When excitation is applied to the synchros, the thermistor is at first an open circuit. Gradually its resistance decreases until it becomes a virtual short with respect to the rotor impedance. This increases the torque of the TR gradually, instead of producing full torque immediately. Thus, the wear and tear on the output gears due to the transient condition were eliminated.

*Jerome Lyman, Development Engineer, Servo Corp. of America, Hicksville, New York.*

## NEW VOUGHT SERVO ACTUATORS TOP-RATED FOR MINUTEMAN



*give unequalled reliability  
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*Unique design simplifications and quality control advancements are incorporated in this servo actuator.*

These improvements enable the assembly to operate reliably under extreme conditions of force, shock, thermal shock, random vibration, sustained acceleration, and to withstand ICBM acoustical punishment. Under extended silo storage requirements, it still maintains close tolerance frequency response. The Air Force's ICBM, *Minuteman*, and other vehicles will use Vought servo actuators, now in quantity production at Vought Electronics, a division of Chance Vought.

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Twin gyro controllers	Complete autopilots
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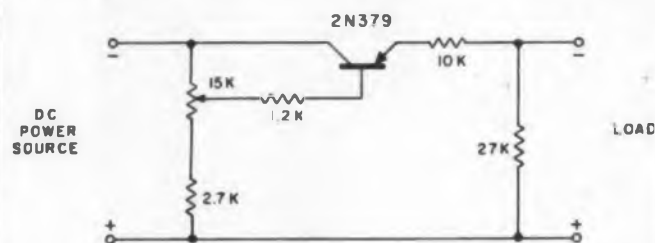
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CIRCLE 202 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Transistorized Pot Allows Fine DC Voltage Adjustments

When breadboarding and testing transistor circuits, it is often desirable to have a fine voltage adjustment of a low dc voltage source. Many times a variable low dc voltage supply is unavailable due to the many laboratory demands for these units. Most laboratories, however, have batteries or 28 vdc lines at hand. The transistorized voltage adjuster shown here is a simple and effective cir-



A transistorized potentiometer provides a fine voltage adjustment of a low dc voltage source, while presenting a high-line impedance.

cuit for providing a continuously variable lower voltage from these fixed dc sources. Its major advantage, as compared to a power potentiometer, is that it presents a high-line impedance (above 10,000 ohms) while handling currents up to 200 ma.

The two input leads are connected to the respective terminals of the dc power source and the load is connected directly to the output. All circuit power is supplied by the source and no other connections are necessary. In effect, the transistor is used as a variable series resistance element.

The 15-K potentiometer provides the adjustable bias, thus varying the effective resistance of the transistor. The 2.7-K and the 1.2-K resistors are used for base-current limiting. The 10-ohm resistor is used as a fuse to limit the output current to a maximum of 250 ma. For the transistor shown, the input voltage should not exceed 70 v. None of the components are critical and can be changed to meet individual requirements, although the allowable transistor power dissipation should be considered.

William B. Turner, Senior Engineer, Fairchild Astrionics Div., Fairchild Engine and Airplane Corp., Wyandanch, L.I., N.Y.

### Variable Capacitor Adjusts Chopping Rate

A simple chopper circuit was needed which had variable chopping rates.

The circuit shown provided our solution. The



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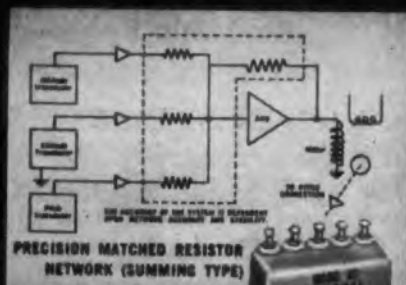
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- logic design

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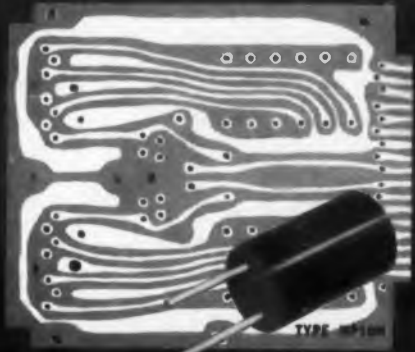
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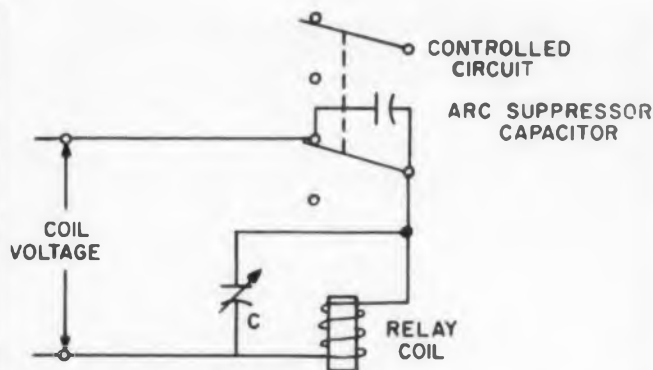
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CIRCLE 204 ON READER-SERVICE CARD

ELECTRONIC DESIGN • March 30, 1960



The variable shunt capacitor C adjusts the circuit's chopping rate.

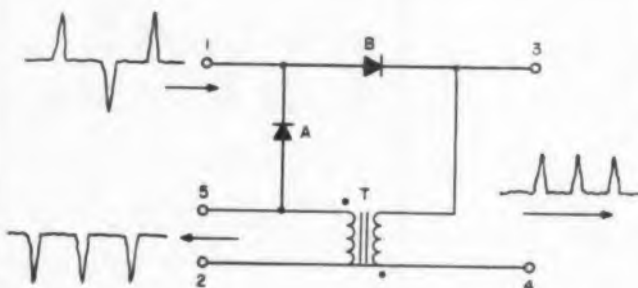
normal operating time for the relay was used for maximum chopping speeds. With the addition of the shunt capacitor the chopping rate was decreased. Rates from 5 msec to 50 msec and more were possible by merely increasing the size of the shunt capacitor. Larger delays were obtained by cascading similar relay circuits.

*H. Havlicek, Engineer, General Electric Co., Schenectady, N.Y.*

## Pulse Inverter for Positive and Negative Pulses

A two-output pulse inverter was required which would convert positive and negative input pulses to all positive pulses in one output, and all negative pulses in the other.

The circuit shown accomplishes this very easily.

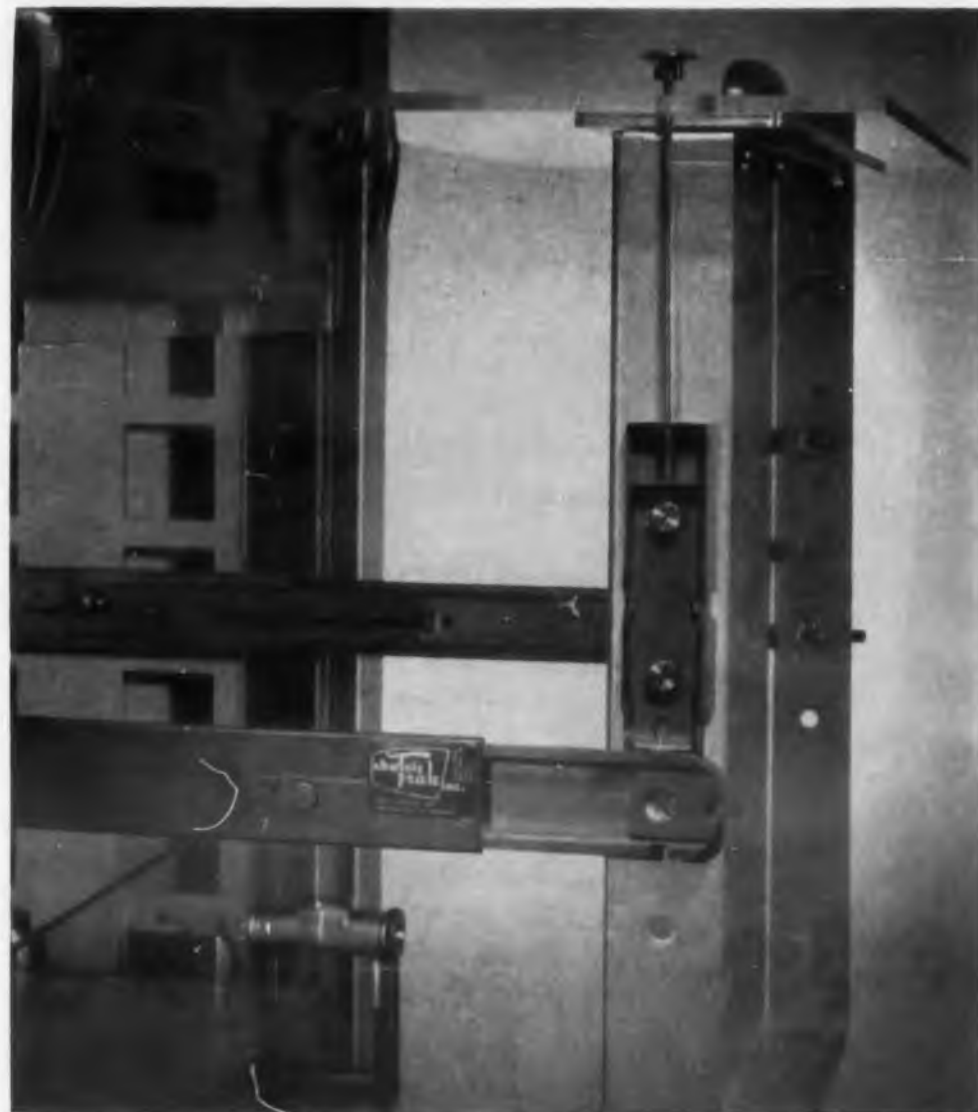


The train of positive and negative pulses is applied at input 1-2. Positive pulses are passed through diode B and appear at output 3-4. Negative pulses are blocked by this diode. However, they pass through Diode A and are then inverted by the pulse transformer to appear as positive pulses at output 3-4.

Similarly, negative input pulses pass through diode A and appear at output 2-5. Positive input pulses, blocked by A, pass through diode B and are inverted by the transformer to become negative pulses at output 2-5.

Thus, every input pulse has been converted to both a positive and negative output pulse.

*Alfred W. Zinn, Engineer, Farrand Optical Co., Bronx, N.Y.*



## From CHASSIS-TRAK NEW FEATHER-LIGHT DETENT SLIDE!

Model C-300 Detent locks in three service positions — 90° up, horizontal, 90° down

Chassis-Trak continues to set the pace in slide design with the new Model C-300 Detent. Never before has a tilt-lock slide come in such a small package, yet despite its space-saving size — 1 1/4" high, 3/4" wide — the Model C-300 Detent will support chassis loads up to 50 lbs. Not the least of the new slide's attractive features is its low price — lowest of any detent slide on the market.

Made of hard, cold-rolled steel, each slide is cadmium plated and then coated with Poxylube 75, a bonded film formulation of molybdenum disulfide, which provides permanent dry lubrication. Solid bearings on all surfaces afford high resistance to shock and vibration.

Model C-300 Detent Slides are available in seven lengths — 12 to 24 in. — and are designed for mounting electronic equipment in any standard rack or cabinet. Like all Chassis-Trak Slides, they are easy to install and smooth and trouble-free in operation.

Be sure to see this new slide demonstrated at the IRE Show — Chassis-Trak Booth 4001. You'll be impressed with its performance.



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For further information contact:

525 South Webster, Indianapolis 19, Indiana

CIRCLE 205 ON READER-SERVICE CARD

from: Army Ballistics Missile Agency  
 to: Fenwal Electronics  
 subject: Taking the temperature of EXPLORER VII

Gentlemen:

In connection with the Explorer VII satellite launching in October . . . the heat balance experiment conducted by Dr. V. E. Soumi provided 5 extra information channels for use by the Army Ballistic Missile Agency

The channels were used for temperature measurements on: a) a portion of the skin of the satellite, b) the solar cells, c) the 20 mc transmitter, d) the storage batteries, and e) the Geiger-Muller tube in the Van Allen experiment.

The sensing device used for all five measurements was a thermistor probe manufactured by Fenwal Electronics, Inc. (Type G-188). All probes matched one another so closely that only one calibration curve was required for all measurements and for all spares . . .

Sincerely,

*Gordon L. Harris*

GORDON L. HARRIS

Public Information Officer

# PATENTS

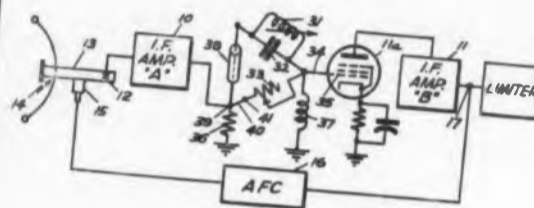
Benjamin Bernstein

## Phase Distortion Controls

Patent No. 2,915,601. N. Freedman. (Assigned to Raytheon Co.)

In a color TV system, phase fidelity is obtained by bridge circuit coupling of the signal to the following stage. The degree of coupling depends upon the magnitude of the deviation from resonance.

If amplifier "A" has a double tuned network coupling to if amplifier "B". The



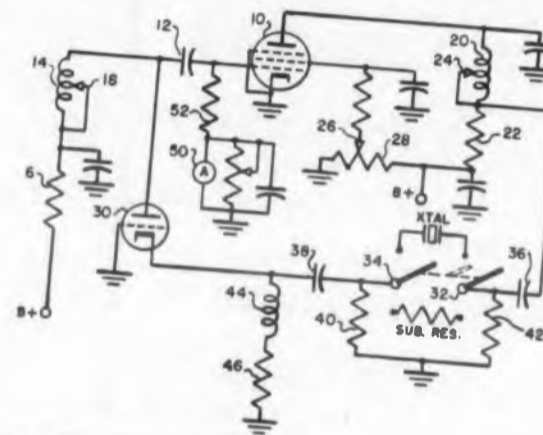
interstage network includes a shunt resonant combination of inductance 31 and capacitor 32. For a signal at the resonant frequency, the tuned circuit is open. The signal is coupled to the grid 34, only through variable resistor 33. Off resonance, the LC network passes an equivalent amount of signal. Connected to the

shunt network is half-wave line 38. This line provides the necessary phase reversal in the signal applied to the LC network.

## Crystal Impedance Meter

Patent No. 2,919,398. G. K. Guttwein and D. Pochmerski. (Assigned to the United States of America.)

The equivalent series-resonant resistance of a piezoelectric crystal is deter-



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ELI



mined by connecting the crystal into an oscillator feedback path containing a grounded-grid impedance matching stage.

The tuned grid, tuned plate oscillator formed with pentode 10 is adjusted to the test frequency. When the low resistance crystal is switched into the feedback path, grounded-grid amplifier 30 transforms this impedance to the high input impedance of tube 10. Crystal resistance is found by substituting a resistor which, at the same test frequency, causes meter 50 to deflect the same amount.

#### Beam Positioning Apparatus

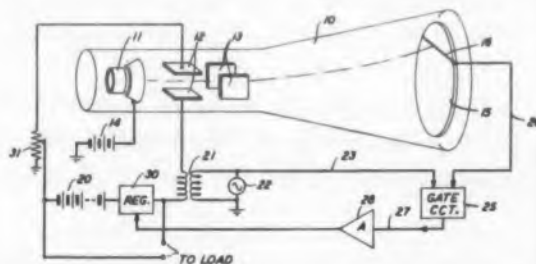
Patent No. 2,913,622. James E. Bartram and David H. Evans. (Assigned to Bell Telephone Laboratories)

The beam position in a cathode-ray storage tube must be registered precisely. The invention furnishes a simple, self-regulating means to stabilize the output voltage of the positioning power supply.

Wire 16 is imbedded in target 15. Power supply 20 is set so that the beam positioned by deflection plates 12 is caused to strike the wire. Superimposed on the dc voltage is the sine wave cou-

pled from generator 22. The dc positioning voltage is correctly adjusted when the beam strikes the wire at the instant the sine-wave amplitude is zero. At this instant, no signal passes through gate circuit 25. If the voltage of supply 20 changes, the beam strikes wire 16 when the sine wave has either a positive or negative value. A signal, in proper phase and amplitude, then passes through the gate to adjust regulator 30, resetting the voltage to the original magnitude.

Gate circuit 25 consists, basically, of a pentode tube. The sine wave from generator 22 is connected to the control grid; wire 16 connects to the suppressor grid. In this AND circuit, plate current flows only when both the control and the suppressor grids are excited simultaneously. The magnitude the current is proportional to the instantaneous control grid voltage.



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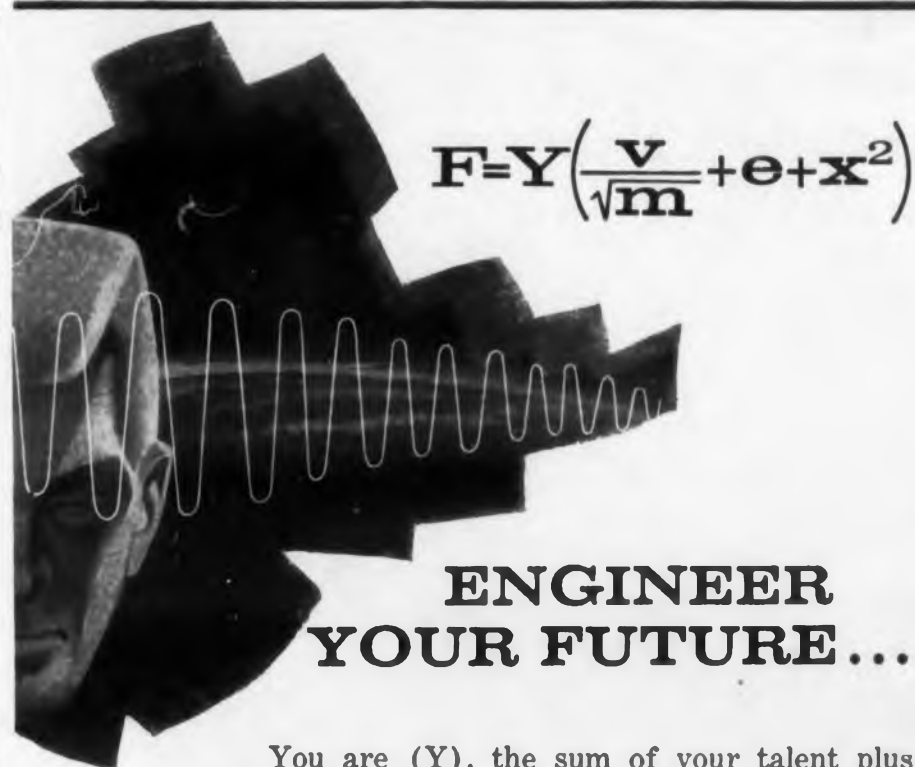


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## BOOKS

### Engineering Economics for Professional Engineers' Examinations

Max Kurtz, McGraw-Hill Book Co., 330  
W. 42nd St., New York 36, N.Y., 261 pp,  
\$6.50.

This book is devoted exclusively to helping the reader prepare for and pass the engineering economics section of the Professional Engineers (P.E.) examination. It covers in concise detail all the important aspects of engineering economics, including the time value of money, investments, sinking funds and annuities, amortization of loans, depreciation, capitalized cost, and the law of contracts.

Many exercises and problems are provided, mostly given with answers or worked-out solutions. Many of these problems are taken from previous P.E. exams.

### The Technical Institute In America

G. Ross Henninger, McGraw-Hill Book  
Co., Inc., 330 W. 42nd St., New York 36,  
N.Y., 277 pp, \$6.00.

This book, in The Carnegie Series In American Education, describes technical institute education in the U.S. today and discusses both its present status and future trends. It strives to resolve the existing confusion between technical institute education, professional engineering education, and vocational-trade education and places the technical institute in its proper perspective as an integral part of the American technical education process.

The author reviews the history of technical education and discusses the philosophy of the "technical institute idea in



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higher education." He describes current administrative practices and problems. Finally, he gives a generous and authentic cross section of currently recognized and accredited technical institute curriculums, including course outlines and descriptions of representative courses. Every aspect of the institute is covered, including student body, faculty, finance, and physical plant.

The book summarizes and consolidates the information developed through the 1956-1958 National Survey of Technical Institute Education, conducted by the American Society for Engineering Education under a grant from the Carnegie Corporation and directed entirely by the author.

#### Servomechanism Fundamentals

Henri Lauer, Robert Lesnick, and Leslie E. Matson, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y., 489 pp, \$10.00.

Written for the engineering student and the practicing engineer, the basic purpose of this book is to introduce the

principles underlying the theory of servomechanisms. It is a revised and enlarged edition of the earlier work by the same authors.

The first three chapters are mostly introductory, outlining the general principles of servo control devices. Chapters 4 through 8 present elementary servomechanisms by deriving their responses to suddenly applied input motions and sinusoidal inputs. Chapters 9 and 10 cover the principles of transfer function analysis of servomechanisms. A chapter on nonlinear servo systems illustrating, in part, the phase-plane methods of representation, is included. The final chapter contains examples of design problems worked out in some detail. However, throughout the text there are examples, exercises and problems, together with the formulas, graphs, and diagrams necessary for their solution.

Not discussed in the text are methods of Laplace transform representation, and the root locus method. Instead, methods are used which emphasize the differential equation as the basic description of both linear and nonlinear servomechanisms.

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\*U.S. Patent No. 2,612,459

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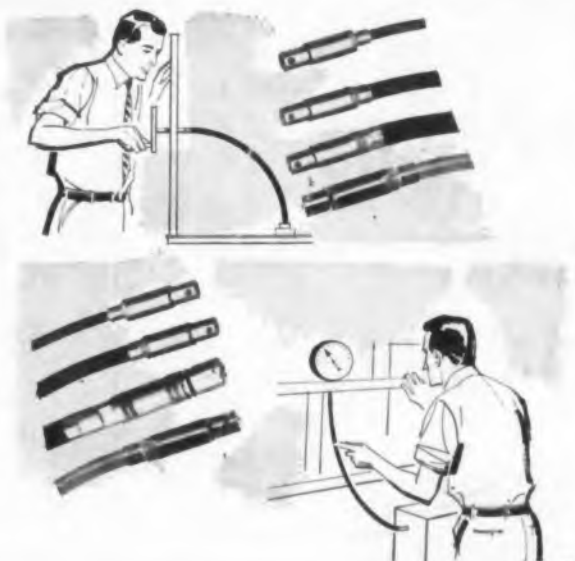
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## RUSSIAN TRANSLATIONS

J. George Adashko

# A Stabilized

**A** STABILIZED current source, suitable for supplying vacuum tube filaments, is shown in Fig. 1. The base of the transistor is fed from stable voltage source  $U_{ST}$ . Because of the nonlinearity of the transistor output characteristics, Fig. 2, the collector current  $I_c$  is almost independent of fluctuations in the rectified voltage  $U_{SUP}$ . Con-

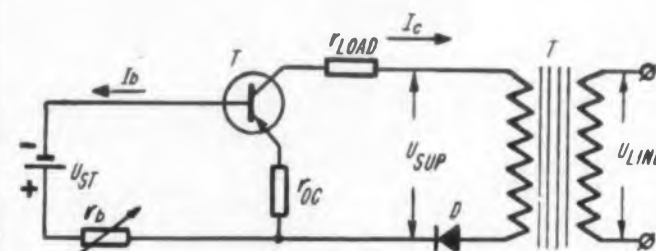


Fig. 1. Principal diagram of filament current stabilizer.

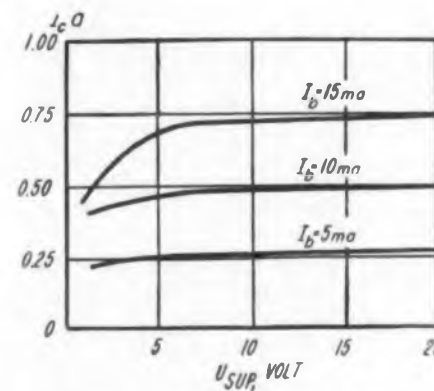


Fig. 2. Output characteristics of type P4U transistor in a grounded-emitter circuit with  $r_{oc} = 2$  ohms.



# Current Source

for  
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lin-  
Fig.  
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on-  
LINE  
izer.

sequently fluctuations in the line voltage  $U_{line}$  also have little effect on the primary winding of the stepdown transformer  $T$ .

By varying the resistance  $r_b$ , it is possible to establish the value of the base current  $I_b$ , and through this, the value of  $I_c$ . Resistance  $r_{oc}$  serves, as is customary in such circuits, to stabilize the current  $I_c$  via negative feedback. Transistors with current gains greater than 20 should be used in this grounded-emitter circuit. With these gains, a base current of 10 to 40 ma, will stabilize a load current of up to 1 amp. The voltage stabilization coefficient depends on the characteristics of the transistor and on the resistance  $r_{oc}$ . It usually ranges from 15 to 30.

The stable voltage source may be a dry cell. However, much better results can be obtained by using a more powerful source of stable voltage, such as a storage battery or an electronic stabilizer. If transistors are connected in parallel, economic stabilization of currents on the order of tens of amperes can be obtained. Tests have shown that the drift in the load current after 30 min of warm-up time amounts to not more than 0.2 per cent per hour.

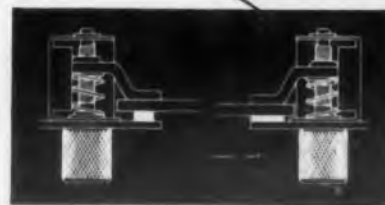
It should be noted that usually in devices where large-current stabilization is required, there is also stabilization of the plate voltage. This voltage can be used to provide the transistor reference voltage.

Translated from Instrument and Measurement Engineering, No. 5, September-October, 1959, pp 145-6.

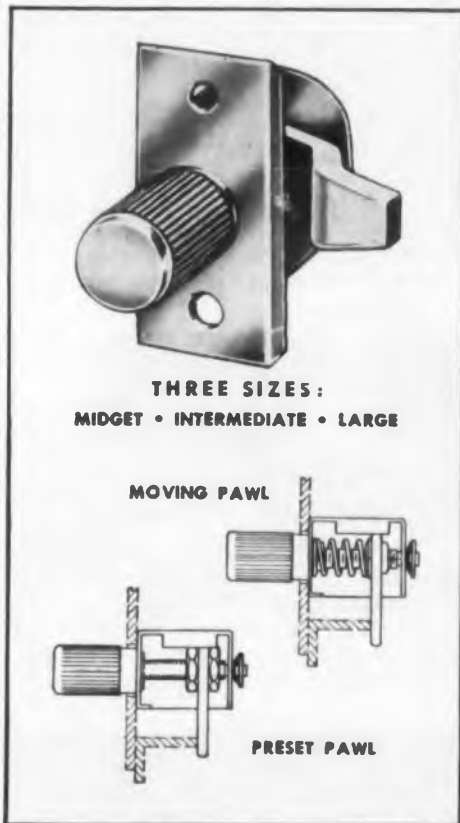
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## GERMAN ABSTRACTS

E. Brenner

# Phase-Corrected RC Networks

**T**HE ELEMENTARY RC low and high-pass two ports, Fig. 1, have small deviation from 90-deg phase shift only over a fraction of their passbands. Thus, when phase characteristics govern the design, their filtering characteristics cannot be used. Since the networks also have high attenuation in the integrating or differentiating bands, if a phase error of the order of 0.1 deg is

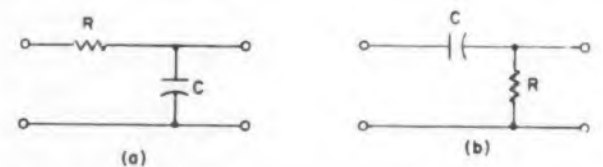


Fig. 1. Elementary RC integrator and differentiator.

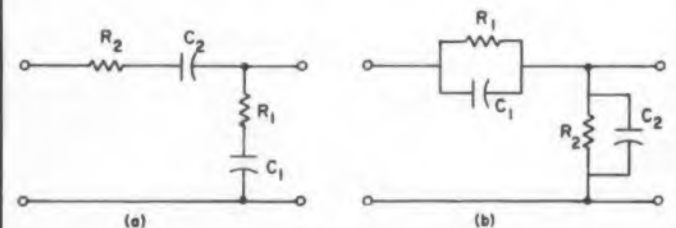


Fig. 2. RC phase equalizers. Either network can correct for positive as well as negative phase errors. If only positive errors are to be corrected,  $C_2$  in (a) or  $R_2$  in (b) is omitted. To correct only negative errors,  $R_2 = 0$  in (a) or  $C_2$  in (b) is omitted.

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allowed, an undesired band corresponding to two decades above or below cut-off is transmitted without relative attenuation.

Active networks, such as the Miller integrator, or passive equalizers isolated by buffer stages may be used to compensate for these effects. Simple passive phase equalizers are shown in Fig. 2. Either of the two networks can correct positive as well as negative phase errors. If only positive or only negative errors are to be corrected, they can be simplified to three-element two ports.

For the networks of Fig. 2, the complex voltage gain is:

$$\frac{V_2}{V_1} = A_0 \frac{1 + j\omega T_1}{1 + j\omega/b_0} \quad T_1 = R_1 C_1$$

where for Fig. 2a:

$$A_0 = \frac{C_2}{C_1 + C_2} \quad b_0 = \frac{1 + C_1/C_2}{1 + R_2/R_1}$$

and for Fig. 2b:

$$A_0 = \frac{R_2}{R_1 + R_2} \quad b_0 = \frac{1 + R_1/R_2}{1 + C_2/C_1}$$

The phase shift provided by these networks,  $\varphi_c$ , is given by:

$$\tan \varphi_c = -\frac{1}{x + k/x}$$

where:

$$x = \omega T_1 / (1 - b_0) \\ k = b_0 / (1 - b_0)^2$$

The optimum parameters of the networks for compensating the characteristics of the high-pass, Fig. 1b, are obtained by choosing  $\omega RC = x$ . Then the total phase error,  $\varphi_e$ , is given by

$$\tan \varphi_e = \frac{k}{x^3 + x(k + 1)}$$

The optimum value of  $K$  that corresponds to an allowable phase error  $\epsilon$  is fixed by requiring an increase from  $(90^\circ - \epsilon)$  to  $\epsilon$  in the minimum band. The optimum result is  $T_1 = T/2$ ,  $T = RC$ , using Fig. 2a with  $C_2$  omitted.

The resulting cascade has a frequency response peak of 15 per cent. It is at a sufficiently low frequency so that the attenuation characteristics in the band  $\varphi_e < \epsilon$  is not materially affected. The cascade has an error  $\epsilon$  at  $x = 2(2/\epsilon)^{2/3}$ , while the original network has a phase error  $\epsilon$  at  $x = 1/\epsilon$ .

For the low pass circuit the optimum value is  $T_1 = 2T$  with similar extension of the useful band.

Abstracted from an article by D. Gossel, Archiv der Elektrischen Übertragung, Vol. 13, No. 12, December 1959, pp 525-529.



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**MINNESOTA MINING AND MANUFACTURING COMPANY**

... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 219 ON READER-SERVICE CARD

## YOUR CAREER

## NEWS AND NOTES

*A Midshipman from Mugu  
Built a missile which actually flew.  
He got himself medals  
Cause he did it with pedals.  
It really caused quite a to-do!*



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Rocket and space advances are pushing out the boundaries of college engineering curriculums. At least three engineering educators have touched on this theme publicly of late.

Dr. Gordon S. Brown, dean of engineering at Massachusetts Institute of Technology, reported to the Winter General Meeting of AIEE that engineering colleges were increasingly foregoing specialization in four-year curriculums. Instead, he said, they are stressing an "integrated body of fundamental knowledge." Industry, he added, must recognize this changing situation and move to meet it.

Addressing the same meeting, M. L. Manning of South Dakota State College at Brookings said that curriculum reform was long overdue. The old distinctions between mechanical, electrical and civil engineering "have partially vanished," he said, and "the basic principles of engineering analysis, together with the science and mathematics subjects basic to engineering, can easily occupy a full four-year program if the humanities and social studies are included." Detailed specialization, he added, should be deferred to graduate work, supplemented by on-the-job educational programs sponsored by industry.

Dr. John A. Hrones, vice president of academic affairs of Case Institute of Technology in Clevel-

and, called attention to the traditional barriers between one branch of engineering and another. Lecturing before the Institution of Mechanical Engineers in London, he noted an urgent need for engineers who could deal with complex problems involving many disciplines.

"At both Case Institute of Technology and the Massachusetts Institute of Technology," he said, "research and design activities and control systems have led to the establishment of inter-departmental laboratories, attracting faculty and students from mechanical engineering, electrical engineering, from the management school and from mathematics."

Why do good engineering teachers leave colleges? A high percentage who take industrial positions do so for higher salaries, according to a survey of 235 former teachers from 77 colleges. A hundred and sixteen reported that income and fringe benefits were the deciding factors in their moves.

Annual salaries of the 235 averaged \$5800 in teaching, or \$7650 when extra income—such as summer jobs and consulting—was included. In their first year in industry the former engineering teachers averaged \$9800.

But money isn't the only reason for switching

from scholastic to industrial posts. Also cited were dissatisfaction with teaching loads, administrative details and relations with college and administration.

The report was prepared under the direction of A. R. Hellwarth, assistant dean of the University of Michigan College of Engineering.

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The "ideal" supervisor for creative groups is a many-splendored human to many engineers. To Gordon C. Lange, executive director of Swarthmore Creative and Development Services, such a supervisor has these qualities:

"An experimental type of mind, with a courageous heart, the patience of a saint and the spiritual development of a Gandhi. The constitution of a horse would help. All of this has to be balanced and controlled by an overriding tenacity of purpose. In short, the ideal doesn't exist, but we can and should search for him!"

The quip appears in the published symposium "Company Climate and Creativity," prepared by Deutsch & Shea, Inc., technical manpower consultants.

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Engineers Joint Council has expanded the circulation of its bulletin. For the first time, all members of organizations affiliated with the council (about 200,000 to 250,000 in the U.S.) are receiving the EJC bulletin directly by mail.

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"Engineering schools should teach only those subjects which will be valid 15 years from now," declared E. F. Branahl, a manager in the missiles division of McDonnell Aircraft Corp.

Speaking at the 12th annual conference of the American Society of Engineering Education at Washington University, St. Louis, Mr. Branahl explained that advances in space-age technologies and engineering were occurring with such speed and diversity that the universities could not hope to keep abreast of them.

Instead, the universities should emphasize fundamentals with which the engineer will always be involved. Practical training will come with the job.

Mr. Branahl pointed to the basic dichotomy facing the fledgling engineer. He may search for detailed answers in a specific field. This calls for narrow and deep training. Or he synthesizes the work of a great many fields. Here, a broad education with less depth is preferred.

Mr. Branahl suggested industry employ professors during the summer to acquaint them with up-to-the-minute problems in engineering and technology. This would give their lectures freshness and immediacy.



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Position Desired \_\_\_\_\_

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College	Dates	Degree	Major	Honors

Recent Special Training \_\_\_\_\_

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All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN*.

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Flames swept across the open plains as the Mongol hordes ran in terror from the "arrows of flying fire". When the smoke had cleared the Chinese had won the battle of Pienking with the first rocket.

Missiles have become greatly more sophisticated since this crude unguided arrow was propelled by gunpowder packed in an open-ended bamboo tube. Today, as a vital part of one of the world's largest electronics companies, Raytheon's Missile Systems Division is making significant contributions to the art of missilery. The exciting new Pin Cushion Project for selective missile identification, the constantly advancing Navy's air-to-air SPARROW III and Army's HAWK are examples of their outstanding creative work.

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Please reply to Mr. Walter N. Wells, Professional Personnel, Missile Systems Division, Raytheon Company, 520 Winter Street, Waltham, Massachusetts.



... creates a climate for talent.

CIRCLE 902 ON CAREER INQUIRY FORM

## CAREER NEWS

**Maj. Gen. J. B. Medaris**, missile commander who retired from the Army last month, has joined Electronic Teaching Laboratories of Washington as chairman of the board. The organization promotes the use of electronic equipment in language instruction. Programs it has fostered range from the experimental treatment of speech defects in the United States to a highly successful adult literacy program in Tunisia.

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Strain-gage techniques will be presented in a five-day course in San Antonio, Tex., under the sponsorship of the Society for Experiment Stress Analysis and Southwest Research Institute. The meeting, April 4 through 8, will cover such topics as:

Basic theory of wire-resistance strain gage; temperature effects in strain gages; installation of strain gages at normal and high temperatures; mechanical and electrical aspects of the gage system; electric circuits for strain gages; dynamic and static strain measurements; computing bridge circuits for direct measurements of quantities depending upon more than one strain; stresscoat as an auxiliary tool; measuring systems and instruments; rosette analysis, and load monitoring and stress analysis.

Tuition for the course is \$175. Address inquiries to Dr. M. M. Lemcoe, Southwest Research Institute, P.O. Box 2296, San Antonio 6, Tex.

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Sliding enrollments in undergraduate engineering have prompted words of caution by the Engineering Manpower Commission of Engineers Joint Council. Enrollments in the nation hit the skids last fall for the second consecutive year: over-all undergraduate engineering total down 5.4 per cent to 234,000; freshmen down 3 per cent to 68,000. Because of the drops, the commission noted in a special report, graduating classes for the next five years will average 37,500, compared with pre-1958 estimates of 43,000.

Against this trend, the report said, are these signs of increased demand for engineers: meteoric growth of technical manpower in the 1950's and projections of continued growth in the 60's; rising recruiting goals in industry; anticipated soaring of Gross National Product; development of new fields of engineering and technology.

The commission sees two inescapable objectives: available engineering manpower must be used to the fullest in the most efficient way, and the future supply must be brought up to expanding needs.

The report, "Engineering Manpower and the National Interest," is available in quantity free from EMC, 29 W. 39th St., New York, N.Y.

CIRCLE 900 ON CAREER INQUIRY FORM  
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