

# ELECTRONIC DESIGN

JUNE 10, 1959

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All-Transistor, Battery  
Operated TV... page 186



An *ELECTRONIC DESIGN* Staff Report

## DIODES

...page 27



# Precision Computing Resolvers



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## HIGHLIGHTS OF ISSU

**ELECTRONI  
DESIG**



### Portable TV (Cover) ..... 186

The first truly portable TV has been put on the market by Philco. It is cordless, transistorized and can be lifted with one finger. Compactness is achieved through the use of an optical arrangement that magnifies a two-inch kinescope picture to 14 inches.

### Diodes ..... 27

Our March 18 editorial invited comments on the need for diode standardization. Questionnaires were sent to hundreds of design engineers in a survey of the diode industry. The results are presented, together with comments and suggestions, in this staff report on Diodes.

The editors examine in detail the factors that contribute to confusion in selecting the proper diode.

### Want to Advance Your Career?

If you are interested in job advancement within your own company or with another organization, you will want to study the announcements and advertising beginning on page 76. Three new regular departments start in this issue, offering: articles on Designing Your Future, listings of Career Opportunity Brochures and a new, rapid Career Inquiry Service form.

Ground rules for success in engineering are covered in this issue in the article, "How to Get Ahead, The Do's and Don'ts," by E. N. Kaufman. Next issue will present a discussion on the subject of transferring from engineering to managing.



## NEWS

Power Sent by Microwave 3

## EDITORIAL

Let's Not Wait Till Next Year 25

## SPECIAL REPORT ON DIODES

Diodes—Choice Performance . . . But Difficult Choice 27

*This special staff report covers the basic problems in specifying diodes, how to cope with confusion, and recommendations.*

Semiconductor Diode Directory of Manufacturers 39

*Manufacturers of eight categories of diodes are tabulated.*

Diffused Silicon Diodes 42

*Advantages of using silicon types diodes are explained . . . F. R. Carlson*

Secondary Effect of Diode Leakage in Selection Matrices 46

*Fall time characteristics of switching circuits can be improved by using diode isolation . . . I. N. Saxe, M. Collins*

Using Diodes as Power Supply Filter Elements 50

*Diodes, used as filter elements, reduce cost and size of equipment . . . D. T. Geiser*

## REGULAR FEATURES

Some Useful Plastics for Special Requirements 52

*Outlines characteristics of a few plastics proving useful for special applications . . . H. J. West*

Thermal Considerations in the Use of Power Transistors 56

*Practical approach to thermal dissipation problems . . . J. R. Baum*

Computer Techniques Help Square Square Waves 60

*Pulse amplifiers and flip flops produce square waves*

Miniaturizing With Modules 62

*Basic considerations in developing miniature modules for electronic equipment . . . D. I. Buchman, N. Guletsky*

How To Get Ahead, The Do's and Don'ts 76

*What every engineer should know to succeed . . . E. N. Kaufman*

Thermoelectric Unit Heats, Cools, Generates Power 179

*New semiconductor uses Peltier effect*

Micro-Diode Designed for Computer Applications 180

*Tiny diodes are ideal for computer*

650 Micro-Module Diodes Fit In 1 Cubic Inch 181

*New diode available in micro-module form*

Three Diode Testers Have Modular Construction, Automatic Features 182

*New testers designed with automaticity and flexibility in mind*

All Transistorized Portable TV 186

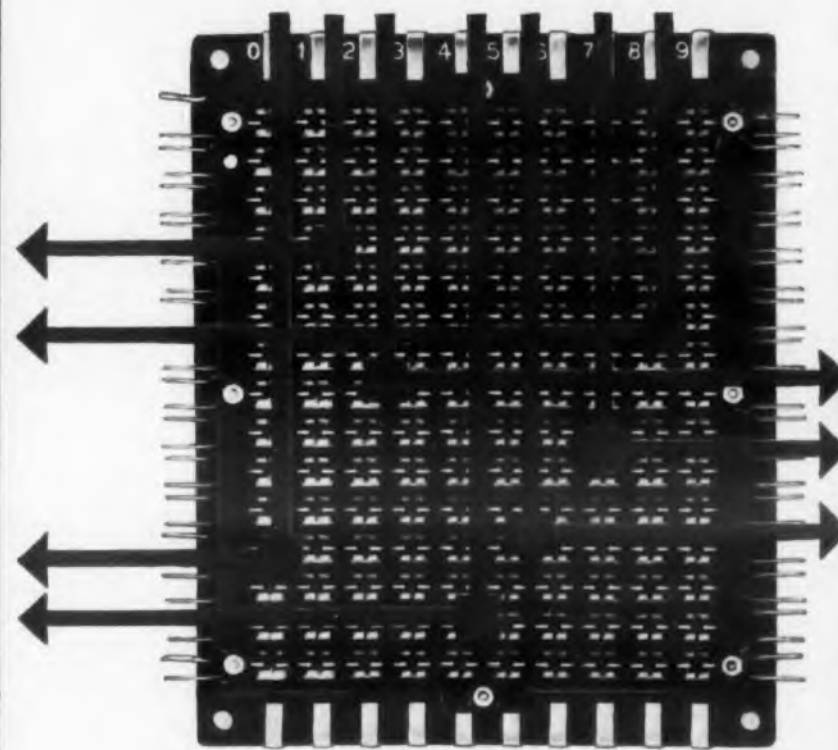
*First portable TV to reach the market*

## DEPARTMENTS

Washington Report	16	New Literature	83
Meetings	20	Russian Translations	90
Ideas for Design	66	German Abstracts	108
Standards and Specs	74	Report Briefs	110
Designing Your Future	76	Patents	114
Career Opportunities		New Products	120
Brochures	80	Advertisers' Index	190

systems translation . . .

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CIRCLE 3 ON READER-SERVICE CARD

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# Amplitron Developments May Mean Power Sent by Microwaves



**Proposed sky platform** would be made possible by Amplitron improvements. Helicopter-like vehicle in this artist's conception hovers about 7 miles above earth to do a variety of heretofore impractical jobs. The platform would carry a circular array of receiving antennas and would be slightly less in diameter than the energy focal area.

**T**WO DEVELOPMENTS—newly designed Amplitron microwave-generating tubes with efficiencies as high as 80 per cent and designs for cooling systems that remove 10 times more heat from the tubes than previously possible—are expected to permit the manufacture of tubes with power levels up to 100 times that of present models. These new tubes, in turn, could lead to a long-sought goal; the transmission of electrical power without wires.

Raytheon, makers of the Amplitron, has already proposed a sky

platform based on the capabilities of the new tube.

The improved Amplitron designs are a result of digital and analog-computer studies of optimum efficiency of the basic tube. The 80 per cent efficiency represents four times the power output of a tube operating at 50 per cent efficiency, in which half of the power input is dissipated within the tube. Amplitrons with the improved cooling system are not expected to be available for a year.

Raytheon's sky platform, which  
*(continued on page 4)*

## Satellites to the Rescue?

In the favorable climate of growing support for an observation satellite program, a satellite-mounted search and rescue system is under study.

The new system would locate nose cones, space capsules, downed planes or ships in trouble. Preliminary work on the method is being conducted by Space Electronics Corp. of Glendale, Calif.

The company suggests that perhaps six satellites, circling 1000

mi above the earth, would receive signals on distress frequencies from lost vehicles. The Doppler effect, involving frequency change of received signals, would be used to pinpoint the vehicles.

The satellites would record incoming signals on a tape that also recorded time signals. The findings would be telemetered to interrogating stations on the ground.

In the Lockheed observation satellite program, called Big Brother or Midas, satellites would circle at about 300 to 400 mi above the earth in 90-min orbits.

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## NEWS

the Air Force is now considering, would be essentially an unmanned helicopter. It would rise and return from its station, using a relatively conventional engine powered by a chemical fuel. Once in position, the helicopter's rotors would be turned by microwave power generated from the ground. This would be done as follows:

A battery of Amplitrons on the ground would feed a 400-ft square array of dish antennas, focusing 3-cm waves on a 100-ft-diam circular array of horns protruding from the vehicle's flat or concave bottom.

Waveguides would carry the energy to radar-type lossy elements, designed to get hot enough to heat compressed gas or air. The compressed gas or air would drive heat turbines that would spin the station's rotor blades. At the proposed operating altitude of about 35,000 ft, air density would be about three per cent of normal.

Antenna size would determine operating altitude. Altitude in turn would determine whether air or gas would be used in the heat turbine. Above 10 mi, air losses about 99% of its ground-level density.

The station would be equipped with automatic, electronic drift-compensating controls that would sense drift out of the energy focal point. The company asserts that 50 per cent of the microwave power generated on the ground could be focused on the receiving antenna and that 35 per cent of the ground power could be delivered to the heat exchangers.

Normally, heat generated in handling microwaves would be considered a liability. The proposed system turns this liability into an advantage.

The platforms could be used for relaying radio and TV signals, tracking missiles, observing weather, or as early-warning stations and lighthouses.

As proposed, the sky station would be unmanned except during flight testing. ■ ■

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## Soviet Solid-State Journal Available

An important new Russian journal on solid-state physics is now available in English translation from the American Institute of Physics.

Russian title is *Fizika Tverdogo Tela*; editor is A. F. Ioffe, world-famous physicist. The monthly periodical presents results of theoretical and experimental investigations in the physics of semiconductors, dielectrics, and associated applied physics.

The English-language edition, titled *Soviet Physics-Solid State*, is published by the American Institute of Physics, 335 E. 45th St., New York 17, N.Y.

## New Target Material Boosts Orthicon Sensitivity

Extremely low-light-level operation is possible with a newly designed image orthicon that uses a high-gain, thin-film target made of a new material.

GE's new tube, the Z-5294, can pick up usable images of stationary or moving objects with a light level of only  $3 \times 10^{-7}$  foot-candles on its photocathode. At a scene brightness of  $2 \times 10^{-5}$  foot-candles, resolution of 200 lines can be obtained.

RCA's 6846 low-light level tube provides 100 to 150 lines with a  $1 \times 10^{-7}$  foot candles of light on its photocathode. However, Farrand Optical Co., which makes a Nite-Owl low-level TV viewing system applicable to any orthicon, is using the RCA tube to achieve extremely low-level, high-resolution operation.

Westinghouse guarantees for its WL-7198 orthicon 275 lines of horizontal resolution at a photocathode light level of  $3 \times 10^{-4}$ .

The new, non-glass, thin-film target in the GE tube is only 2 to 3 millionths of an in. thick, but has an inherent ability to inhibit sideways leakage of electrons. The target functions on the basis of electronic conduction rather than on the standard sodium-ion principle.



## Contamination Control: State of the art

*Happily for you*, Hughes frowns on poor house-keeping. In fact, our plants are famed for cleanliness...and all the other controls that insure highest product quality.

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For additional information about Hughes components or systems please write: Hughes Products, Marketing Dept., International Airport Station, Los Angeles 45, California.



New orthicon is standard in configuration but gives better results in a specially adapted TV camera.

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MTR28-5	24-32	5
MTR28-10	24-32	10
MTR28-30	24-32	30
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DYNAMIC REGULATION:  
RIPPLE:  
DYNAMIC IMPEDANCE:  
PROTECTION:

WEIGHT:  
DIMENSIONS:  
SPECIAL FEATURE:

### SPECIFICATIONS

6-36 Volts @ 15 Amperes  
105-125 Volts, 1 phase, 60 cps  
Line —  $\pm 25$  MV; Load —  $\pm 50$  MV  
Line:  $\pm 50$  MV; Load:  $\pm .75$  V. No Load to full load  
& FL to NL  
5 MV RMS Maximum  
50 Milliohms (0 CPS to 20 KC)  
Short Circuit Proof — Automatic Current Limiting at 18  
Amperes. (Short Circuits and Overloads can be sustained  
indefinitely without damage to the power supply.)  
Approximately 125 Lbs.

19" W x 15" D x 12 $\frac{1}{4}$ " H (Rack panel mount) 20 $\frac{1}{2}$ " W  
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## NEWS

### Faster Photomultiplier Designed

A new photomultiplier tube for scintillation counters and nuclear radiation spectrography has been designed with extremely high definition.

A new electron optical system in the tube is said to reduce transit-time differences to 0.3 milli-microsec, about 100 times better than that of conventional photomultipliers. Output pulse width and rise time are reported as little as 2 millimicro-sec.

The 56 AVP tube, manufactured by Mullard, Ltd., of Great Britain, contains a curved photo-cathode that equalizes travel distance for all electrons leaving its surface. Accelerator and focusing electrodes make up for initial differences in electron velocities.

Opaque silver-magnesium secondary cathodes help provide peak anode current of 1 amp, making an external amplifier unnecessary. Gain under typical conditions is 108 or higher, according to the company.

### Relay to Speed Air Photos

An air-to-ground photo transmission system is being developed for in-flight relaying of aerial photos.

The new Fairchild camera system is designed to give ground commanders and intelligence officers in forward areas sharp photos within seconds after the airborne shutter is snapped.

The system works this way:

A photo is snapped by a modified aerial camera, and the exposed negative passes into a two-stage processor in the camera's film magazine. There an extremely viscous developer solution is applied. Next a plastic film carrying a fixing solution is layered over the negative. This sandwich permits handling of the film as if it were dry.

The photo is then scanned by an opto-mechanical scanner, originally developed for video recorders, and is transmitted to recorders and direct-view monitors on the ground.

Signals are picked up by a narrow-beam, high-gain antenna slaved to tracking radar. This part of

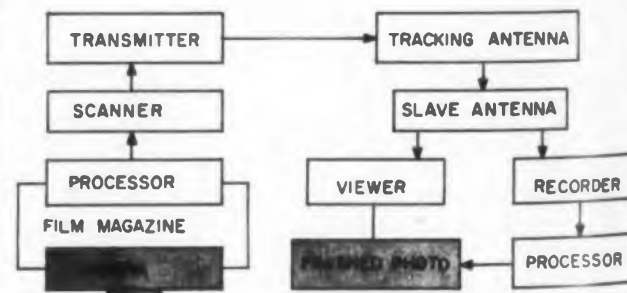


Photo transmission system provides ground personnel with aerial photos comparable in resolution to those of standard aerial camera.



the telemetry link will be designed for quick assembly and disassembly by one man.

The transmission bandwidth is limited by channel allocation to 1.5 mc, which provides only a rough picture for monitoring. One frame requires eight seconds for transmission. The direct-view monitors use storage-type cathode ray tubes.

The high-resolution recorders use photographic film. They are also equipped with fast processors to make finished photos available for standard and stereo viewing.

The first picture of a sequence can be available for viewing within two minutes after the airborne shutter is snapped and succeeding pictures within 10 seconds.

### Tiny Cooler for Infrared Cells

A new infrared device has been developed that can chill an ir cell to 60 deg K (195 C) and raise its sensitivity substantially.

The 8-oz Min-IR-cooler, designed by Arthur D. Little, Inc., is used in a closed-cycle detection system weighing 20 lb. It operates only one moving part—a tiny plastic piston—colder than room temperature. The chilling agent is helium gas, expanding from 300 psi in a 25-in.-diam cylinder.

Cooling an infrared cell makes it more sensitive to any given wave length, particularly to the longer ones. The extra sensitivity ranges from roughly double to a million-fold or more.

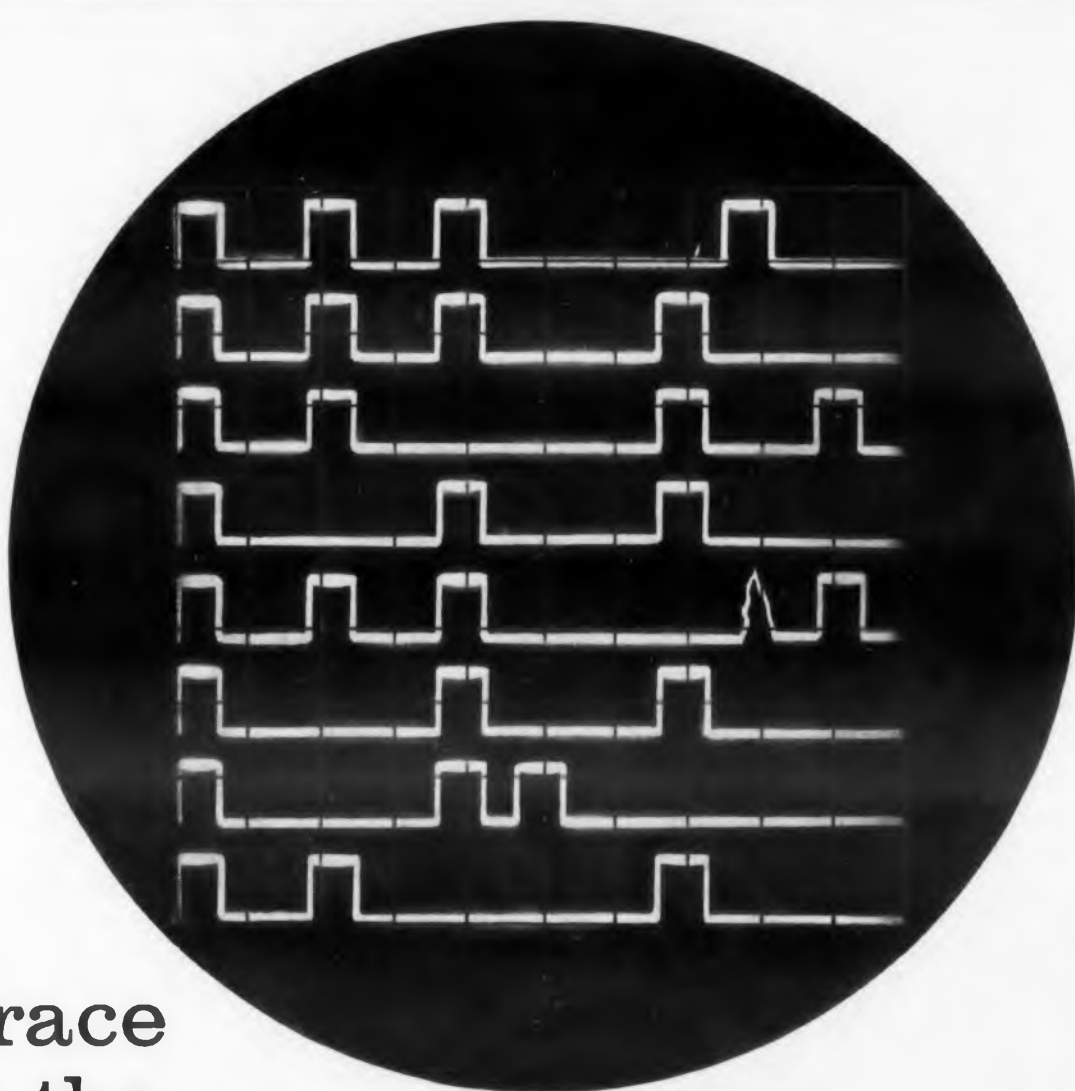
ADL is developing the detector system with the Hamilton Standard division of United Aircraft, which is exclusively licensed to manufacture the cooler for infrared applications only. The company is also applying the same chilling principle to a maser-cooling device. A heavier unit is expected to cool the heavier maser crystal down to about 1.5 K (roughly 5 C).

Replacement of Min-IR-cooler present off-the-shelf compressor is expected to reduce the weight to about 10 lb. For applications not requiring a compressor for an extended supply of compressed gas, the use of a tank could reduce weight much further.



Cold end of compact cooler can chill infrared detector crystals to 195 C.

Trace Retention with MEMO-SCOPE recorder. Application No. 2



which trace  
has the  
transient?

**Data reduction systems** have long been plagued by false signals from intermittents and transients—particularly those using digital bits and words. With the MEMO-SCOPE® recorder you can locate this false information with comparative ease.

For example, the above display shows 8 traces—one showing a non-recurrent transient pulse. The MEMO-SCOPE recorder freezes this transient information on the face of the tube until intentionally erased. Therefore, transients can be retained for study, regardless of the fact that they are intermittent in nature and last only a few microseconds. For more information concerning this application, write for Data Sheet MSAD-A2.

*Many unique problems have been solved with the MEMO-SCOPE recorder through trace retention. Refer your problems to us by writing: Hughes MEMO-SCOPE recorder, Hughes Products, International Airport Station, Los Angeles 45, California.*

A new MEMO-SCOPE recorder accessory... the **Multitracer**... makes it possible for you to automatically program up to 20 different traces on the tube face.

In addition to data reduction trouble shooting, the MEMO-SCOPE recorder makes it possible for you to save time and money in problems associated with:

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- Drift measurements
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- Transducer testing
- XY plotters
- Medical diagnosis problems
- Physical testing
- plus many more

#### SPECIFICATIONS:

Sweep Speed for Storage: 10 microseconds per division to 10 seconds per division (0.33").  
Frequency Response: DC to 250 KC down 3 db.  
Sensitivity: 10 millivolts to 50 volts per division or with optional high sensitivity preamplifier 1 millivolt to 50 volts per division.



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**NEW 1E1 BANDPASS FILTER** The new Bulova 1E1 Bandpass Filters give today's radar microscopic eyes. Shaving the broad frequency range of returning signals into tiny segments, they help reconstruct signals faithfully for maximum information, for accurate measurement of Doppler effect . . . all at greatly reduced noise levels.

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For full information on Bulova standard and custom design filters, on crystal, ovens or packaged oscillators, write Sales Engineering Department, Bulova Watch Company, Electronics Division A-1254, Woodside 77, N. Y.



Typical specification of a single filter in 10 K.C. spectrum:

Center frequency: 144.400 KC  
 Lower 1/2 db. point: 144.330 KC  
 Upper 1/2 db. point: 144.470 KC  
 Lower 3 db. point: 144.300 KC  
 Upper 3 db. point: 144.500 KC  
 40 db. bandwidth: less than 2 KC  
 Insertion loss: less than 1 db.  
 Ripple in pass band: less than 1/2 db.  
 Frequency variation of pass band: less than 10 cps  
 over temperature range of 0°C. to +70°C.  
 Size: 2½" W x 2" D x 1½" H  
 Weight: less than 7 oz.

CIRCLE 8 ON READER-SERVICE CARD

## NEWS

### Air Collision Warner to Be Tested

As part of a vigorous search for a standard, relatively inexpensive collision warning device for aircraft, the Federal Aviation Agency and the Air Force are sponsoring a flight test of Fairchild's PADAR system.

Originally a passive airborne detection and ranging system and now highly developed, PADAR picks up signals from oncoming aircraft via two paths—direct and by reflection from the earth. The time difference between the two signals is measured and the altitude noted. This provides range and rate of closure.

In the test, to be run off immediately a C-123B lab plane will range an F-86L and an F-102, using their standard transmitting equipment.

### Field Radio Has Long Range

An air-portable communications system for Army field use has been designed for a range of up to 3000 miles.

Developed to give field commanders the capability of fixed-station equipment, the new system fits into two vans, exclusive of power supply. It can be set up for interim operation within four hours. Full-capacity operation is possible two days after landing.

The equipment can be airborne within 12 hours.

Adler Electronics of New Rochelle, N.Y., designed the system, AN/TSC-16. It has a 10-kw transmitter with facilities for simultaneous transmission on both upper and lower sidebands, 16 teletypewriter and two voice channels, and a rhombic transmission antenna. Diversity receiving antennas are used, with automatic signal selection.

Transistorization, radical mechanical design and use of the smallest off-the-shelf equipment make it possible to fit the system into its two specially designed vans.

One van houses the transmitter; the other serves



Expandable-sided van contains terminal and receiving equipment of two-van, long-range communications system.





Receiver-comcenter is 30 ft long, has voice, teletypewriter and facsimile facilities. Full crew numbers 48 men.

as receiver-comcenter, with expansible sides for easy servicing and high-storage capacity. Each van is air-conditioned and heated, has its own test equipment and carries more than 15,000 spare items.

The vans operate from different sites and are linked by microwave radio.

### "Calling CQ . . . Calling CQ Stand By for Scientific Discussion"

Amateur radio operators, long noted for their public service in emergencies, are taking an increasing interest in a new role as disseminators of scientific information.

Through the volunteer Military Affiliate Radio System (MARS), the hams have been cooperating in the broadcast of talks by scientists and engineers in electronics, communications and other fields.

S. Edwin Pillar of Whitestone, L.I., N.Y., head of the First Army MARS technical net, reports the presentation of 53 such programs over his group's band in 16 months. To improve what is now an experimental service, he advocates allocation by the Federal Communications Commission of a special band of frequencies for professional groups.

"On the one hand we have this tremendous need for inter-communication by the scientific groups," he says. "On the other hand we have a great communication potential available in the hands of close to 200,000 radio amateurs in this country. All that is necessary to bring the two groups together is the magic catalyst of an organizing force and the availability of some clean channels, on a part-time basis, adjacent to the amateur bands."



## GOLD BONDED

### HUGHES GERMANIUM DIODES

*first of all for reliability.*

Hughes gold bonded diodes exhibit fast recovery together with high forward conductance, low reverse leakage and high peak inverse voltage. They are fusion sealed in a subminiature one-piece glass envelope. This assures you complete isolation from damage or contamination.

Under varied and severe environmental and operating conditions, Hughes Gold Bonded diodes exhibit outstanding performance. You can be assured of reliable performance, since Hughes diodes exhibit the following characteristics: shock resistance . . . vibration resistance . . . thermal stability . . . electrical stability.

Typical performance levels: @ 25°C. unless otherwise stated

	Forward Current (@ +1V (mA min.))	Inverse Current (@ Specified Voltage ( $\mu$ A max.))	Maximum Inverse Voltage (Volts)
1N270	200	100 @ -50V	100
1N276	40	100 @ -50V 100 @ -10V*	60
1N277	100	250 @ -50V* 75 @ -10V*	125

\*Measured @ 75°C.

For additional information write: Hughes Products, Marketing Dept.—Semiconductors, International Airport Station, Los Angeles 45, California.

Creating a new world with *ELECTRONICS*

**HUGHES PRODUCTS**

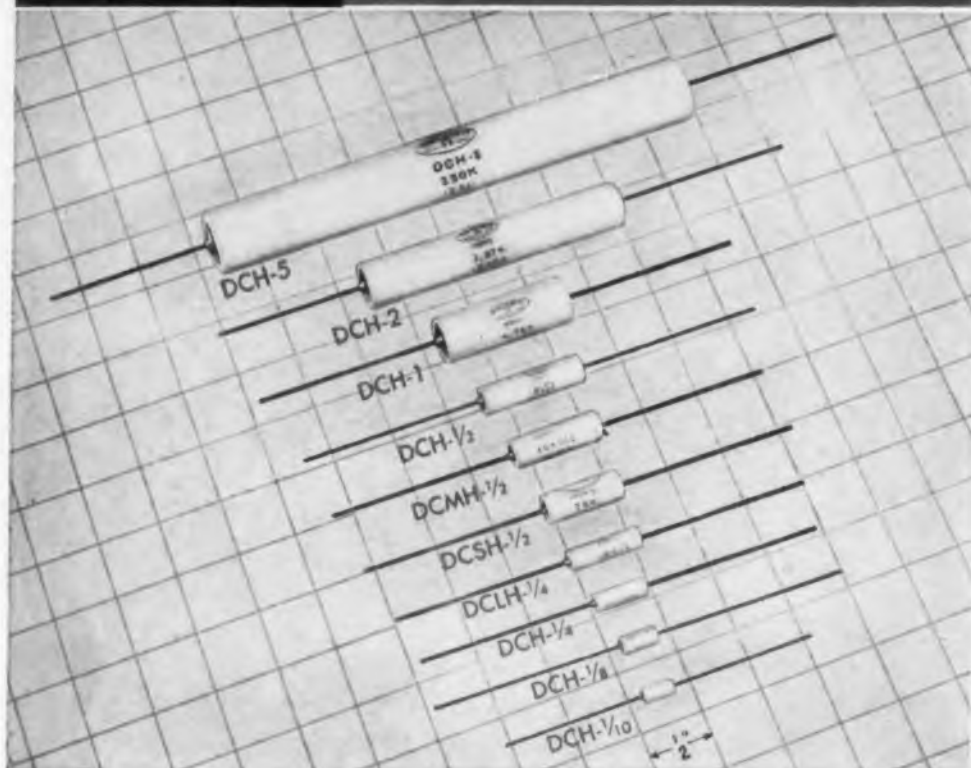
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SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS • OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS

CIRCLE 9 ON READER-SERVICE CARD



... for Complete Reliability Under  
Severe Environmental Conditions



## TYPE DCH HERMETICALLY SEALED RESISTORS

### Deposited Carbon, Precision, Miniature, Ruggedized

A true hermetically sealed deposited carbon film resistor with outstanding stability and rugged performance characteristics. Excellent voltage coefficient, low capacitive and low inductive characteristics for dependable operation under difficult high frequency applications.

- Rated at  $1/10$ ,  $1/8$ ,  $1/4$ ,  $1/2$ , 1, 2, and 5 watts
- Resistance range from 5 ohms to 600Meg-ohms
- Tolerance:  $\pm 1\%$

**TEMPERATURE COEFFICIENT:** 140 to 500 parts per million per degree C., depending on type.

**RUGGEDIZED:** Completely sealed with high temperature alloy solder in newly developed envelope of non-hygroscopic ceramic.

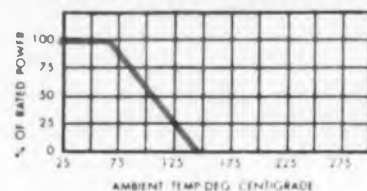
**SMALLEST IN SIZE:** .155" x 9.32" to .562" x 4-1/2".

**RESISTANCE ELEMENT:** Pure crystalline carbon particles that contain no binder or filler.

**MILITARY SPECIFICATIONS:** Surpasses MIL-R-10509B.

Write for Bulletin R-27

TYPICAL DERATING CURVE



### JUST ASK US

The DALOHM line includes precision resistors (wire wound and deposited carbon); trimmer potentiometers; resistor networks; collet fitting knobs and hysteresis motors designed specifically for advanced electronic circuitry.

If none of the DALOHM standard line meets your needs, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.



## NEWS

# Inventions Wanted:

## U. S. Bids Designers Help Solve Military Problems

**T**HE LATEST list of inventions needed by the armed forces includes more than twenty ideas that could come from the electronics industry.

Designers who hear the bell ring on any of the inventions listed here can get more details by writing to the National Inventors Council, U.S. Dept. of Commerce, Washington, 25, D. C.

The glamor item of the current list is a personal, controllable lift device. This should permit the slow descent of a man from an air vehicle to the earth, or allow him to negotiate rough terrain. The operating temperature range should extend from  $-65$  F to 120 F.

Other opportunities for electronics designers:

- **Angle of Attack Meter**—A mechanism to measure angle of attack at hypersonic speeds at high temperatures and in the fringe of the earth's atmosphere.

- **Altimeters**—Simple mechanisms for measuring pressure altitude to 500,000 ft or higher.

- **Precision Wind Meter for Ascending Rocket**—To determine wind speed up to 100,000 ft, or at least 60,000 ft, with an accuracy of one to two mph during the ascent of a small rocket.

- **Automatic or Semi-Automatic Cloud-Droplet-Size Measuring Equipment**—One method to determine the drop-size distribution in clouds is to collect the droplet on a slide, micro-photograph it and count the droplets of different size-ranges. This is very time-consuming. An automatic or semi-automatic device to carry out this task is sought.

- **Wave Measurement Gage**—A device to measure the height of water waves up to 75 ft as a function of time, with an accuracy of one ft. The unit must be capable of measurements in water depths from 25 to 2000 ft.

- **Vibration Isolation Equipment**—Devices to protect sensitive airborne equip-

ment from high "g" stress and severe vibration.

- **Self-Restored Submarine Cable Service**—A system whereby when a break occurs in a submarine cable, the section between repeaters will disconnect and the remaining repeater terminals will start producing sonic waves. A new cable section when put in the area with temporary sonic-seeking, torpedo-type carriers will connect the two end repeaters with the new cable section to restore electrical signal transfer.

- **Pressure Sensing Devices**—A small pressure sensor not dependent on bellows, diaphragms or bourdon tubes, to provide an accurate indication of pressure in fluid lines and combustion areas.

- **Data Transmitting Devices**—Devices accurate and repeatable to within 30 sec of arc. Means are required to transmit electrical signals accurately from sensors to equipment, indicators and subsystems utilized on weapons systems.

- **Preformed Semiconductor Crystals for Device Fabrication**—Germanium and silicon single crystals grown in ribbons or rods, with uniform physical and electrical characteristics, to sizes suitable for direct fabrication into diodes, transistors, solar cells, etc. The semiconductor material should have the properties equal to or superior to material presently used in germanium and silicon transistors. The new growing method should permit the direct utilization of the semiconductor for device fabrication, thus eliminating the conventional wasteful and expensive slicing, lapping and polishing operations. [See *ED*, May 13, p. 3.]

- **Low-Loss, High-Power Ferrites for Use as Microwave Phase Shifter.**

- **A Broadband Maser Amplifier for Use in Microwave Region.**

- **A New Method of Electronically (Not With Frequency Change) Scanning an Antenna.**

- **Reliable Long-Life Cathode**—An



efficient, indirectly heated, unipotential thermionic cathode having 100,000-hr life in negative-grid tube with current density of 500 mdc/cm<sup>2</sup>.

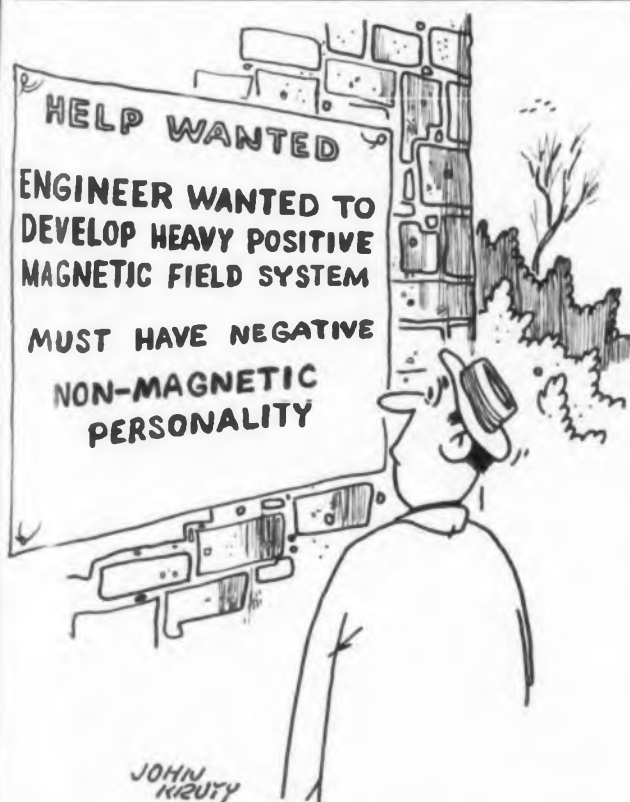
■ **A Dry Battery Performance-Capability Indicator**—A sheet or strip of material that in aging changes colors or textures, or colors and textures.

■ **Carbon Black Evaluation**—A test procedure or device to determine quickly suitability of a lot of carbon black for use in dry batteries.

■ **Resistance Thermometer Filament**—A material having a high-temperature coefficient of resistance, which can be drawn or formed into filament for a resistance thermometer.

■ **Dry Battery Test Method. Two Problems**—(a) Accelerated Dry Battery MnO<sub>2</sub> Evaluation Procedure: An accelerated procedure for evaluating manganese dioxide for use in dry batteries; and (b) Accelerated Dry Battery Evaluation Procedure: An accelerated test method to indicate quality and shelf life of dry batteries.

■ **Water Pressure-Time Gage**—A simple, inexpensive accurate mechanical gage for reliable recording of the pressure-time history of a water shock. The gage is intended for field use and should be self-contained. The pressure-sensing and recording mechanisms must be insensitive to shock, so that the pressure record will not be obscured. Operating depths extend to 200 ft, and shock pressures range from 200 to 15,000 psi. ■ ■



*all-weather radar finds*  *the calm corridor*



Providing a clear picture of turbulence cells in storms ahead. Hughes TONOTRON\* tube gives your airborne weather radar exceptional ability to find the "calm corridor."

Hughes TONOTRON tube gives you several features which make it ideal for weather radar readout and ground mapping:

**Full Gray Scale**—Seven different shades of gray.

**High Picture Brightness**—In excess of 1500-foot lamberts with full halftone range. Even in full sunlight no viewing hood is required—thereby providing maximum safety.

**Controllable Persistence**—Gives you flexibility in analyzing the complete weather problem.

Developed by the famed Hughes Research and Development Laboratories, the TONOTRON tube is just one of the nation's largest family of storage tubes!

For further information about the TONOTRON tube, please write: Hughes Products, Electron Tube Sales, International Airport Station, Los Angeles 54, California.



The new Bendix Airborne Weather Radar uses the Hughes TONOTRON tube for a high-fidelity picture reproduction. With this system the pilot can keep an area as great as 150 miles ahead and to the right and left, under constant observation—day or night.

**The Hughes TONOTRON tube**  
**Applications:** Airborne weather radar, "B" scan radar, armament control radar, plan position indicator information and slow-scan television.

**Available models:** Electrostatic deflection, 3-inch, 4-inch and 5-inch diameters. Magnetic deflection, 5-inch and 21-inch diameters.

\*TRADE-MARK OF H. A. C.

Creating a new world with ELECTRONICS



**HUGHES PRODUCTS**

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CIRCLE 11 ON READER-SERVICE CARD

## NEWS

### Underground Radio Studied

Air Force interest has led to promising headway on the development of an underground communications system that would be almost invulnerable to enemy attack.

The idea is to use a transmitter buried several hundred feet below earth. It would send out an alternating current over insulated electric cables to a pair of buried electrodes. The electrodes would act as an oscillating dipole antenna and disseminate narrow-band, very low-frequency signals.

The signals would move out over a wide area, angle through the earth and travel to the surface to take advantage of a channeling effect that would carry them long distances.

Eventually an underground receiver would pick up the signals looping in from just over and just under the earth's surface.

The Space Electronics Corp. of Glendale, Calif., which is studying the system, says increased power—particularly high-peak power—is needed. And because of bad signal-to-noise ratios inherent in underground propagation, a narrow bandwidth must be used, with its resultant low-information rate.

Another problem is optimizing carrier frequency. Low frequencies suffer less attenuation, but higher frequencies benefit more from the channeling effect. The company reports it is using sophisticated techniques in calculating the variables and is designing both a special antenna and receiver. Information sent over the system would be coded for data-compression.

The advantages of the system? Protection from most enemy attacks, negligible RFI, low vulnerability to counter-measures and low over-all cost.

Its prime application would be the linking of underground missile sites.

### Electronic Sales Peak Forecast

Record sales of \$9 billion were forecast for the electronic industry this year at the 35th convention of the Electronic Industries Association.

And companies can look forward to increasing business for the next several years, Frank W. Mansfield, chairman of the association's marketing data department, told the delegates in Chicago. In making his forecasts, he noted factory sales last year of \$7.5 billion.

The military market for 1959 should reach \$5 billion, Mr. Mansfield asserted, and transistor sales \$300 million.

Electronics, he noted, with 700,000 manufacturing employees, is already the nation's fifth largest

ELECTRONIC DESIGN • June 10, 1959



ANNOUNCING...

## *a new concept in SILICON supply!*

Right off the bat you start doing things the way they *should* be done.

You pick *men* who know — a top-flight manager from the process field, and a well-versed gentleman from the semiconductor field. Then add experienced semiconductor men who understand the device manufacturer's problems. That's your management group.

Next provide a plant. Select a site where conditions are particularly favorable — as they are near the Allegheny National Forest.

Then, devote your efforts *exclusively* to the production of ultra-pure silicon in every form.

This... is Allegheny Electronic Chemicals Co. And this is for you — a *new* concept in silicon supply, a new service for the semiconductor industry.

Your inquiries are invited. Write to Allegheny Electronic Chemicals Co., 207 Hooker-Fulton Bldg., Bradford, Pennsylvania, or 252 North Lemon St., Anaheim, California.

*Silicon polycrystalline bulk, cast  
billets and rods, single crystals, slices,  
seeds and dope.*

# ALLEGHENY

## ELECTRONIC CHEMICALS CO.

207 HOOKER-FULTON BLDG., BRADFORD, PA.

*producers of semiconducting materials for the electronic industry*

CIRCLE 12 ON READER-SERVICE CARD



industry. New sales should rank it even higher, he said.

D. R. Hull, president of EIA, predicted that civilian space-agency expenditures for electronics would total \$4.8 billion through 1970, one-third of all outlays for space equipment.

Transistor figures made special news at the convention. D. W. Gunn, chairman of the EIA's tube and semiconductor division, pointed out that from 1954 to 1959 semiconductor sales grew 20 times—from \$5.1 million to \$112.7 million. He looked forward to semiconductor manufacturers sharing a 1965 market of \$1 billion.

But he went on to discuss "a problem affecting all divisions of EIA—importation of goods from abroad."

"Due to the size and nature of the product, transistors have been affected most severely by the importation of sets and devices," he said, "and it is apparent that some action must be taken to control these imports if the domestic industry is to survive."

## Electronic Night Stick Calls Help



This British-built nightstick is "loaded" with a tiny transistor transmitter that can set off burglar alarms. The watchman presses a button in the butt of the handle. The transmitter sends out a signal, picked up by a loop of wire surrounding the area to be protected. The signal sets off alarms and automatically calls the police. Power supply is 6v, rechargeable battery hermetically sealed into the unit. Multitone Electric Co. of London is the maker.

after routing,  
clip and save



a continuing series on technical topics of specific interest to engineers

## What is the difference between AC and DC capacitors?



A recurrent question confronting the capacitor engineer involves the comparative AC and DC application for chlorinated synthetic oil impregnated and filled paper dielectric capacitors.

Our industry is highly specialized. To realize maximum efficiency and performance of prime equipment and systems, the components utilized must be specifically tailored for the application. Let's see how this concept affects an engineer's decision of capacitor choice.

Although the operations and functions are dissimilar, AC and DC paper capacitors have many similarities. They are almost identical in physical appearance. Both may - - -

- utilize metal containers.
- be hermetically sealed.
- have approximately equivalent case sizes.
- have the same terminal structure.
- have the same container finish.
- be impregnated with chlorinated synthetic oil.

Both are fundamentally a device to store a quantity of electrical energy.

The electrical parameters of AC and DC paper capacitors may appear to be approximately the same. The particular characteristics that are important to their circuit performance are markedly different. Let's now take a look at some of these considerations:

**Insulation Resistance.** This is a very important characteristic of a capacitor used in most DC applications. It is not comparatively as important in the operation of a AC motor running capacitor. In the motor, the capacitor is shunted across a rather low resistance coil.

**Dissipation Factor** — The AC motor running capacitor's useful life may depend greatly on the value of dissipation factor at operating voltage, frequency, and ambient conditions of temperature. Internally generated heat in the capacitor body is proportional to the dissipation factor. Life expectancy is, in turn, inversely proportional to the internally generated heat. The dissipation factor of a DC capacitor is only important as an indicator of general quality.

**Applied Unidirectional Electrical Stress** — This is probably the point of greatest consideration in the comparative rating of DC and AC paper capacitors. Continuous current flow occurs in the dielectric of a DC capacitor upon application of polarized voltage. The magnitude of this current is a function of the insulation resistance at the imposed condition of voltage and temperature. The accumulative effects of these conditions can be insidiously damaging. Eventual capacitor catastrophic failure can occur as a result of progressively accelerated electro-chemical activity. Conductive ions may migrate to one electrode of the capacitor due to the influence of the electrical stress. These ions, primarily acid radicals, may chemically attack the electrode metal, forming metallic salts. The metallic salts may be soluble and may act as a catalyst to

free more conducting ions from the dielectric oil, thus accelerating the destructive action. The capacitor designer combats this condition in a DC capacitor by - - -

- minimizing the initial presence of free acid radicals in all dielectric materials.
- neutralization of trace ions through addition of selected inhibitors.

Such inhibitors are not necessary or desirable in capacitors intended for AC use. The alternating electrical force field does not promote unidirectional migration of mobile ions. We do not infer, however, that the AC capacitor is not subject to chemical deterioration.

**Temperature Rise and Chemical Deterioration** — Both AC and DC capacitors are subject to chemical deterioration as a function of temperature and voltage stress. Chemical activity is roughly accelerated by a factor of 2 for each 10°C increase in temperature. The reactive current in an AC application will cause generation of internal heat as a result of:

- dielectric loss
- resistance losses in the electrodes
- contact resistance losses

The net result is unit temperature rise above the ambient temperature. The capacitor design engineer accomplishes minimum temperature rise by:

- Careful selection of the impregnating oil.
- Careful choice of paper density, purity, and lamination.
- Proper disposition of the internal current carrying members.
- Efficient arrangement of internal capacitive elements.
- Providing maximum heat radiating area in the can surface.
- Providing an efficient heat radiating finish on the container.

The net result is a capacitor of exemplary performance in many AC applications. Such a capacitor will not necessarily deliver optimum results on a continuous duty DC application.

**Frequency Effects** — AC capacitor electrical losses are proportional to frequency, dissipation factor remaining constant. If a unit is designed to operate at maximum temperature rise at a frequency of 60 c.p.s., its internally generated heat will be excessive at any higher frequency. A sizable increase in volume and surface area is necessary for satisfactory performance at increased frequencies. The penalty of ignoring the frequency factor may be a ruptured unit.

We have attempted to cover only the most pertinent factors having to do with the two types of components; to emphasize that AC and DC capacitors are not the same devices. To summarize, they may differ in these respects:

- inherent characteristics of the kraft tissue.
- electrical properties of the impregnating oil.
- internal arrangement of the capacitive elements.
- current carrying capabilities of the internal connections.
- heat dissipating capabilities of the enclosure.

Sangamo Sales Engineers are well qualified to provide council and assistance on the difference encountered in DC and AC oil impregnated paper dielectric capacitors. The Sangamo line is complete and offers a wide selection to meet all applications. In addition, specific Engineering Catalogs are available for your files which clearly define and detail rating factor requirements. Write for Engineering Catalog No. SC59-4.

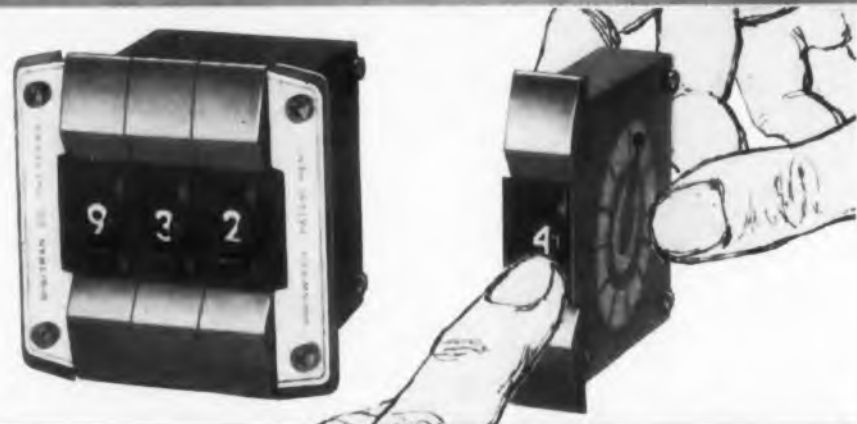
**SANGAMO ELECTRIC COMPANY, Springfield, Illinois**

--designing towards the promise of tomorrow

CIRCLE 13 ON READER-SERVICE CARD



**DIGISWITCH\*** relieves digitension



#### SAVE PANEL SPACE WITH THE DIGISWITCH

Human engineered switch design reduces switch reading and setting errors.

Finger tip switch setting from visual decimal number to binary code (1, 2, 4, 8); to octal code (1, 2, 4, 7) or 10 contact positions (Single or double pole).

Stack any number of switch modules to satisfy design needs. Contacts rated for 200 volts; 1 ampere. Contact resistance 0.5 ohms. Write for complete specifications of Series 7300 Digiswitches.

\* TRADE MARK AND PATENT PENDING

**THE DIGITRAN COMPANY**  
45 WEST UNION STREET, PASADENA, CALIFORNIA  
PHONE: RYAN 1-9667

CIRCLE 14 ON READER-SERVICE CARD

## NEWS



Artificial electronic larynx has a modified telephone receiver at end, which is pressed against throat for voice production. Push-to-talk switch also modulates frequency of vibration.

## Experimental Electronic Larynx

### Uses Pulse Generator

### to Simulate Voice

**A**N ELECTRONIC larynx is being developed for persons who have lost their voices through larynx removal or vocal-cord paralysis.

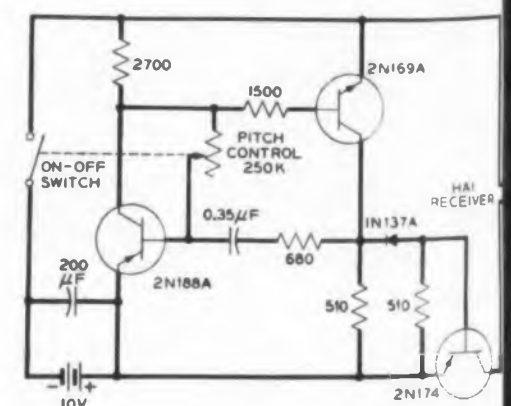
The miniaturized unit pulses vibrations into the throat, where they are transformed by ordinary talking movements into recognizable speech. Designed by Bell Laboratories, the device contains a modified telephone receiver acting as a driver, a pulse generator and a mercury-cell power supply. It works this way:

The operator presses the vibrator-end of the unit against his throat and switches on the transistorized pulse generator. The vibrating drive sends pulses into the throat cavity. There they are turned into speech sounds by normal use of the throat cavity, tongue, mouth, teeth and lips.

Speech volume is equal to the normal voice level, but the sound is a bit buzzy and mechanical. However, a pitch control permits some inflecting. Experienced users can achieve sentence intelligibility of 97 per cent or more.

Circuit parameters are adjusted for maximum acoustic output with minimum current drain. Two transistors are used in a relaxation oscillator, whose frequency is controlled by a variable resistance and whose pulse width is determined by a feedback network.

Output is a negative pulse that may be varied from about 100 to 200 cps by a rheostat that the user operates by pressure on the push-to-talk switch, thus changing the pitch of his voice. For women, the fre-



**Pulse generator** uses 1N137 diode to apply pulses to 2N174 transistor in single-ended power output stage. Circuits yield maximum sound with minimum ma drain.





**Artificial larynx in action.** Unit is held against throat while thumb operates combination push-to-talk and pitch-control switch.

quency range is adjusted to 200 to 400 cps.

A third transistor acts as a single-ended power output stage that amplifies the pulses applied to it from the relaxation oscillator. A diode isolates the multivibrator from the power amplifier input impedance during the period between pulses and is necessary for stable operation.

#### Powered by Mercury Cells

Because a large pulse is required for sufficient acoustic power output at low frequencies, the relaxation oscillator drive circuit has heavy current requirements.

Two 5.2-volt mercury cells in series power the artificial larynx continuously for about 12 hours. These batteries have a 250 ma. hour rating with a maximum permissible current drain of 25 ma. The push-to-talk operation, giving 12 hours of continuous operation, should be equivalent to several days or even weeks of normal talking.

An alternative to mercury cells is a small ac power supply that can be fed from a normal wall outlet at a home or office. When the artificial larynx is plugged into the power supply, its batteries are disconnected from the circuit.

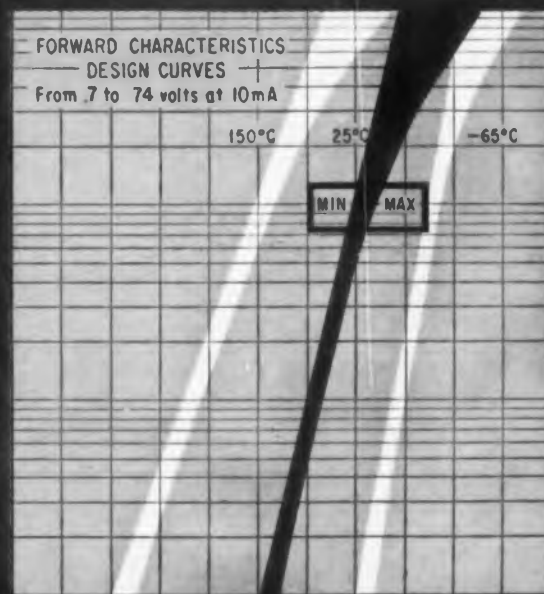
Printed circuitry is expected to cut the size of the present unit. ■ ■

CIRCLE 15 ON READER SERVICE CARD ►

SILICON TRANSISTOR CORPORATION  
NEW SILICON DIODE

# GUARANTEED TOLERANCE

FORWARD BIAS TEST  
100 VOLT, 10 mA



SILICON TRANSISTOR CORPORATION

# WASHINGTON REPORT



Ephraim Kahn

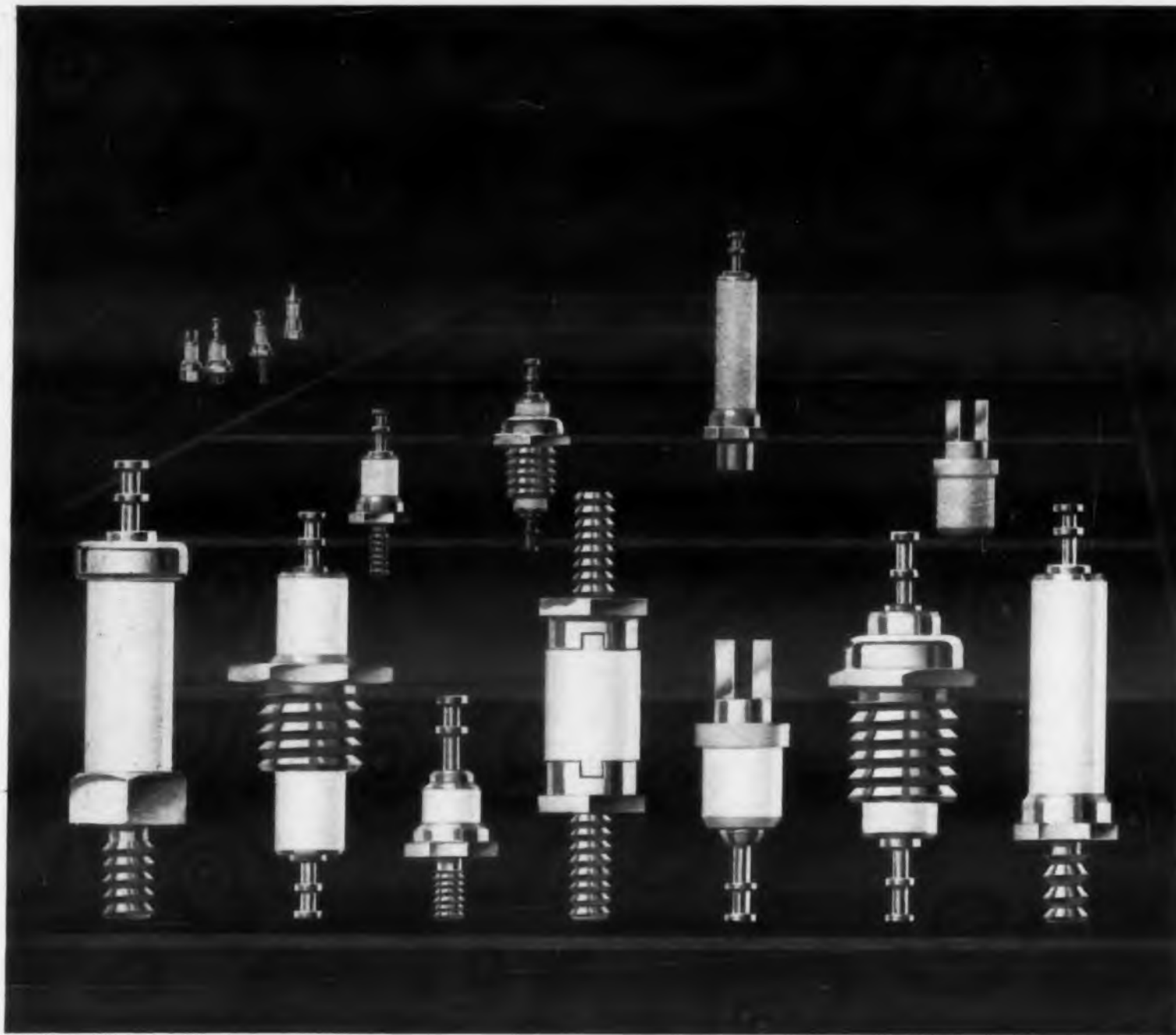
## Light Shed on Three Types of Incentive Contracts

Incentives for defense contractors are starting to shape up, though they are still frankly experimental. Though they have been made a part of the Armed Services Procurement Regulation, they will not be applied across-the-board. Indeed, they can be used only after approval by a high-level military purchasing executive.

Basic type of incentive contracts, which may be written for electronics and other items, are (1) performance and (2) value engineering. Performance-incentive feature may be used in conjunction with fixed-price-incentive or cost-plus-incentive-fee contracts, since it may increase costs to the military. Value engineering provisions are considered suitable primarily where the items being bought are covered by firm government specifications.

Performance-incentive contracts will enable firms to earn bigger profits by providing for payment of a bigger fee if stated targets are surpassed. But a contractor can find his profit cut if he fails to produce an item that meets the government's minimum requirements. To be weighed as a part of "performance" are—in addition to the capabilities of the end-product—such things as timeliness of delivery, ease and simplicity of operation, maintenance economy, etc. Because higher over-all performance of the end-item is the primary objective of such contracts, incentive features will be drafted to reflect a "balancing of the various characteristics which together account for over-all performance, so that no one characteristic will be exaggerated to the detriment of the end-item as a whole."

The military approach the performance-incentive type of contract with considerable caution. They recognize that it is "perhaps most suitable for use in procurements of major weapons systems wherein there are either substantial development goals or potentialities for improved performance which are of great importance to the government." But they acknowledge that "this type of contract poses complex problems in contract administration and should be used only after thorough evaluation of all the factors involved in each case by the contracting officer in conjunction with personnel fully qualified in



CAMBION Insulated Terminals are available in stand-off and feed-through types; with internal or external thread mounts, press-fit mounts, or rivet mounts. And for special mounting requirements, unique types like the Teflon press-fit terminals fill the bill efficiently and economically.

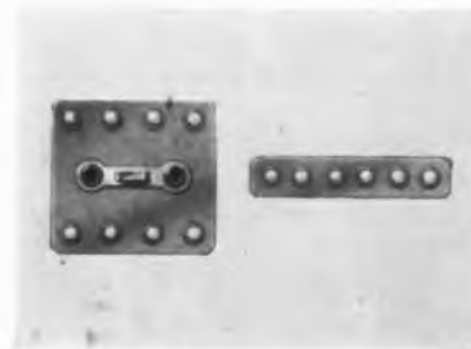
## Solid defense against trouble

You can count on rugged CAMBION<sup>®</sup> Insulated Terminals for trouble-free performance under the toughest service conditions. All three types — ceramic, phenolic, Teflon<sup>®</sup> — withstand constant shock, vibration, and in-service handling. For example, not even prolonged and repeated soldering will loosen terminals on ceramic types. What's more, they're designed to function flawlessly over a broad humidity range; ceramic insulators are silicone-impregnated; phenolic types are varnish-impregnated. In every case, solder terminals are machined from top quality brass and plated to extremely close tolerances; completed units are completely tested for breakdown. And, like all CAMBION components, they're unconditionally quality guaranteed in lots of 1 or 1,000,000.

For complete details, contact your local CAMBION Distributor or write Cambridge Thermionic Corporation,

457 Concord Avenue, Cambridge 38, Mass. On the west coast: E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles, California. In Canada: Cambridge Thermionic of Canada, Limited, Montreal, P.Q.

For high temperature applications, CAMBION Standard Ceramic Terminal Boards provide the ideal solution. Two basic types: 1. Double-row, 8-terminal type in 3 sizes for mounting components with 1/2, 1 or 2 watt resistor body sizes. Ground straps to mounting studs provide positive RF grounding. 2. Single-row, 6-terminal type with end terminals at ground potential. All boards are silicone-impregnated for maximum protection against moisture.



CAMBRIDGE THERMIONIC CORPORATION  
**CAMBION<sup>®</sup>**

The guaranteed electronic components



CIRCLE 16 ON READER-SERVICE CARD



contract pricing." At the outset, it appears as though electronics firms—which clearly work in a most appropriate field for performance incentives—will not be swamped by offers from the military to gamble their skills and inventiveness for a slightly larger payoff.

Value engineering contracts seem to be designed, in part, to furnish the government with better specifications. Their purpose is to ensure that "every element of cost (e.g., labor, material, supplies, styling, and services) contributes proportionately to the function of the item." Contractors will receive a percentage of savings that result from improvements.

Under such a contract, an electronics firm might be required (or encouraged) to maintain a staff to make value-engineering studies. These are intensive appraisals of all the elements of the design, manufacturers or construction, procurement, inspection, installation, and maintenance of an item and its components. Note, however, that under these contracts the government commits itself only to making "reasonable efforts to expedite the analysis of each study submitted by the contractor." If it is accepted, a change order will be issued, "together with a reduction in the contract price corresponding to the agreed percentage of the cost reduction." But, "the government does not have to adopt any study and failure to do so is not subject to the Disputes clause of the contract."

### Reliability Standards to be Tightened

Reliability criteria to be applied by the military in their purchases of electronic gear and other components of weapons systems are starting to get firmer. Soon they will be codified and mandatory reliability goals will be written into new weapons system contracts. Even now, the Air Force is studying a proposed specification for reliability, and it is expected to be made public at the end of June.

The Reliability Monitoring Program, originally proposed for guided missiles, is being applied to all weapons systems by the Air Force. It involves a thorough check on product reliability at specific stages of design, development, and production of a weapons system.

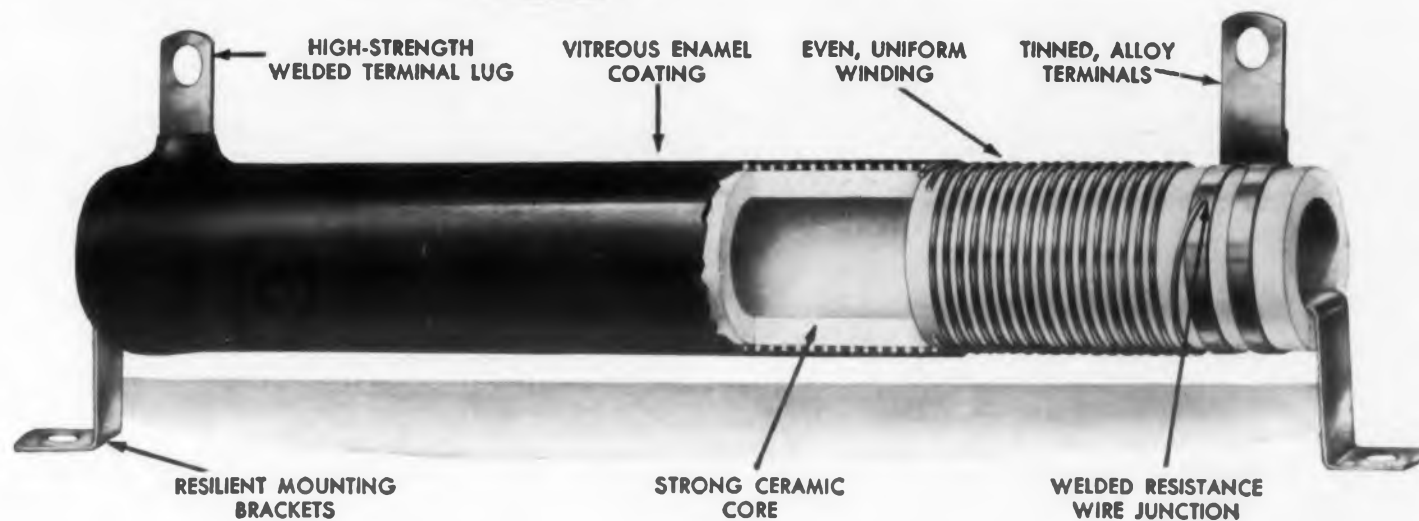
Congress played an important role in nudging the military toward a more active reliability program, though the military had been aware for a long time that there were shortcomings. The House Appropriations Committee, however, made clear in a staff report that it was less than satisfied with the performance of U.S. missiles, and it urged that "appropriate reliability requirements" be included when specifications were written for missile systems and components.

(Continued on page 18)

Quality Features of

# OHMITE®

## VITREOUS ENAMELED RESISTORS



Balanced Thermal Expansion prevents crazing and moisture entrance

In Ohmite resistors, spot welding replaces soldering, brazing, and mechanical fastening. Spot welding produces strong connections that are not affected by vibration or high temperatures. Ohmite welded construction also produces an almost flush connection between the resistance wire and terminal. This prevents thin spots or bulges in the vitreous enamel coating which might cause future trouble and failure. Many different types of terminals are available besides the lug illustrated.

## Ohmite can supply all of your resistor needs

some of the many types available

Axial Lead	Live Bracket Mounting Resistors
Brown Devil® Wire Lead	Edison Screw Base Mounting Resistors
Fixed, Lug Type	Riteohm® Wire-Wound Precision Resistors, Encapsulated; Vitreous Enameled; Molded Jacket; Hermetically Glass Sealed
Dividohm® Adjustable	Riteohm® Metal Film Resistors
Thin Type	Resistors to meet MIL Specifications
Noninductive	High-Shock Resistors
Powr-Rib®, High Current, Round or Ribbon Wire, Open Wound	
Corrib®, High Current, Corrugated, Edgewound Ribbon	
Resistors with Heat Conducting Studs	
Ferrule Mounting Resistors	

Write on company letterhead for Catalog 58

The almost endless variety of Ohmite resistors in many sizes and types—in a wide range of wattages and resistances—makes it possible to meet each individual need. Many of these can be supplied from the world's largest factory stock. Whatever your resistor requirements may be, chances are you will find exactly the type you need in industry's most complete line of high-quality resistors.

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VARIABLE TRANSFORMERS DIODES R.F. CHOKES

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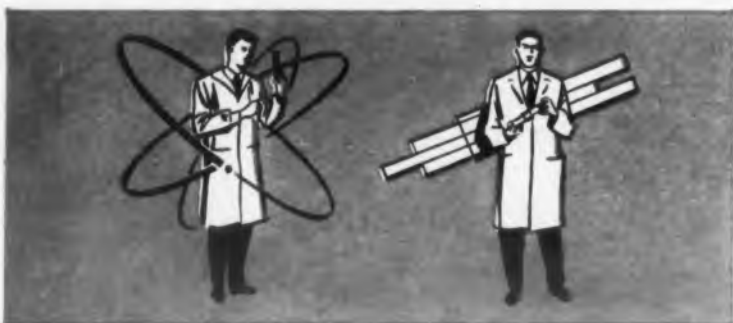


Rapid Automatic Checkout Equipment plays a key role in assuring operational efficiency of weapon systems.

# Five Sperry Pluses

## That Solve Ferrite Problems Fast

(other solid-state materials as well)



### 1. CREATIVE CLIMATE—

for the type of research and development brains eager to go ahead of ideas already established and in use—has attracted the top *scientists* of the field to Sperry Microwave Electronics. This in turn has brought top *engineers* to the task of converting developments into dependable, advanced products.



### 2. PRACTICAL EXPERIENCE—

Sperry Microwave Electronics has pioneered in extremely broadband frequency range components at high and average power levels (such as this ferrite isolator designed for countermeasures systems)—in S-band and below for high power components, and in many special devices.



### 3. LATEST EQUIPMENT—

laboratories—and laboratory equipment such as this—are common in Sperry's modern 85,000 sq. ft. plant in Clearwater—and with it the latest production equipment.



### 4. CONTROLLED MATERIAL—

key to the reliability and repeatability of ferrite and other solid state devices—is produced by Sperry to assure consistent quality.



### 5. PROVED PRODUCTION—

already in use is Sperry "hardware" such as (1) Duplexer; (2) Ferrite Equalizer; (3) High Power Isolator, and (4) Low Power Isolator.

You are invited to use Sperry facilities to the fullest—and take advantage of the investment Sperry has already made in initial research and development. Write:

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**SPERRY MICROWAVE ELECTRONICS COMPANY, CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION**  
Address inquiries: Clearwater, Florida, or Sperry Gyroscope offices in Great Neck • Cleveland • Dayton • New Orleans • Los Angeles • San Francisco • Seattle

CIRCLE 18 ON READER-SERVICE CARD

## WASHINGTON REPORT

### AF Contracts to Include Reliability Clause

Air Materiel Command and Air Research and Development Command have already been ordered to see to it that existing contracts provide sufficient reliability. They have also been told to incorporate a "meaningful reliability requirement in all future weapons system contracts," in addition to tightening up on supporting systems. Top priority has been given to a report on performance reliability under current contracts. The report will be made to the Air Staff.

The Air Force Deputy Chief of Staff (Materiel), Gen. C. S. Irvine, laid his Service's attitude on the line before the House Defense Appropriations Subcommittee. He said: "We feel so strongly about reliability, we intend to require all new weapons system contracts to include a meaningful reliability requirement. By the term 'meaningful' it is meant that contracts must state clearly and specifically what the contractor must achieve and, of equal importance, what specific tests he must use in order to demonstrate that he has achieved the reliability requirement." When the first reliability specification (MIL-R-26674) is completed, it will be applied, but officials expect that "better and tighter" reliability specifications will be written as time goes on.

Moves in this direction already are being made by the ARDC and the AMC. Work toward greater reliability is being carried on in cooperation with employes of firms that hold contracts to which reliability requirements will apply. Policy guidelines have already been laid down, and efforts are being made to apply them to existing situations. Objective is to develop a program of checks "in which the status of reliability can be reviewed at predetermined steps throughout a weapons system's life cycle, thus improving the possibility of meeting specified reliability requirements on time."

Flexibility is to be the hallmark of application of the reliability monitoring program. The framers of the policy want it to be applicable to any modern weapons system—whether air weapons, ground electronics, or other types are involved. Recognizing that reliability monitoring will be costly at first, the military hope to make up this expense by being able to cut inventories of spares, maintenance costs, etc.

There are eight points at which it is now thought essential to apply an adequate test of reliability as an objective review. This would supplement, not replace, the normal surveillance by the contracting agency and customary reliability checks by the contractor. They are:

1. At the very beginning, when a proposal is



made to the government. This should include a reliability program that should provide a detailed design study, including reliability reports on weapons systems and subsystems, preferably based on prediction techniques.

2. Before construction of a prototype, when design engineering and development tests would be reviewed.

3. In the prototype stage.

4. Prior to large-scale production. At this point, reliability achieved will be one of the bases for deciding whether to authorize full-scale output.

5. At the time it is claimed that the product is ready for use in normal service.

6. If the product involved passes its demonstration of service-readiness, a special evaluation will be made to see if the item can be turned out in quantity without loss of performance or reliability.

7. Reliability monitoring would of course, be carried on throughout the production process to make sure that there is no loss of quality.

8. Re-checks would be made whenever there was any major product improvement.

### Small Business Committee Wants Competitive Bids

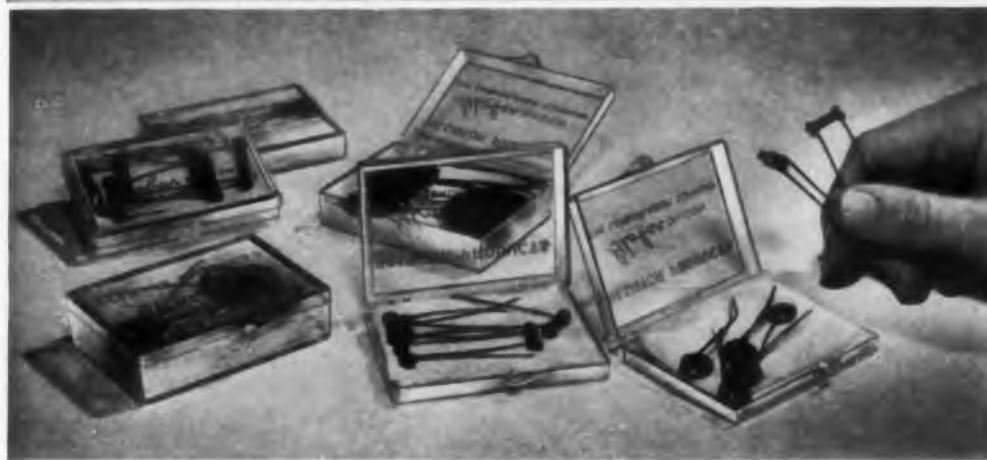
Crackdown on sole-source buying by the military is being vigorously pushed by Chairman Sparkman (D., Ala.) of the Senate Small Business Committee. Asserting that the Defense Department was "throwing away taxpayers' money as effectively as though the actual dollar bills were tossed on a bonfire," Senator Sparkman noted that the Navy's Ships Parts Control Center had effected a saving of 70 per cent by purchasing under competitive bids rather than from sole sources of supply.

Senator Sparkman frankly states that he is "disturbed at the excessive, if not exorbitant costs involved in doing government business on a non-competitive basis with sole-source suppliers when it is apparent that additional competitive producers are available."

The Secretary of Defense was virtually told by the Small Business Committee chairman that competitive bidding should be encouraged on all fronts. He put it obliquely, this way: "Should you conclude that the efforts of the Ships Parts Control Center to inject an element of competition into former sole source purchases are worthy of emulation by other Army, Navy, and Air Force purchasing offices, you may wish to institute a program designed to maximize competitive buying in the area under discussion." Needless to say the Senator asked that he be kept informed of the progress that is being made in conducting the procurement functions of the Department on an economical and business-like basis."

# Electronic Products **NEWS**

by **CARBORUNDUM**  
Registered Trade Mark



## Having transistor troubles?

### THERMISTOR AND VARISTOR TEST KITS available for development and experimental work

Interest in the temperature-sensitive and voltage-sensitive characteristics offered by GLOBAR® ceramic type non-linear resistors is now being demonstrated in many electronic applications. In transistorized circuits, for example, GLOBAR thermistors help to stabilize  $I_c$  variations with temperature and to prevent thermal run-away. GLOBAR varistors protect transistors against over-voltage.

For those who would like to experiment with possible applications, test kits are available at a very nominal charge. Bulletins GR-2 on varistors and GR-3 on thermistors give physical and electrical characteristics, types and sizes available and other pertinent data. Just drop a line to Global Plant, Refractories Division, Dept. EDR 59, The Carborundum Company, Niagara Falls, N. Y.

CIRCLE 712 ON READER SERVICE CARD

### GRADED SEALS—KOVAR® ALLOY to Pyrex-type Laboratory Glass



One of the many examples of glass-to-metal sealing made possible by KOVAR alloy is the graded seal shown here. This is a tubular transition piece for hermetically joining metal tubing to laboratory Pyrex-type glassware. The metal end, which can be joined to other metals, is of KOVAR alloy. Its thermal expansion characteristics are almost identical with those of borosilicate hard glass, which is used for the first glass section, fused to the metal. Succeeding glass sections, graded in thermal expansion coefficient, connect the borosilicate glass to the Pyrex-type glass, which can be fused to laboratory Pyrex systems.

Stock sizes are from  $\frac{1}{8}$ " to 1.9" diam. at the metal end and from  $\frac{3}{8}$ " to 14" overall length. For further information, write to Latrobe Plant, Refractories Division, Dept. EDS 59, The Carborundum Company, Latrobe, Pa.

CIRCLE 713 ON READER SERVICE CARD

### Large Ceramic-to-Metal Assembly solves problem in new electronic devices



The problem of sealing a heavy metal ferrule to a large ceramic cone was brought recently to Carborundum's Latrobe Plant. Team effort involving research and long experience in producing high strength, high temperature, vacuum tight ceramic to metal assemblies resulted in the final design shown above. The ferrule is bonded to a dense, 96% alumina cone. It will withstand assembly and operating temperatures far above the range of soft solders and is extremely rugged.

Carborundum has facilities for manufacturing ceramic-to-metal assemblies to meet a wide range of specialized requirements. Our engineers will welcome the opportunity of discussing your particular problems. Write to Latrobe Plant, Refractories Division, Dept. EDC 59, Carborundum Company, Latrobe, Pa.

CIRCLE 714 ON READER-SERVICE CARD

### NEW DATA SHEET ON HIGH TEMPERATURE RESISTORS



New Technical Data available on high temperature resistors—type SP. All essential technical information, including watt ratings, sizes, resistance ranges, terminations, temperatures, overload capability etc., are included. For your copy, write to Global Plant, Refractories Division, Dept. EDR 59, Carborundum Company, Niagara Falls, N. Y.

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The Wilkinson Company specializes in custom fabrication of precious metal components for industrial devices—doped gold discs for providing ohmic contact for silicon diodes, gold and platinum ribbon for diode whiskers, high purity aluminum wire segments and foil, and a variety of precious metal, rare metal and metal alloy units.

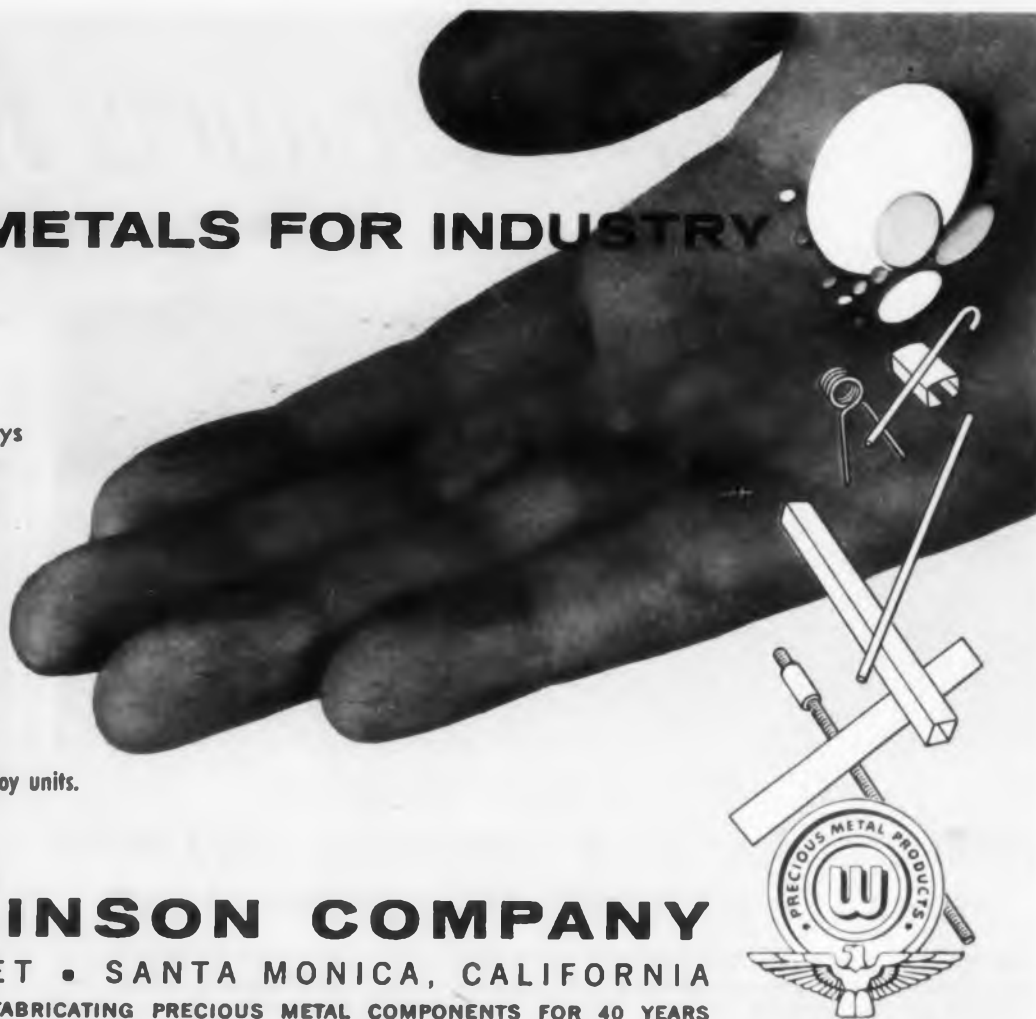
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METALLURGISTS—ALLOYING AND FABRICATING PRECIOUS METAL COMPONENTS FOR 40 YEARS

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# MEETINGS

## Calendar of Events

### June

- 14-18 American Society of Mechanical Engineers, Semi-annual meeting, Chase-Park Plaza Hotel, St. Louis, Mo.
- 15-17 Annual meeting, American Nuclear Society, Gatlinburg, Tenn.
- 15-18 Summer Meeting, Institute of Aeronautical Sciences, Los Angeles, Calif
- 15-20 First International Conference on Information Processing, Paris, France\*
- 15-20 Symposium on Electromagnetic Theory, Univ. of Toronto, PGAP, URSI, University of Toronto, Ont., Canada
- 16-18 American Meteorological Society, Boston, Mass.
- 16-18 International Symposium on Circuit and Information Theory (IRE), Los Angeles, Calif.\*
- 17-20 1959 Engineering Progress Exposition, National Society of Professional Engineers, Hotel Commodore, New York City, N.Y.
- 17-27 International Plastics Exhibition, London, England
- 21-26 ASTM 62nd Meeting, Chalfonte-Haddon Hall, Atlantic City, N.J.
- 22-26 Summer and Pacific General Meeting AIEE, Olympia Hotel, Seattle, Wash.
- 22-26 ASEE-ASTM Symposium on Education in Materials, Atlantic City, N.J.
- 24-26 Second Nuclear Instrumentation Symposium, Idaho Falls, Idaho
- 24-28 International Conference on Medical Electronics, UNESCO, Rockefeller Institute, IRE-PGME, Paris, France
- 29-1 National Convention on Military Electronics (IRE), Washington, D.C.\*
- 30 Regional Conference, Society of Plastics Engineers, Sheraton-Cadillac Hotel, Detroit, Mich.

### July

- 16-17 Radio Technical Commission for Aeronautics, RTCA, IRE, Room 1072, Bldg T-5, Washington 25, D.C.

### August

- 4-6 Annual Convention of Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Calif.
- 9-12 ASME-AICE Heat Transfer Conference, University of Connecticut, Storrs, Conn.
- 17 National Ultrasonics Symposium (PGUE), Stanford University, Stanford, Calif.
- 18-21 WESCON Show and Convention, Cow Palace, San Francisco, Calif.
- 23-26 AIEE, 6th Electrical Conference of the Petroleum Industry, Wilton Hotel, Long Beach, Calif.
- 31-2 Semiconductors Conference, Metallurgical Society of AIME, Statler Hotel, Boston, Mass.

\* Includes meetings described herewith.

### 1st International Conference on Information Processing, June 15-20

UNESCO House, Paris. The conference program has been expanded to six major topics: 1. Method of Digital Computing; 2. Logical Design of Digital Computers; 3. Common Symbolic Lan-

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### DIODE TESTER

MODEL DT-257

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- Rapid and accurate measurement of static characteristics of germanium and low-power selenium diodes.
- Transfer control switches pre-set forward and reverse operating points for rapid checking.
- Reverse voltages to 150 volts. Forward current to 500 ma.
- Meter accuracy 2%.
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\$125.00  
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### MILLIMICROAMMETER

As an accessory to the Model DT-257 Diode Tester this instrument will measure the low reverse currents of Silicon Diodes. Minimum full scale range is extended to 0.01 microamperes.



DT-257 Diode Tester, MA-259 Millimicroammeter in RA-81 Rack Mounting Adapter





guage for Digital Computers (includes Automatic Programming); 4. Automatic Translation of Languages; 5. Collection, Storage, and Retrieval of Information; 6. Pattern Recognition and Machine Learning. The formal technical program will be held in plenary sessions. Thus there will be time to visit AUTOMATH 1959, a major technical exhibit, which opens before these sessions and closes afterwards.

**International Symposium on Circuit and Information Theory, June 16-18**

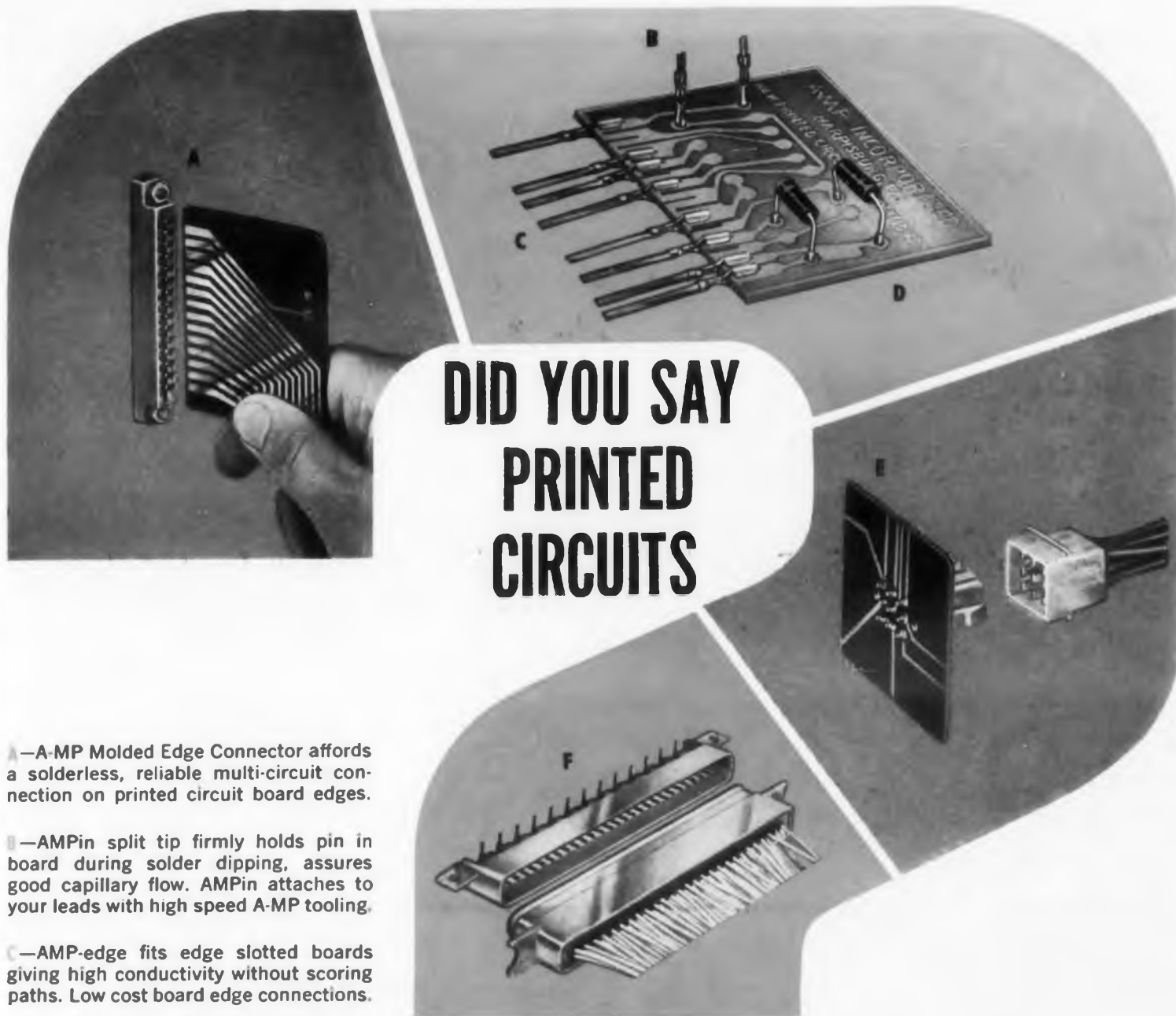
University of California, Los Angeles, Calif. The purpose of the Symposium will be to consider recent advances in Information Theory and Circuit Theory, and in particular to explore areas of interest common to two disciplines. For information contact: *Dr. G. T. Turin, Hughes Research Laboratories, Culver City, Calif.*

**Third National Convention on Military Electronics, June 29-July 1.**

Sponsored by the IRE Professional Group on Military Electronics, Sheraton-Park Hotel, Washington, D.C. The technical program includes more than 100 papers to be presented at 5 classified and 18 unclassified sessions, covering these topics: missile guidance, radar techniques, operations research and tactics, data transmission and processing, space electronics, instrumentation (two sessions), navigation, surveying and reconnaissance, communications (two sessions), space propulsion, missile electronics, radar systems and equipment, computers, components, space communications, detection and tracking, space guidance and tracking, simulation, navigation and reconnaissance, guidance, reliability. Exhibits of the latest military components and equipment representing the products of more than 100 companies will be held concurrently with the program. Advance registration, including the Proceedings, are \$2 for IRE members, \$3 for non-members, \$1 for students. For more information contact *L. R. Everington, Radiation Inc., Orlando, Fla.*

**Courses and Seminars**

A summer study course designed to meet the demands of widespread use of radar and the increased use of microwave heating, testing, and communication systems in industry will be offered from **July 20-31** by **Case Institute of Technology**. Background requirements for engineers wishing to take the course should include college level studies in ac circuits and elementary electron tube circuits, as well as mathematics through differential equation. Additional information on the course may be obtained from *Dr. James R. Hooper, Jr., Dir. of Special Programs, Case Institute of Technology, Cleveland 6, Ohio.*



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**A**—A-MP Molded Edge Connector affords a solderless, reliable multi-circuit connection on printed circuit board edges.

**B**—AMPin split tip firmly holds pin in board during solder dipping, assures good capillary flow. AMPin attaches to your leads with high speed A-MP tooling.

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Production and assembly speeds are miles ahead of most other techniques. Versatility is unbeatable, permitting A-MP products to be used on different applications and in combination with each other.

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## NEW FROM CORNING

### C-42 low-power, low-cost film-type resistor

What this Country needs is a good five-cent resistor—and here it is.

At the heart of the C-42 you'll find a glass core coated with a very thin film of metallic oxide. It's this construction that gives you the exceptional performance you've come to expect from metallic film-type resistors.

In every characteristic, this new C-

42 outperforms the requirements of MIL-R-11B.

Here's a quick summary of some of the important data:

Humidity: 1% max. resistance change  
Shelf life: 0.2% per year, maximum.  
Noise output: .1 microvolt per volt

Nominal length of the C-42 is  $1\frac{1}{16}$ "  $\pm$   $\frac{1}{32}$ ". Power rating is 2 W at 70°C.

You can get the new C-42 in resistances from 200 ohms to 1.5 megohms.

For all the facts, including detailed comparison of the C-42 with MIL-R-11B, write to Corning Glass Works, 540 High Street, Bradford, Pa. Or contact our sales offices in New York, Chicago, or Los Angeles.

See us in Booths 506 to 508 at the WESCON Show, August 18-21.



## CORNING GLASS WORKS

Electronic Components Department

CORNING MEANS RESEARCH IN GLASS  
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## MEETINGS

### Courses and Seminars

**An Introduction to the Use of Digital Computers**, an intensive course for engineers, scientists, industrial and business users of digital computers, is being offered by the **University of North Carolina, August 17-28, 1959** on The Chapel Hill campus. Direction will be under John W. Carr II, Director of the Research Computation Center, which is installing one of the largest digital computers being used for research and education, the Univac Scientific 1105 Computer and Data Processor. Two advanced courses will be "interlaced" in the hours of lectures, **Frontier Research in Programming and Artificial Intelligence**, and **Frontier Research in Numerical Analysis for Computers**. Both advanced courses will allow the practicing scientist, engineer, and professional computer programmer to hear lectures by, and discuss recent developments with, leading computer mathematicians and programmers from all over the world. Applications for enrollment and requests for information should be directed to **James G. Steagall, University Extension Division, Box 1050, Chapel Hill, N. C.** A fee of \$150 covers instruction, course notes, and computer operation costs for the introductory course. Apply by June 15.

The 1959 **Statistical Methods in Industry Course**, which includes a basic course in quality control by statistical methods and an advanced course in industrial statistical methods, will be held **August 3-14** at the **University of California, Los Angeles**. In addition, a special program on current developments and applications in industrial reliability problems is scheduled **July 27-August 14**. The University Extension program, sponsored by the UCLA Department of Engineering and the Los Angeles section of the American Society for Quality Control, should be of special interest to engineers concerned with quality control, inspection, and reliability problems in research, design, development and production.

Enrollment limited. Obtain details from: **Professor Edward Coleman, Department of Engineering, University of California, Los Angeles 24, Calif.**

### Paper Deadlines

**June 30, 1959:** Deadline for papers for the **Fifth National Communications Symposium** to be held **October 5-7, 1959** in Utica, N.Y. Abstracts of 100-150 words, double spaced, in triplicate, should include name, position title, company affiliation, brief biographical sketch. Send to: **Director of Communications, Rome Air Devel-**



opment Center, ATTN: Mr. Ralph L. Marks, Technical Program Chairman, Fifth National Communications Symposium, Griffiss Air Force Base, N.Y. If an unclassified abstract of the classified paper (for the one-day classified symposium sponsored by the Rome Air Development Center) cannot be prepared, a classified abstract will be acceptable.

**June 30:** Paper deadline for a Technical Paper Contest being sponsored by the Standards Engineers Society to stimulate new ideas and to encourage a more widespread awareness of the value of standards. Rules are: (1) Papers may be confined to one aspect of standardization. (2) Length should be free from 1600 to 2400 words. (3) Contest open to anyone. (4) Entries must be typed double-spaced on one side of 8½" x 11" paper and submitted in quadruplicate to: Mr. Fred Oberlander, Materials Standards, RCA, Camden 2, N.J. An award of \$50 for the winning paper will be presented at the SES Annual Meeting September 21, 1959. The paper will be published in Standards Engineering, the Society's magazine.

**July 1:** Deadline for papers to be presented at the 1959 Mid-America Electronics Conference, November 3-5, 1959. Send abstract to either: Dr. Sheldon L. Levy, Midwest Research Institute, 425 Volker Blvd., Kansas City 10, Mo., or Dr. Charles A. Halijak, Electrical Engineering Department, Kansas State College, Manhattan, Kans. Areas to be covered are: medical electronics, engineering management, engineering education (students, technical writing, research in education), airborne electronics and components, simulation, computers and nucleonics (analog, others), components, sensors and reliability, wave propagation (masers, parametric amplifiers), adaptive servos and other non-linear systems.

**July 15:** Paper deadline for the Fourth IRE Instrumentation Conference and Exhibit to be held November 9-11, 1959 at the Atlanta Biltmore Hotel Atlanta, Ga. An informative abstract of approximately 200 words is required. Earlier submission of papers is requested although final deadline for acceptance of abstracts is July 15. Send titles abstracts to W. B. Jones, Jr., School of Electrical Engineering, Georgia Institute of Technology, Atlanta 13, Ga.

**August 15:** Submit by this date four copies of a 100 word abstract and a 1000 word summary of papers on any phase of computing for the 1959 Eastern Joint Computer Conference. The Conference will be held December 1-3, 1959. Forward abstracts to: J. H. Felker, Chairman, EJC Program Committee, Bell Telephone Laboratories, Mountain Ave., Murray Hill, N.J.

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All Continental general purpose diodes are "burned-in" for 200 hours at 200°C—before being tested for specification parameters.

This burning-in process is a high temperature aging which accelerates chemical reactions of any contaminants within the diode envelope. Under normal operation, these reactions might extend well into the service life of the diode, resulting in gradual performance degradation or even complete failure. An extremely high percentage of silicon diodes that survive burn-in remain stable over an indefinite life.

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comprise Continental's Reliability Assurance Program. This program represents a significant forward step by assuring built-in reliability during manufacture and providing the necessary checks to allow the diodes to be used with confidence of trouble-free operation. To insure the reliability of your important equipment, it will pay you to investigate the full Reliability Assurance Program pioneered by Continental. A description of this program is available upon request.

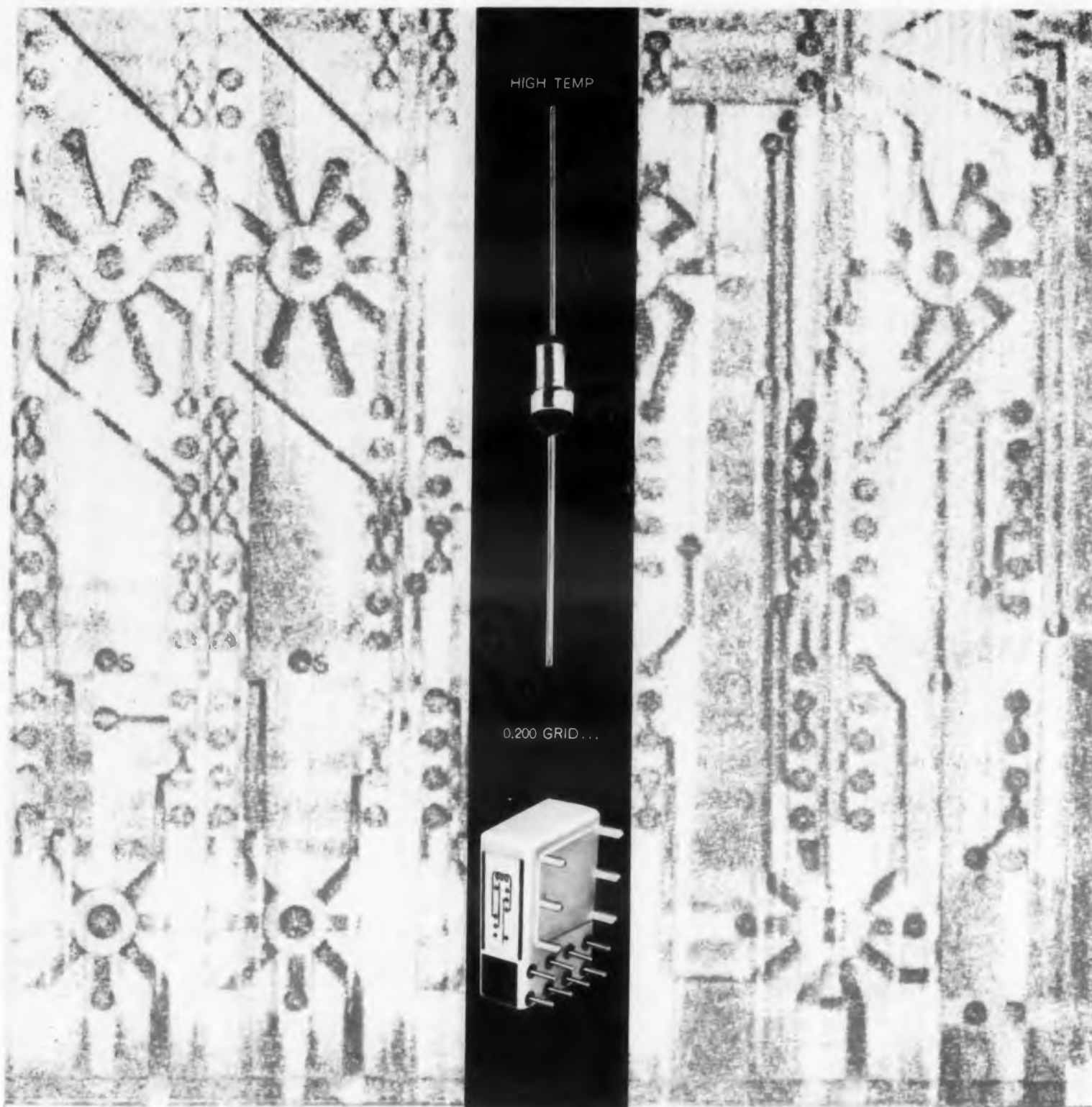


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SPECIFIED WITH  
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# EDITORIAL

## Let's Not Wait Till Next Year

Mr. Design Engineer you have a problem.

- You spend too much time selecting a semiconductor diode type for a particular application—up to six hours on a general-purpose type; as much as 30 to 40 hours on a more specific unit.
- You find manufacturers' test-method description and derating curves incomplete. Furthermore you discover that published values are too often "optimistic" or "exaggerated."
- You are "very much annoyed" by similar diode types bearing different JEDEC numbers.
- You are convinced that diode standardization would be helpful and cut wasted time.

This is what you told us in response to our March 18th editorial on diode standardization. Several hundred engineers were quick to respond to our questionnaire seeking insight on the problems created by the rising diode listing—from 2500 types last year to 4000 today.

There is no question that non-conformity among manufacturers in the specification and testing of diodes is causing serious difficulties. Lack of time or reluctance to follow through on a tedious search job is causing some of you to overlook cheaper or improved diodes.

Manufacturers were interviewed to obtain their viewpoint. Typical comments were:

- "Users are much too critical."
- "Tight specs are demanded in situations where they are not needed."
- "By insisting on special types, where stock units would do the job, the user is responsible for the increase in number of diode types."

Thus the finger of blame alternates from user to manufacturer. One point is obvious. The confusion and lack of standardization are costing the military—and thus the public—millions of dollars.

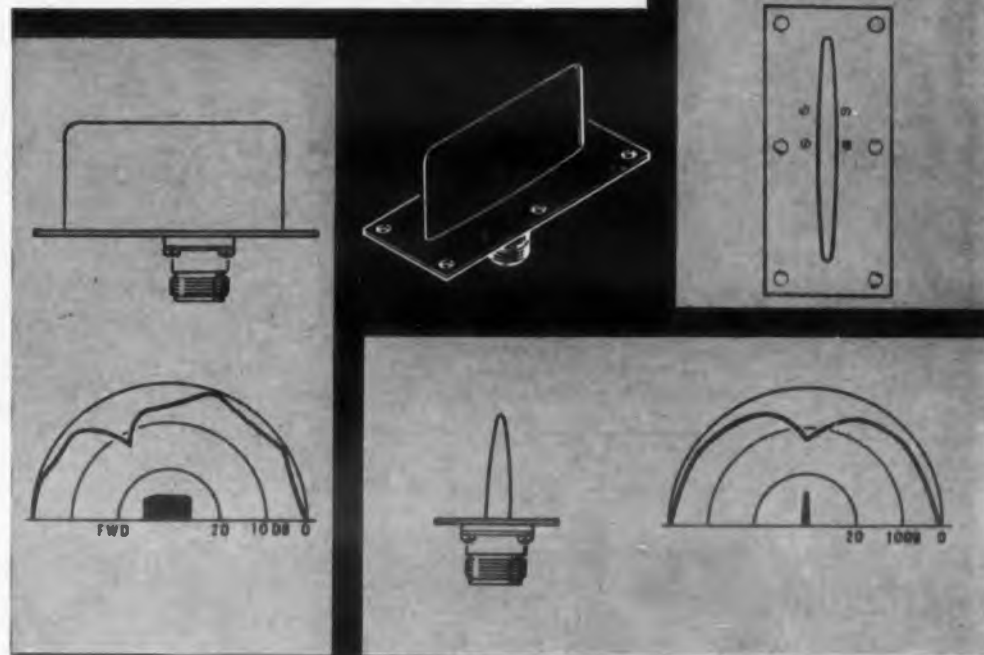
All branches of the military are complaining of the manpower and expense needed to requisition, stock, inventory and evaluate the wide variety of diodes. Since the military bears the brunt of the confusion, one might expect it to quit yearning for improvement some day and to "wield a big stick."

But we hope manufacturers will show mature responsibility first and work out standards among themselves. Talk about "the semiconductor art in its infancy," about "growing pains" and "in the near future" is stale after years of use.

Engineering time is valuable. How much more will be wasted before the "infant" matures?

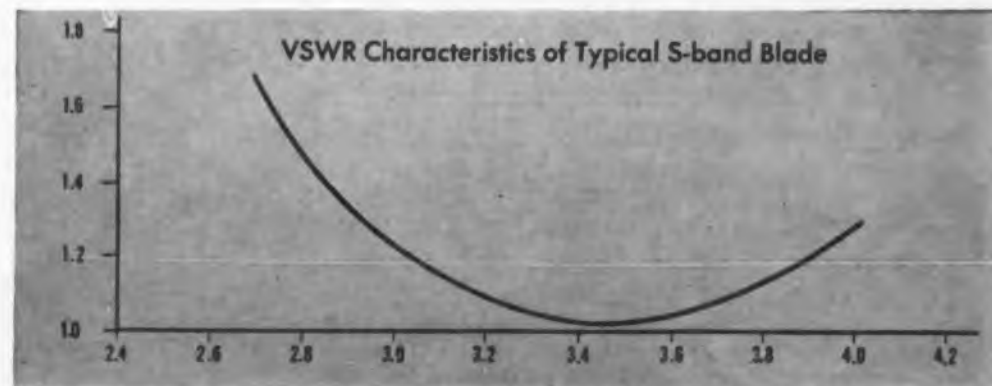
*Howard Bierman*

## HI ASPECT RATIO LO DRAG



### AERODYNAMIC BLADE ANTENNAS

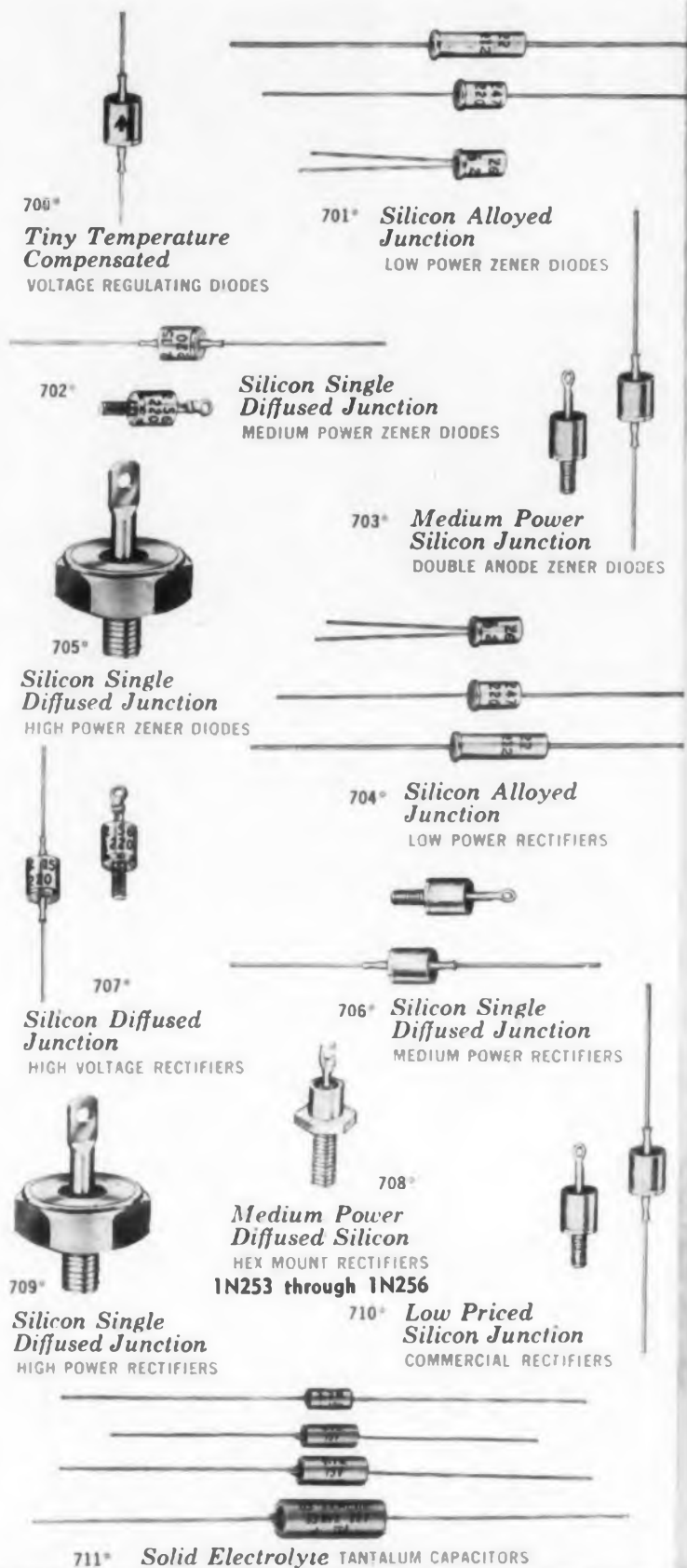
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An *ELECTRONIC DESIGN* Staff Report:

# DIODES

Semiconductor diodes perform well. Their reliability has been lauded by the large majority of users. Even pricing has received only scanty criticism. Still, they pose a serious problem to design engineers. Over 1500 types have been added by industry to last year's 2500. Engineers simply cannot keep pace with the rising list.

To evaluate new types with care requires considerable time. To ignore new listings may result in bypassing a cost saving or an additional source of supply.

Engineers' reaction to increasing type numbers, manufacturers' explanations and methods of coping with the situation are analyzed in this special *ELECTRONIC DESIGN* staff report.

# DIODES—

Choice Performance . . .  
But Difficult Choice

Howard Bierman

Associate Editor

## 1 THE BASIC PROBLEM

**D**IODES are smaller than aspirins, but they produce the opposite effect on design engineers—they create headaches. Oddly enough, neither performance nor reliability is the cause; all but the most critical engineers are pleased with the improved service, more refined characteristics and miniaturization achieved in the last few years.

The headaches are created by an ever-growing diode listing.

Each week sees new publicity releases and advertisements extolling the latest types. The alert, conscientious engineer should be aware of these new components. When design calls for a particular diode type, it is his responsibility to choose the proper one. But the choice can be complicated.

### The Search Begins

Suppose a design engineer, working on new equipment, decides to use a semiconductor diode

for a particular application. Let us assume he proceeds with current design practices and determines the required parameter values. What is his next step?

If he is employed by a large, well-staffed company, he may turn his requirements over to a special standards group or purchasing division. His next step is to await samples of the ordered type for operating tests. Fortunately he is little involved in the actual selection of a diode.

However, if he is employed by a small or even medium-sized outfit, he must personally select the diode for his application.

Just how many types will he have to check?

The latest count comes to roughly 4000. Of these, 1800 are JEDEC (Joint Electronic Devices Engineering Council) types registered by the EIA (Electronic Industries Association). Approximately 1800 are diodes bearing private, or "company house," numbers. The remainder are being imported from foreign suppliers.

Does the design engineer have to wade through 4000 types to find the one diode he is interested in buying? Well, if he is short on time, he can consult a single manufacturer's brochure and with luck come up with a type close to what he wants. However, if he is interested in locating several

sources of supply, he will be forced to consult all manufacturers' listings.

Since cross-referenced interchangeability lists are not available for all types of diodes and since many companies do not publish such lists, he cannot cut corners on time.

### Confusion Mounts

After searching, the conscientious engineer may end up with seven different type numbers, each more or less suitable for his purpose. He faces a problem:

"Which is best? Since each is listed under a separate number, all must be different somehow." After puzzling a while, he may select two or three types and use these as his final selection. Or he may request samples and prices for all seven.

To honestly justify his selection, he may subject samples of the seven types to numerous tests. Days later he may conclude that the seven types are identical, so far as his use is concerned.

Well, then, why so many type numbers for similar units? After all, a 6V6 tube made by ten tube manufacturers is still called a 6V6. If its physical properties are altered, it might be called a 6V6 GT, but it is still easy to find.



### Problem Due to Infancy of Semiconductor Art?

Unfortunately the semiconductor field is in a state of confusion on standardization, possibly because of its infancy. As more and more diodes are made, the listing mounts. In the last year 1500 types have been added. If the additions were truly new and represented advances in the semiconductor art, there would be no cause for concern.

#### Production Method at Issue

But such is often not the case. Advances are but one reason for the growing diode list. Here is another:

Suppose a manufacturer receives an order for 100,000 diodes to meet a particular spec. He may decide to make as many as 150,000 to obtain the yield to fill his order. At the completion of production, he will sort out the units according to parameter measurements.

If all has gone well, his highest output will fall in the center area of the yield curve, whose form somewhat resembles a low "Q" response shape. Units that fall to either side of the curve will not satisfy the customer's spec. Should this large quantity be scrapped or kept?

#### From "Junk" to Spec

As mentioned in our diode report last year (*ED*, July 23, 1958, pg. 18),

"One man's junk is another man's spec." Other users, with non-critical applications are willing to purchase those diodes that can fill their bill. The manufacturer therefore will sort his output into several groupings. The major bulk will be assigned to the original customer; the remainder will be put up for sale to the industry.

If the manufacturer is producing this diode type for the first time and plans to carry it as regular stock, he may reserve a JEDEC number by supplying advance information on characteristics to EIA. At the completion of production, exact figures will be sent for final type registration.

#### Cooperation Put to Test

This is when cooperation between manufacturers is put to trial. If EIA should advise the company that its type is similar to an existing one, the concern can perform a service to the industry by accepting the older number designation. The diode types created from units outside the specified yield area may also be sent to EIA for type registration. Failure to comply with the suggested listing may easily result in a half-dozen new numbers for the engineer to consult during diode selection.

Why should a manufacturer deliberately aim at registering new types? When questioned on this, marketing and sales executives asserted that

#### A Sampling of Reader Reaction to ED's March 18 Editorial on Diode Standardization follows:

- In order of preference, which three components would I like to see standardized? Diodes, diodes, and diodes.
- Situation is a pain in the neck—not to mention the drain on our economy due to confusion, multiple duplication of effort and wasted time.
- All groups in industry, IRE, EIA, AIA and the Department of Defense must cooperate to clear up the staggering problem.
- Something must be done to reduce the fantastic number of "different" diodes. This is a job for the diode manufacturers . . . not the circuit-design engineer.
- There are far too many almost identical types. I doubt if the circuit designer would be penalized if the number of types were cut in half.
- Who are the manufacturers trying to kid with all these types?

Many users indicated they were losing patience with "improved" types that turned out to be identical to older types. Many reported they were continuing to use the older types rather than bother to evaluate "newer" versions. Others said they favored one or two companies as "pets" and would deal only with them until standardization took place.



Up to 200 v can be switched on or off with Shockley Transistor Corp. four-layer diode, type AD.

#### An ED Editorial of March 18, Advocating Diode Standardization, Evoked Mixed Comments from Manufacturers.

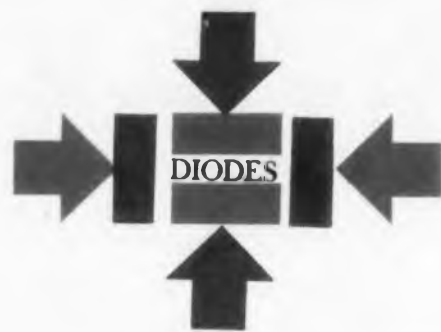
##### Sceptics advised:

- Don't raise too much of a storm—the problem is ticklish enough right now.
- Go ahead and try. We doubt that anything will come of it.
- Situation will get worse before it gets any better.
- Want to reduce the diode list to about 100 types? Easy. Just use our catalog sheet as a guide. How many types do we make? One hundred!
- Tell EIA to be less lenient in type-number registration.

##### Concerned spokesmen replied:

- It's about time we settled down to the issue. The confusion will catch up with us soon if we don't.
- Advise engineers to work more closely with our application staff. In many cases cheap stock diodes can be used in place of new, tight-spec types.
- Standardization will benefit the entire industry in the long run.

Most manufacturers agree that standardization is necessary. Many feel it will take years to achieve. A few admit they profit by the confusion. Others urge better cooperation between user and producer to limit new types.



Piv ratings, from 50 v to 600 v, at 750 ma forward current are available in ten silicon types supplied by Fansteel Metallurgical Corp.

late type numbers signified advances and better products. To list old types in a new brochure would be poor practice, they argued.

Others hinted that more types meant greater confusion and time investment by the user. This, in turn, often led to orders based on users' specs. After all, why spend excessive time to find an existing type?—it may be cheaper in the long run to order a custom-made unit.

The "custom" type may not really be anything special. Additional tests on stock units will often ferret out the desired type—at a nominal mark-up for the manufacturer.

#### Leaders Unaware of Problem

Key personnel in leading diode companies apparently are unaware of confusion in the selection of their products. Interviews with top men in marketing and sales divisions resulted in long explanations to justify a request for a late JEDEC number registration. Those interviewed were not convinced that the practice was frustrating and time-consuming to the average design engineer.

At the conclusion of the interviews, each man was asked to estimate the number of available

types. Answers ranged from 250 to 600. When informed that 4000 types were presently available, the leaders were surprised. Typical comments were: "As many as that!" . . . "Something should be done about it." But they would not concede that any of their diode types were unessential; other companies were surely the offenders and should reduce their types.

Not all the blame for the increased types lies with the manufacturer. Application engineers for top diode makers and standards engineers employed by large users argue that quite a few design engineers don't really know what they want. Rather than take a chance, they impose tight specs on diodes to achieve the utmost circuit performance and reliability. Thereby they spawn new types.

#### Users Often Resist Too

A spokesman for a large eastern manufacturer voiced this opinion:

"Several diode companies are aware of the problem and earnestly want to help in bringing about some solution. But in the past year, specs are getting tighter and tighter."



Currents as high as 50 amp can be controlled by as little as 15 ma with G. E.'s ZJ-50 silicon-controlled rectifier.

G. E. offers 58 silicon rectifier types for applications requiring up to 1 amp at 600 v piv.





**Key Military Men Concerned with Diode Selection Were Unanimous in Favoring Standardization. Typical Comments Were:**

■ Standardization is vital. We spend as much as one week to convert a new diode type to our spec form. Just count the new types coming each week!

■ Am I annoyed by the increasing list of diode types? No, I'm frightened. What will happen in an emergency to equipment service and maintenance without interchangeability?

■ Standardization must be accelerated. It's costing the Government a fortune to stock, inventory and requisition all types used.

■ Selectivity in standardization is the only effective way to cost reduction in the military supply system.

But despite their strong feelings, the critics felt obliged to remain anonymous for "job security" reasons. Hit hard by the diode confusion, the military, instead of leading the battle to expedite standardization, appears slow-moving and disorganized. Users blame the lack of military push for the diode mess.

"Our application engineers advised many users to sample existing stock types; they felt, for certain uses, the tight specs were not in order. Only one major company went along with us—and saved several thousand dollars in the process. Others became insulted and threatened to take their business elsewhere if we couldn't supply orders to their specs."

More thorough analysis of circuit conditions by the design engineer could very well uncover possibilities for less critical diode specs. More confidence in the advice of application engineers might, according to some manufacturers, keep new types, as well as prices, down.

**Military Viewpoint**

Agencies of the armed services were quick to voice their complaints on the diode issue. Since official interchangeability lists do not exist, there is no practical method for grouping similar types of diodes used in military equipment.

Requisition, purchase, stock and inventory listings, as well as other details, mount with the increased diode listing. Manufacturers contend, rightly, that the price per diode is reduced when

# NEW ECONOMY OF CIRCUIT DESIGN with new NPN power transistors



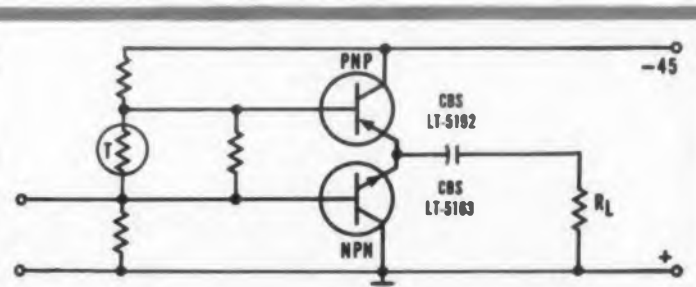
**... in complementary push-pull circuits**

These new NPN transistors in the complementary push-pull circuit eliminate input and output transformers with many resulting advantages:

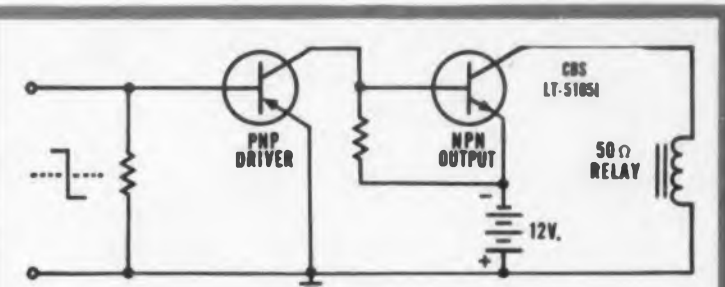
1. Economy.
2. Miniaturization.
3. Improved frequency response.
4. Ease of applying negative feedback.

**... in complementary cascade circuits**

CBS NPN power transistors are also intended for single-ended cascade output circuits, and three types are designed for use with inductive loads such as output transformers, motors and relays. The simplified direct-coupled circuits permit economies through elimination of components.



COMPLEMENTARY CLASS B AMPLIFIER



DIRECT-COUPLED COMPLEMENTARY CONTROL AMPLIFIER

**FIRST COMPREHENSIVE LINE OF NPN POWER TRANSISTORS**

Type	Max. W Diss. (25°C Ambient*)	Max. V <sub>CEO</sub>	Max. V <sub>CE(s)</sub>	Min. h <sub>FE</sub> (I <sub>C</sub> =0.5A)	Max. Thermal Res. °C/W	Similar PNP Types
FOR RESISTIVE-LOAD CIRCUITS						
2N326	20	35	35†	30	3	2N326
LT-5165	20	35	30‡	30	3	LT-5181
LT-5183	20	60	45‡	30	3	LT-5182
LT-5164	20	80	60‡	30	3	LT-5183
FOR INDUCTIVE-LOAD CIRCUITS						
LT-5165L	20	35	30φ	30	3	LT-5181L
LT-5163L	20	60	45φ	30	3	LT-5182L
LT-5164L	20	80	60φ	30	3	LT-5183L

All seven types have: Max. collector current, 3 amps; storage temperature, -65 to +85°C; avg. cutoff frequency, 150 kc. \*Adequate heat sink required. †I<sub>CE(s)</sub> = 1 ma. max. ‡I<sub>CE(s)</sub> = 10 ma. φI<sub>CE(s)</sub> = 300 ma.

New design economies in complementary push-pull and cascade circuits are made possible by these CBS NPN power transistors. They feature high voltages . . . up to 80 volts. Their proven reliability (they meet the MIL-19500A specification) is what you might expect from specialists in reliable NPN switching and PNP power transistors. Check the typical circuits and abbreviated data for this versatile and comprehensive line. Write for complete technical Bulletin E-332 . . . and, if you wish, for Bulletin E-348 on CBS PNP power transistors for complementary circuits.

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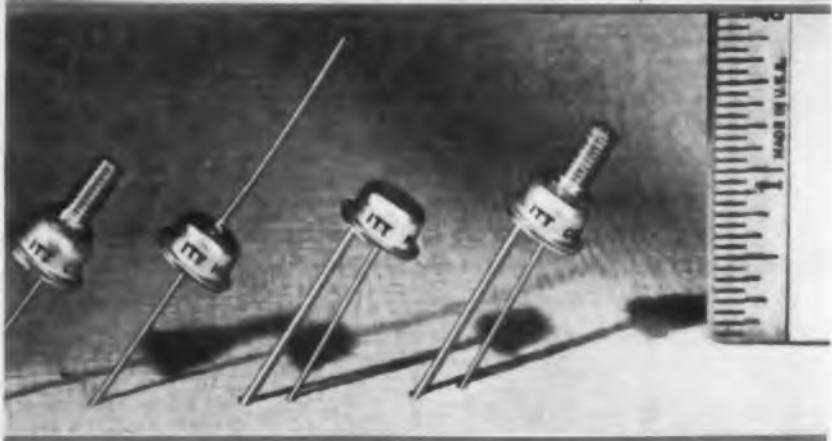
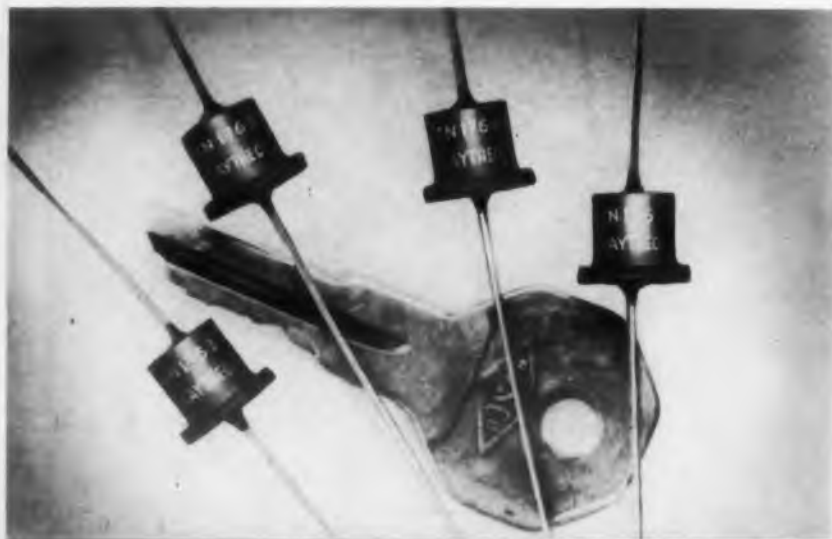
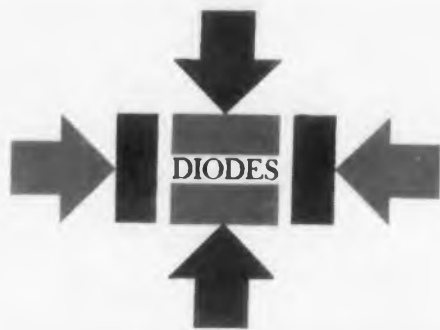
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Raytheon top-hat silicon rectifiers (bottom) are rated at maximum reverse currents of 100  $\mu$ a at 500 v piv.

This line of I. T. T. silicon rectifiers (center) can handle up to 3 amp at 600 v under 150 C ambient conditions.

Motorola diffused-junction silicon rectifiers (top) are well suited to printed board assembly.

fallouts are not discarded but instead sold as another series. But would the savings in paper work, multiple stocking and similar waste more than offset the initial component outlay?

#### Translating Specs

To insure that delivered components, such as tubes, semiconductor diodes and transistors, meet exact requirements, the military draws up and evaluates specification sheets. Converting manufacturers' data on a diode type into military spec form may take one man several days to a week. The time spent by each branch to keep up with the rapid rise in semiconductor types depletes not only money but technical manpower, of which the military is already short.

New, advanced-type diodes are resulting from concentrated research and development work. In the interests of better military equipment, they should be fully tested and incorporated when successful. To expend time and effort on all detail work involved in the advanced type is justified.

It's another story to waste the same efforts on a "new" type which is actually identical to a previous unit but is called by another "name" to satisfy a manufacturer's advertising department.

But while criticizing the confusion in diode listings, the military spokesmen were also almost universal in their acclaim of superior diode performance and reliability.

This, they noted, has led to another problem. Some equipment has performed so well for several years that spare-parts depletion has been slow, and only recently has inventory replacement of diodes become necessary. When orders for replacements were given to the original sup-

pliers, this reply was encountered:

"Sorry, we don't make that type anymore. But we can deliver a fairly similar diode."

This gives rise to further headaches; for another type just can't be substituted in military field equipment. The new types must be sampled, evaluated, put on life tests and approved. During this time, the equipment may be gathering dust.

#### General Underscores Waste

A comment on the military attitude was given by Brig. Gen. Earle Cook, Chief of Research and Development, U. S. Army Signal Corps.

In a speech at the Texas Instruments, Inc., plant dedication in Dallas on June 24, 1958, he said the following about semiconductor standardization:

"I hope that an effective program of standardization can be initiated to reduce the types required in order to save in the cost of our supply maintenance and stocking system.

"The one thing I want to avoid at all costs is the situation in the electron tube area that we have been trying to extricate ourselves from, with some degree of success, for many years. Too many similar types of tubes were developed with only very slight differences in their characteristics and found their way into the military system.

"We don't want this sort of situation to develop again. Selectivity in standardization is the only effective way to cost reduction in the military supply system."

#### EIA Position

A number of manufacturers and users, when questioned on the causes of the growing diode

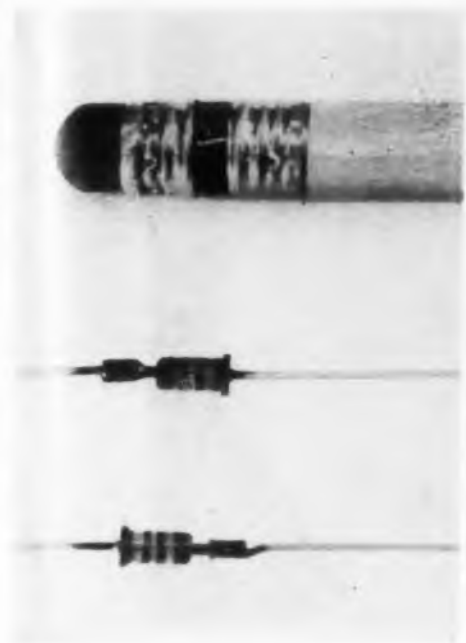
#### Diode Popularity Poll

Readers were asked to submit lists of their "most popular" diode types for various applications. Although no single diode could be considered an outstanding winner in terms of unanimous preference, the types which were repeatedly mentioned are tabulated below.

Military sources furnished the types which are considered as "standard" by the Department of Defense.

Application	Reader Choice	Military
Small-Signal	IN34, IN34A, IN100, IN198, IN251, IN270, IN277, IN457, IN458, IN459, IN629, IN645, IN648	IN98, IN251, IN270, IN276, IN277, IN281, IN457, IN458, IN459
Microwave	IN23, IN23C, IN78	IN21C, IN23C, IN23CR, IN25, IN26, IN31, IN32, IN53, IN78
Power Supply	IN91, IN92, IN93, IN253, IN255, IN256, IN540, IN589	IN538, IN540, IN547, IN253, IN254, IN255, IN256





**Western Electric** diffused-junction diode 1N673 can be connected in series in high-voltage supplies without the use of paralleling resistors.

list, quickly blamed Electronic Industries Association (EIA) for "being too free in issuing new numbers." Some contended:

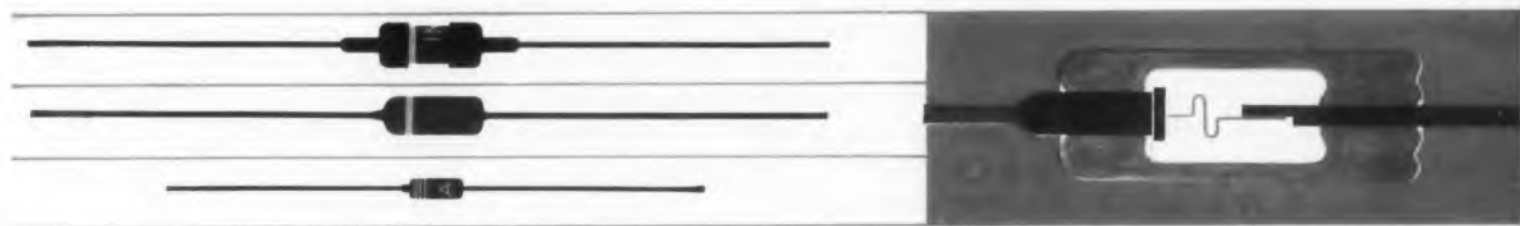
"EIA slaps a new number on an early type of diode just because its body diameter is 0.01 in. larger than a previous body size."

When confronted by these accusations, EIA spokesmen outlined step-by-step a practice not uncommon with some manufacturers:

Assume Manufacturer A submits data on five new types for EIA review and registration. After suitable search, EIA informs manufacturer A that three of the submitted types are sufficiently different from previous types and will receive, for example, JEDEC listing 1N4000, 1N4001 and 1N4002. However, the remaining two types fall into the category of 1N100 and 1N150, registered by company B several years ago.

This news does not please the marketing people of company A. How would it look to distribute brochures of a "new" line of semiconductor diodes—three with late JEDEC numbers and two with old numbers? Manufacturer A then ad-

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**MINIATURE** *all-glass technique...*

*point-contact or gold-bonded*

*construction... available with*

*solder-in leads or clip-in studs.*

**SUBMINIATURE** *all-glass technique...*

*copper-heat-sink...*

*available on standardized tape*

*for automatic insertion.*

**AVAILABLE TYPES** *standard EIA or*

*to your own specifications.*

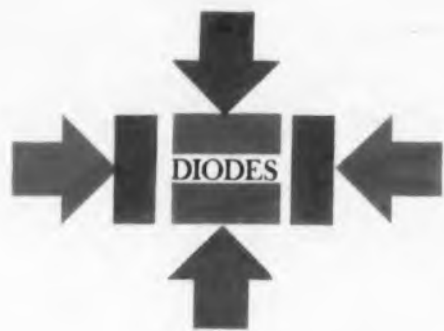
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vises EIA: "By the way, we neglected to mention that the two early-number types will be encapsulated in a slightly different package than company B's units. Now how about registering these two as 1N4003 and 1N4004?"

### EIA Can Only 'Suggest'

At this point, EIA is obliged to allocate new numbers to what are, in effect, older types. When the design engineer tries to evaluate these new types with previous ones, he will be at a loss to detect any electrical differences.

How far can EIA go to force standardization? Any efforts on its part to compel companies to comply with its recommendations can be met with allegations of "trust activity." Urgent pleas and strong recommendations are about the limit of EIA's power.

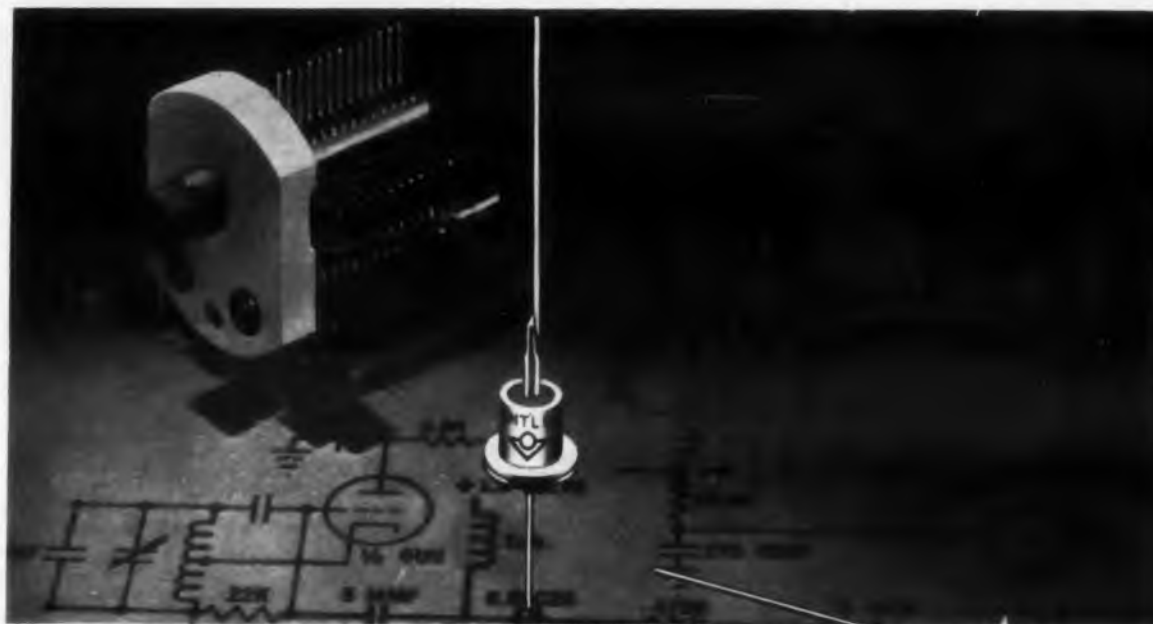
While many manufacturers are cooperating to clear up the confusion, others persist in practices that deliberately foil the efforts of the EIA. For example, companies A, B, and C each decide to register a new series of diodes. Company A sends data sheets to EIA on its types with reverse current readings given at  $-2.5$  v,  $-5$  v and  $-25$  v. Company B offers data at  $-3$  v,  $-10$  v and  $-50$  v. Company C uses  $-5$  v,  $-10$  v and  $-30$  v. Other data might also be submitted by each company.

Suppose the diodes of company A and C seem identical. Rather than draw graphs and interpolate points, the obvious solution is to prepare standard forms with fixed points and to have each company fill in the appropriate data. Comparison between different types from different manufacturers could be rapid and accurate. A simple, practical suggestion?

### Test Uniformity Needed

Then why, after suitable EIA distribution, are so many new registration requests made on a company format with points not in agreement with EIA data forms? To facilitate comparison and expedite standardization, cooperation in data submission is essential.

The failure of manufacturers to get together on test methods has further impeded standardization and interchangeability.



Miniature silicon high-"Q" variable capacitor diode manufactured by International Rectifier Corp.

A prominent case in point is the procedure to measure reverse recovery time. When bias conditions are suddenly changed from forward to reverse, a semiconductor diode will not reach its steady-state reverse resistance immediately. The reverse recovery time is the time required for the resistance to some predetermined value.

By noting the reverse transient current through a specific load resistance as the bias is switched from a particular forward to reverse voltage, reverse recovery time can be measured. Since this parameter is a critical factor in such applications as high-speed computers, it is often carefully considered during diode selection.

### Individuality Creates Difficulties

Unfortunately all manufacturers do not agree on the same test setup. Although many favor and

use the IBM-Y or its modified version, several companies prefer their own methods.

How does this give rise to problems? Suppose an engineer scans several manufacturers' brochures and is searching for a diode type with certain characteristics, one being  $1.0$   $\mu$ sec reverse recovery time. He finally locates several types from three manufacturers and more or less hopes to gain by having three sources of supply plus possible interchangeability.

After careful scrutiny of the test procedures of each company, he may be disappointed to find that each used different values of load resistance in reverse recovery time measurement. If the engineer's application is tight, he cannot assume that the three companies will supply diodes that are close enough to fill the bill. His only recourse is to decide what he wants, draw up a spec sheet, include specific test procedures and submit the

1. DIODES												
LISTED IN ORDER OF MAXIMUM WORKING VOLTAGE, MINIMUM FORWARD CURRENT, and TYPE No.												
LINE No.	TYPE No.	Max. Cont. Working Voltage (volts)	Minimum Forward Current (ma)	MAX. REVERSE CURRENT @ 25 C						ABSOLUTE MAX RATINGS @ 25 C		DESCRIPTION
				$I_{R1}$	$I_{R2}$	$I_{R3}$	$I_{R4}$	$I_{R5}$	$I_{R6}$	DISS (mw)	Avg. Rect. Fwd. Current (ma)	
	1N616	30	8.0	1.0	18	1.5	150	30	25	30	75	Ge
	1N34	60	5.0	1.0	30	10	500	50	25	50	90	Ge
	1N1842	99Z	11	3.0	240	78	300	78	100J	28	25A	SiC
		17E	3.0							40	75BA	Si*

2. RECTIFIERS												
LISTED IN ORDER OF MAXIMUM WORKING VOLTAGE, MAXIMUM D.C. OUTPUT CURRENT, and TYPE No.												
LINE No.	TYPE No.	Max. Cont. Working Voltage (volts)	Max. D.C. Output Current (amps)	ABSOLUTE MAX RATINGS @ 25 C						MAX. REVERSE CURRENT		DESCRIPTION
				Fall Load Voltage Drop (volts)	Surge Current (one cycle) (amps)	Max. TEMP. (C)	$I_{R1}$	$I_{R2}$	$I_{R3}$	DISS (mw)	Max. TEMP. (C)	
	1N2229	50	5.0	25	.60	100	30	.50	50	150	SiC	
	1N1095	500	.25	150	.80	15	.30	800	150	SiC		
	1N1131	1500	300	25A	1.50	5.0	1.50A	.050A	1500	25A	Si	
		15K	250	75A							Si	

3. REFERENCE DIODES												
(ZENER, AVALANCHE, or OTHER TYPES)												
LISTED IN ORDER OF MINIMUM $E_{B1}$ , MAXIMUM $E_{B2}$ , and TYPE No.												
LINE No.	TYPE No.	REFERENCE VOLTAGE RANGE			DYNAMIC IMPEDANCE			MAX. DISS (mw)	Nominal Temp. Coeff. (%/C)	MAX. TEMP. (C)	DESCRIPTION	
		Min. $E_{B1}$ (volts)	Max. $E_{B2}$ (volts)	Temp. Tol. (ppm)	$Z_{0.1}$ (ohms)	$Z_{10}$ (ohms)	$Z_{100}$ (ohms)					
	1N2170	9.0	9.5	4.5	10	15	10	1000	.0005	125	Si	
	1N1900	43	51	10	10	15	10	1000	.0005	125	Si	
	1N1953	510	520	10	10	15	10	1000	.0005	125	Si	

4. SWITCHING DIODES												
---------------------	--	--	--	--	--	--	--	--	--	--	--	--

Typical information sheets contained in Derivation and Tabulation Associates' index of diodes.



data to several companies. He will, of course, pay a premium price, because he is ordering something "special."

#### Charts Serve as Guide

Interchangeability charts are offered by some manufacturers as a guide for designers and maintenance groups. They are often carefully prepared. But, again, until test procedures are standardized, comparative data listings and charts can only be trusted for general-purpose applications. Computers, high-reliability military equipment and the like must be supplied from carefully prepared specs, containing exact test setup procedures.

A few manufacturers offered this typical comment on differences in reverse recovery time procedures: "Computer designers asking for a 10  $\mu$ sec diode have designed the circuits to operate with enough leeway to use 60 or even 80  $\mu$ sec units. Even with differences in test methods, they'll still get what they want."

Not so, according to engineers on the staff of top computer outfits. When 10  $\mu$ sec is defined as maximum recovery time, 20 or even 15  $\mu$ sec may cause problems. And engineers maintaining computers using 100,000 or more diodes can ill afford problems.

#### EIA Standard Offered

Practically all manufacturers agree that tests should be standardized, but they prefer their method as the standard. EIA is hopeful that its standard Proposal 590 for reverse recovery time, prepared by JEDEC JS-2 Committee on Signal Diodes, will soon be accepted on an industry-wide basis.

Why do manufacturers disagree on test methods? Engineers at various companies pride themselves on keeping up-to-date in techniques of processing, application and testing. New and improved tests are required, they feel, as certain parameter levels outdo earlier types.

Users, on the other hand, view the lack of test standardization in a different light. Computer engineers, for example, may be informed of a new super high-speed diode, just released by company A, having a 0.05  $\mu$ sec reverse recovery time. It's just what they've been looking for. Samples are ordered, price quotes are estimated and wheels are set in motion. When the diodes arrive, they are checked and evaluated—with what results? They may fall into the class of 0.1 or 0.2  $\mu$ sec units presently being supplied by companies B and C.

By modifying its test methods, company A can boast of a new, fast diode, superior to present types. Conversion to comparative test methods

# MERCK HAS ALL FOUR FORMS OF Silicon IN PRODUCTION QUANTITIES

**MERCK DOPED SINGLE CRYSTAL SILICON**—offers doped float zone single crystals of high quality at low costs. Yields of usable material are reported to be especially high when device diffusion technics are used with these crystals. Float zone single crystals doped either "p" or "n" type with resistivities from 3 to 300 ohm cm. any range plus or minus 25% and a minimum lifetime of 100 microseconds are available in diameters of 18 to 20 mm., and random lengths of 2 to 10 inches.

*NOTE: Doped single crystals in other diameters, resistivities, or lifetimes not listed above can be furnished as specials.*

**MERCK HIGH RESISTIVITY "P" TYPE SINGLE CRYSTAL SILICON**—offers float zone single crystals of a quality unobtainable by other methods. Available with minimum resistivity of 1000 ohm cm. "p" type and a minimum lifetime of 200 microseconds, diameter 18 to 20 mm., random lengths 2 to 10 inches.

**MERCK POLYCRYSTALLINE BILLETS**—have not previously been melted in quartz, so that no contamination from this source is possible. Merck guarantees that single crystals drawn from these billets will yield resistivities over 50 ohm cm. for "n" type material and over 100 ohm cm. for "p" type material. Merck silicon billets give clean melts with no dross or oxides.

**MERCK POLYCRYSTALLINE RODS**—are ready for zone melting as received . . . are ideal for users with float zone melting equipment. Merck polycrystalline rods are available in lengths of 8½ to 10½ inches and in diameters of 18 to 20 mm. Smaller diameters can be furnished on special order. In float zone refining one can obtain from this material single crystals with a minimum resistivity of 1000 ohm cm. "p" type with minimum lifetime of 200 microseconds or the material can be doped by user to his specifications.

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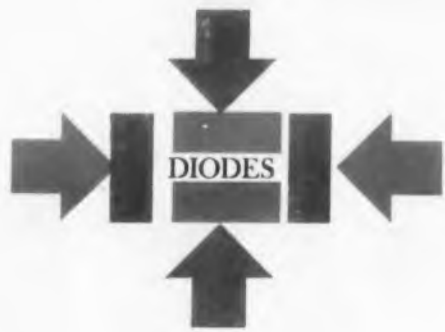
For additional information on specific applications and processes, write Merck & Co., Inc., Electronic Chemicals Division, Department ED-3, Rahway, New Jersey.

ULTRA-PURE

Silicon —a product of MERCK

**BASE BORON CONTENT BELOW ONE ATOM OF BORON PER SIX BILLION SILICON ATOMS**

CIRCLE 30 ON READER-SERVICE CARD



reveals that only slight, perhaps unimpressive, gains can be realized.

To avoid losing valuable time, large user outfits assign several engineers, generally in the standards section, to keep aware of new types. Any significant developments are followed routinely and translated into data in accordance with company test policies. In this way, diode

types can be evaluated on a strict comparative basis. The data may not agree with the diode manufacturer's figures, but by this method non-conformity among manufacturers' tests does not enter the picture.

Here again, the smaller manufacturer of equipment may lose out. It may be too expensive to evaluate new types until the need for their application arises. At this time, the engineer will be forced to spend valuable time, money and effort to compare late and early types. If he chooses to ignore newer types, he may be forced to sacrifice performance.

## 2 COPING WITH CONFUSION

### File Can Aid Engineers

To cope with diode-listing confusion, the design engineer can resort to several aids.

An obvious plan is to set up a file with all manufacturers' brochures and catalogs arranged alphabetically. The value of this system is contingent on the effort in keeping the charts up-to-

date. Since diode catalogs, advertisements and data sheets arrive unscheduled from different manufacturers, it is quite common to sidetrack them until a design calls for a diode.

At this time the file may be put in order and search begun. Unfortunately there is little or no interchangeability listing available, and tedious line-by-line scanning of each brochure is required. If time limits the search, the penalty may be the overlooking of a cheaper type.

Large companies can overcome these problems by assigning technical assistants to the daily filing and cross-indexing of all incoming data. To smaller outfits this job, of necessity, might fall to an engineer, who might otherwise be engaged in more useful output.

### Engineering Services Available

Valuable time can be saved by subscription to an engineering service, such as that offered by Derivation and Tabulation Associates, Inc., 95 Harrison Ave., West Orange, N.J.

Data on semiconductor diodes and rectifiers, totaling 4000, have been compiled from 63 companies, 50 American and 13 foreign manufacturers. Information on all parameters has been checked by the manufacturers for accuracy and completeness. Characteristic symbols are consistent with IRE and AIEE recommendations.

For rapid selection, semiconductors have been separated into the following groups: general-purpose diodes; reference, or Zener, diodes; switching diodes; microwave mixer diodes; microwave video detector diodes; voltage variable capacitor diodes and rectifiers. Other types are grouped under "miscellaneous."

A cross-index for type numbers and manufacturers' type list complete the publication. Revised editions are distributed in April and October. The cost is \$23.25 a year.

### Pik-N-Peek Card System

The latest data service plan for the design engineer is being offered by Data Search, Inc., of 15510 Norwood Pike, RFD-1, Silver Spring, Md. Although semiconductor diode classification is not yet available (initial output is slated for this summer), a recently released transistor service has been praised by many users.

Pik-N-Peek punched cards are the heart of the rapid transistor search method. Each card represents a certain characteristic, such as type, power dissipation, collector voltage and so forth.

A card marked "germanium," for example, would have numbers 1 to 500 printed on it, with the 2N transistor prefix omitted. Transistor types made of germanium would have holes punched above their numbers. Another card marked "pnp" would have holes punched for each pnp type. By superimposing both cards, all transistors up to

COLLECTOR DISSIPATION		1.01-3W		2.24	
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42
43	44	45	46	47	48
49	50	51	52	53	54
55	56	57	58	59	60
61	62	63	64	65	66
67	68	69	70	71	72
73	74	75	76	77	78
79	80	81	82	83	84
85	86	87	88	89	90
91	92	93	94	95	96
97	98	99	100	101	102
103	104	105	106	107	108
109	110	111	112	113	114
115	116	117	118	119	120
121	122	123	124	125	126
127	128	129	130	131	132
133	134	135	136	137	138
139	140	141	142	143	144
145	146	147	148	149	150
151	152	153	154	155	156
157	158	159	160	161	162
163	164	165	166	167	168
169	170	171	172	173	174
175	176	177	178	179	180
181	182	183	184	185	186
187	188	189	190	191	192
193	194	195	196	197	198
199	200	201	202	203	204
205	206	207	208	209	210
211	212	213	214	215	216
217	218	219	220	221	222
223	224	225	226	227	228
229	230	231	232	233	234
235	236	237	238	239	240
241	242	243	244	245	246
247	248	249	250	251	252
253	254	255	256	257	258
259	260	261	262	263	264
265	266	267	268	269	270
271	272	273	274	275	276
277	278	279	280	281	282
283	284	285	286	287	288
289	290	291	292	293	294
295	296	297	298	299	300
301	302	303	304	305	306
307	308	309	310	311	312
313	314	315	316	317	318
319	320	321	322	323	324
325	326	327	328	329	330
331	332	333	334	335	336
337	338	339	340	341	342
343	344	345	346	347	348
349	350	351	352	353	354
355	356	357	358	359	360
361	362	363	364	365	366
367	368	369	370	371	372
373	374	375	376	377	378
379	380	381	382	383	384
385	386	387	388	389	390
391	392	393	394	395	396
397	398	399	400	401	402
403	404	405	406	407	408
409	410	411	412	413	414
415	416	417	418	419	420
421	422	423	424	425	426
427	428	429	430	431	432
433	434	435	436	437	438
439	440	441	442	443	444
445	446	447	448	449	450
451	452	453	454	455	456
457	458	459	460	461	462
463	464	465	466	467	468
469	470	471	472	473	474
475	476	477	478	479	480
481	482	483	484	485	486
487	488	489	490	491	492
493	494	495	496	497	498
499	500				

Punched cards form the core of the Data Search Pik-N-Peek rapid-search system.



Dynamic characteristics of silicon rectifiers, (above) with average forward currents up to 500 amp, can be rapidly evaluated by the Wallson Silicon Rectifier Dynamic Test Set.



I. T. T. silicon Zener voltage regulators cover a range of 3.6 v to 30 v from 750 mw to 10 w. Top hat packaging is used for the low-power devices and stud-mounted cases for 3.5 w and 10 w sizes.





**International Rectifier Corp.** high-voltage silicon rectifiers can handle up to 1500 v piv at 300 ma.

2N500, of germanium pnp construction, could be found by noting the numbers that allow holes to show through both cards. If a card marked "Collector Dissipation —1.01 to 3.0 w" is added to the other two, it is a simple matter to find the germanium pnp types that could handle this power range.

By cross-referencing the indicated types with a Table of Transistor Characteristics, arranged in order of 2N-number, summary data and the manufacturer's name can be found to assist in final selection.

Indexing space is extremely compact, since there is not one card for each transistor type. For example, for a full cross-index of all transistors from 2N1 to 2N500, a total of 68 cards is required to reference 10 categories (type, alpha cut-off, beta, etc.) into sub-divisions (alpha cut-off —0 to 300 kc, 301-1000 kc, 1.01-3 mc, etc.). Four sets of 68 cards are available to index 2000 transistor types.

#### Card Index Stays Compact

As new types are issued, new holes are punched, and the card index set does not expand. Previous card systems, using one or several cards for each type, with cross-references, are cumbersome and multiply too rapidly for comfort.

Diode service would be similar in operation. Cards might be labeled for type (germanium, silicon), application (general purpose, high-speed, rectifier), piv (0-250 v, 251-500 v, etc.), forward current and other important parameters. The time spent in selection could be reduced to minutes for even tightly-specified requirements. The cost of the transistor service, which is updated monthly, is \$60 per year—the charge for the diode version is expected to be the same.



# Here's how to pick the best **DIODES** for your money

Price is no clue when diodes sell for about the same, and just looking at them tells nothing. But if you ask the right questions about the three key factors in the production of quality germanium gold bonded diodes, you have your clues to more long-term reliability for your money. Here they are:

#### BAKING TIME AND TEMPERATURE

bear a direct relationship to long-term stability. You get a measure of the quality of diodes by asking: "How long do you bake, and at what temperature?" (All GT diodes are baked at 140°C for at least 96 hours—the highest and longest in the industry!)

#### STRICT, STATISTICAL, HISTORY LOGGING

traces the progress of every single wafer made from each ingot of germanium. At GT, if a few wafers fail to pass the stringent GT quality tests along the way, then all from the ingot are suspect and can be identified and pulled out. There are no "stowaways" in a shipment of GT quality diodes.

#### LEVEL OF TESTING STANDARDS

reveals the level of quality. Ask about "everyday" test standards. (In the GT Seal Test, diodes are submerged in a penetrant-dye solution for 24 hours under 75 psi. This test is so sensitive that it will reveal a leak so small it would take over 300 years for 1 cc of gas to diffuse through the case.) All GT quality tests—100% electrical, 100% shock and vibration, and 100% temperature cycling—are at the highest industry level... and as a final mark of quality, the color bands on GT Germanium Gold Bonded Diodes are baked on to stay.

GT is equipped to supply diodes tested to individual customer requirements, such as JAN Qualification Inspection Tests and many others.

To get the full measure of quality in Germanium Gold Bonded Diodes, see your GT representative; or write directly to the company with know-how NOW.

**GENERAL TRANSISTOR CORPORATION**

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



FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. PRECISION MAGNETIC RECORDING HEADS AVAILABLE FROM GENERAL TRANSISTOR WESTERN CORP., 6110 VENICE BLVD., LOS ANGELES, CALIF.

CIRCLE 31 ON READER-SERVICE CARD

for reliable performance . . .

# TI Silicon Diodes and Rectifiers



## GENERAL PURPOSE SILICON DIODES

Type	Case Type	PIV	V <sub>Z</sub>	Min DC Fwd I (@ 25°C) ma at 1v	Max I <sub>b</sub> (@ 25°C) μa	P (@ 25°C) mw	Ambient Temp °C	I <sub>b</sub> ( <sup>†</sup> ) μa	P mw
Max at Elevated Temps (150°C)									
1N645	N	225	275	400	0.2	600	100	15	
AF1N645	N	225	275	400	0.2	600	100	15	
1N646	N	300	360	400	0.2	600	100	15	
1N647	N	400	480	400	0.2	600	100	20	
AF1N647	N	400	480	400	0.2	600	100	20	
1N648	N	500	600	400	0.2	600	100	20	
AF1N648	N	500	600	400	0.2	600	100	20	
1N649	N	600	720	400	0.2	600	100	25	
AF1N649	N	600	720	400	0.2	600	100	25	
600C	M	27	30	3	1 @ -10v	150	100	20 @ -10v	40
601C	M	45	50	10	0.025 @ -10v	150	150	40 @ -10v	40
604C	M	4	7	5	60	150	150	40	40
606C	M	6	8	7	35	150	150	40	40
608C	M	10	11	25	0.1	150	150	40	40
610C	M	15	17	20	0.1	150	150	40	40
612C	M	22	25	20	0.1	150	150	40	40
614C	M	33	37	20	0.1	150	150	40	40
616C	M	47	52	10	0.2	150	150	40	40
618C	M	68	75	10	0.2	150	150	40	40
620C	M	100	110	10	0.2	150	150	40	40
622C	M	150	170	7	0.2	150	100	20	40
624C	M	220	250	3	0.2	150	100	20	40

<sup>†</sup> At PIV except for types 600C and 601C

## HIGH CONDUCTANCE SILICON DIODES

Type	Case Type	Min Saturation Volts @ 100μa PIV v	Av Rect Fwd I @ 25°C ma	Recurrent Peak Fwd I (@ 25°C) ma	P (@ 25°C) mw
1N482	N	30	40	125	400
1N482A	N	30	40	200	650
1N483	N	60	80	125	400
1N483A	N	60	80	200	650
1N484	N	125	190	125	400
1N484A	N	125	150	200	650
1N485	N	175	200	125	400
1N485A	N	175	200	200	650
1N486	N	225	250	125	400
1N486A	N	225	250	200	650
1N487	N	300	330	125	400
1N487A	N	300	330	200	650
1N488	N	380	420	125	400
1N488A	N	380	420	200	650

## SILICON COMPUTER DIODES

Type	Case Type	PIV	V <sub>Z</sub>	Max T <sub>R</sub> (@ 25°C) μsec	Max I <sub>b</sub> (@ 25°C) μa	I <sub>0</sub> (@ 25°C) ma	Min I <sub>b</sub> (@ 100°C) ma	Typ Cap (@ 25°C) f = 1mc VR = -12v μf	Max I <sub>b</sub> (@ PIV) (@ 100°C) μa
1N659	N	50	60	0.3	5	100	6	2.7	25
1N660	N	100	120	0.3	5	100	6	2.7	50
1N661	N	200	240	0.3	10	100	6	2.7	100

## PHOTO DEVICE

Type	Bias Voltage v max	Dark Current (@ 25°C) ± 50v max μa	Dark Current (@ 100°C) ± 50v max μa	*Typ Light Current @ 25°C (@ ± 10v) μa	*Typ Sensitivity (@ 10v) μh/mw/cm <sup>2</sup>
1N2175	50	0.5	100	200	22.3

\* Light current measured in terms of radiation. Radiation = 3 mw/cm<sup>2</sup> in a frequency bandwidth of .7 to 1 micron.

## SILICON RECTIFIERS — ECONOMY PACKAGE

Type	Case Type	PIV	I <sub>0</sub> ma	Recurrent Peak Current @ 25°C a	Dynamic Forward Voltage Drop @ 100°C v @ ma	Dynamic Reverse Current @ 100°C ma @ v
1N2069	W	200	750	500	6	0.6 @ 500
1N2070	W	400	750	500	6	0.6 @ 500
1N2071	W	600	750	500	6	0.6 @ 500

## POWER REGULATORS AND DOUBLE ANODE CLIPPERS

Available with either anode or cathode to stud

Type	Case Type	Zener Voltage (@ 25°C)	I <sub>Z</sub> ma	Power Diss (@ 60°C) w	Reverse Current I <sub>b</sub> 25°C μa	max Z <sub>Z</sub> (@ 25°C) ohms	Typ Temp Coef %/°C
1N1816	R	13	500	10	25	2	0.07
1N1817	R	15	500	10	15	2	0.07
1N1818	R	16	500	10	10	3	0.07
1N1819	R	18	500	10	10	3	0.07
1N1820	R	20	250	10	—	10	0.08
1N1821	R	22	250	10	—	10	0.08
1N1822	R	24	250	10	—	10	0.08
1N1823	R	27	250	10	—	10	0.08
1N1824	R	30	250	10	—	10	0.08
1N1825	R	33	150	10	—	10	0.08
1N1826	R	36	150	10	—	10	0.09
1N1827	R	39	150	10	—	10	0.09
1N1828	R	43	150	10	—	10	0.09
1N1829	R	47	150	10	—	10	0.09
1N1830	R	51	150	10	—	10	0.10
1N1831	R	56	150	10	—	10	0.10
1N1832	R	62	50	10	—	10	0.10
1N1833	R	68	50	10	—	10	0.10
1N1834	R	75	50	10	—	10	0.11
1N1835	R	82	50	10	—	10	0.11
1N1836	R	91	50	10	—	10	0.12

Suffix A (±5% Tolerance) Suffix C (Double Anode Clipper)

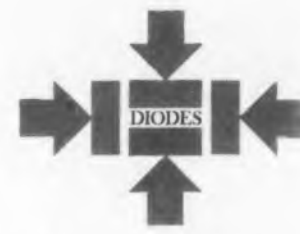
## VOLTAGE REGULATOR DIODES

Type	Case Type	Zener Voltage (@ 25°C) <sup>a</sup>	Max Total Power mw	25°C	150°C	Z <sub>Z</sub> max ohms
1N746†	N	3.3	400	100	28	
1N747†	N	3.6	400	100	24	
1N748†	N	3.9	400	100	23	
1N749†	N	4.3	400	100	22	
1N750†	N	4.7	400	100	19	
1N751†	N	5.1	400	100	17	
1N752†	N	5.6	400	100	11	
1N753†	N	6.2	400	100	7	
1N754†	N	6.8	400	100	5	
1N755†	N	7.5	400	100	6	
1N756†	N	8.2	400	100	8	
1N757†	N	9.1	400	100	10	
1N758†	N	10	400	100	17	
1N759†	N	12	400	100	30	
650C	M	3.7-4.5	150	40		
651C	M	4.3-5.4	150	40		
652C	M	5.2-6.4	150	40		
653C9	M	6.2-8.0	150	40		
654C9	M	8.5-9.5	150	40		
655C9	M	9.5-10.5	150	40		

<sup>†</sup>Suffix A (±5% Tolerance)

## SILICON RECTIFIERS

Type	Case Type	Mounting	PIV v	I <sub>0</sub> ma	Recurrent Peak Current -65°C to +150°C ma	E <sub>b</sub> (@ 25°C) v @ a	I <sub>b</sub> (@ 25°C) μa
1N588	O	Axial	1500	1000	25	10	10 @ 10ma
1N589	O	Axial	1500	1000	50	25	8 @ 50ma
1N1130	P	Cathode Stud	1500	1000	300	150	1 a
1N1131	P	Anode Stud	1500	1000	300	150	1 a
1N538	Q	Axial	200	200	750	250	2.5 a @ 25°C
1N539	Q	Axial	300	300	750	250	2.5 a @ 25°C
1N540	Q	Axial	400	400	750	250	2.5 a @ 26°C
1N1085	Q	Axial	500	500	750	250	2.5 a @ 25°C
1N1086	Q	Axial	600	600	750	250	2.5 a @ 25°C
1N1124	R	Cathode Stud	200	200	3 a	1 a	10 a @ 50°C
1N1125	R	Cathode Stud	300	300	3 a	1 a	10 a @ 50°C
1N1126	R	Cathode Stud	400	400	3 a	1 a	10 a @ 50°C
1N1127	R	Cathode Stud	500	500	3 a	1 a	10 a @ 50°C
1N1128	R	Cathode Stud	600	600	3 a	1 a	10 a @ 50°C
1N1124R	R	Anode Stud	200	200	3 a	1 a	10 a @ 50°C
1N1125R	R	Anode Stud	300	300	3 a	1 a	10 a @ 50°C
1N1126R	R	Anode Stud	400	400	3 a	1 a	10 a @ 50°C
1N1127R	R	Anode Stud	500	500	3 a	1 a	10 a @ 50°C
1N1128R	R	Anode Stud	600	600	3 a	1 a	10 a @ 50°C



CBS indium-bonded germanium diodes offer high forward-to-reverse current ratios.

3

## RECOMMENDATIONS

But despite the aids available, needed at once are definitions of parameters and standardization of test methods. From these, it is conceivable that all existing diode types could be re-evaluated by their manufacturers on a comparative basis. These, in turn, could give rise to an accurate and practical interchangeability for industry and the military. With everyone talking the same language, it should be possible to set up a new classification system in which the type number could signify key parameter data. This would be invaluable to the design engineer.

Critics are hopeful that industry can come up with a sensible solution without Government pressure.

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# Semiconductor Diode and Rectifier Directory of Manufacturers

## CATEGORY AND TYPES PRODUCED\*

Henry Tulchin, Editor

D.A.T.A.'s Semicon. Diode  
and Rectifier Characteristics  
Tabulation

Fifty U.S. and 13 foreign manufacturers are producing a total of 4000 different diodes and rectifiers, an increase of more than 1500 in the last year. This chart, prepared in conjunction with the April, 1959, edition of the semiannual Semiconductor Diode and Rectifier Characteristics Tabulation,<sup>o</sup> shows eight categories of the units, with the approximate number of types made by each manufacturer.

"Miscellaneous types" include video detector, uhf mixer, harmonic generator, photo-diode, four-layer bistable diode, parametric diode, solar cell and controlled rectifier.

The manufacturers for each category, except miscellaneous, total: diodes, 35; rectifiers, 39; reference diodes, 17; switching diodes, 21; microwave mixers, 6; microwave video detectors, 5, and voltage variable capacitors, 6.

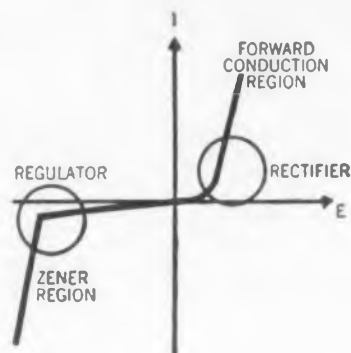
<sup>o</sup> Subscriptions available from Derivation and Tabulation Associates, 95 Harrison Ave., West Orange, N.J. For further information, turn to the Reader Service Card and circle 100.

Manufacturer	Diodes	Rectifiers	Reference Diodes	Switching Diodes	Micro. Mixer Diodes	Micro. Video Detector Diodes	Voltage Variable Capacitor Diodes	Miscellaneous
Allegemeine Elektricitats-Gesellschaft		39						
Amperex Electronic Co.	53	2		1				
Audio Devices Inc.		46						
Bendix Aviation Corp.		15						
Bogue Electric Mfg. Co.		43						
Bomac Labs, Inc.					36	2		
Bradley Semiconductor Corp.		28						
British Thomson-Houston Export	1	8	7					5 U.H.F. Mixer
Compagnie Generale de T.S.F.	8	5		3				
CBS-Hytron	68			10				11
Clevite Transistor Prod.	146			12				
Columbus Semiconductor Mfg. Div.		256						
English Electric Valve Co.		8						
Erie Electronics Div.	16			4				1
Fansteel Metallurgical Corp.		84						
Ferranti Ltd.	21	30	10				2	4
Gahagan, Inc.	61			6				
General Electric Co., Ltd.	14	13	16	2	8	1		3
General Electric Co.	10	170						17 Controlled Rectifiers
General Instrument Corp.	136	230	22	35				
General Transistor Corp.	11			1				
Hoffman Electronics	40	25	178	5				
Hughes Products	79	28	19	17			7	
Institute for Halvledarforskning	4							
International Rectifier	20	215	63				1	15 Solar Cells
International Resistance Co.	8							
International Tel. and Tel. Corp.		326	88					
Kemtron	90	14			30	4		
Laboratoire Central de Telecommunications	2							
P. R. Mallory		15						
Microwave Associates Inc.					29	9	26	
Motorola Semiconductor Div.		15	76					
Mullard Overseas, Ltd.	16		14	4				1
North American Electronics, Inc.	62							1
Ohmite Mfg. Co.	298			166				
Pacific Semiconductors, Inc.	59	56	21	30			23	8
Philco Corp.					3			2
Qutronic Semiconductor Corp.				35				
Raytheon Semiconductor Div.	56	22						4
RCA Semiconductor Div.	4	2						
Sarkes Tarzian, Inc.		195						
Semicon, Inc.		55						
Semi Elements, Inc.	94							
Shockley Transistor Corp.								16 Four Layer Diode
Siemens and Halske	2		15					1
Silicon Transistor Corp.	30							
Solid State Products Inc.								5 PNP controlled Switch
Sony Corporation	4							
Sperry Gyroscope Co.	19			9				1 Avalanche Switch
Standard Telephones and Cables Ltd.		20						
Sylvania Electric Prod., Inc.	70			15	25	10		1
Tekade	11	1	5	1				3
Texas Instruments	36	22	178	3				2
Texas Research Assoc.								4 Solion Diode
Thermosen, Inc.		30						
Trans-Sil		100						
Transitron Electronic Corp.	32	33	20	3			9	2
Tung Sol Electric Co.		28						
U.S. Semiconductor Products	25	77	182					
U.S. Dynamics		31						
Vickers Electric Products Div.		18						
Western Electric Co.		3	32	4				
Westinghouse Electric Corp.		138						4 Dynastor Switch 1 Transistor Switch

\*Number of types as of April 1959

## DIODE MANUFACTURERS

Allgemeine Elektrizitäts-Gesellschaft  
Belecke (Mohme), Germany  
Amperex Electronic Co.  
Hicksville, N. Y.  
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Long Branch, N. J.  
Bogue Electric Mfg. Co.  
Paterson, N. J.  
Bomac Labs, Inc.  
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Bradley Semiconductor Corp.  
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Lowell, Mass.  
Clevite Transistor Products  
Waltham, Mass.  
Columbus Semiconductor Mfg. Div.  
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Compagnie Generale de T.S.F.  
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English Electric Valve Co.  
Chelmsford, Essex, England  
Erie Electronics Div.  
Erie, Pa.  
Fansteel Metallurgical Corp.  
North Chicago, Ill.  
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Oldham, Lancs., England  
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Esmond, R. I.  
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Syracuse, N. Y.  
General Electric Co., Ltd.  
Stockport, Cheshire, England  
General Instrument Corp.  
Newark, N. J.  
General Transistor Corp.  
Jamaica, N. Y.  
Hoffman Electronics  
Evanston, Ill.  
Hughes Products  
Los Angeles, Calif.  
Institute for Halvledarforskning  
Stockholm, Va. Sweden  
International Rectifier Corp.  
El Segundo, Calif.  
International Resistance Co.  
Boone, N. C.  
International Tel. and Tel. Corp.  
Clifton, N. J.  
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Newburyport, Mass.  
Laboratoire Central de Telecommunications  
Paris, France  
P. R. Mallory and Co., Inc.  
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Microwave Associates, Inc.  
Burlington, Mass.  
Motorola Semiconductor Div.  
Ridgefield, N. J.  
Mullard Overseas Ltd.  
London W. C. 1, England  
North American Electronics, Inc.  
Lynn, Mass.  
Ohmite Mfg. Co.  
Skokie, Ill.  
Pacific Semiconductors, Inc.  
Culver City, Calif.  
Qutronic Semiconductor Corp.  
New York, N. Y.  
Raytheon Semiconductor Div.  
Needham Heights, Mass.  
RCA Semiconductor Div.  
Harrison, N. J.  
Sarkes Tarzian Inc.  
Bloomington, Ind.  
Semicon, Inc.  
Lexington, Mass.  
Semi Elements, Inc.  
Saxonburg, Pa.  
Shockley Transistor Corp.  
Palo Alto, Calif.  
Siemens and Halske  
Munich, Germany  
Silicon Transistor Corp.  
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Salem, Mass.  
Sony Corp.  
Shinagawa-ku, Tokyo, Japan  
Sperry Gyroscope Co.  
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Englewood, N. J.  
Transitron Electronic Corp.  
Wakefield, Mass.  
Tung Sol Electric Co.  
Livingston, N. J.  
U. S. Dynamics Corp.  
Boston, Mass.  
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typical I-E characteristic curve  
for Hoffman Silicon Diodes

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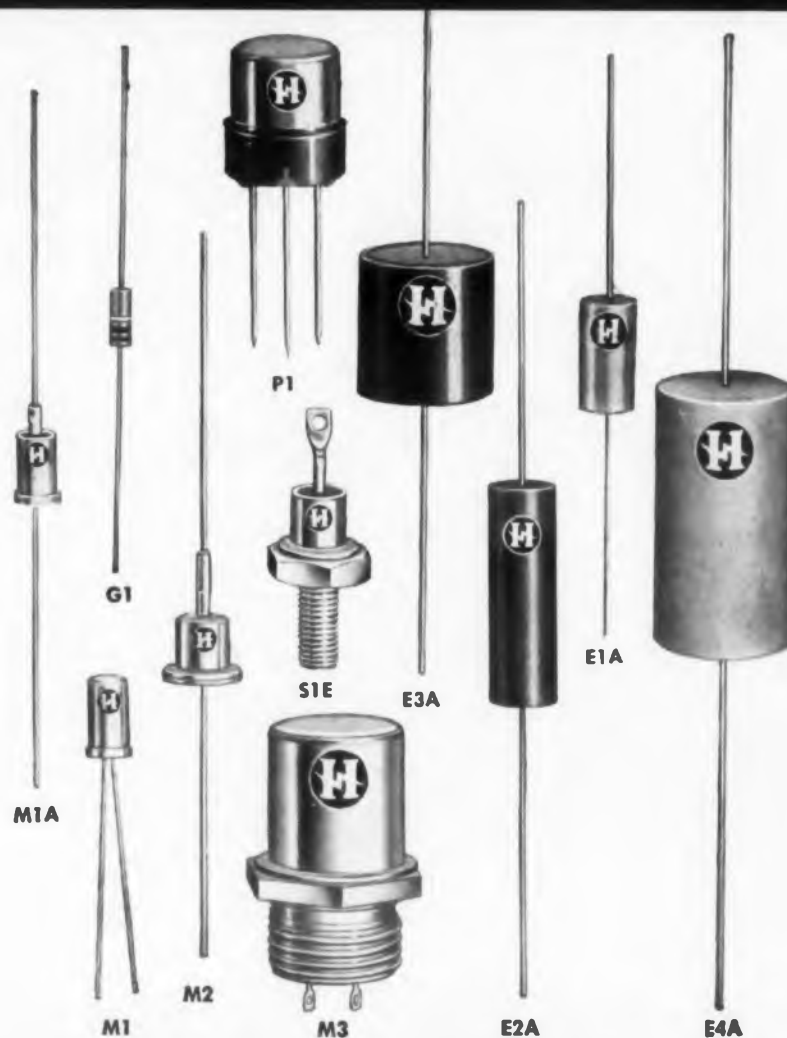
<b>6</b> ZENER LOW VOLTAGE DIODES • 200mW • Zener Voltage Range: 2.0V — 8.0V	CASE TYPE  M1	<b>9</b> ZENER "DOUBLE ANODE" MEDIUM VOLTAGE DIODES • 150mW • Zener Voltage Range: 7.5V — 45V	CASE TYPE  M1	<b>38</b> ZENER VOLTAGE REGULATORS 10 WATT • Zener Voltage Range: 5.6V to 200V ± 10% • Dynamic Impedance: 1 ohm to 140 ohms (over the entire line)	CASE TYPE  S1E
<b>6</b> ZENER MICRO-MINIATURE GLASS LOW VOLTAGE DIODES • 250mW • Zener Voltage Range: 2.0V — 8.0V	G1	<b>6</b> ZENER REFERENCE DIODES & ELEMENTS • Operating Zener Voltage: 1N429: 6.2V ± 5% 1N430, 1N430A, 1N430B, 1N1530, 1N1530A: 8.4V ± 5% • Dynamic Impedance: 1N429: 20 ohms Others: 15 Ohms	M1 M3 P1	<b>38</b> ZENER VOLTAGE REGULATORS 1 WATT • Zener Voltage Range: 5.6V to 200V ± 10% • Dynamic Impedance: 1.2 ohms to 1100 ohms (over the entire line)	M1A
<b>5</b> ZENER "DOUBLE ANODE" LOW VOLTAGE DIODES • 250mW • Zener Voltage Range: 3.0V — 8.0V	M1	<b>4</b> ZENER REFERENCE MICRO-MINIATURE DIODES • Operating Zener Voltage: 5.9V to 6.5V • Dyn. Imp.: 15 ohms	G1	<b>38</b> ZENER VOLTAGE REGULATORS 1/4 WATT • Zener Voltage Range: 5.6V to 200V ± 10% • Dynamic Impedance: 3.5 ohms to 1400 ohms	G1
<b>15</b> ZENER "SINGLE ANODE" MEDIUM VOLTAGE DIODES • 150mW • Zener Voltage Range: 7.5V — 145V	M1	<b>15</b> ZENER REFERENCE STRINGS • Operating Zener Voltage: 6.2V thru 49.6V ± 5% • Dynamic Impedance: 20 ohms to 180 ohms (over the entire line)	E1A E2A E3A E4A		

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- 150mW
- PIV Range: 6.8V thru 470V

CASE TYPE  
M1

**6 HB GENERAL PURPOSE SILICON DIODES**

- 150mW
- PIV Range: 6.8V thru 270V

M1

**8 GLASS GENERAL PURPOSE DIODES**

- 200mW
- PIV Range: 25V to 175V

G1

**5 GLASS FAST RECOVERY SILICON DIODES**

- 200mW
- PIV Range: 25V to 175V

G1

**11 SILICON DIFFUSED JUNCTION MEDIUM POWER RECTIFIERS**

- PIV Range: 50V to 1000V

CASE TYPE  
M1A

**7 SILICON DIFFUSED JUNCTION MEDIUM POWER RECTIFIERS**

- PIV Range: 50V to 500V

M2

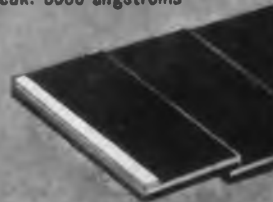
**8 SILICON DIFFUSED JUNCTION MEDIUM POWER RECTIFIERS**

- PIV Range: 95V to 570V

S1E

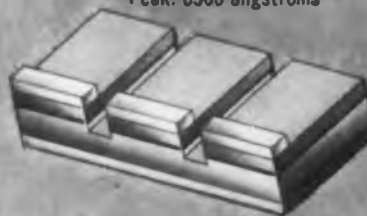
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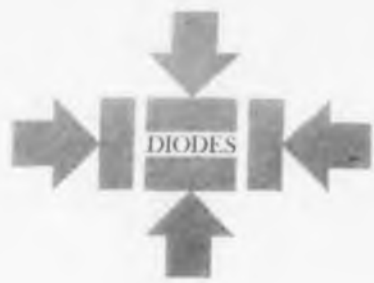


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# Diffused Silicon Diodes

## Boast Closely-Controlled Characteristics

**Franklin R. Carlson**  
Project Engineer  
U. S. Semiconductor Products, Inc.  
Phoenix, Ariz.



During the past two years, Mr. Carlson has specialized in the application of diffusion techniques to silicon device development. He believes that diffused diodes will find wide use, in the near future, as voltage variable capacitors.

**D**IFFUSED silicon diodes combine, in a compact and rugged package, desirable characteristics of high forward conduction, low reverse saturation current, and high peak inverse voltage. Advantages of the diffused junction include the readiness with which it lends itself to the production of large-area junctions and the considerable accuracy with which the process can be controlled. These features make possible the fabrication of devices with highly reproducible characteristics.

Out of the diffusion process has grown both a line of rectifiers and Zener diodes. The only actual difference in the process is the resistivity of silicon which goes into the diffusion step. Zener diodes have very low dynamic impedance.

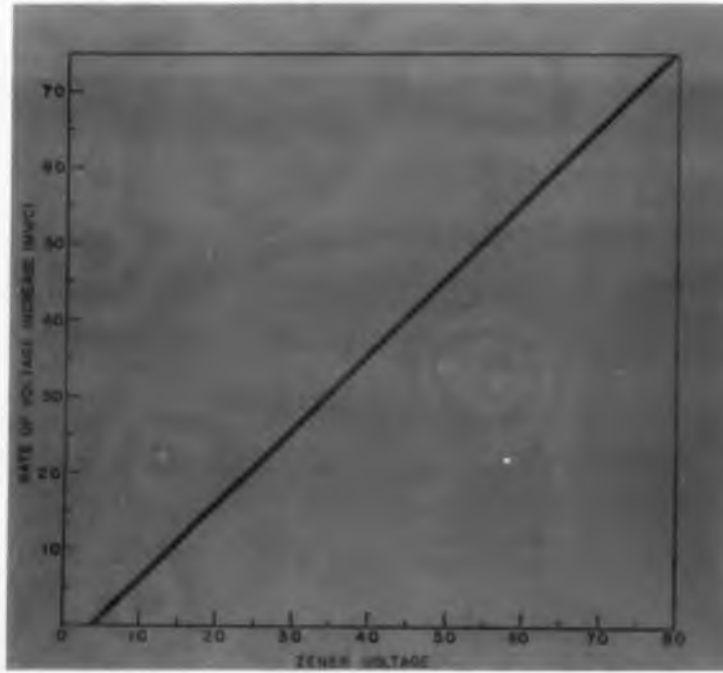
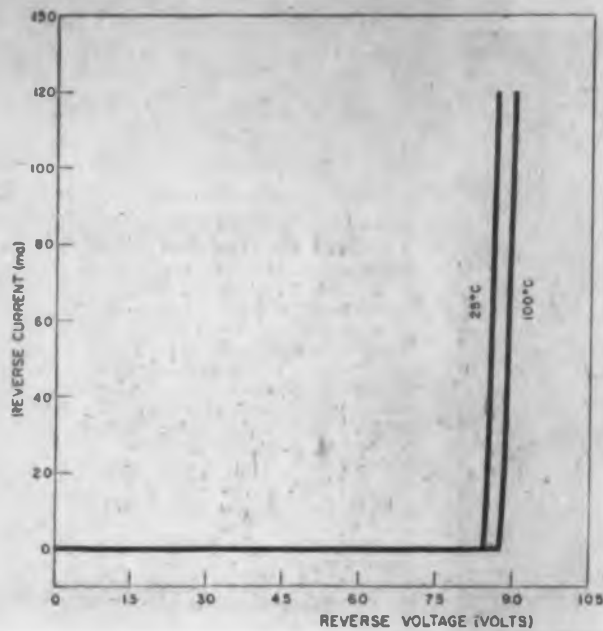
### Reverse Characteristics

Boron-doped silicon crystals of about 35 ohm-centimeter resistivity are currently used to manufacture rectifiers. A peak inverse voltage of 700 v is commonly obtained with ratings as high as 1300 v possible from single junctions. The reverse saturation current of 700 v rectifiers, measured at 500 v, is of the order of 0.05  $\mu$ amp. This low saturation current is attributed to the perfection of the diffused junction and the extreme difference in doping concentrations on opposite sides of the junction. The p-type impurity concentration on one side of the junction is of the order of  $10^{14}$  atoms per cubic centimeter, while on the other side of the junction the phosphorus impurity concentration approaches  $10^{23}$  atoms per cubic centimeter.

A typical reverse characteristic for an 8.2 v diffused Zener diode is shown in Fig. 1. As a reverse bias voltage is applied across the diode, only very low saturation current, in the order of 1.0  $\mu$ amp or less, flows. At 8.2 v, the avalanche or Zener voltage, the current begins to increase extremely rapidly with increasing voltage. The graph also shows that Zener voltage increases with junction temperature; this increase of Zener voltage with temperature is constant over a wide range of temperature and shows little change with current. At 10 ma there is little heat generated in the junction so this voltage change becomes primarily a function of the external temperature. The slope of the curve in the avalanching or Zener region is termed the Zener Impedance, and is important when the diode is used for voltage regulation.

### Linear Temperature Coefficient

In Fig. 2 is shown a plot of Zener voltage versus the rate of voltage increase with temperature, expressed in millivolts per degree centigrade rise. Temperature coefficients of Zener diodes are usually expressed as percent voltage change per degree rise; however, for reasons of simplicity,



**Fig. 1.** (Above, left) Reverse Voltage vs. Reverse Current (Diffused 8.2 volt Zener diode)

**Fig. 2.** (Above, right) Zener voltage vs rate of voltage increase

**Fig. 3.** (Left) Zener impedance vs Zener voltage

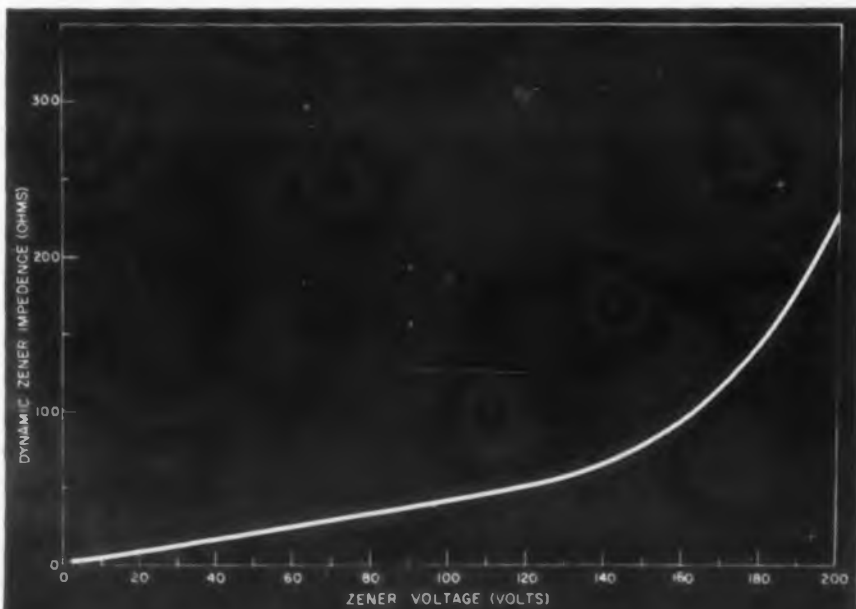




Fig 4. Zener Voltage Spread for Diffusion Lots

Lot No.	Average Zener Voltage (Volts)	Standard Deviation (Volts)
1	13.8	0.22
2	64.0	2.00
3	18.2	0.70
4	22.5	0.29
5	105.0	2.70
6	21.7	0.50
7	44.0	1.80
8	7.8	0.130
9	8.2	0.100

\*25 units Randomly Sampled from Each Lot

this article describes temperature coefficient as the change in millivolts per degree of temperature change. From the curve it is seen that the temperature coefficient increases quite linearly with Zener voltage.

Dynamic Zener impedance at 7.5 ma versus Zener voltage is plotted in Fig. 3. This curve shows a linear relationship up to about 150 v and then a rapid increase in Zener impedance with Zener voltage. At higher currents, the dynamic Zener impedance is lower for any particular Zener voltage.

The Zener voltage of a diode is basically controlled by the boron impurity concentration in the region of the crystal used to make the junction. On this basis, silicon crystals are doped and grown to produce a predetermined Zener voltage.

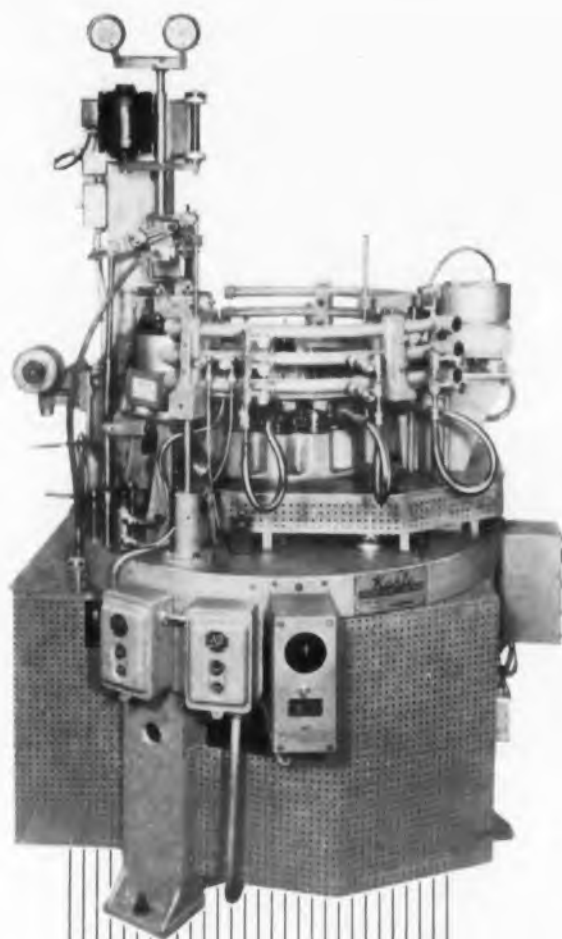
#### Altering Zener Voltages

By using boron as the basic doping impurity in the silicon, crystals are obtained which have only slight variations in resistivity throughout the crystal. Zener voltages obtained from these crystals usually show less than 5 per cent variation throughout the length of the crystal.

Fig. 4 indicates the distribution of Zener voltage obtained by the diffusion process. Highly precise results become a problem when it is necessary to produce Zener diodes with one per cent tolerances at a voltage slightly out of the range of a particular crystal. However, the Zener voltage obtained from a given crystal can be altered by modifying the concentration gradient in the junction; this can be done by changing either the diffusion time or temperature. In practice, the Zener voltage obtained from a crystal can be altered by as much as 25 per cent above and below that obtained by the normal diffusion process.

#### Forward Characteristics

Another outstanding property of diffused junction diode is the low forward voltage drop which is obtained. This voltage drop, at currents above 0.5 amp, is 25 per cent to 50 per cent lower than



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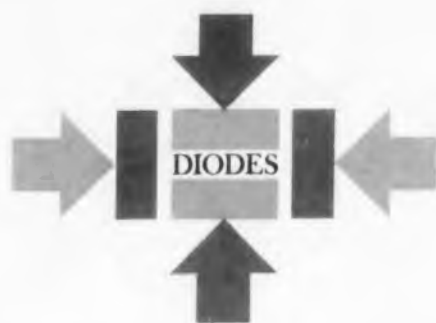
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CIRCLE 34 ON READER-SERVICE CARD



that obtained by alloyed-type junctions of the same junction area.

A plot of forward current versus forward voltage drop for diffused junction diodes, at junction temperatures of 25 C and 100 C, is shown in Fig. 5. The significance of the forward characteristic can be seen by considering the curve at 25 C. As a forward bias voltage is applied across the diode, there is essentially no current flow until the bias reaches about 0.5 v. At this point, the current begins to increase exponentially as the bias voltage is increased, reaching 2.0 amp at about 0.9 v. However, this is an instantaneous reading so that the junction does not have time to warm up.

The forward voltage drop across a diode is the sum of a junction potential barrier plus ohmic drops caused by resistance in the silicon and contacts to the silicon. It is this ohmic resistance which has been most affected by the diffusion process. By decreasing the ohmic resistance in the diode, the forward characteristic becomes more nearly that of the potential barrier.

The typical dynamic impedance of a forward biased diffused diode is 0.3 ohm at 50 ma and decreases to 0.15 ohm at one amp. This low dynamic impedance, combined with the Zener-like characteristic of the forward-biased junction, results in a device well adapted for special applications, such as voltage regulation in regions of low voltage which cannot be reached by ordinary Zener diodes. A common use for forward biased diodes is overvoltage protection on meter movements.

The forward voltage drop across a diode operating in an ambient temperature of 25 C will always be less than that given by the 25 C curve in Fig. 5. As shown, the forward voltage drop decreases with increasing junction temperature. When forward current is flowing through a diode, heat is generated in the junction. This increase of junction temperature will result in a decrease of the forward voltage drop. The overall result is that as more current is passed through the diode, increasing the voltage drop, there is additional heat generated which tends to counteract this effect by lowering the voltage drop. A plot then of forward current versus voltage drop under operating conditions in a 25 C ambient temperature would resemble the 25 C curve in Fig. 5 at low currents, but rise more perpendicularly at higher currents. For example, the forward voltage drop for an axial lead diffused rectifier operating in a

25 C ambient is essentially constant at 0.8 v for all dc currents over 0.5 amp.

#### Rectifier Power Losses

The real importance of forward voltage drop of rectifiers lies in the power losses in the rectifier. If, for example, forward voltage drop can be decreased by 33 per cent, only two-thirds as much heat will be generated in the junction while delivering the same amount of current to the load. This means, for a given load current, it is necessary to provide for only two-thirds as much heat dissipation. A direct result of this is a decrease in package size. A plot of the load current versus power dissipation in an axial lead diffused diode is given in Fig. 6.

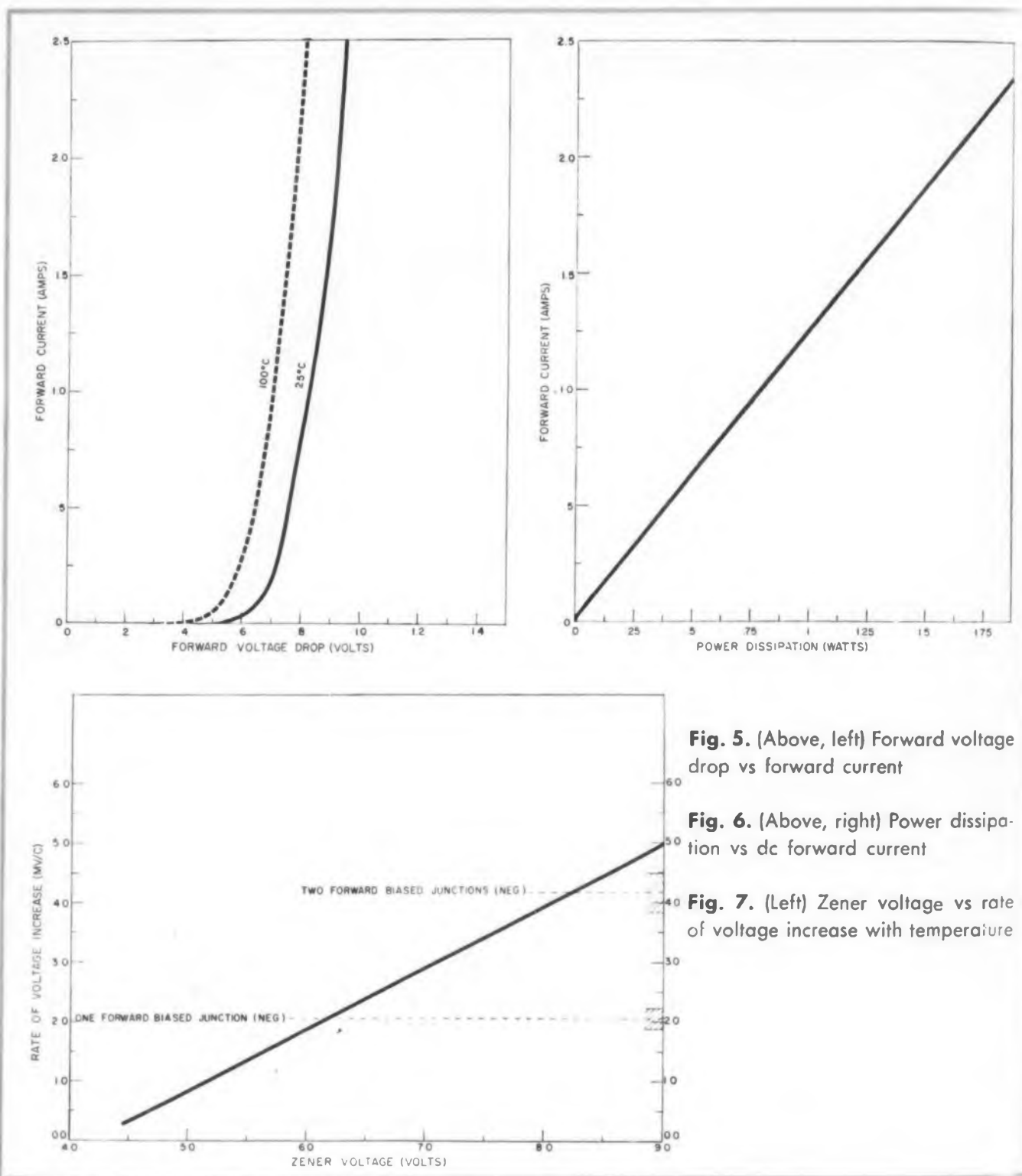
The forward voltage drop of diffused diodes

at currents above 50 ma appears to be independent of the resistivity of the p-type silicon used to produce the junction. Both 900 v PIV rectifiers and 10 v Zener diodes have essentially the same forward characteristic above 500 ma. At low currents, the forward voltage drop is slightly lower for high voltage rectifiers. This is dissimilar to alloyed-type junctions in that they usually have higher forward impedances when made from higher resistivity silicon.

#### Special Devices

Certain modifications and special properties of diffused-junction diodes and rectifiers have been utilized in producing special devices.

Very high peak inverse voltages for rectifiers can be attained by connecting several rectifiers





in series. This can be done in a single package using diffused junctions. As many as three dice containing diffused junctions can be stacked one above the other in the medium power package with no modifications in the assembly line, yielding rectifiers with PIV as high as 2000 v. This also places the three forward voltage drops in series, tripling the forward voltage drop as compared to a single junction rectifier.

Decreasing voltage drop with increasing temperature in a forward-biased silicon junction and increasing voltage drop with increasing temperature in a reversed-biased Zener diode have been utilized to produce a temperature-compensated voltage reference element. The high precision with which the temperature coefficients of Zener diodes can be predetermined has resulted in the fabrication of reference elements with a total voltage change of only 12 mv over the temperature range of  $-55^{\circ}\text{C}$  to  $185^{\circ}\text{C}$ , at a voltage of about 9.4 v. This is equivalent to 0.0005 per cent change per degree centigrade change. Temperature compensated elements with this tolerance are currently produced by no other process.

Manufacturing these devices can be best explained by the use of Fig. 7. This curve is the lower region of the Zener voltage versus temperature coefficient curve shown in Fig. 2. Also indicated is the negative temperature coefficient of a single and two-series forward-biased junctions. First, the negative temperature coefficient is determined for forward biased junctions produced from a given crystal; then Zener junctions are produced which will compensate for the negative temperature coefficient of two forward-biased junctions. From the curve it is seen that an 8.2 v Zener junction will do this. The resultant voltage of the compensated device is the voltage drop across the Zener junction plus the voltage drop of two forward-biased junctions.

#### Twin-Zeners

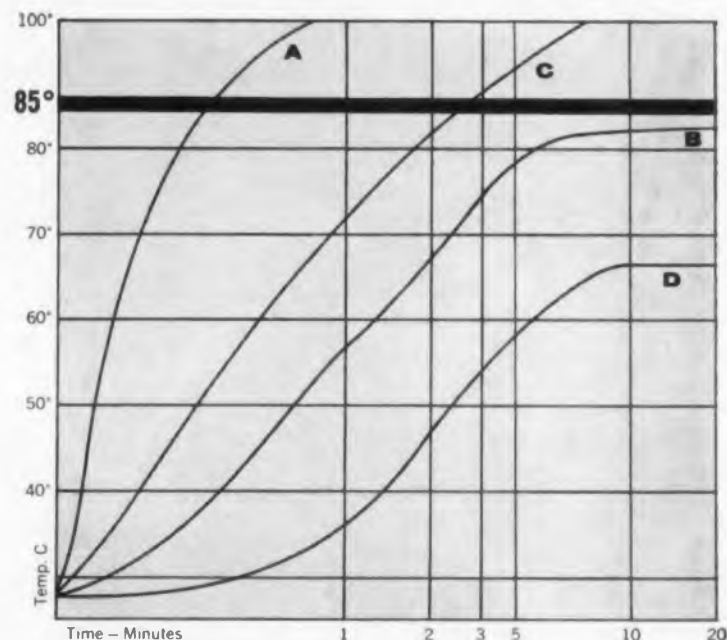
Double-anode type Zener diodes, or twin Zeners, can be produced by the diffusion technique even more simply than can the normal Zener diodes. In the first stage of the diffusion process, junctions are formed on both sides of the silicon slice. The normal procedure is to remove the junction from one side leaving only one junction in the slice. However, if both of these junctions are allowed to remain in the slice, the resulting device will show a reverse biased Zener characteristic when biased in either direction. Twin Zeners produced by the diffusion process exhibit the same characteristics as reverse biased single junction Zener diodes with the exception that the temperature coefficient is lower. The Zener voltages exhibited by these devices when biased in either direction are usually within one per cent.

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#### TEST CONDITIONS

Test was conducted using commercially available power transistor with a power dissipation of 13.5 watts, mounted on phenolic and metal chassis (with mica washer), using the same transistor with and without a Birtcher Transistor Radiator. The ambient was maintained at a constant.

#### TEST RESULTS

- A** — Transistor on 6" x 6" phenolic chassis
- B** — Transistor on 6" x 6" phenolic chassis with Radiator
- C** — Transistor on 6" x 6" metal chassis (with mica washer)
- D** — Transistor on 6" x 6" metal chassis (with mica washer) and Radiator

In both instances where a Radiator was not employed the temperature rose above the destructive level inside of 3 minutes. In both cases where a Radiator was used the temperatures remained well within safe limits.

The above results are typical of tests which have been conducted on every type of Birtcher Transistor Radiator.

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Copies of test results on power transistors plus a reprint of an article "Increased Cooling for Power Transistors" will be included.

Birtcher cooling and retention devices are sold only by The Birtcher Corporation and through their authorized Sales Representatives. They are not sold through distributors.

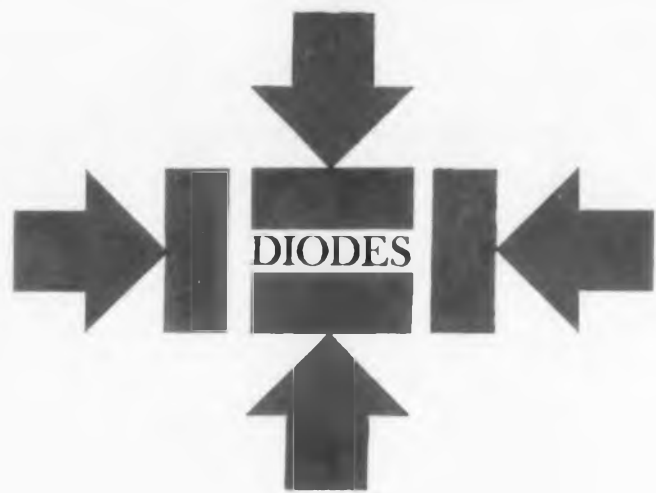
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## THE BIRTCHER CORPORATION

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CIRCLE 35 ON READER-SERVICE CARD



# Secondary Effect of Diode Leakage in Selection Matrices

**I. N. Saxe**

Technical Assistant to the Manager  
Sage Project Office, IBM, Kingston, N. Y.

**M. Collins**

Manager of Semiconductor Group,  
IBM, Kingston, N. Y.

A simple modification of multiple level switching circuits will guarantee consistent operation. The technique described can be used in both germanium and silicon matrices.

**B**Y APPLYING diode isolation to multiple-level switching circuits, fall-time characteristics can be greatly improved by reduction and discharge of circuit capacitance.

In a multi-level diode selection matrix or cas-



I. N. Saxe (left) received his B.S.E.E. from V.M.I. in 1939. Between 1939 and 1955, he worked in industry as well as the Army Signal Corps. In 1955, he joined IBM and has been engaged in the design of power and computer systems, logic and circuitry for magnetic drum equipment.

M. Collins (right) was graduated from Cornell in 1950 with a B.E.E. degree. He joined IBM in 1953 and has been active in computer design and component application.

caded "OR" circuit, the "fall time" is sometimes slower than calculations indicate it should be. In other cases, a matrix whose fall time is satisfactory by tests fails to operate satisfactorily in isolated instances. The widening use of silicon diodes will increase the occurrence of this type of difficulty.

## Conventional Circuit

A typical "OR" circuit (Fig. 1) for a large number of inputs poses the problem that any input must supply the reverse current of all the other input diodes, in addition to the current demands of  $R_L$  and any connected load. When the number of inputs is large, the load on the driver can be excessive, especially when the design has properly allowed for "end of life" diode leakage.

Reduction of this current is easily accomplished by adding an additional stage of diodes, as shown in Fig. 2. In this case, a 100 input "OR" circuit with 10 additional diodes has the leakage of 18 diodes in parallel. This addition of 10 diodes results in a reduction of approximately 92 per cent in leakage current loading.

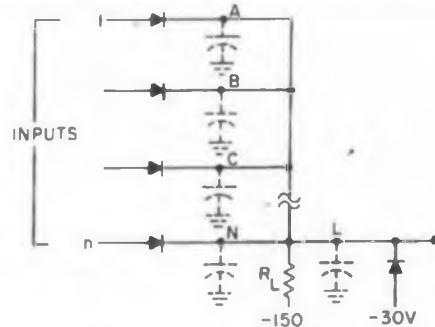


Fig. 1. "OR" circuit with multiple inputs.

In the circuit of Fig. 1, the capacitance of all lines represented by A through N, as well as that in L, is driven by each and every input. Since a large number of diodes normally implies a great deal of wiring, the reduction in capacitance is of great importance when fast fall times are desired.

## Stray Capacitance Minimized

An additional advantage of the circuit of Fig. 2 is a reduction of the stray capacitance seen by the load during the fall or "OFF" transition. If input 1 is falling, the capacitance  $C_2, C_3 \dots C_{10}$  is isolated from the load by the diodes in the M or second level. Thus the total capacitance seen is  $C_1 + C_L$ .

The combination of smaller groups of diodes, which is possible in Fig. 2, leads to additional gains in stray capacitance reduction through proper wiring techniques of the small groups.

Thus it may be seen that even when very low leakage diodes (silicon) are used, the circuit of Fig. 2 may be used to advantage.

## Hidden Weak Point

However, there is a weak point in this design which is normally overlooked. The "slow fall time" condition will be described in its worst case to make it more understandable. Refer to Fig. 2 and assume that diodes CR (N2) through CR (N100) have no leakage and assume that the leakage of CR (M2) through CR (M10) is finite as indicated by the dotted resistors. After one selection has been made for a long time and "V ON" applied to CR (N1), the stray capacitance shown by  $C_2$  through  $C_{10}$  will become charged to "V ON" (0 volts).



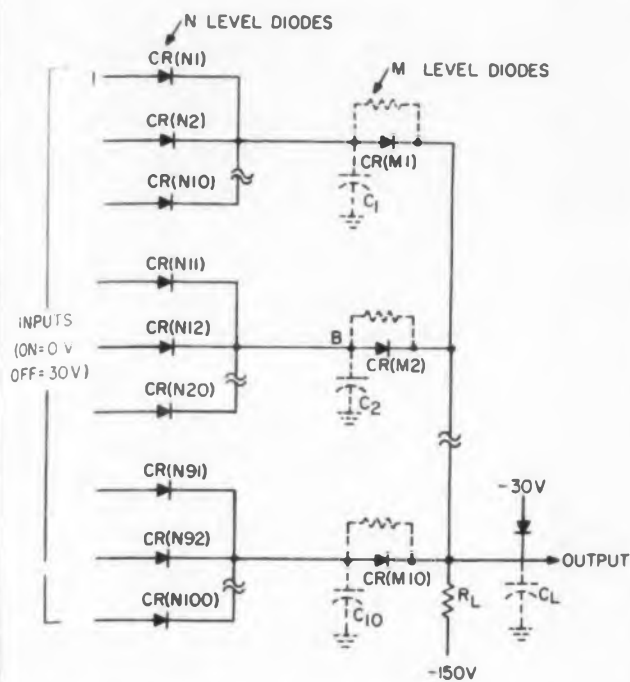


Fig. 2. "OR" circuit with isolation diodes.

When the voltage applied to CR (NI) goes from 0 to -30 v, the fall time of the matrix's output is governed by the stray capacitance in the entire network, instead of being governed entirely by the stray capacitance in just one branch (shown as C1). Therefore, under the conditions described

$$\frac{\text{Ideal Fall Time}}{\text{Actual Fall Time}} = \frac{R_1 (C_L + C_1)}{R_1 (C_L + C_1 + C_2 + \dots + C_{10})}$$

$$= \frac{C_L + C_1}{C_L + C_1 + C_2 + \dots + C_{10}}$$

(Continued on page 48)

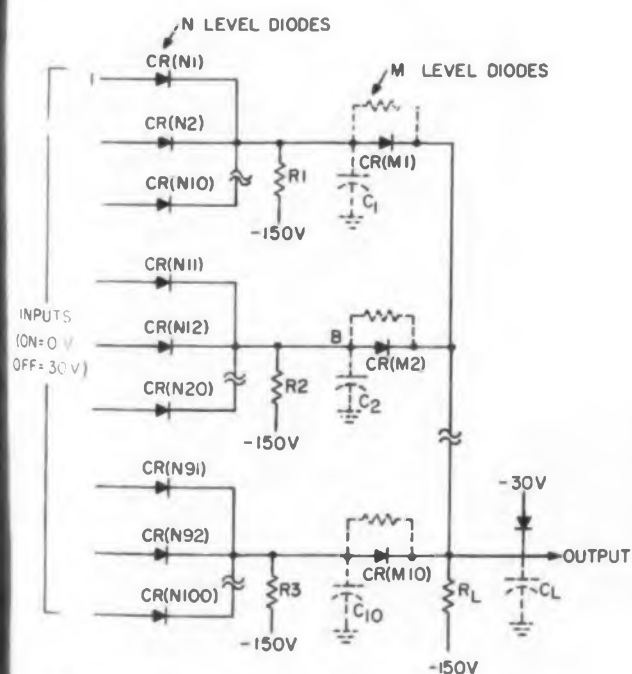
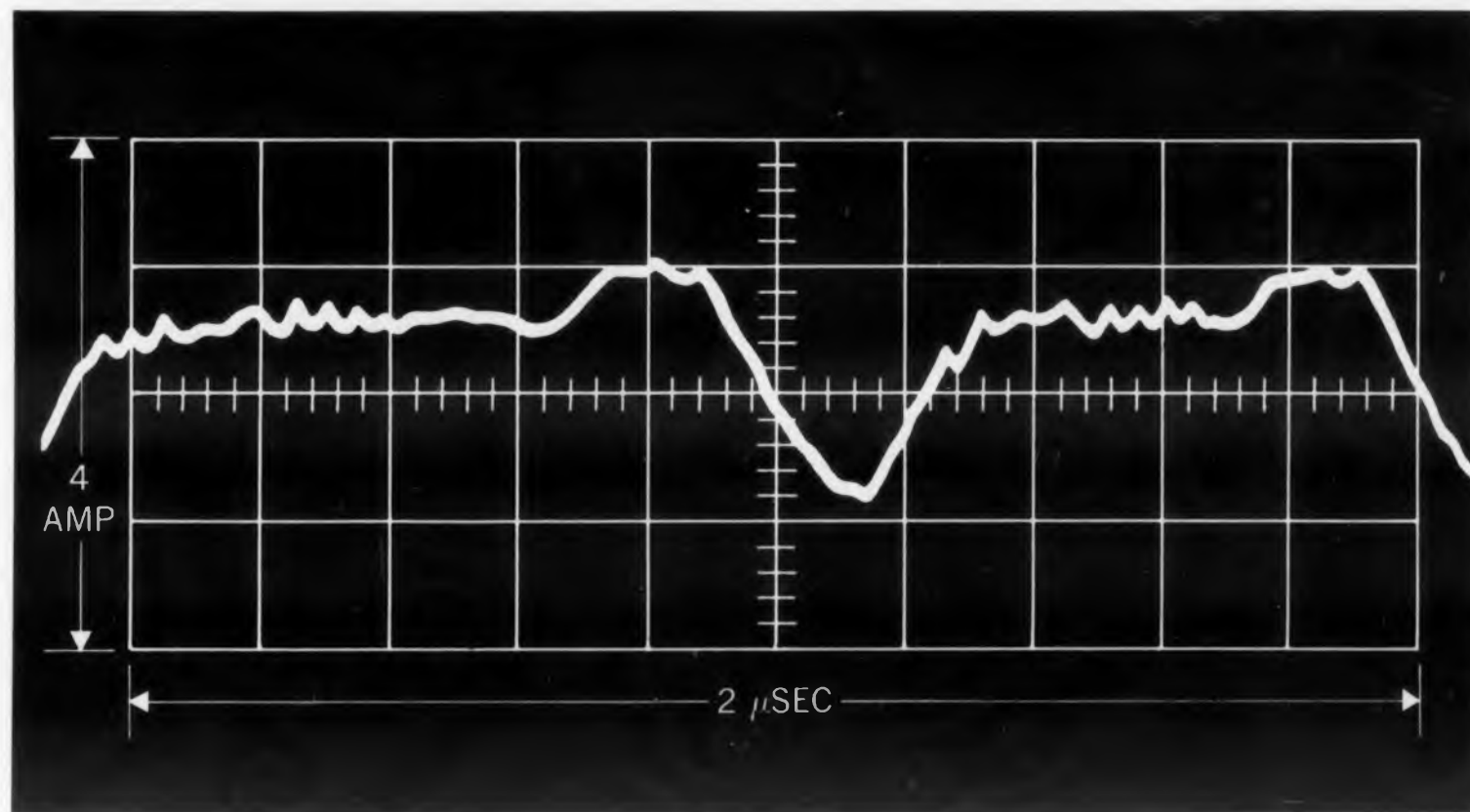


Fig. 3. "OR" circuit with isolation diodes plus broader resistors.



Photograph of typical word driver current from the high speed memory.

## 83,200 bit memory with 1 μsec access time made possible with Shockley 4-layer diodes

This outstanding achievement has been made possible by two recent developments—the impulse core switching technique and the Shockley 4-layer transistor diode. The impulse core switching technique was developed by R. E. McMahon and reported by him ("Impulse Switching of Ferrites") at the Solid State Conference in Philadelphia, February, 1959.

Shockley diodes give the high rate of current build-up required for impulse core switching. In experimental circuits, build-up rates greater than

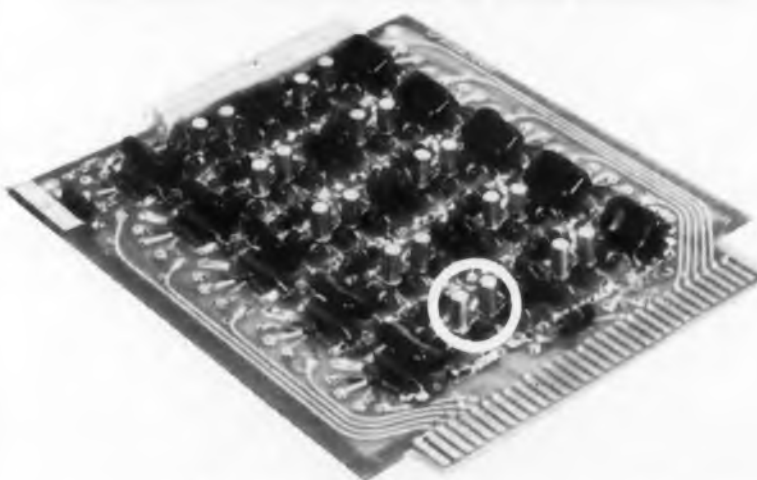
$10^9$  amperes/second have been obtained.

The designers of the new high-speed memory describe it as—"a sequential access, linear selection ferrite core memory consisting of 1040 words of 80 bit length (83,200 bits of total storage)." The access time between words is less than 1 μsec and the complete cycle time of the cores is of the order of 0.5 μsec. The technique used to obtain such high speed switching with normal ferrite cores is known as impulse switching.

The Shockley 4-layer diode is a two terminal silicon switch, invented at Bell Telephone Laboratories, which is turned on by a voltage pulse across the device. By combining fast switching with higher power handling ability, the 4-layer diode is solving application problems in many fields—computers, telephone switching, sonar and magnetron pulsing, detonator firing circuits, ring counters, pulse generators, oscillators and relay functions.

A typical magnetic core driving circuit is available on request. Ask for Application Data Sheet AD-5.

This large, high speed memory uses the Shockley 4N50D 4-layer diode. The 4N50D with switching voltage of  $50 \pm 4$  volts and holding current of  $15 \pm 5$  ma, is available at \$3.75 each in quantities over 500. Write for price and delivery on types and ranges for other applications.



Twenty Type 4N50D Shockley 4-layer diodes in core driving circuit. Each diode drives 80 cores in one word.

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Silicon Junction Diodes Germanium Diodes Power Transistors Solder Lug Power Transistors

### TECHNICAL DATA

Type	Max. DC Inver. Oper. Voltage	Forward Current @ Specified Voltage	Max. Inverse Current		
			@ 25°C	@ 150°C	Test Volts
1N457	60 V	20 ma @ 1.0 V	0.025 $\mu$ a	5.0 $\mu$ a	60 V
1N458	125 V	7 ma @ 1.0 V	0.025 $\mu$ a	5.0 $\mu$ a	125 V
1N459	175 V	3 ma @ 1.0 V	0.025 $\mu$ a	5.0 $\mu$ a	175 V
1N662	90 V	10 ma @ 1.0 V	20 $\mu$ a	100 $\mu$ a (@ 100°C)	50 V
1N663	90 V	100 ma @ 1.0 V	5.0 $\mu$ a	50 $\mu$ a (@ 100°C)	75 V
1N778	100 V	10 ma @ 1.0 V	0.5 $\mu$ a	30 $\mu$ a (@ 125°C)	100 V
1N779	175 V	10 ma @ 1.0 V	0.5 $\mu$ a	30 $\mu$ a (@ 125°C)	175 V

Degradation of fall time will occur when two conditions exist:

- (1) The "ON" time is very long.
- (2) One or more of the M level diodes have high leakage compared to any of its N level diodes.

Since the combination of these two conditions are not typical, the design may result in occasional circuit failures which are difficult to detect.

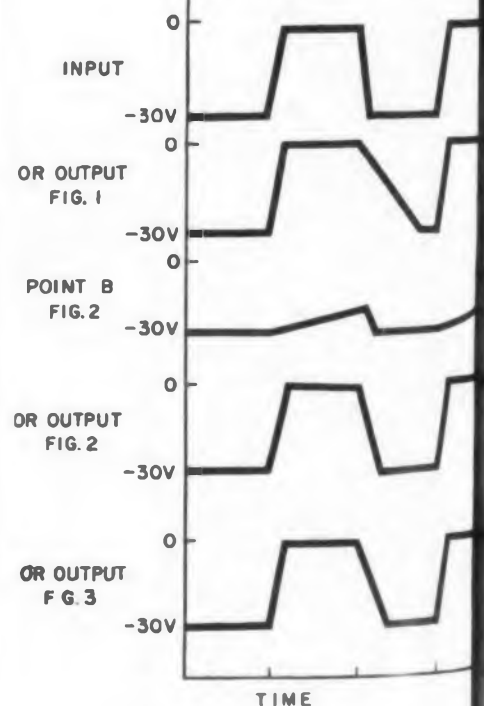
#### Circuit Improvement

Fig. 3 indicates the remedy—the addition of bleeder resistors to discharge the capacitance which exists between the two levels of diodes. The fall time of this circuit is independent of the time the input remains in the "ON" condition.

The cost to the designer of adding this protection is, of course, the additional resistors and the additional load current through these resistors which must be applied by the "ON" input circuit. This also adds additional load current for the "OFF" input circuits; since this occurs during the minimum load condition of those circuits, it is not important.

The resistance value of these additional resistors may be determined as follows:

$$\frac{("OFF" \text{ Voltage}) - (\text{Bleeder Voltage})}{R} = \text{Max Diode Leakage}$$



← CIRCLE 37 ON READER-SERVICE CARD



in which case no charge buildup can occur. In the illustrated case, assuming that a germanium diode may read 0.5 ma of back current, the resistor required is determined as follows:

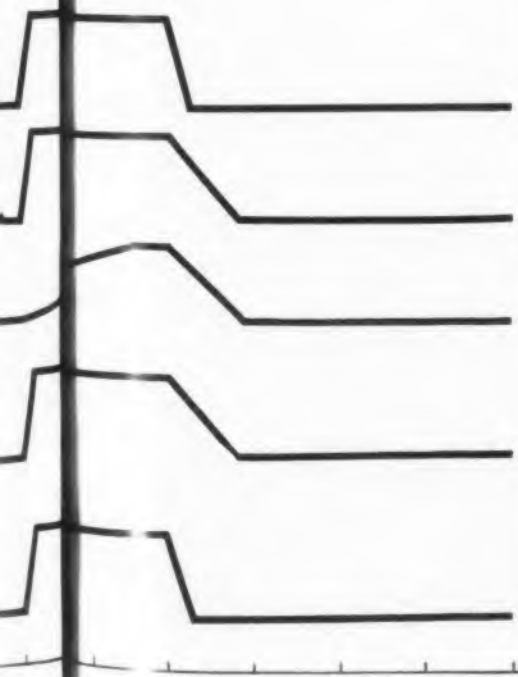
$$\frac{-30 \text{ v} - (-150 \text{ v})}{R}$$

$$= 0.5 \times 10^{-3} \text{ amp}; R = 240 \text{ K ohm.}$$

Fig. 4 shows the response times of each of these circuits. Circuit 1 has the poorest fall time characteristic since no capacitance isolation is obtained. Circuit 2 shows an improvement, although it is affected by the change  $C_1$ ,  $C_2$ , etc. This charging depends on the time in the "ON" condition as shown, as well as the leakage of each  $M$  level diode and its  $N$  level diodes.

Two levels of diodes are equally important when silicon diodes are used. In this case, the major benefit is isolation of capacitance. Since silicon diodes show a large variation of leakage, although very small, the unusual situation shown by Fig. 2 will occur more frequently. Use of bleeder resistors is almost mandatory if capacitance isolation is desired; also, the circuit can remain in the "ON" condition for extended periods. ■ ■

Fig. 4. (below) Comparison of "OR" circuits' response time.



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High forward conductance and 0.3 microsecond inverse recovery are combined with low 125°C leakage currents. The performance of logic circuits in the 10 ma region is improved with the low capacity (3  $\mu\text{mf}$ ) 1N806-1N807 diodes. Higher current circuitry can be reliably operated using 1N808-1N809 diodes.

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Production quantities of all types are immediately available from stock. Small quantity requirements can be obtained from your authorized Transitron distributor.

### FAST SWITCHING SILICON DIODES, SUBMINIATURE GLASS PACKAGE

Type	Minimum Forward Current @ 1 V (ma)	Max. Rev. Current @ Specified Voltage ( $\mu\text{a.}$ @ volts)		Minimum Saturation Voltage @ 100 $\mu\text{a.}$ (25°C) (volts)	Reverse Recovery (256 JAN)			
		25°C	125°C		Max. Rec. Time $\mu\text{sec}$	Rec. Level $\mu\text{a}$	I ma	V volts
1N809	100	1.0 @ 200	50 @ 200	220	0.3	350	30	35
1N808	100	1.0 @ 100	50 @ 100	110	0.3	350	30	35
1N807	4*	.5 @ 175	50 @ 175	200	0.3	100	5	40
1N806	4*	.5 @ 100	50 @ 100	110	0.3	100	5	40
		25°C	100°C	25°C				
1N663	100	5 @ 75	50 @ 75	100	0.5†	200	5	40
1N658	100	.05 @ 50	25 @ 50	120	0.3	500	5	40
1N659	6	5 @ 50	25 @ 50	55	0.3	88	30	35
1N660	6	5 @ 100	50 @ 100	110	0.3	88	30	35
1N661	6	10 @ 200	100 @ 200	220	0.3	88	30	35
1N643	10	1 @ 100	15 @ 100	200	0.3†	200	5	40
1N662	10	20 @ 50	100 @ 50	100	0.5†	400	5	40

\* Maximum 1 mc capacity = 3  $\mu\text{mf}$  (-10 Volts)  
† IBM Modified "Y" Circuit  
Temperature Range -55°C to 150°C

For complete data, write for bulletins PB-51 and TE-1350.

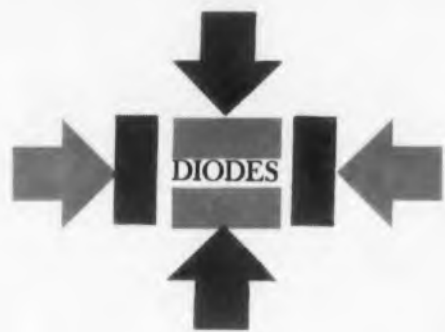
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# Using Diodes as Power Supply Filter Elements

David T. Geiser  
General Electric Co.  
Utica, N. Y.

The problem of maintaining steady-state conditions under multiple transient loads can be solved by using diodes as power supply filter elements. In addition it reduces both the cost and size of the equipment.

**V**ARIATION of supply voltage caused by multiple transient loads can be effectively eliminated by using diodes as power supply filter elements. The advantages of using diode isolation instead of electronic voltage regulators are:

- Less power consumption and heat generation
- Lower voltage drop
- Lower total capacitance requirements

In the past, solutions to the problem of supply voltage variations usually involved the use of electronic voltage regulators or larger values of supply-output filter capacitance. These approaches are quite effective with single loads, but multiple-load-use sometimes leaves much to be desired. Electronic regulators operating near maximum ratings under steady-state conditions tend to change from constant voltage to constant current operation under transient increased load. Large enough filter capacitors to handle long duration low impedance transient loads are often too bulky and costly.

### Using Diodes As Filters

Basic isolation circuit consists of series diodes connecting the power supply to the loads. The loads are shunted with parallel capacitance as in Fig. 1. Should some load (such as #1) sud-

denly increase and cause the power supply voltage to drop, diode  $D_2$  disconnects load #2 from the power supply. Capacitor  $C_2$  supplies power to load #2 until the power supply voltage again equals the load voltage.

The ripple seen by the second load is mainly dependent on the capacitance of  $C_2$ , the resistance of load #2, the duration of the low voltage condition, and the charging impedance seen by  $C_2$  through diode  $D_2$  and the power supply. If the discharge voltage of  $C_2$  does not drop below the lower power supply voltage during constant-time transients, load #2 will see a nearly constant ripple voltage regardless of the depth of the power supply voltage drop. This effect is seen by comparison of Fig. 2 and Fig. 3. In Fig. 2, a light pulsing load (shown in Fig. 4) at 10 cps was applied to a power supply to show the case of discharge almost reaching minimum voltage level. Fig. 3 shows the negligible output ripple change resulting from a 10-times increase in power supply voltage change.

It should be noticed that in each of these cases the charging time is a small fraction of the discharge time. If higher harmonics present in this waveform are not permissible, they may be reduced by more nearly equalizing charge and discharge times. This last technique penalizes



Fig. 2. Lower photo: power supply transient 10 cps squarewave. Upper photo: network output ripple to 200K load, capacitor 30  $\mu$ f. (left)



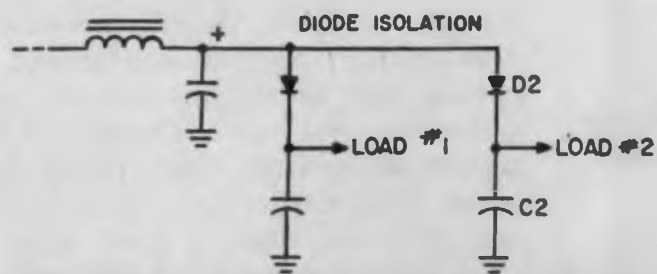


Fig. 1. Suggested arrangement of diode and capacitor networks to isolate loads of a common power supply.

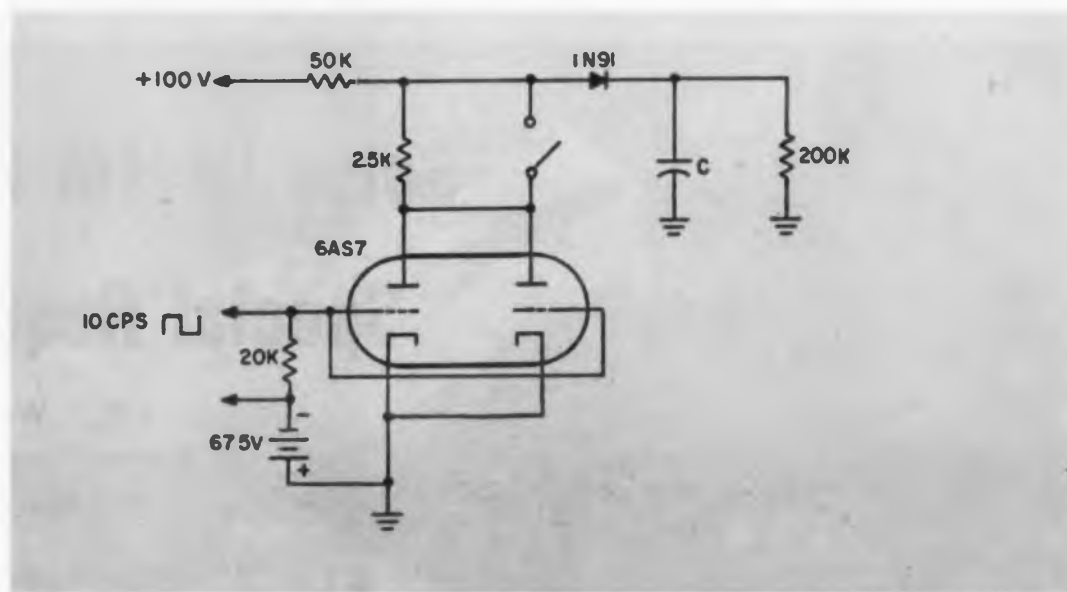


Fig. 4. Circuit used to evaluate isolation effect.

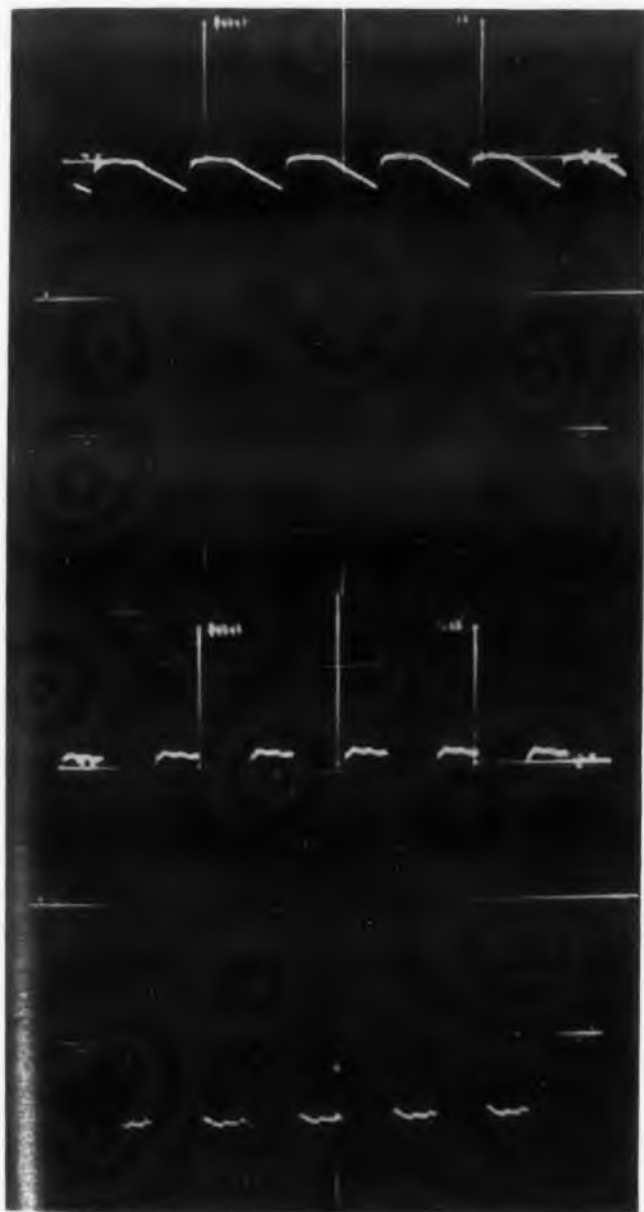


Fig. 3. Same conditions of Fig. 2 except that power supply transient has been increased 10 times. (right)

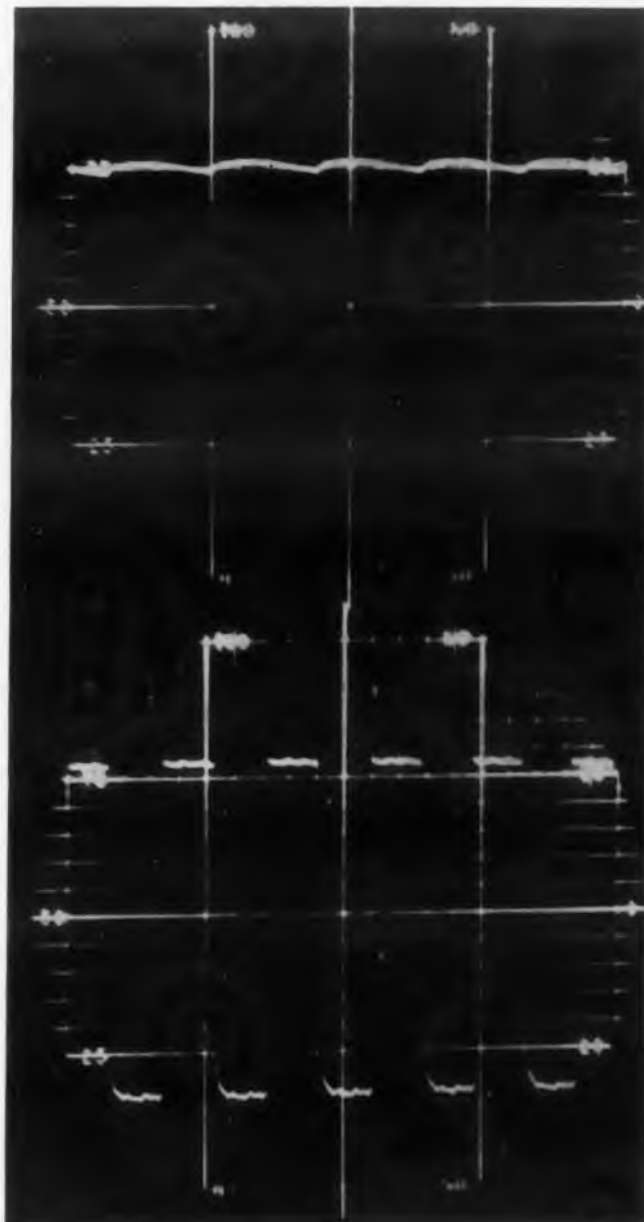


Fig. 5. Conditions of Fig. 3 except that capacitance increased to 100  $\mu$ f.

output voltage stability by seeking the average power supply voltage.

The effect of increasing capacity across the filtered load is shown in Fig. 5. Here the power supply is heavily pulsed as in Fig. 3, but the capacitance is increased from 30 to 100  $\mu$ f.

#### Applications

Actual uses of diode isolation techniques include independent operation of low voltage high current relays from rectifier power supplies as well as satisfying more conventional electronic isolation needs. Advantages found in use are (1) less power consumption and heat generation, (2) lower voltage drop, and (3) lower total capacitance requirements. The major disadvantage is the constant ripple factor. This situation presupposes that the designer knows the tolerable disturbance. A psychological disadvantage also exists, for increased capacitance proportionally reduces ripple and an unsophisticated designer is tempted to use higher capacitance than needed.

Diode choice is limited by the difference between maximum and minimum power supply voltage (the diode peak inverse voltage) and both the initial capacitor-charging surge current and lower recurrent surges caused by power supply transients.

Germanium point contact and hot cathode vacuum diodes can be used for electronic circuitry, while both germanium junction diodes and selenium rectifiers have seen lower frequency use. While most experience is with electrolytic capacitors, paper and higher-quality types of capacitors can be used for energy storage in this application with the added precaution of limiting surge current by adding series resistance to the isolation diodes. ■ ■

# Some Useful Plastics for Special Requirements

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American Cyanamid Co.

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Obviously, no single plastic can be suitable for all applications. While some materials are useless for certain applications, others excel in those same areas. This article outlines characteristics of a few plastics which should prove useful for special applications.

**E**LECTRONICS designers must select their materials with care to insure adequate performance under severe operating conditions. Industry offers plastics which excel in certain specific requirements. Three of these groups are aminoplastics, methylstyrene and polyester plastics.

## Aminoplastics

**Urea-Formaldehyde Plastics.** Parts molded from urea-formaldehyde material have relatively good dielectric strength but relatively poor dielectric constant and dissipation factor. Arc resistance is excellent. In comparison with thermo-

plastics, urea plastics show good heat resistance. They are non-flammable. Their main limitations are poor dimensional stability, relatively poor mechanical strength and high mold after shrinkage. Despite these limitations, however, urea plastics are ideal materials for electrical applications under relatively low voltage conditions in parts not requiring molded-in metallic inserts. Most household applications fall within this category. Typical uses are: low voltage circuit breaker cases, switch housings, small terminal blocks, household sockets and plugs, wall panels, instrument housings, and tube sockets.

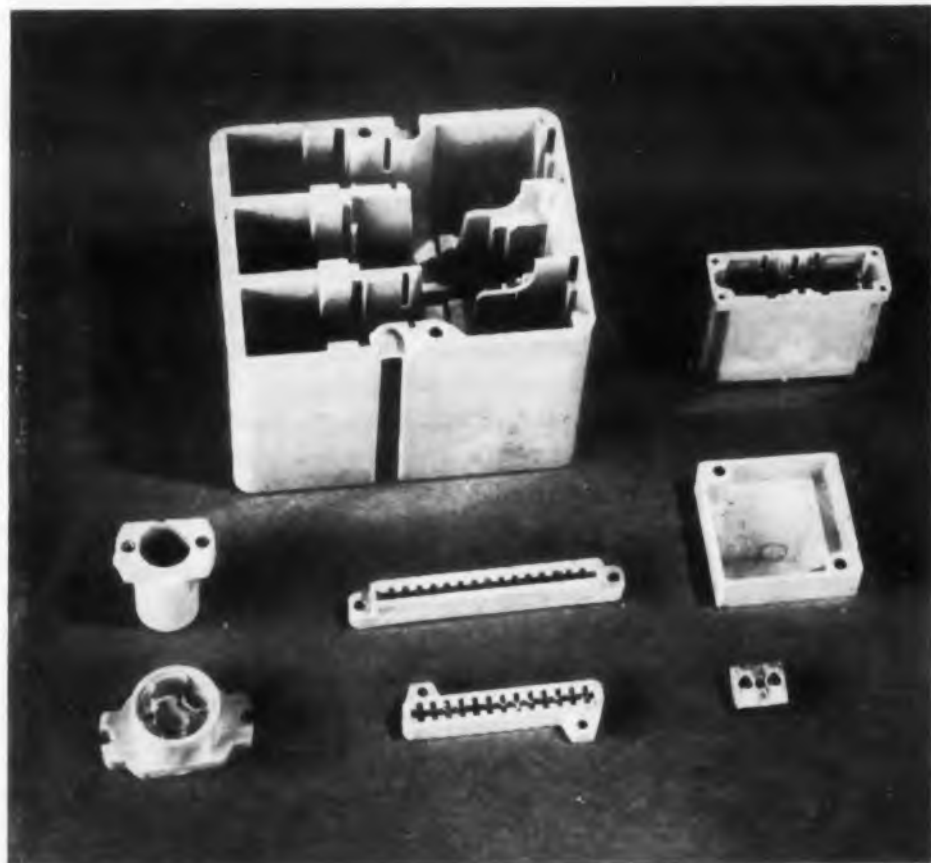


Fig. 1. Complex forms made of glass-filled melamine where mechanical strength and good arc resistance are desired.



Fig. 2. These armature windings are impregnated with a polyester resin compound to increase insulation resistance.

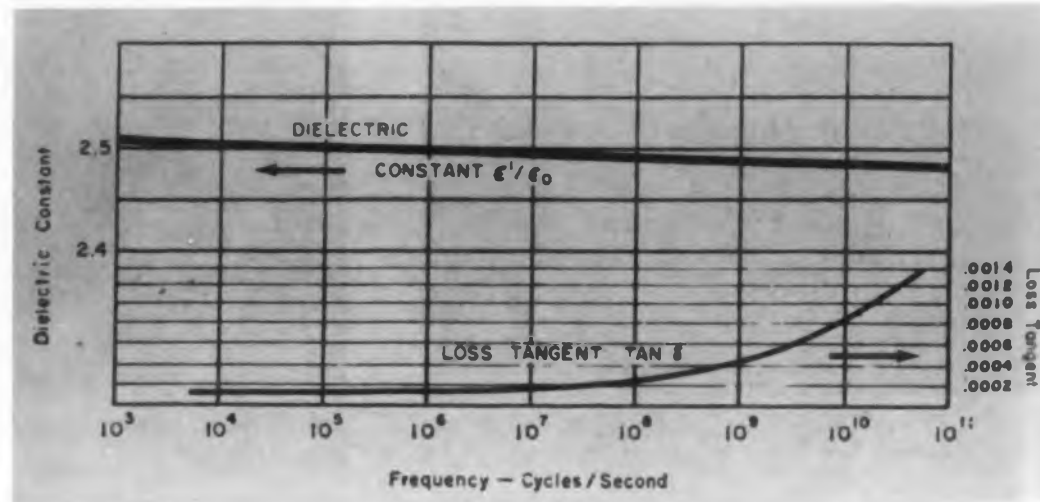


Fig. 3. (right) Dielectric constant and losses of methylstyrene molding compounds.



**Melamine-Formaldehyde Plastics.** The outstanding properties of melamine molding compounds are non-flammability, low water absorption, heat resistance, and excellent non-tracking properties. Special grades are available offering high mechanical and impact strength, good dimensional stability, and good insert retention. Four types are especially suited for electronics:

- Wood-flour filled.
- Mineral (asbestos) filled.
- Glass fiber filled.
- Glass mat or cloth laminates.

Asbestos-filled melamine molding material is intended for industrial applications requiring arc resistance and dielectric strength with retention of these properties under continuous service at temperatures up to 300 F. The arc resistance of these materials by standard ASTM test method is excellent and it is one of the few thermosetting plastics rated good under the Boeing Power-arc test.

Although not rated as an impact material, mineral filled melamine has adequate strength for heavy duty molded parts. It has excellent dimensional stability, minimum tendency to crack around inserts and good insert retention. Readily moldable by injection methods it is suitable for intricate molded-in insert systems. Typical applications are high-altitude ignition system components, industrial circuit breakers, terminal blocks, and switch gear.

Many similar industrial uses not requiring as high a degree of heat or arc resistance can be met with wood-flour filled melamine. Typical applications include industrial connector plug inserts, watt-hour meter blocks and other small parts (Fig. 1).

Maximum mechanical strength with outstanding arc resistance and dielectric strength is obtained with the glass filled melamine molding compounds. Heavy-duty switch gear, terminal strips, sockets, and coil forms are applications where glass filled melamine can be used to advantage, when mechanical strength requirements are not met with the mineral filled types.

The ultimate in mechanical strength is provided by the use of melamine glass cloth laminates. Electrical panel is a typical application.

#### Polyester Resins

Polyester resins have basic properties of value in the electrical and electronics industries. Some of the significant properties of the cast resins are:

- Good humidity resistance.
- Excellent insulating properties including high dielectric strength.
- Relatively low dielectric constant and loss factor, and good arc resistance.
- Transparency to microwave radiation.
- Dimensional stability.

(Continued on page 54)



**CONNECTOR RELIABILITY** is the most important specification you can buy. CEC's NEW Series 500-C Multi-Contact Rectangular Connectors have it in every detail! Consider

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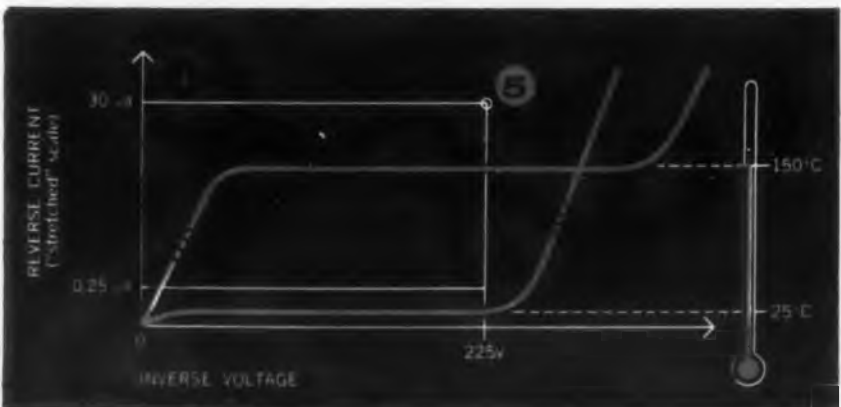
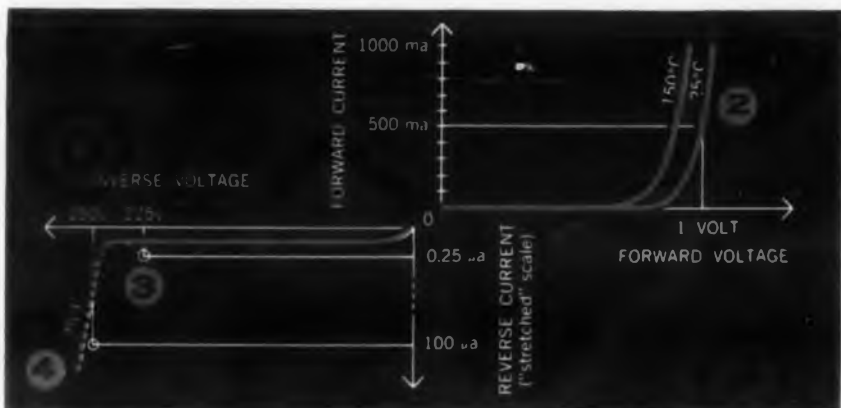
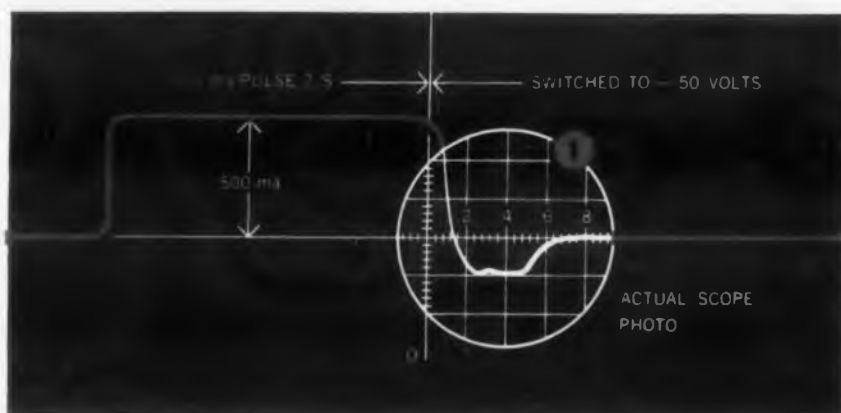
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# 1/2-AMPERE FAST SWITCHING DIODE



**NEW FROM SPERRY** is this high-temperature IN690 series silicon diode which gives you greater current-handling capability than germanium diodes — *with no sacrifice in recovery time!*

Check for yourself the performance characteristics of this new diode in the graphs at left . . . then compare them with our *minimum* specifications below.

**1 FAST RECOVERY.** Maximum recovery time is 0.8 microseconds to return to 10 K ohms. Recovery test switches from a forward current 2 microsecond pulse of 500 ma, to a reverse voltage of -50 volts with a loop impedance of 1 K ohm.

**2 HIGH FORWARD CONDUCTANCE.** The forward current specification is 400 ma at 25° C with 1.0 volt maximum drop under static (d-c) conditions. Conductivity increases with temperature — diagram shows typical "x-y" plots at 25° and 150° C.

**3 LOW LEAKAGE** at high inverse voltage. Specification at 25° C is maximum 0.25  $\mu$ a at rated voltages.

**4 HIGH INVERSE VOLTAGE.** Saturation voltages can be supplied in a range from 40 to 150 volts for this high current series.

**5 HIGH-TEMPERATURE OPERATION.** Typically, leakage current is no greater than 30  $\mu$ a at working inverse voltage and 150° C. Diodes are rated for both operation and storage at temperatures from -65° to +150° C.

**SPERRY SEMICONDUCTOR DIVISION**  
SPERRY RAND CORPORATION  
South Norwalk, Connecticut

**ADDRESS ALL INQUIRIES:** Marketing Department, So. Norwalk, Conn., or Sperry offices in Brooklyn, Cleveland, Seattle, San Francisco, Los Angeles, New Orleans, Boston, Baltimore, Philadelphia.

In addition, glass-fiber polyester resin laminates and moldings show phenomenally high impact strength sometimes exceeding twenty foot pounds per inch of notch, high flexural and tensile strengths and heat distortion temperature up to 300 C. Special resins are available from which, in conjunction with antimony trioxide, a fair degree of flame resistance is obtained.

The unfilled resins may be used for casting for these typical applications:

- Encasing transformer windings.
- Casting terminal blocks.
- Encasing capacitors.
- Encasing miniature printed radio circuits.
- Embedding hearing-aid assemblies.
- Encasing miniature amplifier units.
- Impregnating paper capacitors.

The outstanding use of glass filled polyester resin laminates in the electronics field is the fabrication of radomes. Here, phenomenal structural strength plus micro-wave transparency, combined with ease of fabrication in large structures, make glass reinforced polyester the ideal material. Light weight and rigidity can be achieved through honeycomb or foamed-in-place sandwich construction.

Other structural and insulating applications in electrical and electronic devices include coil barriers, separators, and supports, coil core insulation, insulating washers, lead separators, armature and laminations (Fig. 2).

For those who are willing to compound their own materials from glass fiber, filler, and polyester resin, polyester premix molding compounds can be formulated for use in a wide range of electronic applications. The properties can be varied according to the amount and type of filler used and the ratio of glass fiber to resin. Specific formulation suggestions are provided by most manufacturers of polyester resins.

Fire-resistant compounds can be formulated from special types of polyester resins and using specified amounts of antimony trioxide with the filler. However, these compounds, although self-extinguishing are not as good as the melamines in non-flammability.

Applications for polyester resin premix molding compounds are similar to those for the mineral-glass filled melamines and include heavy duty standoff insulators, coil forms, brush holder assemblies, circuit breaker parts, and contact arm insulation. Typical electrical properties of an electrical grade polyester resin casting are:

Laminac 4111, 1/8 in. casting		
Dielectric constant	60 cps	2.91
	10 <sup>6</sup> cps	2.82
	3 x 10 <sup>9</sup> cps	2.73
Dissipation factor	60 cps	0.0028
	10 <sup>6</sup> cps	0.0084
	3 x 10 <sup>9</sup> cps	0.0077



Dielectric strength, 77 F. Short time V/MIL 430  
 212 F. Short time V/MIL 400  
 Arc resistance (ASTM) seconds 108

#### Methylstyrene Molding Compounds

Polymethylstyrene ranks with polystyrene among the best dielectric materials. The values for dielectric constant and dissipation factor are approximately the same for both materials over wide frequency ranges. Polymethylstyrenes also exhibit high dielectric strength.

Methylstyrene-acrylonitrile copolymer, although not as good as the homopolymer in electrical properties, also rates as an excellent dielectric material. The methylstyrene compounds are useful in molding a wide range of electronic components which are not subject to severe mechanical stresses or elevated temperatures. These molding compounds are thermoplastic, and cannot be used for applications involving high heat. Methylstyrene molding compounds are, however, considerably more heat resistant than the polystyrenes and under no load withstand continuous service at 210 F. Typical applications are miniature tube sockets, capacitors, and antennas insulation.

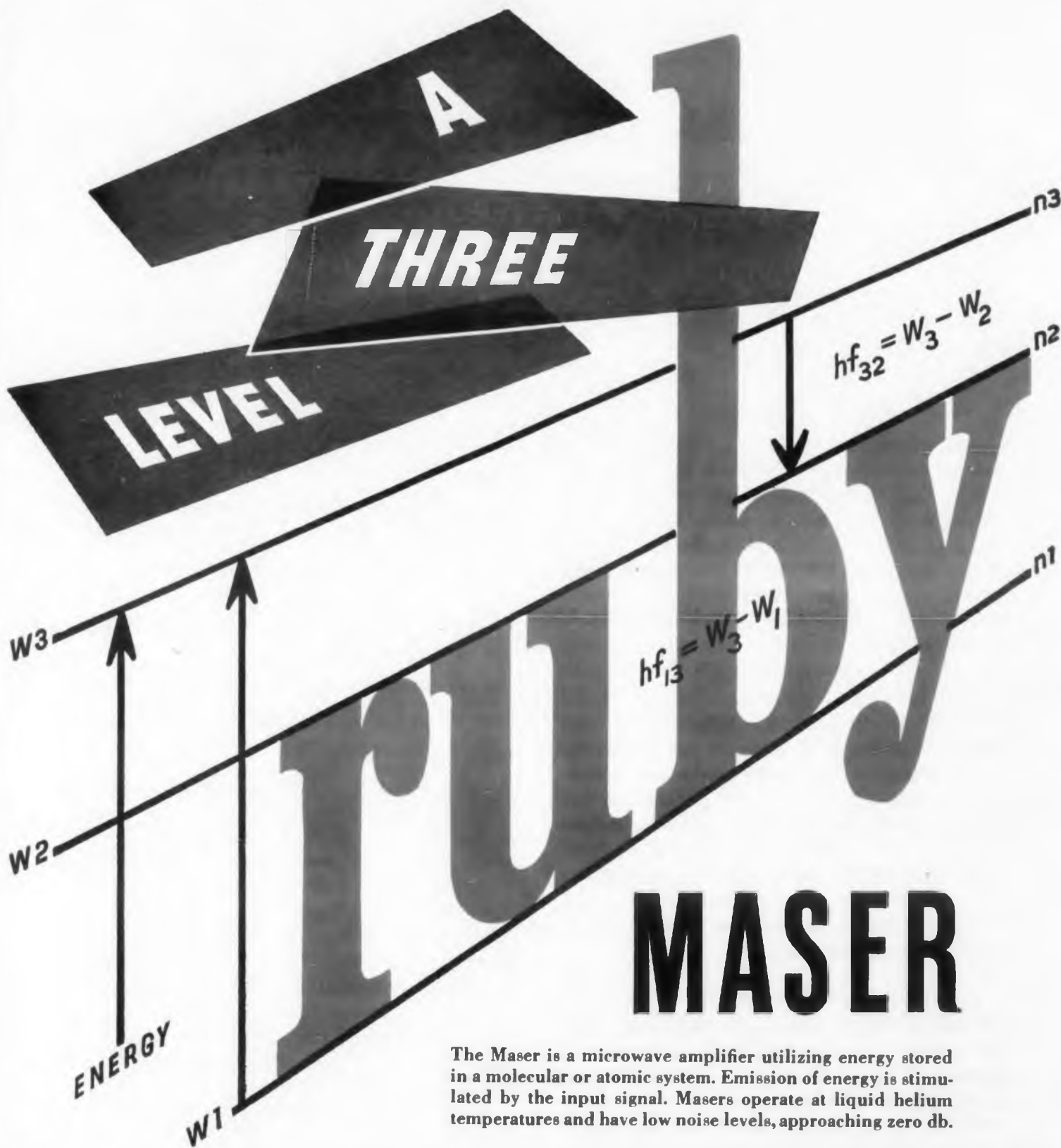
Because of the small loss tangent, these materials are particularly useful for high frequency insulation.

Modified methylstyrene molding compounds are available which although similar in intrinsic electrical properties to polymethylstyrene are unique in their ability to tolerate wide environmental changes without impairment of these properties. As shown in Fig. 1 the dielectric constant and loss factor are remarkably uniform over a wide range of frequencies.

Moldings and extrusions from these materials have been cycled from minus 65 F. to plus 160 F. under wide humidity ranges without adverse effect.

Ten thousand volts has been specified as a minimum radio-frequency heating and breakdown requirement for antennae component when tested according to MIL-A-7965-ASG. The special methylstyrene molding compound actually withstood 18,000 volts at 3.44 inches mercury and 3 megacycles per second. It also met the electrical insulation-to-space and other electrical specifications of Paragraph 4.4.1 of MIL-E-5272, Amendment No. 1, both before and after exposure to the severe environmental testing procedure.

Moldings from this type of material have unusually high surface resistivity under the most adverse conditions. It can readily be molded or extended and the parts have excellent moldability. Suggested uses are external and submarine antenna components, radar lenses and other applications for which polystyrene or polymethylstyrene has been found useful but where exposure to the element is also involved. ■ ■



## MASER

The Maser is a microwave amplifier utilizing energy stored in a molecular or atomic system. Emission of energy is stimulated by the input signal. Masers operate at liquid helium temperatures and have low noise levels, approaching zero db.

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LINDE supplies other crystals, including rutile, spinel, and sapphire. ( $Al_2O_3$ ). Sapphire is used in infrared optical sys-

tems, windows for higher power microwave tubes, spacers and supports in vacuum tubes, radiation pipes. It has strength at elevated temperatures, melts at 2040°C., is hard, inert, non-porous, and can be sealed to metals and glasses. Sapphire is available in the shape of domes, windows to 4½ inches in diameter, rods and special configurations.

For more information, write Crystal Products Department, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

†Maser Action in Ruby, by G. Makhov, C. Kikuchi, J. Lambe, and R. W. Terhune. "Physical Review," Vol. 109, No. 4, p. 1399, Feb. 15, 1958.

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**Linde** **UNION CARBIDE**

CIRCLE 501 ON READER-SERVICE CARD

# Thermal Considerations In The Use Of Power Transistors

**J. R. Baum**

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Motorola, Inc.  
Military Electronics Div., Phoenix, Ariz.

By properly analyzing power transistor mounting methods and heat transfer techniques, full power output capabilities can be efficiently attained. Design principles are outlined together with relative results for different schemes, to enable the design engineer to apply a practical approach to thermal dissipation problems.

CLOSE examination of the thermal path from the power transistor collector junction to the ambient, along with a careful analysis of transistor mounting methods, supply the solution for maximum heat dissipation and full power output capabilities. To achieve minimum thermal resistance, a dissipator of high thermal conductivity and suitable cross sectional area is required. Various heat transfer methods, and relative results, will be analyzed and compared.

## Typical Power Transistor Mounting

A cross-sectional view of a typical power transistor mounted with an electrical insulator onto a dissipator is shown in Fig. 1. The object is to transfer heat to the ultimate sink.

The heat in a power transistor is generated at the collector junction. It must be transferred to the ultimate sink via the thermal path between the junction and the sink. The overall rate of heat transfer from the collector junction to the ambient may be expressed in equation form as follows:

$$Q = U_a (T_j - T_a) \quad (1)$$

where  $Q$  = the heat transferred in watts\*

$U_a$  = the overall heat transfer coefficient between the junction and ambient in watts/C\*

$T_j$  = temperature of junction in C\*

$T_a$  = temperature of ambient or of ultimate sink as applicable, in C\*

Reference to Eq. (1) clearly indicates that the allowable dissipation from the transistor is directly proportional to the overall heat-transfer coefficient,  $U_a$ , and the magnitude of the junction-to-ambient temperature difference,  $(T_j - T_a)$ .

$T_j$  cannot be allowed to exceed the maximum temperature given by the manufacturer for the particular transistor. This temperature usually ranges between 85 C and 90 C for germanium types, and between 150 C and 200 C for silicon types. As a general rule, a maximum of 85 C for germanium types will provide the most reliable operation.

With  $T_j$  maximum fixed, the temperature difference,  $(T_j - T_a)$ , can be increased only by lowering  $T_a$ . However, the design ambient or sink temperature is usually fixed by specification or configuration and cannot be easily lowered. Therefore, the minimum temperature difference,  $(T_j - T_a)$ , which must be used in design is usually fixed. Once the minimum temperature difference is set for a given problem, the only means of increasing the allowable transistor dissipation is by increasing the overall heat-transfer coefficient,  $U_a$ .

## Analysis of the Overall Coefficient, $U_a$

In order to consider methods of increasing the overall coefficient  $U_a$ , it must be broken down

into the individual coefficients corresponding to the heat transfer between various points in the system. Reference to Fig. 1 indicates four consecutive portions of the heat flow path to be considered: the first from the junction to the case, the second from the case to the dissipator, the third within the dissipator, and the last from the dissipator to the ambient. Eq. (2) is the relation between the overall heat-transfer coefficient,  $U_a$ , and the individual conductances associated with each portion of the heat-transfer path between the junction and the ambient.

$$U_a = \frac{1}{\frac{1}{R_t} + \frac{1}{A_c \left(\frac{K_c}{X_c}\right)} + \frac{1}{A_{cd} \left(\frac{K_d}{X_d}\right)} + \frac{1}{(h_a + h_r) A_d}} \quad (2)$$

\*Units: Traditionally, heat transfer units have been the BTU, the foot, and the F. When considering heat transfer in electronic equipment, the use of watts, inches, and C have become accepted. This paper will use watts, inches, and C throughout. For comparison purposes, the conversion factors between systems are given below:

$$1 \text{ watt} = 3.416 \frac{\text{BTU}}{\text{HR}}; 1 \text{ C} = 1.8 \text{ F};$$

$$1 \frac{\text{Watt}}{\text{C-in}^2} = 273 \frac{\text{BTU}}{\text{HR-FT}^2 - \text{F}}$$

Temperature in C = [(Temperature in F)-32] 5/9



**Table 1—Average Conductance of Various Insulators**

Insulator	Conductance $\left(\frac{K_t}{X_t}\right) A_t \cdot \frac{\text{Watts}}{C}$	
	Dry	With D.C. 4**
	Average	Average
Bare (no insulator)	1.8	2.8
Anodized aluminum (.016")	2.4	3.0
Anodized aluminum (.125")	0.8	2.5
Mica (.002") one thickness	.8	2.2
Mica (.002") two thickness	1.00	1.7
Mica (.002") three thickness	.90	1.4
Mylar (.003") one thickness	.57	1.02
Mylar (.003") two thickness	.5	.6
Mylar (.003") three thickness	.4	.45
Glass cloth, Teflon coated (.003")	0.79	—

\*  $(A_t = 1 \text{ in}^2)$

\*\* D. C. 4 is Dow Corning 4 Compound, Silicone Lubricant.

**Table 2—Conductivity of Common Dissipator Materials**

Material	K - Thermal Conductivity	Watts-in C-in <sup>2</sup>
Copper	9.75	
Aluminum (pure)	5.75	
Aluminum (6061T4)	3.92	
Aluminum (2024T3)	3.08	
Magnesium (A231B)	1.89	
Steel	1.18	
Fiberglas, laminate	0.007	

where:

$R_t$  = internal thermal conductance of transistor  $\frac{\text{watts}}{C}$

$\frac{K_t}{X_t}$  = thermal conductance between transistor base and dissipator  $\frac{\text{watts}}{C\text{-in}^2}$

$A_t$  = area of transistor base  $\text{in}^2$

$\frac{K_d}{X_d}$  = thermal conductance between mounting point of transistor and mid-point of dissipator area  $\frac{\text{watts}}{C\text{-in}^2}$

$A_{cd}$  = cross-sectional area of dissipator in direction of heat transfer  $\text{in}^2$

$h_o$  = coefficient of convective heat transfer from dissipator to ambient (ultimate heat sink)  $\frac{\text{watts}}{C\text{-in}^2}$

$A_d$  = area of dissipator  $\text{in}^2$

$h_r$  = radiation heat transfer coefficient  $\frac{\text{watts}}{C\text{-in}^2}$

For  $U_a$  to be a maximum, each of the conductances,

$R_t$ ,  $A_t \left(\frac{K_t}{X_t}\right)$ ,  $A_{cd} \left(\frac{K_d}{X_d}\right)$ , and  $(h_o + h_r) A_d$  should

be a maximum. Each one will be discussed separately to point out methods of improvement.

#### Junction-To-Base Thermal Conductance

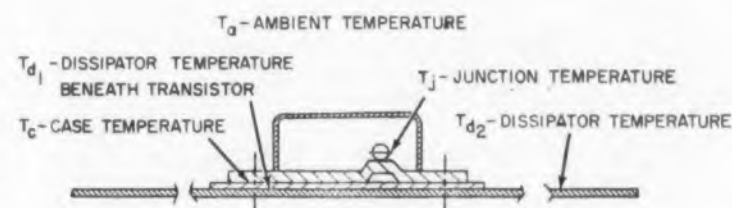
Parameter  $R_t$  is a function of the internal construction of the transistor, and is usually reported by the manufacturer. Between transistors of the same design there may be a significant variation of this value; however, it is not feasible for the user to experimentally check each unit. Therefore, the manufacturer's rating should be accepted, probably as conservative. A typical value is 1 watt C. It may also be given as so many C/watt, in other words, as  $1/R_t$ .

#### Conductance Between Base and Dissipator

The conductance term  $\left(\frac{K_t}{X_t}\right) A_t$  governs heat transfer across the boundary between the transistor base and the dissipating element. If the transistor is mounted without an electrical insulator, only the bare surface contact resistance is present. Addition of an electrical insulator, such as mica or Mylar, will further increase the resistance of heat transfer, by lowering  $K_t/X_t$ .

Prediction of an exact value for this term is difficult, as very little pertinent data is available. A good general discussion of contact resistance can be found in Reference (1). Due to the number of variables involved, it is also difficult to obtain consistent experimental data. Table 1 indicates the average results of some experiments made at Motorola, Phoenix, and reported in References (2) and (3).

For the various insulators, it is obvious that the contact resistance is the governing factor rather than the insulator thickness. In general, the mating



**Fig. 1. Typical power transistor mounting arrangement.**

surfaces should be as smooth as possible with maximum contact pressure. Minimum insulator thickness should be used, consistent with electrical requirements. If possible, a conductive grease should be applied in the joint.

#### Internal Conductance of the Dissipator

The resistance to heat transfer within the dissipator can be considered by examining the term  $A_{cd} \left(\frac{K_d}{X_d}\right)$  which appears in Eq. (2). This term should be as large as possible for optimum dissipator performance. The use of a highly thermal-conductive material is the best method of assuring efficient dissipator performance. Consistent with weight and space requirements, a large enough cross-sectional area should be used to increase conductance. When weight limitations are involved, thermal conductivity and material density must be considered together. On this basis, it is found that, for the same weight, the conductivity of magnesium and aluminum are superior, in that order, to copper. This is true, in spite of the fact that magnesium and aluminum have a lower thermal conductivity than copper. Where space alone is a consideration, then thermal conductivity will govern. Table II lists basic conductivity data of common dissipator materials.

The distance,  $X_d$ , between the transistor base and the average temperature point, of the dissipator should be kept to a minimum consistent with the thermal conductivity and thickness. This particular point must be considered, together with the necessity for having sufficient dissipator surface area, as discussed in the following paragraphs on heat transfer to the ambient. For example, if an increase in horizontal dissipator area is required in a particular case, then the thickness or material conductivity must be increased proportionally. Failure to do this can increase the resistance to heat transfer in the dissipator at almost the same rate that heat transfer from it is being increased—with no real gain. One approach to this problem is to provide a dissipator configuration (such as vertical finning) so that  $X_d$  may be kept short with no loss in area.

#### Dissipation to the Ultimate Sink

In some cases, the designer can choose the method of dissipating the heat to the ultimate sink. If this is the situation, the selection of dis-

sipator and cooling methods go hand in hand. The more common situation is to have the cooling method previously specified so that the designer or engineer must utilize it in the best possible manner. In either case, however, it is necessary that he be familiar with the various methods available in terms of performance and limitations. It is assumed that the dissipator provides the conductive link to the final method of dissipation to a sink. So-called conduction cooling still requires final dissipation to the ambient air or to a coolant fluid at some point. In most electronic equipment it is necessary to consider final dissipation to some coolant, whether it be ambient air or a liquid. For any transistor mounting the designer must be sure that sufficient capacity exists to ultimately dissipate the heat. Some of the methods of dissipation are:

- Cold Plate Mounting
  - Air
  - Liquid
  - Evaporative
- Direct forced air convection
- Free convection to ambient air
- Radiation heat transfer

Other methods, such as direct liquid cooling, could be used but the above are the most commonly encountered.

#### Cold-Plate Mounting

Cold-Plate mounting will be examined briefly in relation to the other methods. It presents the few-

Table 3—Heat Transfer Rates

Cold-Plate Type	$h_o$ $\frac{\text{watts}}{\text{C-in}^2}$
Forced air	0.1
Liquid	3.0
Evaporative	5.0

Table 4—Values of E for Various Positions

Orientation and Position	E
Vertical rectangular plate	0.55
Horizontal rectangular plates facing upward	0.71
Horizontal rectangular plates facing downward	0.35

The significant dimension L is also a function of configuration, as shown in Table V.

est problems in transistor mounting, since, for most efficient use, it requires parts designed for conductive cooling, as are transistors. The conductance term for heat transfer from the dissipator to the ambient was given in Eq. (2) as  $(h_o + h_r) A_d$ . The cold plate provides a high convection coefficient,  $(h_o)$ , due to the use of high turbulent flow rates in the cold plate channels. It should be noted that the sink temperature,  $T_s$ , used in the cold plate analysis is not the ambient temperature, but rather the local cold-plate coolant temperature. The radiation coefficient is usually negligible in relation to the convection term. In most cold-plate designs the channel walls are mounting surfaces for the components. Good cold-plate design dictates that the walls have high thermal conductivity, maximum cross-sectional area normal to the heat transfer path, and a minimum path length. These features will greatly eliminate dissipator conduction problems. Representative heat transfer rates associated with cold plates are presented in Table III.

#### Forced Air Convection

The term "forced air convection," as used here, refers to the use of blowers or externally supplied cooling air for circulation within the electronic equipment.

In terms of transistor cooling, it means that a source of moving air is available for cooling, but without the refinements of cold-plate construction. In order to fully utilize the air supply for maximum heat transfer, an attempt should be made to maximize  $h_o$  and to utilize as large a dissipator area as possible. The simplified equation for the heat transfer coefficient from a flat plate by forced convection is given below:

$$h_o = B \frac{V^{0.75}}{L^{0.25}} \quad (3)$$

where  $B$  = a constant dependent on the air properties and configuration

$V$  = velocity of air over dissipator

$L$  = length of surface in direction of flow

An increase of velocity and a decrease in the length of surface in the direction of flow will increase  $h_o$ . The velocity over the dissipator can be increased by the use of baffles or ducting to direct and increase the local velocity of the available air over the desired area. A short dimension in the flow direction is desirable and this may dictate the baffle orientation. Typical values of about 0.03 watts/C-in<sup>2</sup> may be obtained in forced air cooling.

The radiation term in forced air convection, as in cold plates, is usually neglected for calculation purposes since it is considerably less than the convective transfer. However, advantage should be

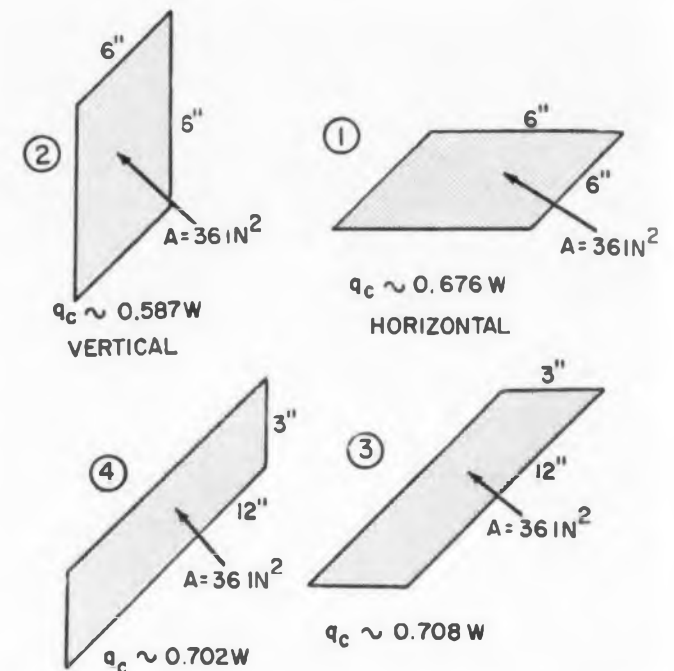


Fig. 2. Relative values for free convection for various plate configurations

taken of any radiation transfer than can be obtained by making  $h_r$  a maximum.

Where no central forced air circulation exists, it may still be necessary to provide for high rates of local heat dissipation by use of small blowers. A number of miniature blowers are available to meet variety of situations. The choice would be based on the required velocity, space, and other requirements.

#### Free Convection

Probably the most common method of getting rid of heat in electronic equipment is by free convection. Where transistors are mounted on metal chassis of large area, in room ambients, usually no serious problem exists. With higher ambients and denser packaging, the problem can become acute. The simplified general expression for the free convection heat transfer coefficient is:

$$h_o = DE \frac{(T_{d2} - T_a)^{0.25}}{L^{0.25}} \quad (4)$$

where  $D$  = a constant dependent on the fluid properties

$E$  = a dimensionless constant dependent on the configuration of the dissipator

$L$  = a characteristic length dependent on the dissipator configuration and dimensions

$(T_{d2} - T_a)$  = the temperature difference between the ambient air and dissipator.

Some representative values of  $E$  are shown in Table IV.

Substituting Eq. (4) for  $h_o$  into the free con-



vection heat transfer equation yields the following relation:

$$\begin{aligned} \text{Free convection} \\ \text{heat transfer} &= h_o A_d (T_{d_2} - T_a) \\ &= DE \frac{A_d (T_{d_2} - T_a)^{1.25}}{L^{0.25}} \quad (5) \end{aligned}$$

This equation can be used to compare various dissipator configurations.

One common decision to be made, in orientation of the dissipator, is whether it should be mounted horizontally or vertically. Four plates of the same material and thickness, with the same area and same ambient conditions but with different orientations and configurations, are shown in Fig. 2. Relative values for free convection heat transfer are given for each.

From Fig. 2, it can be seen that there could be as much as a 20 per cent increase in heat transfer from the same area by using a specific orientation. In general, vertical surfaces with the short dimension vertical are the most desirable. A series of short vertical fins very close to the transistor is effective. This configuration also minimizes the distance from the transistor to the dissipator and reduces the accompanying internal thermal resistance of the dissipator. Typical values of  $h_o$  range from 0.003 to 0.006 watts/C-in.<sup>2</sup>. The extremely low values of convection heat transfer show the need for providing maximum dissipating area and minimizing thermal resistance up to the dissipating area.

#### Radiation Heat Transfer

Radiation heat transfer is important with free convection, since it can be of the same order of magnitude as the convection term. The radiation heat transfer coefficient may be defined as:

$$h_r = \frac{\sigma F_e F_a (T_{d_2}^4 - T_a^4)}{(T_d - T_a)} \quad (6)$$

where

$\sigma$  = radiation constant  $\frac{\text{watts}}{\text{in}^2 - (^{\circ}\text{K})^4}$

$F_e$  = emissivity factor Dimensionless

$F_a$  = shape factor Dimensionless

$T_{d_2}$  = absolute temperature of  $^{\circ}\text{K}$  dissipator

$T_a$  = absolute temperature of  $^{\circ}\text{K}$  ambient

In Eq. (6) it is assumed that the receiving surfaces are at ambient temperatures.  $F_e$  and  $F_a$  (the emissivity and shape factors respectively) are the only terms capable of being increased. The shape factor is fixed by the overall orientation of the dissipation with respect to its surroundings. This is a function of the particular configuration and cannot be easily altered. The emissivity factor is a

Table 5—Values of L for Various Configurations

Shape	Position	L
Plate (rect.)	Horizontal	$\frac{\text{area}}{\text{length} + \text{width}}$
Plate (rect.)	Vertical	$\frac{\text{area}}{\text{height}}$

Table 6—Surface Finish Effect on Heat Transfer

Configuration	Surfaces	( $F_e F_a$ )
Enclosed body; small in relation to enclosure	Black paint	0.88
Enclosed body; small in relation to enclosure	Rough polish aluminum	0.2
Enclosed body; large in relation to enclosure	Black paint	0.78
Enclosed body; large in relation to enclosure	Rough polish aluminum	0.111

Table 7—Typical Emissivity Values for Various Surfaces

Material Surface	Condition	Temperature	Emissivity
Aluminum	Sheet	100 C	0.09
		100 C	0.10
	Rough polish Heavy black anodize	20 C	0.40
Copper	Commercial polish	20 C	0.03
Black paint		20 C	0.80-0.90
White paint		20 C	0.75-0.80

Table 8—Typical Heat Transfer Rates

Method of Heat Transfer	Heat Transfer $\left(\frac{\text{watts}}{\text{in}^2}\right)$	
	$T_a = 25 \text{ C}$	$T_a = 60 \text{ C}$
Cold plate — liquid	135.00	30.00
Cold plate — air	4.50	1.00
Forced air	1.10	0.24
Free convection and radiation	0.40	0.09

direct function of the finish or radiating "color," of the dissipator and the receiving surfaces. A highly emissive finish such as flat black is desirable. Surface finish is one factor often overlooked where the heat transfer can be increased with practically no effort. Typical values of  $F_e F_a$  are listed in Table VI.

To attain the best possible surface for radiation, a high emissivity surface should be provided on both the dissipator and receiving surfaces. In the temperature range normally encountered,  $h_r$  might vary from 0.002 to 0.005 watt/C-in.<sup>2</sup>.

The previous discussion on methods of heat transfer from the dissipator applied to steady-state conditions. In certain applications in missiles, short-term usage makes it possible to absorb the heat in the mounting, allowing a temperature rise which would not exceed the allowable limit during the time of operation. Usually, however, a means of dissipating the heat is required for long-term ground checkout; this means that the same steady-state problems exist as discussed above.

#### Comparison of Heat Transfer Methods

The various heat transfer processes associated with power transistor mounting show the need for minimum thermal resistance in the transistor-to-dissipation joint. A dissipator of good thermal conductivity and suitable cross section is required in order to have maximum heat transfer within the dissipator. The relative values of the heat transfer rates associated with the various methods of heat transfer from the dissipator clearly show their limitations. Some of the typical heat transfer rates for a 70 C plate dissipating to 25 C and 60 C environments are tabulated in Table VIII.

The advantages of utilizing cold-plate techniques are obvious; some increase can be obtained in the forced air figure by increasing local velocities. The free convection-radiation transfer represents average conditions. For example, to dissipate 5 watts into a 25 C environment, 12.5 square inches of area are required with free convection and radiation, but only about 4.5 square inches are required with forced air circulation. High ambients depending on free convection and radiation require an area prohibitive in size; otherwise a serious loss of capacity will occur in the transistors. ■ ■

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4. McAdams, "Heat Transmission," McGraw-Hill Book Company, Incorporated, 1954.

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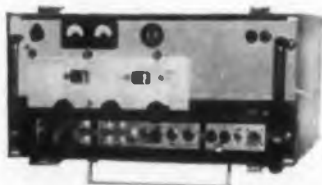
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CIRCLE 41 ON READER-SERVICE CARD

## Computer Techniques Help Square Square Waves

**B**Y USING pulse amplifiers instead of wide band amplifiers, and by combining them with a flip-flop and two output current drivers, this instrument can generate unusually flat-topped pulses and square waves, with very rapid rise and fall times.

Conventional pulse and square wave generators form a pulse, shape it, amplify it, and obtain power and impedance match in an output stage. Compounding of amplifiers, peakers, clippers, and output stages usually makes them bulky and complex instruments, which require very critical adjustment for proper functioning.

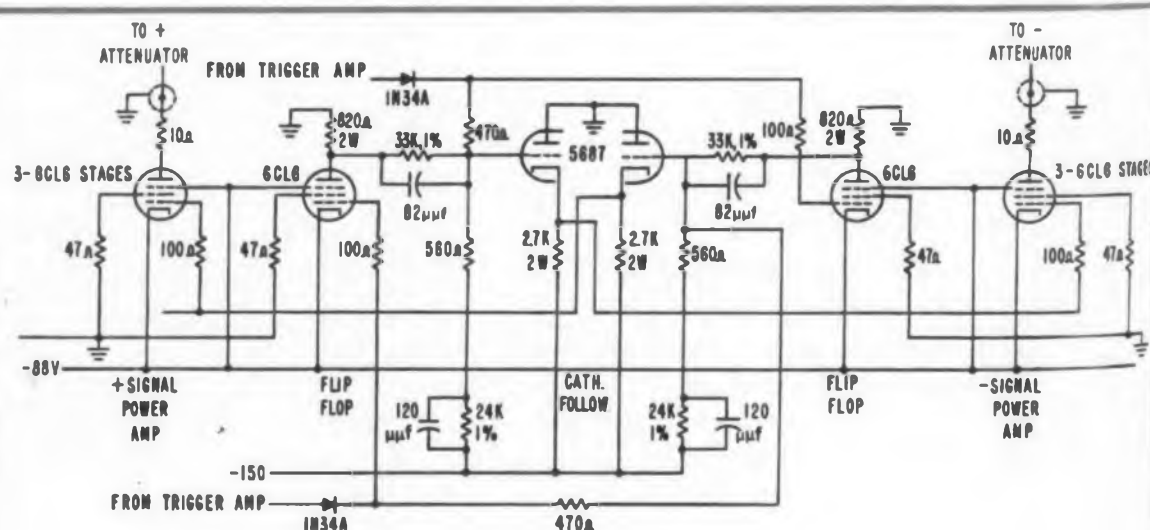
Seeking a better solution, Chief Engineer Leroy Packer and Senior Engineer

Martin Raphael of General Applied Science Laboratories, Inc., 59 Hempstead Gardens Drive, Hempstead, N. Y., decided to make the output stage the heart of their pulse generator design.

### Flip-Flop Times Power Output

They used a flip-flop and two current drivers for pulse timing and power output. To drive the output stage, all that is required is a pair of start-stop triggers. The variable frequency and pulse width of the output signal are obtained from the repetition rate and spacing of the triggers.

The amplifiers ahead of the flip-flop do not have to be wide band; they need



A flip-flop switches the output current drivers in this pulse generator.





Compact pulse generator with the case removed.

only amplify pulses.

The flip-flop switches the output current driver tubes from cutoff to grid-clamp, so rise and fall time and output current are always the same. The combined transition time of the flip-flop and current drivers is less than 0.1  $\mu$ sec, so an output pulse width of 0.1  $\mu$ sec is easily obtained.

Because the output is from a constant current source, there is no droop or tilt in the output wave at any pulse width, and the output may be shorted without damage.

With the balanced output attenuators, ringing and overshoot are easily kept below two per cent.

#### Rate Generator Determines Frequency

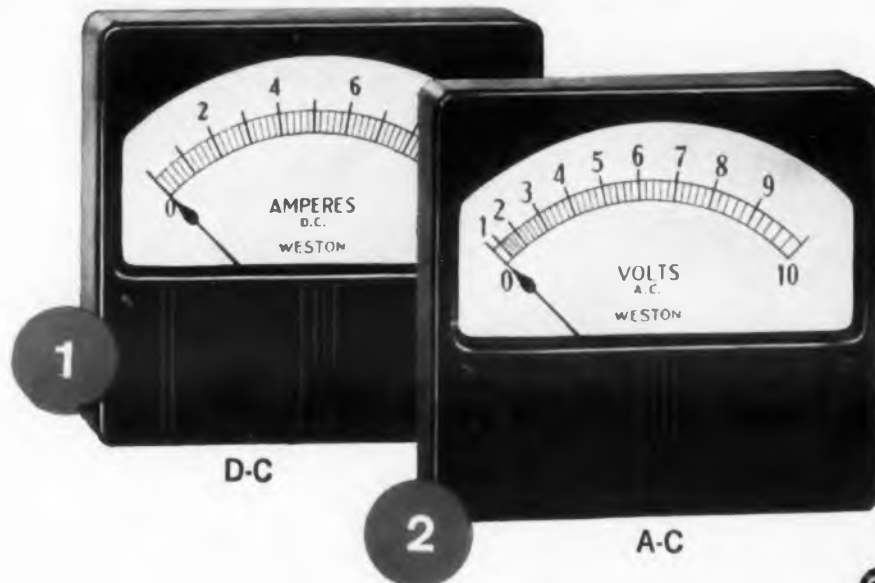
A front-panel-controlled, free-running multivibrator, with a 1 cps to 1 mc range, serves as the pulse rate generator. A Schmitt trigger locks this multi to any external sync waveform in the frequency range.

The leading and trailing edges of the multi's square wave are shaped and applied as set and reset pulses to the output flip-flop which switches the current drivers.

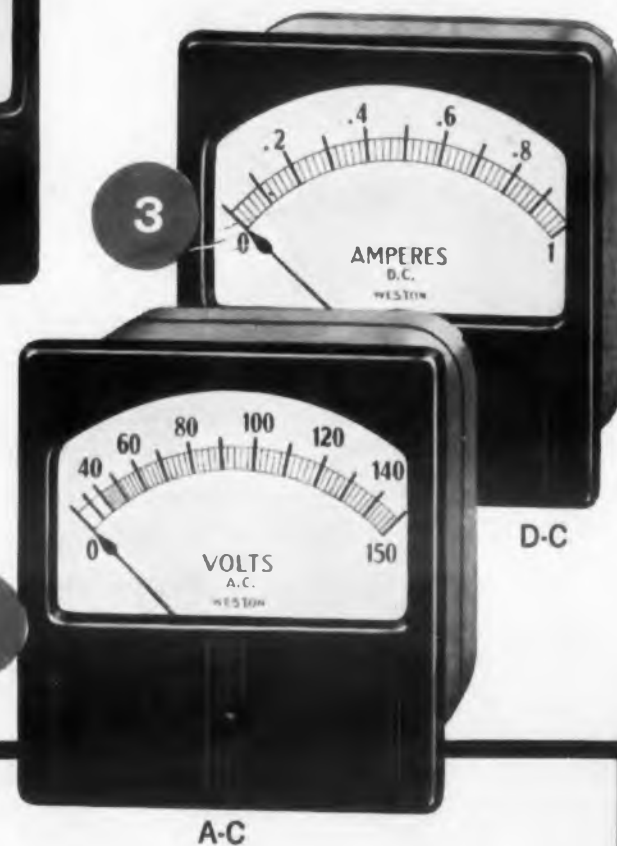
To generate variable width pulses, only the leading edge trigger from the rate multi is used. It is applied simultaneously as a set pulse to the output flip-flop, and to a panel-controlled, monostable multi, which resets the output flip-flop, and thus determines the pulse width.

For more information on this pulse and square wave generator, turn to the Reader-Service Card and circle 101.

### Model 961 Group Instruments



### Model 741 Group Instruments



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## Ground Rules for . . .

# Miniaturizing With Modules

Packaging is far too complex for more than a cursory treatment. The purpose here is to suggest certain rules or procedures useful in deciding when and how modular concepts can be applied when packaging electronic components in suitably miniaturized forms.

**David I. Buchman**  
**Nicholas Guletsky**  
Ordnance Department  
General Electric Co.  
Pittsfield, Mass.



**Fig. 1.** These modular units will be part of the same assembly and should have the same dimensions. This results in more assembly flexibility.



**Fig. 2.** Mounting of four capacitors as one unit saves assembly time and eliminates several solder connections.



Nicholas Guletsky left, feels that there is a strong controversy in the philosophy of how to package electronics for the military. Co-author David Buchman agrees and adds that there seems to be a promiscuous use of encapsulation without regard for use. The attitude seems to be, "This is the latest fad. Let's use it so our design will look up to date." This article is an expression of their strong feelings on the subject.

MODULAR construction is a commonly abused term. Generally, any structure containing sub-units of identical dimension is labeled modular. Insofar as form and symmetry are concerned, the term is accurate and descriptive. However, modular concepts, when extended to electronic equipment, are defined more subtly. For military electronic equipment—rugged, light and reliable—the modular concept means a functionally integrated electronic circuit and mechanical package design. This is, in effect, a judicious compromise between physical size and electrical performance.

### Ground Rules

Development effort on new military products is concentrated in two major problem areas: (1) problems of design and (2) problems of operation.

Design problems weigh most heavily on the electronic circuit designer; he must develop circuits capable of performing specific functions consistently. In devising exact methods to attain an established level of performance it is imperative that the circuit designer keep these ground rules in mind:

1. Circuit design must not be so critical that function is affected by the proximity of other operating components.
2. Circuit function is unaffected by changes in dielectric when encapsulated.
3. Thermal characteristics must be carefully evaluated during the selection of components.
4. Proven, standard components which are readily available must be used to the maximum extent practicable.
5. Adequate operating margins must be used to prevent failures because of transients or probable overloads.
6. Circuitry must be fully evaluated functionally. When all these conditions have been satisfied, the circuit is ready for product design.

Although the product designer now undertakes the task of creating hardware, these ground rules are reviewed continuously in this phase also. But now these additional points are considered:

1. The end use of the product.
2. How can circuitry best be translated, keeping the end use in mind, into form, size, and weight?
3. Make provision for all predicted operating and storage environments.
4. The end product must be easy to manufacture and economical to maintain.
5. Can all necessary operating adjustments be



made speedily and with the necessary accuracy? It is in this area that problems of design and operation merge, and it is here that the techniques of modular encapsulation can be properly exploited. Modular encapsulation is most useful when there are stringent requirements covering size, weight, form, and reliability.

#### Can Bury Mistakes

The product designer must beware of encapsulating indiscriminately merely because the techniques are popular, or novel, or where programs are rushed to meet unrealistic deadlines. Oftentimes, encapsulation, like the graveyard, is used to hide inadequate or careless engineering.

An illustration of where the modular concept may be applied with success is the airborne or portable, transistorized digital computer. Since the trend is to use computers with more and more accuracy, the electrical and mechanical configurations of such equipment are very complex. Under close analysis we see many repetitive functions such as logic networks, shift registers, and flip-flops in various combinations.

Each of these functions can be conveniently broken down into subminiaturized, encapsulated modules without compromising design requirements. Ancillary units, on the other hand, must be treated with some discretion and judgment, inasmuch as other structural or packaging forms may be required to solve all requirements.

That the modular concept of encapsulation is not a brute-force technique cannot be overstressed. It is a creative tool and a high order of creativity is needed, especially in the transition from a prototype to a production model.

In prototype development, circuitry and structure have crystallized, but a high level of refinement is lacking. Unexpected situations will be encountered frequently, and therefore, the product designer must anticipate intensive testing, evaluation, and redesign. For this reason, especially in complex equipments, it is advantageous to have an open type of modular construction. That is, the package configuration is such that essential circuitry is accessible for engineering tests. The package must be adopted to change—even radical change. This feature of openness minimizes time of assembling and disassembling structures, a process which contributes nothing to the solution of engineering problems. This, if nothing else, is sufficient reason to avoid bulk encapsulation of components under all circumstances.

Having this quality of openness, the product designer may anticipate problems of manufacture and maintenance by the judicious use of form, and sometimes color without seriously disrupting this package design.

*(Continued on following page)*



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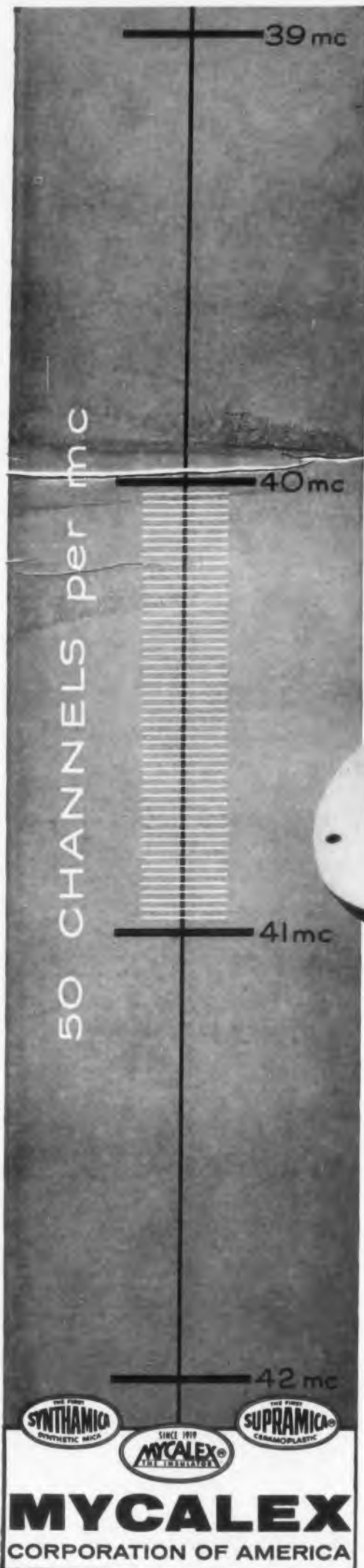
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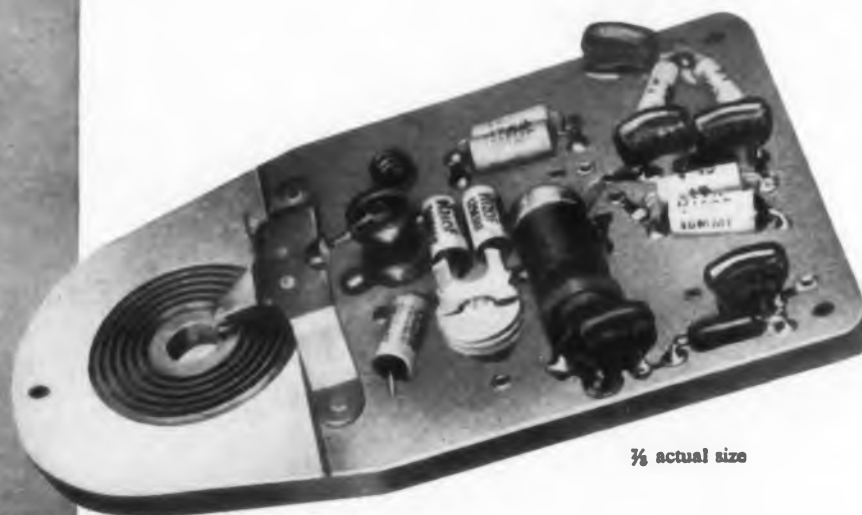
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**Fig. 3.** This amplifier was encapsulated for reasons of space allocations, but with no regard for the ultimate use of the circuit. Many problems were encountered due to proximity of components and dielectric changes caused by the encapsulant.

### Keep Same Shape

To achieve this flexibility it is best to synthesize a structure which accommodates an assortment of small modules. The geometrical form of the modules should be square or rectangular and with flat planes. Modules can then be grouped in convenient clusters or layers. Small arrangements utilize space more efficiently and simplify wire connections. At the same time the simple geometry of the module facilitates manufacture. Figs. 1, 2 and 3 are examples of this type of construction.

Oftentimes, the apparently minute breakdown of modular units raises questions of cost. If a circuit fits into a one-inch cube, why can't two or even more circuits be put into a larger cube? This could increase a tool's efficiency three-fold with little or no additional cost over original cost. Such reasoning is fallacious because only one point of improvement is under consideration. Costs of additional tooling facilities to maintain a proper lease of component encapsulation are quickly justified after the effect of scrap losses when more complex units are rejected. More complicated test procedures may also be required to locate trouble areas in a multiple circuit unit as opposed to a single circuit item.

As pointed out before, encapsulation is a very effective method of packaging military products, but by no means can it be considered a universal solution for the product designer's problem of making electronic equipment smaller, lighter, and above all, more reliable. Disadvantages or limitations, however, arise because of other reasons.



### Need Better Component Shapes

Electronic components are marketed in a great variety of sizes and shapes. Collectively, these items cover a significant functional and environmental performance range. Indeed, many components represent remarkable engineering advances. Yet, despite these achievements, one noteworthy feature shackles product refinement: components still have conventional jackets which are incompatible with the encapsulating process. Therefore, even before any design involving the encapsulation technique is undertaken, the product designer is penalized with a lower volumetric efficiency because of the form in which his building materials are marketed.

As an example, resistors are manufactured with plastic or ceramic housings to meet such various electrical and environmental conditions as dielectric strength, insulation resistance, load life, moisture resistance and temperature cycling. If this same resistor is then encapsulated, the original housing, or jacket, loses its identity and purpose for existence. More often than not, this housing becomes a liability because of incompatible coefficients of thermal expansion between the housing and the encapsulating material. Such undesirable characteristics are found with varying degree in all other components.

In the present state of the art, designers employing techniques of encapsulation have been satisfied to work with components of conventional form. The urge is to "get on with the job," and perhaps for this reason component manufacturers have never been asked to justify why a special product line "for encapsulation only" has failed to appear. Designers should not be content to accept penalties of products designed for other applications; components should be made available which are designed and suitable for encapsulation.

Selection of a suitable encapsulating material calls for a meticulous review of physical properties. For a given material, the coefficient of elasticity must be examined with regard to the transmissibility of vibration and shock, the thermal resistance for adequate heat transfer, and, the coefficient of thermal expansion for compatibility with component materials. Curing temperatures must be such that circuit components are unaffected, Fig. 4.

The configuration of the module must be in harmony with its supporting structure, yet must be easy to manufacture. Every effort must be taken to use component leads as module terminals: their arrangement must be such that they can be wired easily, and without resorting to awkward runs. Finally determine whether a plated or solid encapsulating material will best meet specification requirements. ■ ■

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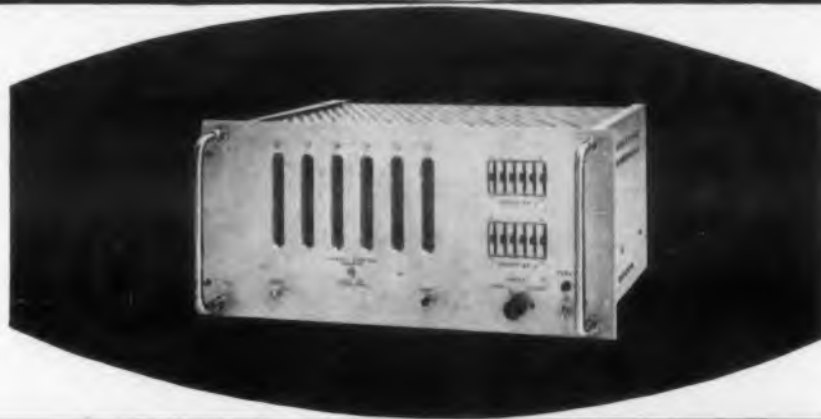
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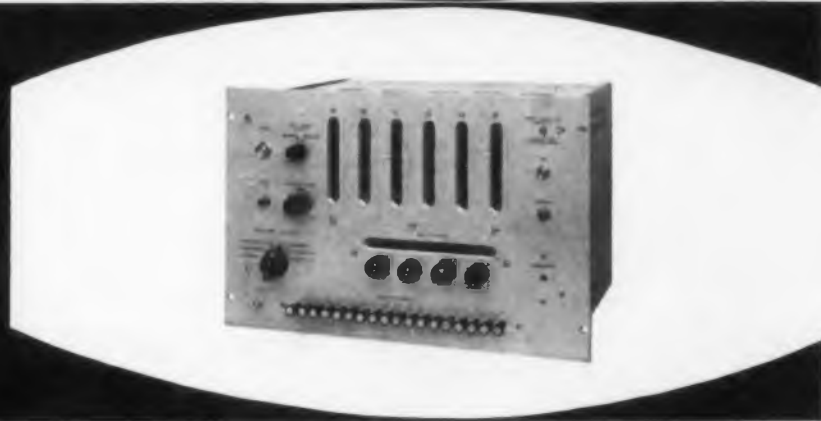
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My solution was a combination of three parts: a dc power source, a current regulator, and a voltage sensing element, as shown in the accompanying circuit diagram.

The dc power source is a standard one taken directly from the General Electric "Transistor Handbook." It would have been better to use a step-down transformer to supply the power but as none was available and the power consumption was low, it was convenient to use dropping resistors.

The current regulator is designed around the constant current properties of transistors. A Motorola 2N662 is used as it is inexpensive and available. The current flowing through this transistor is regulated by the GE 2N167 which turns on as the voltage across the battery rises. R1

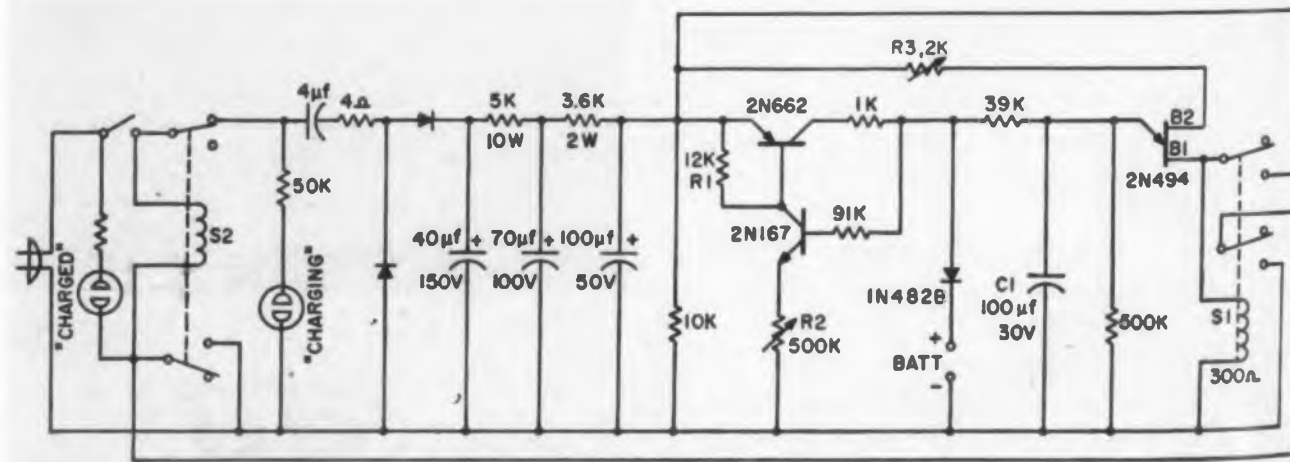
starts the circuit charging when the battery voltage is zero. The charging current can be adjusted by varying R2.

The voltage sensing circuit uses GE's unijunction transistor to dump the charges on C1 when the emitter voltage reaches a certain percentage at the B2 voltage. As the battery charges, so does the 100 µfd capacitor C1. The voltage at the emitter rises with the battery voltage until it reaches a certain value, determined by the adjustment of R3.

At this time the transistor dumps the charge on C1 through S1 relay coil, energizing it. S1 stays closed until the charge on the power supply filter capacitors is dissipated. When S1 closes, it closes the S2 relay which opens the circuit, extinguishing the "Charging" lamp, and lighting the "Charged" lamp, informing the operator that the battery has reached its full charge. The circuit stays in this condition until the power switch is opened.

S1 is a 28 vdc relay with a coil resistance of about 300 ohms and S2 is a standard 115 vac unit. The entire circuit is packaged in a small 4 x 5 inch sloping front cabinet.

R. A. Mammano, U. S. Naval Ordnance Test Station, China Lake, Calif.



Constant current battery charger turns itself off when battery voltage reaches predetermined level.



## Inexpensive, Stable Low Frequency Pulse Generator

Conventional low frequency oscillators are considered inherently unstable. For this reason, stable low repetition rate timing or "clock" pulses are generally derived from a stable high frequency source, such as a crystal oscillator or tuning fork, by means of a dividing down process. I found it possible to eliminate these complex and costly techniques by the use of a standard battery operated clock.

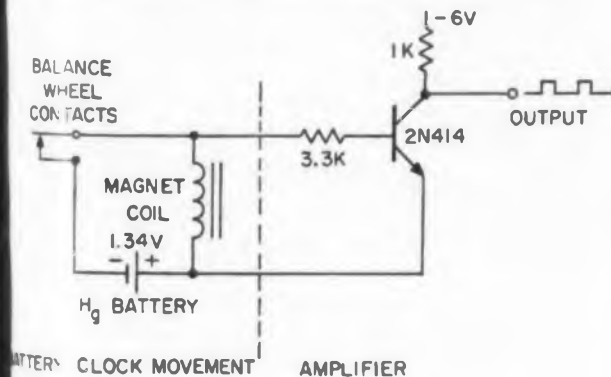
These devices normally contain a jewel mounted hairspring balance wheel which drives an electrical contacting device. The balance wheel is essentially a magnetic armature mounted between the pole pieces of an electromagnet. The contacting arrangement provides the appropriate electrical pulses to the electromagnet to make sustained oscillation possible.

Power is supplied by a mercury battery which is an essentially constant voltage supply. As a result, the pulsed energy supplied to the highly stable electro-mechanical resonant circuit tends to maintain this high degree of stability.

The circuit shown was used to obtain an electrical pulse output. Connections were made by removing the case cover and soldering directly to the coil leads. It was also found that an output could be obtained without opening the case by placing a 100 ohm resistor in series with the battery. A high gain amplifier was used to step up the voltage appearing across the resistor to a useful value.

In tests performed over a period of six months, a Benrus Model EZ 101 clock (\$7.95—Benrus Watch Co., N. Y.) maintained a frequency stability of one part in  $10^6$  at room temperatures. The nominal pulse repetition rate of this unit is five cycles per second. A frequency calibration adjustment on the balance wheel hairspring permits a deviation of approximately 10 per cent from this value. Power consumption is approximately 50 microwatts.

Saul Walker, Senior Engineer, Republic Aviation Corp., Missile Systems Div., Mineola, N.Y.



**Inexpensive clock movement** provides very stable, low frequency pulse generator.

## DESTINATION KNOWN

When a mighty "Thor" blasts off from Vandenberg Air Force Base it is checked out, launched and tracked by Packard Bell's ground support equipment and Missile Impact Prediction System.

### ENGINEERING BEYOND THE EXPECTED

The Missile Impact Predictor is one-eighth the size and was built at one-tenth the cost of previous systems. Ground support equipment matches the reliability built into the "Thor." All combine to guarantee an effective weapon for retaliation or space exploration... destination known.

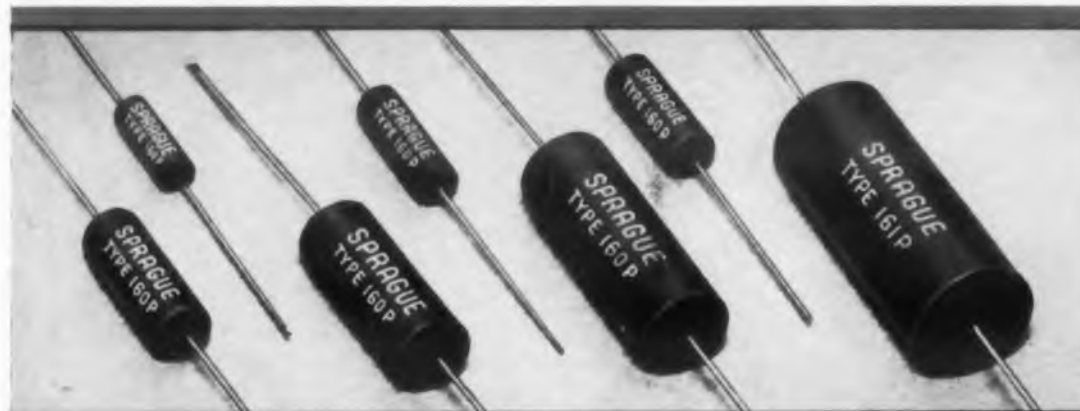
### PACKARD BELL ELECTRONICS

Technical Products Division  
12333 W. Olympic Blvd.  
Los Angeles 24, Calif. - BR 9-3771

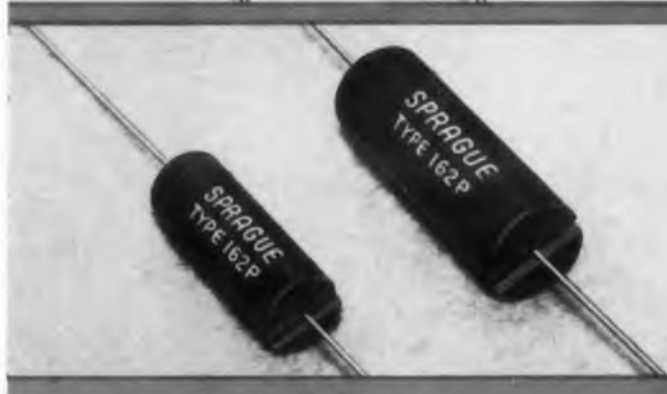
# DIFILM<sup>®</sup> DUAL DIELECTRIC

gives new **BLACK BEAUTY<sup>®</sup>** series of small, low-cost capacitors outstanding performance characteristics

- withstand 105C operation with no voltage derating
- moderate capacitance change with temperature
  - excellent retrace under temperature cycling
  - superior long-term capacitance stability
  - very high insulation resistance



**NEW!**... DIFILM Type 160P fully-molded case and Type 161P pre-molded case capacitors in 5/16" to 1" diameters for general commercial and entertainment electronics.



**NEW!**... DIFILM Type 162P slotted-base multi-purpose molded case capacitors for auto radios and other severe vibration applications. Slot prevents collection of moisture around leads when capacitor is end-mounted against chassis.



• New DIFILM Black Beauty Capacitors represent a basic advance in paper tubular capacitor design. DIFILM Capacitors combine the proven long life of paper capacitors with the effective moisture protection of plastic capacitors... by using a *dual dielectric of both cellulose and polyester film that's superior to all others for small, yet low cost, capacitors.*

• Just check the characteristics listed above. This overall performance is fully protected by HCX<sup>®</sup>, an

exclusive Sprague hydrocarbon material which impregnates the windings, filling all voids and pinholes before it polymerizes. The result is a solid rock-hard capacitor section, further protected by an outer molding of humidity-resistant phenolic. *These capacitors are designed for operating temperatures ranging up to 105°C (221°F) ... at high humidity levels ... without voltage derating!*

For complete specifications on DIFILM Black Beauty Capacitors, write for Bulletin 2025 to Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

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CIRCLE 48 ON READER-SERVICE CARD

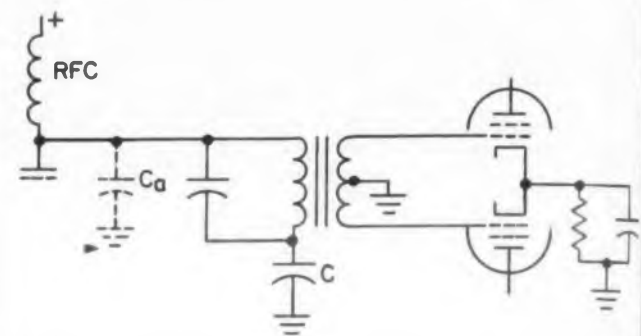
## IDEAS FOR DESIGN

### Better Balanced Drives From Unbalanced

When the drive on a double-ended stage is to be balanced with a single-ended driver, an additional capacitance  $C$  (in the figure) should be placed in series with the transformer primary. Its capacitance should equal the output capacitance,  $C_o$ , of the driver tube.

Each grid of the push-pull stage will then see the same capacity to ground.

Arthur M. Goldschmidt, Moorestown, N.J.



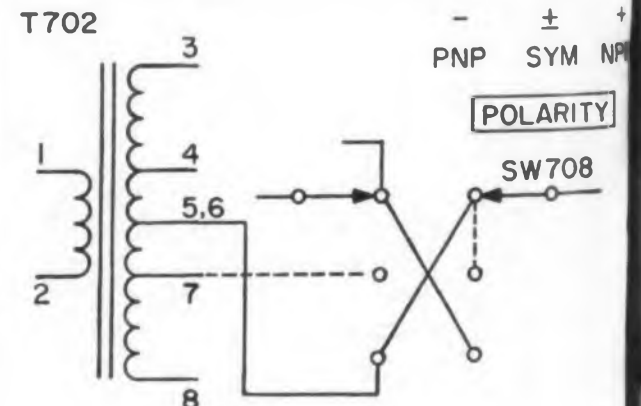
Series capacitor  $C$  helps provide more balanced drive for push-pull stage.

### Curve Tracer Modification For Forward and Inverse Displays

It is frequently desirable to display both the forward and inverse collector characteristics of a transistor on an oscilloscope at the same time. For example, this is useful in the evaluation of symmetrical transistors.

The Tektronix Type 575 transistor curve tracer can be easily modified to display the forward and inverse collector characteristics. The dpdt "polarity" switch (SW708) is replaced by a 3-position switch (non shorting type) and the circuit is modified as shown by the dotted lines on the diagram.

With the switch set at the center position a full wave ac voltage is applied between emitter and



Modification for Tektronix 575 allows display of forward and reverse collector characteristics.



collector of the transistor so that both the forward and inverse collector characteristics of the transistor are displayed on the scope.

There are two limitations to this circuit which should be pointed out. (1) The base current generator is limited to a maximum output voltage of about 12 v. For this reason, the inverse characteristics cannot be displayed at collector voltages above 10 v. (2) The base current flows through the emitter circuit so that the apparent inverse current gain is increased by unity.

$$\beta I_{(apparent)} = \beta I_{(actual)} + 1$$

T. P. Sylvan, Application Engineer, General Electric Co., Syracuse, N.Y.

### Snow-Like Breadboard Chassis

A comparatively new product known as Styro-Foam, a polystyrene snow-like substance, has proven to be an excellent chassis for experimental work. The material is inexpensive, light, and offers good electrical properties.

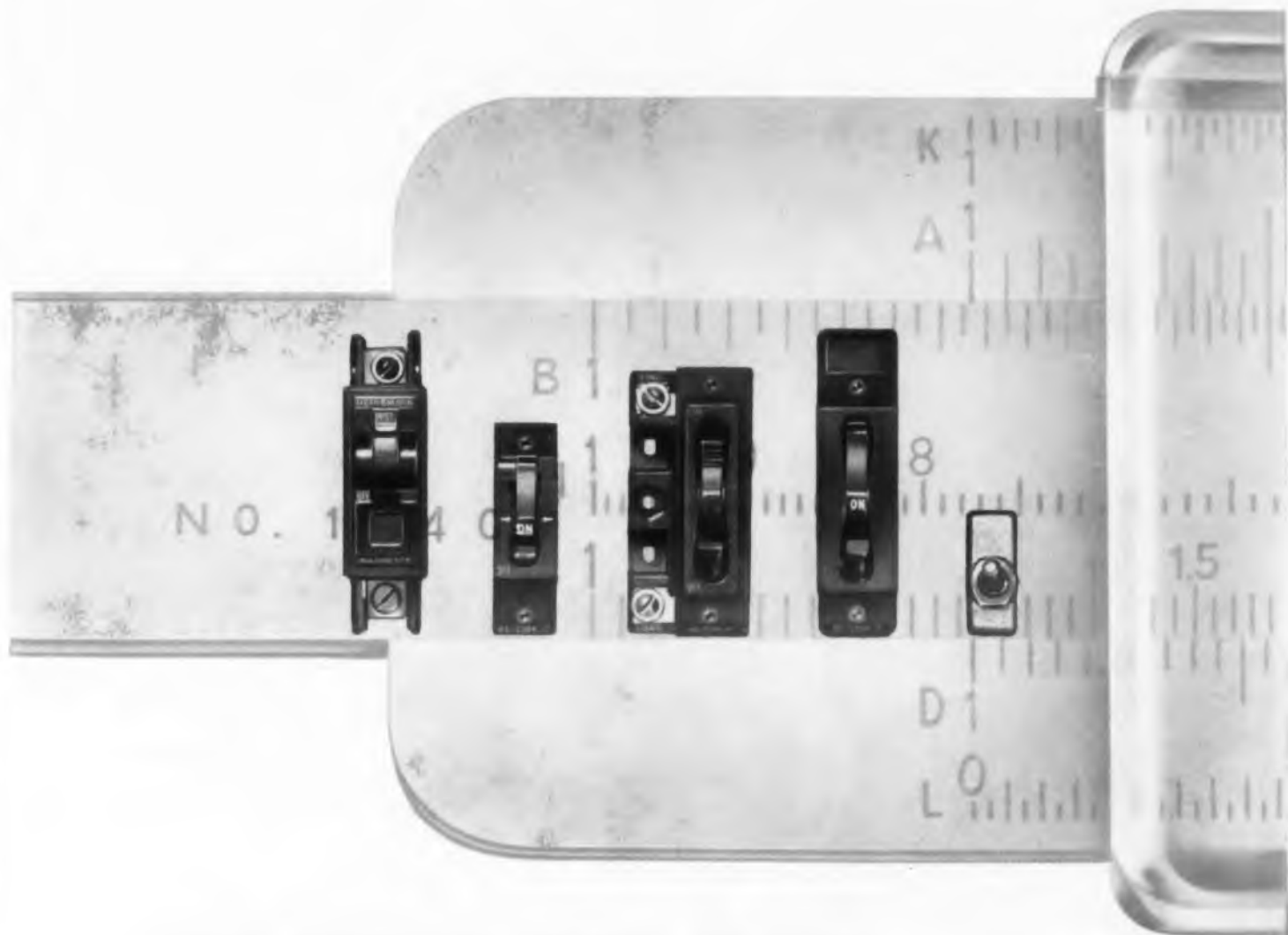
No tools are required to punch holes, make slots, or mount parts. A pencil, pushed into the foam, will form a neat hole without effort. Various components can be mounted easily by impressing their contour into the foam.

Slots or channels can be made by pressing a straightedge into the material. These slots can be used to fix connecting wires to the chassis. Minor changes are easily made on the breadboard and, should a larger chassis be required, one can lift the circuit, intact, out of the foam, into a larger board.

The components are held rigidly in place and do not fall out under normal usage. The material is available from:

Connecticut Circuit Labs., P.O. Box 52, Norwalk, Conn.; Industrial Safety Supply Co., West Hartford, Conn.; and Commercial Plastics Co., New York City.

Rudolf Polak, Electronics Dept. Supervisor, Sperry Semiconductor Div., South Norwalk, Conn.



## WITH HEINEMANN CIRCUIT BREAKERS

## YOU WRITE THE PERFORMANCE SPECS

## EXACTLY AS YOU WANT THEM

Electrical and electronic equipment is best protected against overcurrent when the protection is closely matched to the equipment operating characteristics. It's something like the difference in fit between a ready-made suit off the rack and a custom-tailored one made to measure.

Heinemann gives you the custom-tailored fit — when you need it.

Take current ratings, for example. With Heinemann breakers you can get the *precise* rating required—even if it's a fractional value such as 3.4 amperes. No second-best compromises necessary.

There's a choice of time-delay characteristics, so that you can obtain just the right correlation be-

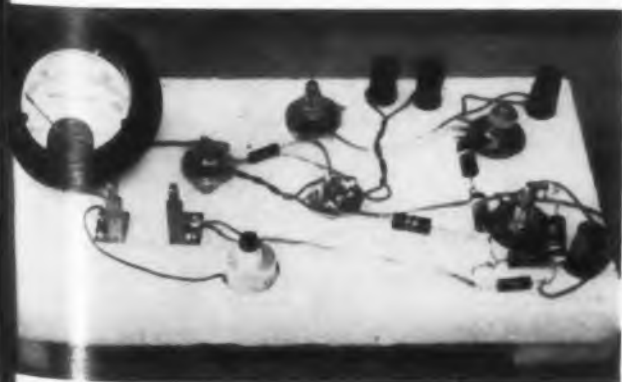
tween tolerable overload and tripping response. This eliminates a lot of guess-work and uncertainty.

If you need exceptional ruggedness, there are breaker models specially designed for difficult environmental conditions. And if small size is essential, Heinemann can offer you a sub-miniature breaker no bigger than a matchbox.

With this kind of special service routinely available, it's small wonder that Heinemann circuit breakers are so widely used. Perhaps you can use them too. For a clear, concise view of the Heinemann product line, send for Bulletin 301. It's a handy shopping guide for your reference shelf.

**HEINEMANN ELECTRIC COMPANY**  **156 PLUM ST. TRENTON 2, N.J.**

CIRCLE 49 ON READER-SERVICE CARD

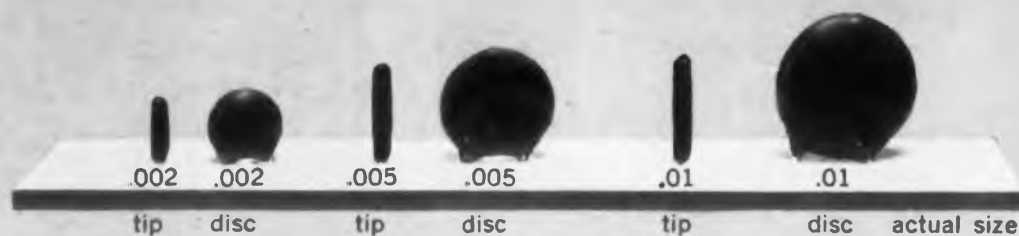


Components are pressed into this snow-like breadboard chassis.

**NEW****KEMETAL**

# tip CAPACITORS

## LESS THAN .100 DIAMETER



TIP CAPACITORS compared in size with discs of equal capacity

# SPACE SAVERS

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ating types. Can be mounted vertically or (when specified) horizontally. Leads can be furnished straight, short or crimped.

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CIRCLE 50 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

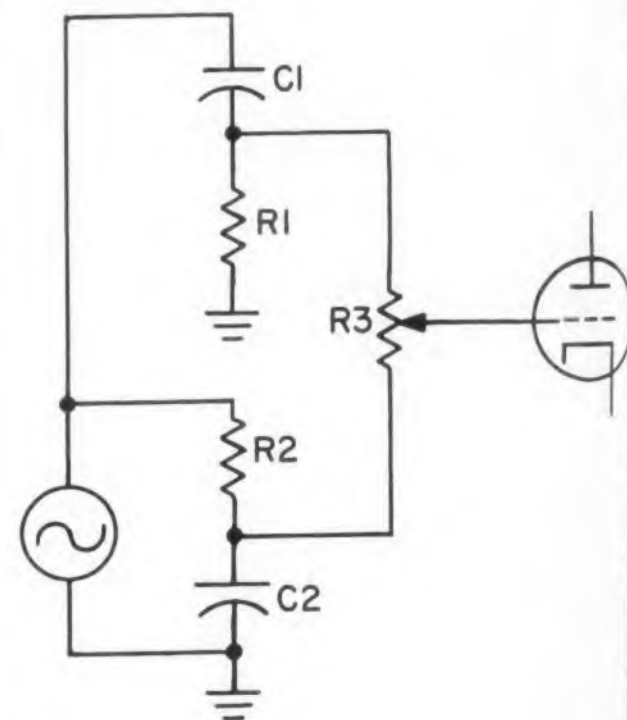
### Just A Little Bit Of Phase Shift

We needed a circuit to provide a limited amount of phase shift on both sides of zero degrees for fixed frequency sine wave signals. The RC circuit shown in the figure provided the necessary phase shift with minimum amplitude change.

In the circuit,  $C1-R1$  provides a  $+45$  deg shift while  $C2-R2$  provides a  $-45$  deg shift.  $R3$  selects a point between these extremes. For proper operation,  $R1 = 1/\omega C1 = R2 = 1/\omega C2$ .  $R3$  should be greater than about five times  $R1$ . If it is not,  $R1$  will have to be increased to produce the proper time constant with  $C1$ .

The wiper of  $R3$  should be loaded as lightly as possible if amplitude variations are to be minimized.

*Fred Close, Engineer, Magnavox Co., Ft. Wayne, Ind.*

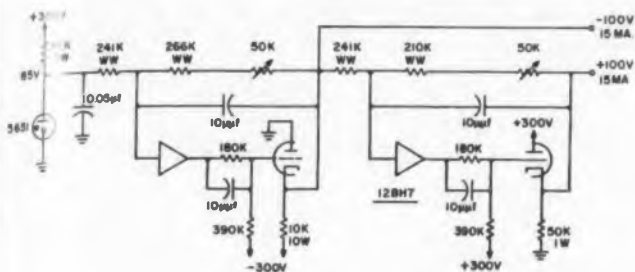


Small phase shifts around zero degrees are provided by this simple circuit with little amplitude change.

### Analog Computer Reference Supply

The accompanying diagram illustrates the design of simple but remarkably accurate reference power supplies for electronic analog computers. A VR tube or Zener reference voltage is amplified by a pair of commercially available computer type dc amplifiers to yield positive and negative





**Simple, reference power supply.** All resistors not marked otherwise are 1/2 w, 5 per cent types.

reference voltages at output impedances of less than 0.1 ohm.

Regulation is within 0.1 v from no load to full load for the supply shown from no load to a 15 ma full load.

To permit the use of low cost plug-in dc amplifiers (Philbrick K2-W), each amplifier is provided with an external cathode follower. Additional cathode follower sections can be paralleled for larger loads.

One can easily adjust the output voltages by changing the feedback resistors. To reduce long term drift to below 0.2 v, the dc amplifiers may be chopper-stabilized, but this is rarely necessary.

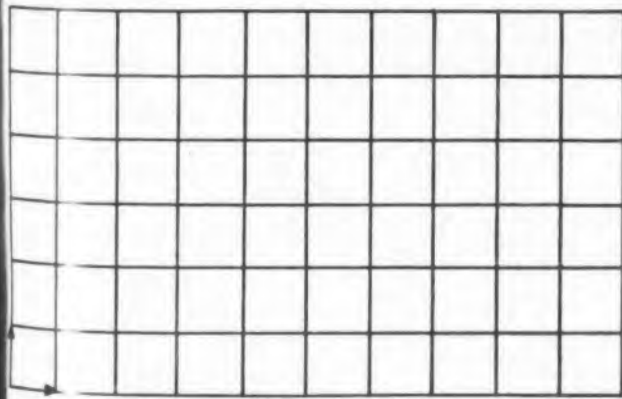
If a battery reference is to be substituted for the VR tube, a "bootstrap" resistor from the positive output terminal must be connected to the positive reference terminal to supply just enough current for zero battery drain.

C. E. Foiles, J. P. Hartmann, and H. Koerner, University of Arizona, Tucson, Ariz.

### Which Way Is Up?

Here's a simple way to identify the orientation of an oscilloscope picture regardless of camera type or camera orientation. Just scratch, or etch arrow heads on the graticule. These will be illuminated with the graticule divisions to provide positive orientation of the trace.

Glenn L. Roark, Development Engineer, Aerojet-General Corp., Azusa, Calif.



Arrow heads scratched on scope graticule provide positive picture orientation.



## For ALNICO MAGNETS—Stock or Special Specify "ARNOLD"

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Cast Alnico Magnets are most commonly made in Alnico V, VI or III. Sintered Alnico Magnets usually are made in Alnico II, V or VI. Special permanent magnet materials supplied by Arnold include Vicalloy, Arnox III and V, and Cunife.

### Engineering Data

Write for your copy of *Bulletin GC-106C*, a general catalog of all Arnold products. It contains useful data on the physical and magnetic properties of Alnico magnets. Lists stock items and standard tolerances for cast and sintered magnets—also stock sizes and pertinent data on tape cores, powder cores, C & E cut cores, etc.

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YOUR best bet for a source of Alnico permanent magnets and assemblies is Arnold—producer of the most complete line of magnetic materials in the industry. We can supply your need for any size, shape, or type of Alnico magnet. Weights range from small sintered parts weighing less than a gram to large castings of 80 lbs. or more.

Special assemblies such as rotors, traveling wave tube and magnetron magnets, etc., may be supplied aluminum-jacketed for easy mounting and added protection of the magnet—and magnetized and stabilized as desired. Large magnet assemblies

may also be supplied for mass spectrometer and other measuring applications, where a high degree of stability and uniformity of field is required.

For your convenience, we carry a wide range of the more popular sizes and types of Alnico magnets in stock for immediate shipment. Unsurpassed plant facilities assure quick delivery of all special orders.

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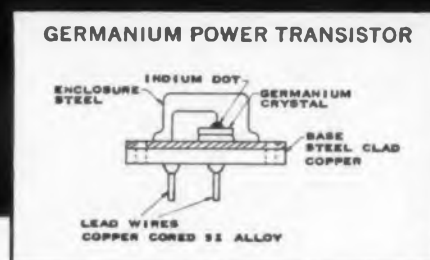
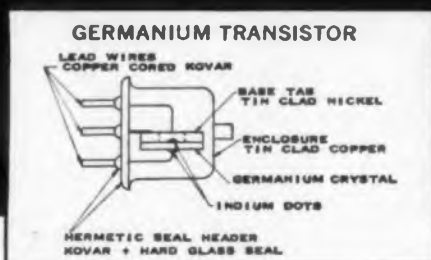
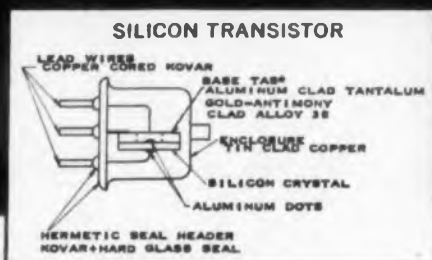
BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES  
Find them FAST in the YELLOW PAGES

CIRCLE 51 ON READER-SERVICE CARD

# General Plate Clad Metals

## IMPROVE PERFORMANCE - CUT COSTS

### In Semiconductor Applications



#### I BASE TAB MATERIAL

##### A For Germanium (Single Clad Only)

1. Tin Clad Nickel
2. Tin Clad Alloy 30 (42% Nickel-58% Iron)
3. 63.2% Lead-35% Tin-1.8% Antimony Clad Nickel
4. 63.2% Lead-35% Tin-1.8% Antimony Clad Alloy 30
5. 63.2% Lead-35% Tin-1.8% Indium Clad Nickel
6. 63.2% Lead-35% Tin-1.8% Indium Clad Alloy 30
7. 99% Tin-1% Gallium Clad Nickel
8. 98% Tin-2% Antimony Clad Nickel
9. 95% Tin-5% Antimony Clad Nickel
10. Tin Clad Steel
11. Tin Stripe on Nickel
12. Tin Clad Titanium

##### B For Silicon (Single or Double Clad & Stripes)

##### \*\*Solder

1. Gold
2. 99.5% Gold-.5% Antimony
3. 99% Gold-1% Gallium
4. 95% Gold-5% Indium
5. 99.9% Gold-.1% Boron
6. 99% Gold-1% Aluminum
7. 99% Gold-1% Arsenic
8. Fine Silver
9. 99.5% Silver-.5% Antimony
10. 95% Silver-5% Indium
11. Aluminum
12. High Purity Aluminum

##### BASE METAL

1. Nickel
2. Alloy 20 (40% Nickel-60% Iron)
3. Alloy 30 (42% Nickel-58% Iron)
4. Kovar
5. Titanium
6. Tantalum
7. Molybdenum
8. Silver
9. Platinum

\*\*NOTE: These solders may be single or double clad on any of the base metals listed above. Solders in group B may be purchased unclad.

#### II LEAD WIRE MATERIAL

1. Copper Cored Rodar (Soft Glass Seals)
2. Copper Cored 52 Alloy (Compression Seals)
3. Copper Cored 446 Stainless Steel
4. Nickel Clad Copper Wire
5. Copper Clad Nickel Wire

#### III WHISKER WIRE MATERIAL

1. 95% Platinum-5% Ruthenium
2. 99% Gold-1% Gallium
3. 99.5% Gold-.5% Antimony
4. 90% Platinum-10% Iridium

#### IV BASE MATERIAL

1. Aluminum Killed Low Carbon Steel Clad Copper
2. Stainless Steel Clad Copper
3. Nickel Clad Steel (Nifer)<sup>®</sup>
4. Nickel Clad Copper
5. Nickel Clad Tantalum
6. Silver Clad Tantalum
7. Aluminum & Nickel Double Clad Tantalum

#### V ENCLOSURE MATERIAL

1. Tin Clad Copper
2. Glass Clad Nickel Silver
3. Tantalum Clad Nickel Silver

If you are seeking metals with useful characteristics that can't be found in a single metal or alloy, investigate clad metals. General Plate Clad Metals do what other metals can't. Made by metallurgically bonding single metals or alloys to other metals in the solid state by exclusive processes\*, the composite metals give you the *combined* advantages of the selected metals and can *yield new advantages* such as lower cost, better fabricating qualities, improved parts performance, etc.

The General Plate Clad Metals for semiconductor applications described here comprise only a partial listing. To find out more about these or other combinations to meet your specific requirements, write directly to Industrial Metals Product Manager, or request our special catalog on clad and solid metals for electronics applications.

\*Patented processes of Metals & Controls Corporation.

## METALS & CONTROLS

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GENERAL PLATE PRODUCTS: Clad Metals • Electrical Contacts • Truflex<sup>®</sup> Thermostat Metal • Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

CIRCLE 52 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Blister Package Seals In Bearing Performance

Bearing contamination, always a serious threat to optimum performance of equipment, can be largely eliminated, thanks to a new packaging technique.

The new package, developed by the Eclipse-Pioneer division of Bendix Aviation Corp. with assistance from Celanese Corp. of America, seals individual bearings with a preservative in a transparent acetate blister. This allows a single bearing to be visually inspected and removed from the package when it is needed.

Formerly, 10 bearings were sealed in a single unit; they ran the risk of air contamination when the package was opened to remove a single bearing.

In packaging the bearings, an operator in a dust-free atmosphere places a bearing with preservative fluid in each of the individual blisters of a preformed acetate strip, as shown in the photo. An acetate cover strip and a strip of lint-free paper board are heat sealed to the blister strip in one operation.

The paper board makes the assembly rigid and provides an area for identification. The cards are perforated so individual blisters can be torn off.

The packaging machine is manufactured by Packaging Industries Ltd. of Montclair, N.J.



Packed in individual blisters, these bearings run far less risk of air contamination.

### Sine to Square Wave Converter

The circuit shown is for a sine to square wave converter which may be plugged into the output of a sine wave signal generator. Power for the converter is derived from the generator output, so no other supply is required.

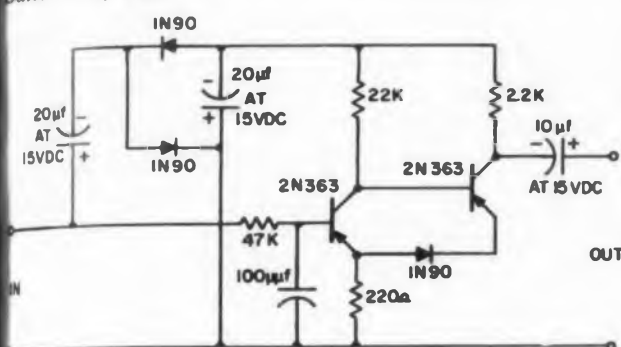
As a result, the frequency and the amplitude



controls of the generator function as usual, but the output is now a square wave.

The circuit uses a half wave doubler which converts the output of the generator to dc, and a Schmitt trigger pulse shaper which chops the dc into square waves at a rate controlled by the generator frequency. The square wave's amplitude is a function of the output amplitude of the generator.

Roy P. Foerster, Engineer, The Martin Co., Baltimore, Md.



Plug-in sine to square wave converter derives its power from the input sine waves.

### "Approach to Ground" Warning

It is occasionally necessary to sense the approach of a potentiometer arm to ground. This may be done readily by means of the simple transistor circuit shown.

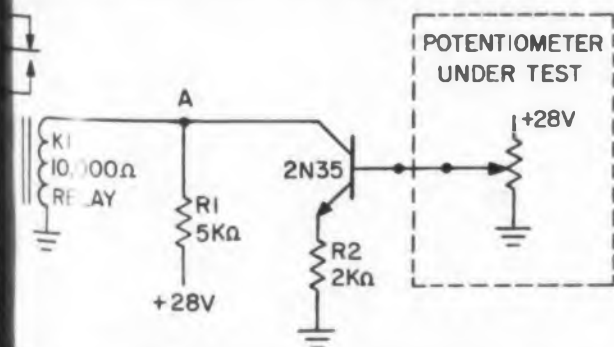
As long as the arm of the potentiometer under test holds the transistor base sufficiently positive, the collector-emitter circuit of the transistor will conduct, keeping the voltage at point A too low for sensitive relay K1 to operate.

As the arm approaches the ground end of the potentiometer, the base will become less positive and the collector emitter conductance will decrease, raising the voltage at A until K1 pulls in.

The relay firing point with respect to potentiometer arm position may be present by varying R2 and using a precision potentiometer to calibrate the circuit.

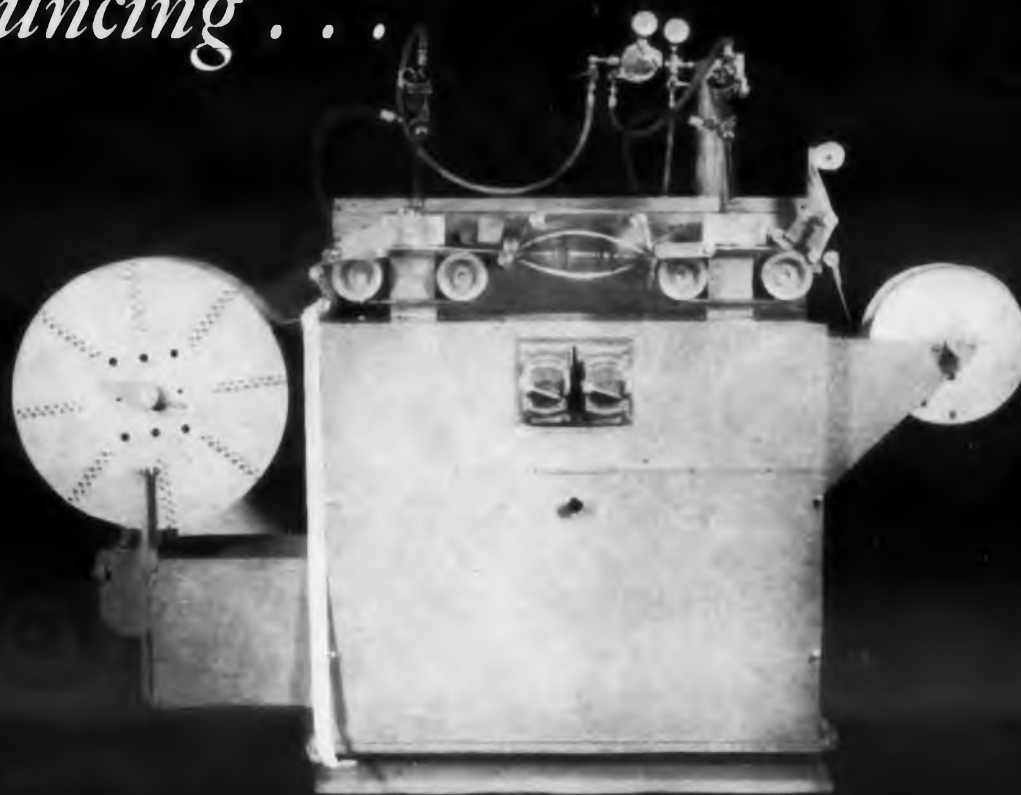
This circuit was used to measure the step function response of a device with a potentiometer output.

Paul H. Weisz, Sr., Electrical Engineer, Hoffman Electronics Corp., Los Angeles 7, Calif.



This transistor circuit senses the approach of the potentiometer arm to ground.

*announcing . . .*



## Wright Diode Painting Machine

### Automatically And Precisely Paints Pre-Taped Diodes At Speed Of 3600 Per Hour

Diode manufacturers can realize substantial savings with an automatic painting machine developed by Wright Machinery Company Division of Sperry Rand Corporation.

The unit automatically applies an opaque covering coat of non-conductive paint to pre-taped diodes. Its operating speed is 3600 diodes per hour.

Only one attendant is required to set up and to monitor the operation. In addition to saving labor costs, the reduced manual handling of the diodes helps maintain uniform quality and minimizes damage.

Precision painting is assured through use of calibrated air brushes and paper tape masks. Standard adding machine tape is used for masking.

**WRIGHT MACHINERY COMPANY**

DIVISION OF SPERRY RAND CORPORATION • DURHAM, N. C.

Gentlemen: Please send me data on the Diode Painting Machine.

Name & Title \_\_\_\_\_

Company & Address \_\_\_\_\_

CIRCLE 53 ON READER-SERVICE CARD

**DOW****MAGNESIUM PRODUCTS**

## NEW ALLOY DAMPS VIBRATIONS IN U.S. ARMY NIKE HERCULES

Dow plants cast a new lightweight magnesium alloy with superior damping capacity for electronic bases, housings.

K1A CASTINGS used on the Nike Hercules. Electronic guidance components are mounted on the die casting and housed within the sand casting. Dow is the production source for both castings.

Damping capacity—the ability of a material to reduce vibration by absorbing energy—is a highly important factor in electronic equipment used in missiles and aircraft. The performance of sensitive instruments can be severely affected by high energy vibrations generated in missiles in take-off and flight.

A big step forward in solving this increasingly critical problem is the development of K1A, a new magnesium alloy. Used in electronic bases and housings, this lightweight alloy eliminates complex mounting and suspension systems that often take up precious weight and space in missiles.

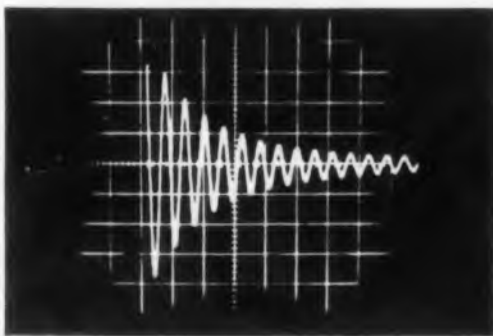
This new magnesium alloy has vibration damping characteristics much better than cast iron, aluminum or other magnesium alloys. Its heat conductivity and diffusivity are approximately twice that of standard magnesium alloys, thus making possible substantially reduced environmental temperatures for electronic instruments. Welding and machining have no adverse effect on the damping properties of K1A.

Bell Telephone Laboratories has done extensive work in determining properties and characteristics for the alloy, and in establishing its suitability for Western Electric's work on the guidance control system of the Nike Hercules. K1A is now available in the form of sand and die castings.

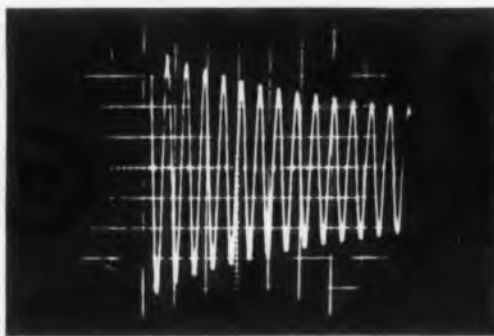


NEW BROCHURE on damping characteristics of magnesium discusses K1A, other Mg alloys. Contact the Dow sales office or THE DOW CHEMICAL COMPANY, Midland, Mich., Magnesium Products Sales Dept. 1313BC6-10.

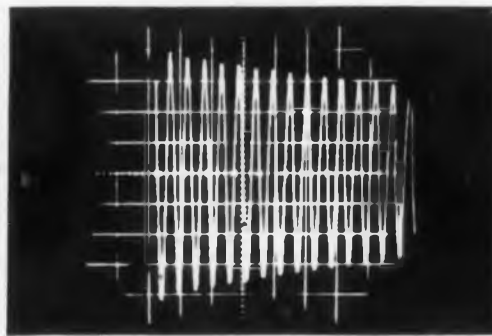
K1A MAGNESIUM



AZ81A MAGNESIUM



355 ALUMINUM



OSCILLOSCOPE PATTERNS, taken under identical test conditions, demonstrate high damping capacity of K1A compared to other magnesium and

aluminum alloys. The superiority of K1A is evidenced by rapid absorption of energy as shown by the sudden reduction in amplitude of the vibration.

**THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN**

CIRCLE 54 ON READER-SERVICE CARD



## STANDARDS AND SPECS

Sherman H. Hubelbank

### Magnetic Materials

MIL-P-55034, STABILITY OF POWDERED MAGNETIC MATERIALS (MOLDED) FOR CORES (FOR USE IN ELECTRICAL AND ELECTRONIC PARTS), 19 SEPTEMBER 1958

This spec covers the evaluation of the uniformity and the stability under environmental conditions of molded, powdered magnetic materials for use as cores in such electrical and electronic parts as coils, transformers, etc. The cores covered in this spec are intended for use in applications where uniformity and stability of electrical and magnetic characteristics under adverse environmental conditions is a prime requisite. Minimum requirements for mechanical and electrical strength are established. Specific performance of cores, however, is not covered.

### Resistors

MIL-R-11C, GENERAL SPECIFICATIONS FOR FIXED COMPOSITION (INSULATED) RESISTORS, AMENDMENT 1, 27 JANUARY 1959

The requirement paragraphs for acceleration shock, and high-frequency vibration have been clarified.

MIL-R-19A, VARIABLE WIREWOUND RESISTORS (LOW-OPERATING TEMPERATURE), AMENDMENT 6 JANUARY 1959

Acceleration, shock and high-frequency vibration test requirements have been clarified. Test inspection and test equipment requirements have been revised. The latest packaging information has been added.

MIL-R-93B, FIXED WIREWOUND (ACCURATE) RESISTORS, 2 FEBRUARY 1959

The square or rectangular alternate construction has been deleted from the detail specs.

MIL-R-11804C FIXED FILM RESISTORS, AMENDMENT 1, 16 FEBRUARY 1959

Test equipment and inspection facilities have been revised to incorporate the latest paragraph on responsibility for inspection. Single and combined type submission for qualification inspection has been clarified.



### Sampling Procedures

MIL-STD-414, MATHEMATICAL AND STATISTICAL PRINCIPLES

This technical report provides the mathematical and statistical principles underlying the sampling procedures contained in MIL-STD-414. Copies of this report are available from the Government Printing Office for 25 cents. Order Catalog No. 72:M42.

### Current Limiting Reactors

ASA C57.16-1958, REQUIREMENTS, TERMINOLOGY, AND TEST CODE FOR CURRENT LIMITING REACTORS  
This standard applies to current limiting reactors connected in series with the phase conductors for limiting the current that can flow in a circuit under short-circuit conditions. The present revision brings the standard up-to-date and into agreement with ASA C57.12-1956 and C57.12d-1957 and with NEMA TRI-1954. Copies of this standard are available from ASA, 70 East 45th Street, New York 17, N.Y. at \$2.00 each.

### Printed Wiring

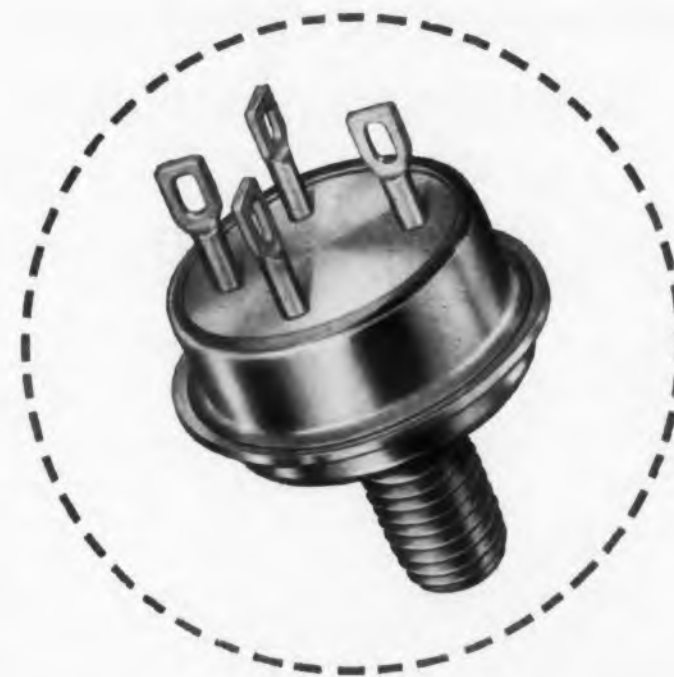
IA RS-216, STANDARD METHOD OF TEST FOR ADHESION OF PRINTED WIRING, FEBRUARY 1959

Standards are established to determine resistance to pull-off of lands before and after soldering component leads; resistance to peel or stripping conductors at standard room temperatures before and after solder dipping, and at elevated temperatures; and resistance of large conductor leads to blistering as a result of solder dipping. Pull strength has been defined as the load per unit width required to sustain separation of the conductor from the base at an angle of 90 deg. It is expressed in pounds per inch of width. Pull-off length is the load, normal to the printed test pattern, required to separate the land from the base. Blistering is defined as visual evidence of separation or delamination within the base material. Copies are available from the Electronic Industries Association, 11 West 42nd Street, New York 36, N.Y. for 50 cents each.

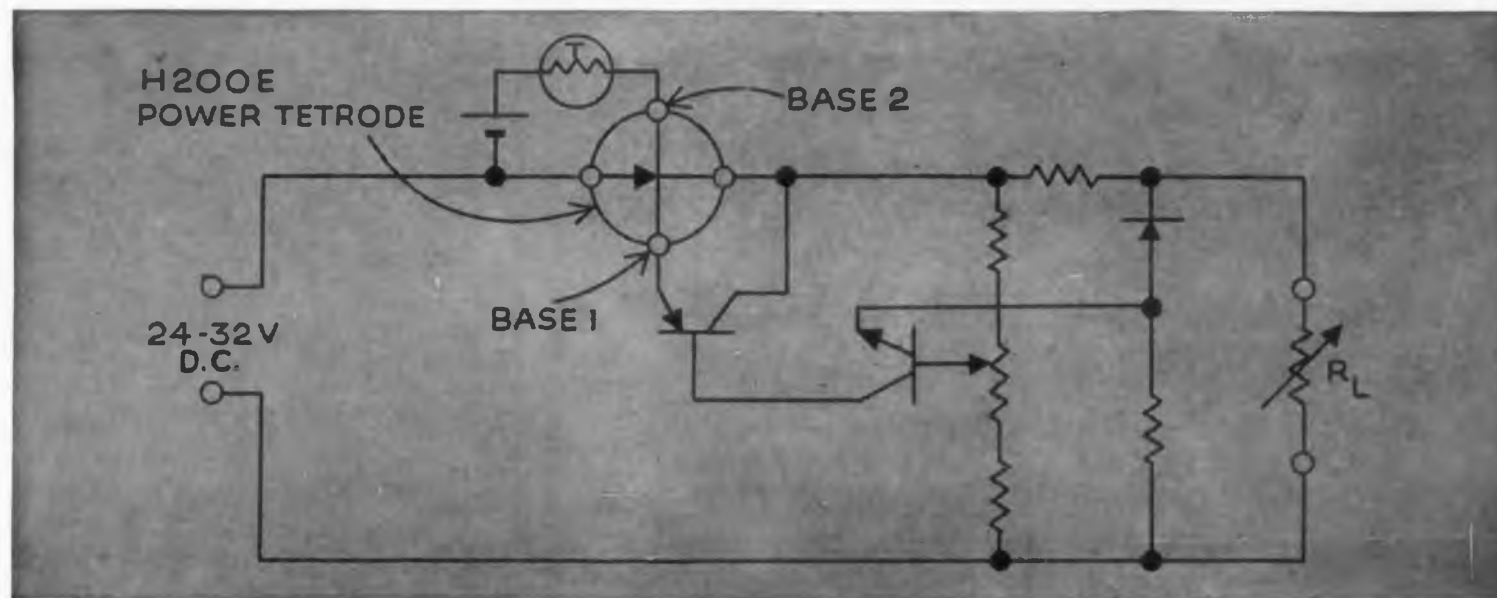
### Wound Cut Cores

IA RS-217, WOUND CUT CORES, FEBRUARY 1959  
The listings for the simple, shell, and core type configurations were combined with each core following recommended usage. There is no stipulation, however, that a shell-type core cannot be used in a simple-type construction. There is also a listing of recommended cores for use in L-T-2A cases. Copies of this spec are available from the Electronic Industries Association, 11 West 42nd Street, New York 36, N.Y. for 60 cents each.

# Open Circuit Regulation Maintained at 71°C.



—with Honeywell's Power Tetrode



Shown above is a voltage regulator circuit using Honeywell's H200E Power Tetrode. This circuit is designed to supply 22 volts output with 1% regulation, with inputs of 24 to 32 volts and load currents of zero to 3 amperes. The system has short circuit protection.

Circuit values can easily be adjusted to maintain regulation at other voltages and through other current ranges. The base 2 circuitry can be modified to give varying degrees of leakage current stability.

The Tetrode makes possible an improved series

voltage regulator for systems where current requirements are apt to vary widely. It offers overload protection, improved high temperature operation, and controlled regulation characteristics. Its second base connection provides control of the total system leakage.

For complete voltage regulator circuit description along with component values, write Honeywell, Dept. ED-6-58, Minneapolis 8, Minnesota. Regional representatives may be reached in Union, New Jersey, (MURdock 8-9000), Boston (ALgonquin 4-8730), Chicago (IRving 8-9266), and Los Angeles (RAYmond 3-6611 or PARKview 8-7311).

## Honeywell



*First in Control*

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give yourself and your family  
all the big city advantages at a  
relaxed midwest pace, while you  
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Outstanding career opportunities are waiting at the many Motorola research and development laboratories in the Chicago area. This is your opportunity to advance your career with a swiftly expanding company, working in the most modern and well instrumented laboratories . . . with liberal employee benefits, including an attractive profit sharing plan and association with men of the highest technical competence.

You'll like living in one of the beautiful suburbs of the playground of the midwest, where there are endless social, cultural, and educational activities to choose from the year-round. Exciting life or quiet life—Chicago offers either.

**MILITARY  
POSITIONS OPEN**

- Radar transmitters and receivers
- Radar circuit design
- Antenna design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using klystron, traveling wave tube and backward wave oscillator
- Display and storage devices

**CIVILIAN  
POSITIONS OPEN**

- 2-WAY RADIO COMMUNICATIONS**
- VHF & UHF Receiver • Transmitter design & development • Power supply
  - Systems Engineering • Selective Signaling • Transistor Applications • Crystal Engineering • Sales Engineers
- PORTABLE COMMUNICATIONS**
- Design of VHF & UHF FM Communications in portable or subminiature development.
- MICROWAVE FIELD ENGINEERS**

Write to:

Mr. L. B. Wrenn Dept. B  
MOTOROLA, INC.  
4501 Augusta Blvd., Chicago 51, Ill.

ALSO . . . there are excellent opportunities in  
**PHOENIX, ARIZONA • RIVERSIDE, CALIFORNIA**

**MOTOROLA**

CIRCLE 900 ON CAREER INQUIRY FORM

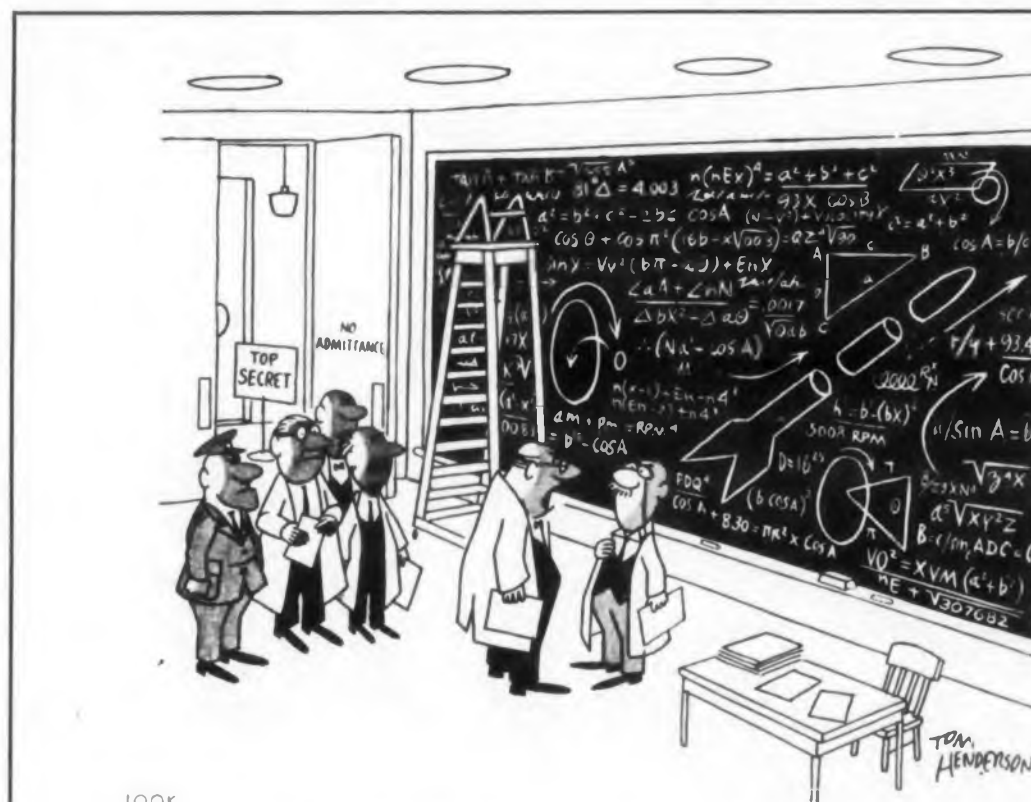
## DESIGNING YOUR FUTURE

A new regular feature starting this issue.  
See also listings of Career Opportunity Brochures  
and new rapid Career Inquiry Service form on following page.

**How To Get Ahead  
the "do's" and "dont's"**

**HIS ATTITUDES**, the way he deals with people, what he says or doesn't say—these and other personal characteristics have a strong bearing on the young design engineer's chances of success. Getting ahead depends on understanding these factors as well as having technical proficiency—and sometimes more so. In this article are 15 "do's" and "don't's" that have served as useful guides for other engineers.

1. **Give It Your Best.** No matter how menial and trivial your early assignments may appear, give them your best effort. Success depends largely on the intelligent prosecution of any job. Your ultimate chances are much better if you do a good job on some minor detail than if you do a mediocre job as section head.
2. **Get Things Done.** There's always a premium on getting things done. For that you need: (a) Energy to start things and



LOOK

"Well, we don't agree with you! We say it's your night to erase the blackboard!"



## Opportunities to work on FIRE CONTROL AND GUIDANCE COMPUTER ELECTRONICS for the POLARIS MISSILE



E. N. Kaufman, a senior engineer, lists 15 principles in this article that spell out what those "Think" and "Plan Ahead" signs imply.

**8. Be Concise And Clear.** This goes for oral and written reports. The trick is to convey the most significant information in the least time. If there is one bane of an executive's existence, it's the man who takes a half an hour to say what could be told in a 20 word sentence. It is so difficult to get a direct answer out of some men that their usefulness is greatly diminished. The tendency sometimes is to explain the answer before answering the question. This should be done only when it is important to add the pertinent background to illuminate a simple statement.

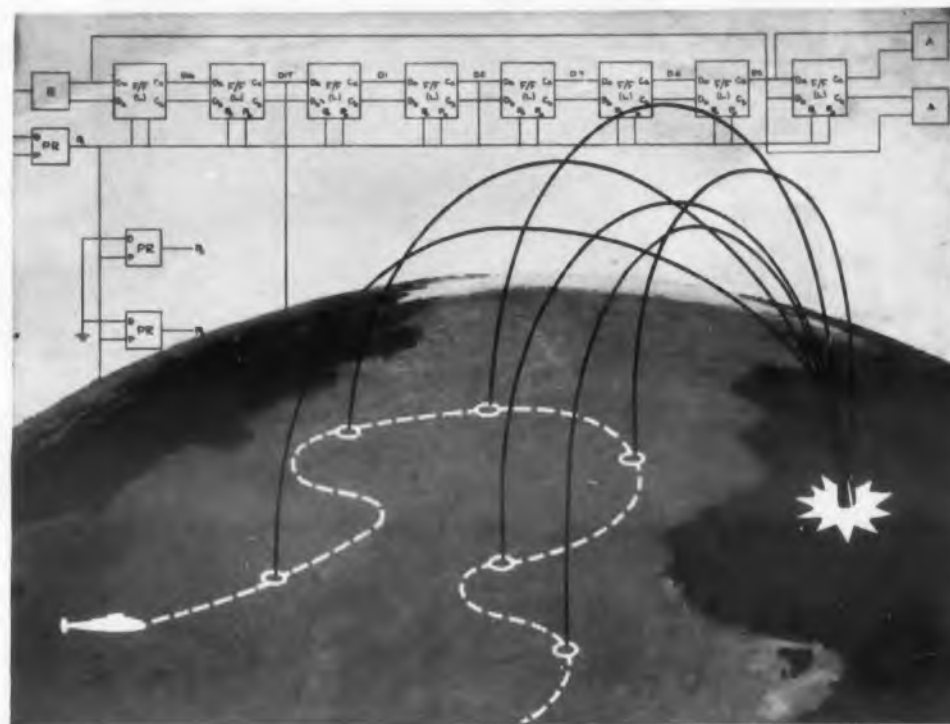
**9. Don't Guess.** Be accurate in your statement. Many men lose the confidence of their superiors and associates by habitual guessing when they don't know the answer to a direct question. It's important to answer questions concerning your responsibilities, but a wrong answer is worse than no answer.

**10. Work For Your Boss.** Sure you're working for society, the company, the department, your family and yourself. But primarily, you're working for and through your immediate superior. Some men never get it.

### Help Your Boss Help You

**11. Inform Your Boss.** One of the first things you owe your boss is to keep him informed of all significant developments. He is constantly asked to account for, defend, and explain your activities to the "higher-ups," as well as coordinate your activities into a larger plan.

(Continued on p. 78)



### High Priority Project Presents Unique Challenges to Computer Engineers

Design and development men at the Light Military Electronics Department of General Electric are now working on one of the most stimulating problems ever faced by computer engineers.

It is one of the functions of the fire control computer electronics to keep the Polaris missile—now under development—always battle-ready, with a freshly calculated trajectory toward its pre-programmed target. The computer electronics operate continuously, constantly plotting the submarine's changing position, taking into account all parameters of speed, direction, angular disturbance, compass references, etc., and cranking new trajectory equations into the memory circuits of Polaris' guidance computer electronics.

The Guidance Computer furnishes the commands which guide the missile to its pre-programmed target on the basis of inputs from the fire control computer, and its own inertial reference sensor.

Current assignments on Polaris Computer Design & Development are representative of the professionally advanced work always in progress at Light Military. Engineers chosen for these positions will find their own advancement can be rapid. Promotion is fully based on individual contributions, backed by performance appraisals.

For prompt consideration, write in confidence to Mr. W. Gilmore, Dept. 76SMF



LIGHT MILITARY ELECTRONICS DEPARTMENT

GENERAL  ELECTRIC

FRENCH ROAD, UTICA, NEW YORK

CIRCLE 901 ON CAREER INQUIRY FORM

Explore new areas  
at IBM in

# SOLID STATE

Solid state studies are now yielding important discoveries at IBM. Ranging from basic research to product development, solid state projects include a study of the behavior of molecules adhering to a surface in an ordered array. Another project involves the development of high-speed semiconductor switching devices. In magnetics, engineers and scientists are developing a ferrite core which will function normally at 500°C., and a one-million bit memory drum weighing only five pounds. Advanced work such as this requires creative engineers and scientists with inquiring minds and an enthusiasm for investigating the unknown. At IBM you will enjoy unusual professional freedom and the support of a wealth of systems know-how. Comprehensive education programs are available plus the assistance of specialists of many disciplines. Working independently or with a small team, your individual contributions are quickly recognized and rewarded. This is a unique opportunity for a career with a company that has an outstanding growth record.

#### CAREERS AVAILABLE IN THESE AND RELATED AREAS . . .

Circuit Design	Nuclear Physics
Component Engineering	Optics
Computer Design	Phosphors
Cryogenics	Physical Chemistry
Inertial Guidance	Physics
Logic	Radar Circuits
Magnetism	Reliability
Mathematics	Semiconductors
Metallurgy	Systems Engineering
Microwaves	Transistors

For details, write, outlining background and interests, to:  
Mr. R. E. Rodgers, Dept. 555F2  
IBM Corporation  
590 Madison Avenue, New York 22, N. Y.

Qualifications: B.S., M.S. or Ph.D. in Electrical or Mechanical Engineering, Physics, Mathematics or Physical Chemistry — and proven ability to assume a high degree of technical responsibility in your sphere of interest.

# IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

## DESIGNING YOUR FUTURE

**12. Think For Yourself.** Don't be too anxious to follow the boss's lead. This is where a manufacturing organization differs from an army. The program laid down by the department head, in general, is tentative rather than sacred. It's intended to serve only until a better program is proposed and approved. So tell your boss what you've done at reasonable intervals, and ask his approval of any well-considered deviations or new projects.

**13. Consider Other People.** In all transactions be careful to "deal-in" everyone who has a right to be in. In a large corporation it's easy to overlook the interests of some division or individual who isn't represented, or in mind, when a big step is taken. Very often the result is the step has to be retracted or considerable damage is done. The effect on morale may be serious. Even when it does no apparent harm, most people don't like to be left out when they have a stake in the matter. Before you do another man's job to get your own work done give him a fair chance to deliver, or have him agree to your taking over. If you must offend in this respect, realize that you are being offensive.

#### Promises, Promises, Promises

**14. Stick To Schedules.** Promises, schedules and estimates are necessary and important in an ordered business. Many fail to realize this, or habitually try to dodge the irksome responsibility for making commitments. Make promises based on your own estimates for your part of the job, together with estimates obtained from others for their parts. No matter how rushed the job, give a conservative estimate. A good manager will set schedules which he can meet by energetic efforts at a pace commensurate with the significance of the job.

**15. Go Through Channels.** When you're dissatisfied with the services of another section, make your complaint to the individual most directly responsible for the function involved. Complaints made to man's superiors engender strong resentments. Go over a person's head only when direct appeal fails. In many cases such complaints are made without giving the man a fair chance to correct the grievance, or even before he knows of any dissatisfaction. ■ ■



After completing, mail career form to *ELECTRONIC DESIGN*. Our Reader Service Department will forward copies to the companies you select below.

12

(Please print with pencil or type.)

Name \_\_\_\_\_ Telephone \_\_\_\_\_

Home Address \_\_\_\_\_ City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

Date of Birth \_\_\_\_\_ Place of Birth \_\_\_\_\_ Citizenship \_\_\_\_\_

**Educational History**

College	Dates	Degree	Major	Honors

Recent Special Training \_\_\_\_\_

**Employment History**

Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience \_\_\_\_\_

Professional Societies \_\_\_\_\_

Published Articles \_\_\_\_\_

Minimum Salary Requirements (Optional) \_\_\_\_\_

Use section below instead of Reader Service Card. Do not write personal data below this line.

Circle Career Inquiry numbers of companies that interest you

900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924  
 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

# Advancement Your Goal? New Form Speeds Action

We introduce with this issue a Career Inquiry Service form to help engineers advertise themselves. This new service will speed applicants to the jobs they seek. It is the first such service offered in the electronics field.

To present your qualifications immediately to the personnel managers of companies that interest you, simply fill in the attached standardized short resume.

Study the employment opportunity ads in this section, and circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

*ELECTRONIC DESIGN's* Reader Service Department will make photocopies of your standardized resume and send it to all companies you select . . . *the same day the resume is received.* (*ELECTRONIC DESIGN* will detach the circle number portion of the form, so that no company will know how many numbers you circled.)

The standardized resume will permit personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you directly. In the past much time has been lost through personal-manager requests for resumes from applicants who proved ineligible.

Readers who desire only company brochures should use the regular Reader Service card.

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## TRANSMITTERS RCA MOORESTOWN

Invites Inquiries From Transmitter Engineers Who Wish To Contribute To Advanced Missile Detection Programs.

Project BMEWS (Ballistic Missile Early Warning System) and other advanced missile detection systems have created unlimited project management or technical opportunities for engineers and managers to participate in the development and design of transmitters ranging from very low power to super-power radar transmitters delivering peak power in the multi-megawatt range.

The scope of original design effort ranges from the design of low power pulse and RF circuits to the design of super power hard-tube pulsers and RF cavity type amplifiers.

Experience in the development of design of communications, TV, radio and radar transmitters or their components is required. A knowledge of high power tube design and the application of klystron, magnetron, or grid-controlled tubes would be beneficial.

Salary to \$17,000.

Please address all inquiries to:

Mr. W. J. Henry, Box V-16F  
RCA, Moorestown, New Jersey  
(8 miles from Philadelphia)



**RADIO CORPORATION OF AMERICA**

Missile and Surface Radar Division

CIRCLE 903 ON CAREER INQUIRY FORM

## A Short Survey

We asked this question of the first four engineers we saw.

**DID YOU EVER THINK OF BECOMING AN EDITOR?**

Answer. **NO.**

This reply is not at all startling except for the fact that the four people asked are now *ELECTRONIC DESIGN* editors. Their answer was true right up to the time they read one of our help wanted ads. It never occurred to them there was a career in editing. There is.

If you have a BEE degree, a year or two of design engineering experience, a little disillusionment with the slow pace of engineering, but a flair for writing, why don't you inquire? Send resume to:

**James A. Lippke**  
Managing Editor  
**ELECTRONIC DESIGN**  
830 Third Avenue  
New York 22, N.Y.

CIRCLE 904 ON CAREER INQUIRY FORM

## CAREER OPPORTUNITIES BROCHURES



Motorola Inc.

Seven ways of "Selecting An Engineering Career with a Future" key the introduction to Motorola's 32-page, illustrated brochure. Diversification of electronic products is emphasized and the need for every type of electronic engineering skill. The general work activity in three plants—Chicago, Phoenix, and Riverside, Calif.—is described, with an itemized list of current work areas in each division.

Photographs and drawings supplement each section and present a comprehensive and pictorial view of life in each area of the country. Educational opportunities available to employees are presented including in-plant training and full tuition reimbursement for those completing university courses successfully. General employee benefits are listed. Featured in the back of the book is a ready-to-mail resume for engineers.

L. B. Wrenn, Motorola Inc., Dept. ED, 4501 Augusta Blvd., Chicago 51, Ill.

CIRCLE 870 ON READER-SERVICE CARD

**Bendix Aviation  
York Division**



"The Challenge of the Space Age" illustrates and briefly summarizes the product line, laboratory facilities, personnel, and supplementary services of the Engineering Dept. within the York Division. Activated in 1952 to develop and produce a VT proximity fuze, the company has now expanded its capabilities to embrace a broad field of activities, each discussed separately. Emphasis is on the personnel holding the executive positions of this department and the products of the company.

Bendix Aviation Corp., York Div., Dept. ED, York, Pa.

CIRCLE 871 ON READER-SERVICE CARD

ENGINEERS

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TO WORK IN...



...TO LIVE IN

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more than just one  
kind of climate.*

**PROFESSIONAL CLIMATE**—Advanced programs will challenge your technical creativity. You'll make major contributions in the fields of electronic defense, radar, communications and data processing systems. Because Sylvania is one of the nation's fastest growing electronics organizations, there are an unusual number of growth opportunities.

**LIVING CLIMATE**—You and your family will enjoy the healthful atmosphere and sunny climate of the San Francisco Peninsula. You'll find plentiful housing, excellent shops, fine schools and year round recreation.

**Openings in:**

System Studies / Circuit Design / Computers & Data Handling / Electronic Packaging / Development Engineering / Concept & Planning / Advanced ECM Circuitry / Equipment Development / Product Engineering / Tube Engineering / Tube Application Engineering / Mechanical Engineering / Tube Production Engineering / Theoretical Physics / Experimental Physics / Mathematics / Microwave Engineering / Engineering Writing / Tube Research Engineering

*You may communicate in confidence  
to Wayne L. Pearson*  
**MOUNTAIN VIEW OPERATIONS**

**SYLVANIA** ELECTRONIC SYSTEMS  
A DIVISION OF SYLVANIA ELECTRIC PRODUCTS INC.

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Mountain View, California

CIRCLE 905 ON CAREER INQUIRY FORM



# Engineers and scientists return to the midwest

where there's time and opportunity to enjoy yourself while climbing to the top in the field you like best.

The fish are biting in Minnesota. One of our fellows in the infra-red lab caught a 8 $\frac{3}{4}$ -pound walleye opening up on the Lake of the Woods. He had a minnow and June bug spinner. A little boy pulled in 10 crappies. Some of our fellows take their families camping nearly every weekend—up on the north shore of Lake Superior. Great country, this Minnesota. You would be here—with your wife and children—and you can be . . .

Research and Engineering Laboratories at the Mechanical Division of General Mills—in Minneapolis—need top level staff members for creative design, research and development work in the following fields:

- |  |   |
|--|---|
| Electronic Circuit Design                | • Advanced Digital Computer Circuit Development     |
| Radio-wave Development                   | • Advanced Pulse and Video Circuit Development      |
| Atmospheric Physics                      | • Advanced Inertial Navigational System Development |
| Digital Computer Logic                   | • Applied Mechanics                                 |
| Field Engineering                        | • Optical and Infra-Red Equipment Engineering       |
| Advanced Digital Computer Systems Design | • Research Physics                                  |

Positions available are for purely technical and technical-supervisory work—titles and salary provide equal opportunity for advancement in both. People enjoy their associates, liberal company benefits and non-routine projects, as evidenced by our extremely low turnover rate.

You have from three to five years experience in any of the above fields and like to tell you more about opportunities at General Mills. Send today for all the facts. We'll keep your inquiry in strict confidence.

**MECHANICAL DIVISION** 

G. F. Lambert, Manager  
Professional Employment  
Personnel Department

303 E. Hennepin, Minneapolis 13,  
Minnesota

CIRCLE 907 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • June 10, 1959

Link Aviation Inc.



"This is Link" is a 28-page, photographically illustrated booklet presenting top management, training equipment, systems, and plant facilities of Binghamton, New York and Palo Alto, California. Nature of the work of each department is given including fabrication, assembly, specialized, and administrative. Capabilities of the Company are listed and a summary of diverse facilities indicated. Statistics on personnel, finance, manufacturing plant facilities, quality control and engineering research and development are presented in chart form.

Link Aviation, Inc., Dept. ED, Binghamton, N.Y.

CIRCLE 872 ON READER-SERVICE CARD



**Metals & Controls  
Corporation**

A brief historical sketch of the corporation since 1916 introduces the reader to the scope of engineering, administrative, sales and supervisory positions available at Metals & Controls. Informal, on-the-job photos show the new engineer how he would fit into each of the three divisions: General Plate, manufacturing clad metals, Spencer, manufacturing Klixon® controls and protective devices, and Nuclear Inc., producer of nuclear products. Positions are described in each case. Engineering and production facilities are fully illustrated and described.

Expansion of the company in sales volume, employees and plant facilities is indicated graphically. Opportunities for personal development include a full engineering library, educational courses within the company and from nearby universities. Employee benefits are listed and a photo story of life in Attleboro completes "Your Opportunities At Metals & Controls Corporation."

Employment Director, Metals & Controls Corp., Dept. ED, Attleboro, Mass.

CIRCLE 873 ON READER-SERVICE CARD

Dear Virginia:

Ever since time began, children like you have asked the question: "Is there really a man on the moon?"

So far we haven't contacted anyone from there, but we are working on some ideas in COMMUNICATIONS, MISSILES and RADAR that may soon help get a man to the moon . . . and back.

Right now, though, we need a few experienced electronic engineers with your curiosity and imagination, Virginia, who can introduce important contributions in these fields. With them on our team, it won't be very long before we can truthfully say:

## Yes, Virginia, there is a man on the moon!

P.S. If your dad is an engineer who wants to help us prove our point, have him write to:  
R. D. EARY, Technical Staffing  
Director, The Magnavox Company,  
2131 Bueter Road, Fort Wayne, Ind.

# Magnavox

CIRCLE 907 ON CAREER INQUIRY FORM

CAREERS

## Genius is Rare

...and not what we expect... necessarily



Leonardo da Vinci

But we do have significant opportunities for the man with the mature, blessedly curious engineering mind. At Melpar—where advancing the state of the electronic art is our mission—there are engrossing projects which enable you to gain the highest possible levels of accomplishment. The capacity to reach deeply into provocative lines of inquiry is particularly valued, and the finest facilities, colleagues, and incentives constitute our design for working. Your own intellectual dimensions govern remuneration and assignments.

Opportunities are now available at Melpar in the following areas

Reconnaissance Systems Engineering  
Airborne Equipment  
Ground Data Handling Equipment  
Ground Support Equipment  
Simulation & Training Systems  
Communication & Navigation Systems

Detection & Identification Systems  
Antenna & Radiation Systems  
Chemistry Laboratory  
Applied Physics Laboratory  
Production Engineering  
Quality Control

INTERVIEWS ARRANGED IN YOUR LOCALE

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Professional  
Employment Supervisor



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CIRCLE 908 ON CAREER INQUIRY FORM

## CAREER OPPORTUNITIES

### Fairchild Astrionics Division



All phases of work in which engineers at Fairchild Astrionics engage is stressed: systems management, guidance and control, surveillance and data links, radar, training devices and simulators, ground support and checkout equipment, research and development. This 24-page, illustrated booklet also covers the engineering team, the reliability program, applications of human engineering and modern facilities of the plant.

Personnel Director, Fairchild Astrionics Div., Dept. ED, Straight Path Rd., Wyandanch, L.I., N.Y.

CIRCLE 874 ON READER-SERVICE CARD



### Burroughs Corporation

"Opportunity," a press kit offered by Burroughs Corporation, contains three pamphlets covering structure of the organization, employee benefits, and work of the Paoli Research Center, Pa.

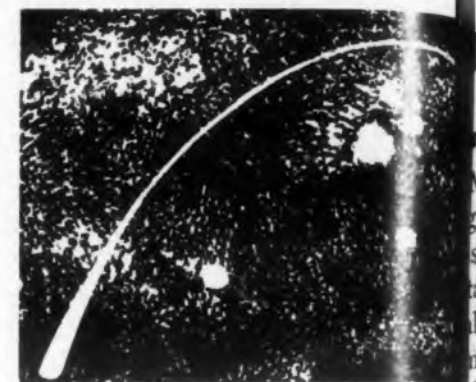
The present status and principal business of Burroughs is concisely presented in a brief historical sketch, followed by an illustrated discussion of each division and company within the Corporation. Number of employees, the product line, location, and financial data are included with each item.

Employee benefits are thoroughly treated in a second brochure, compiling all company-wide employee policies: insurance, retirement income plan, holidays, citizenship, educational aid, relocation arrangements.

Paoli Research Center is the focus of attention in the last pamphlet, which describes the nature of the work, types of projects, products, and technical training opportunities.

Burroughs Corp., Dept. ED, 6071 Second Ave., Detroit 32, Mich.

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Here is your chance to prove your ability doing *important* work on missile fuzing, beacons, guidance, packaging and related test equipment. We have key openings that offer you the opportunity to move ahead rapidly in your profession. At Bendix York, you benefit from the advantages of a small company atmosphere in a growing division of one of the nation's largest engineering and manufacturing corporations. Also, you'll enjoy the "good life" in our beautiful suburban community. Good salaries, all employee benefits.

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CIRCLE 909 ON CAREER INQUIRY FORM



## NEW LITERATURE

### Radioactivity Measuring Instruments 56

More than 125 products for detecting, counting, and recording radioactivity are described in this 76-page, two-color catalog. Sections in the catalog are devoted to nuclear training devices, scalars, ratemeters, gamma-ray spectrometer systems, Geiger and scintillation detectors, portable alpha, beta, gamma, and neutron survey meters, radioactive sources and chemicals, and nuclear accessories. The new catalog describes more than 100 new products and groups of products. Nuclear-Chicago Corp., 229 W. Erie St., Chicago 10, Ill.

### Generator Data Sheet 57

This data sheet lists and gives full technical details on the complete line of generators. Included are ac and dc tachometers, rate tachometer with squirrel cage rotor, damping and dc motor generators. John Oster Mfg. Co., Avionic Div., 1000 Main St., Racine, Wis.

### Simplified Logical Design 58

This 11-page paper describes the advantages of using Sheffer Stroke or Nor gates in computer design. All logic and static memory for a digital system can be built from gates of either type, replacing the networks of And gates, Or gates, flip-flops, etc. found in most computers. The paper also describes Sheffer Stroke and Nor logic and presents a simple means of transforming equations from And-Or form to Stroke form. Typical designs are discussed. Abacus, Inc., 3040 Overland Ave., Los Angeles 34, Calif.

### Impulse Counting Devices 59

This condensed catalog, illustrates and describes all types of Sodeco impulse counting devices. Included are short type and standard size manual and electric reset counters, mono-decade counters, hours, minutes and seconds indicators, predetermined counters including heavy duty types, ac counters and impulse transmitters and amplifiers. Landis & Gyr., Inc., 45 West 45th St., New York 36, N. Y.

### Insulating Tapes, Fabrics 60

Five new bulletins describe CDF woven-glass-epoxy insulating tapes and fabrics. The two-page, two-color bulletins cover properties and applications of glass tapes, fabric sheets, wrappers and cut pieces, both silicone-varnished and rubberized. Each bulletin includes, in tabular form, complete information on both physical and electrical properties. Continental-Diamond Fibre Corp., Newark, Del.



*The industry's  
most complete  
DCU line-*

## You can count on CMC for all your DCU needs

CMC now offers original equipment makers no less than 28 standard DCU models, including the new transistorized Model 100T. That's the most complete line available from one source. In most cases, you're supplied from stock in a matter of days.

### *Price Important?*

CMC gives you a double price break. First, you pay less for CMC equipment to start with. Second, you get a special OEM discount on quantity orders. Prices on request.

### *Quality a Must*

There's no excuse for making an inferior DCU. We don't. Your local CMC engineering representative has the facts to prove it.

### *Applications Almost Endless*

CMC DCU's fill almost every conceivable circuit requirement for digital data handling systems, counters, scalars, frequency and time interval meters and preset counter-controllers. CMC's units are interchangeable with most existing counting equipment. Including our own.

### *Ready for Solid State?*

CMC is now in production on transistorized DCU's. These compact units incorporate decade readout and coded output matrix. No separate cards and plugs required. Available with vertical number panel or Nixie readout.

### *Concise Catalog Available*



Our new DCU catalog gives you prices and key specs at a glance. If you don't have it, write, wire or call and we will mail it to you free. Please address Dept. 196.

*CMC can supply you with better DCU's at lower prices, plus off the shelf delivery. It will pay you to check with us first.*

## Computer Measurements Company

*A Division of Pacific Industries, Inc.*

5528 Vineland Avenue, North Hollywood, Calif.

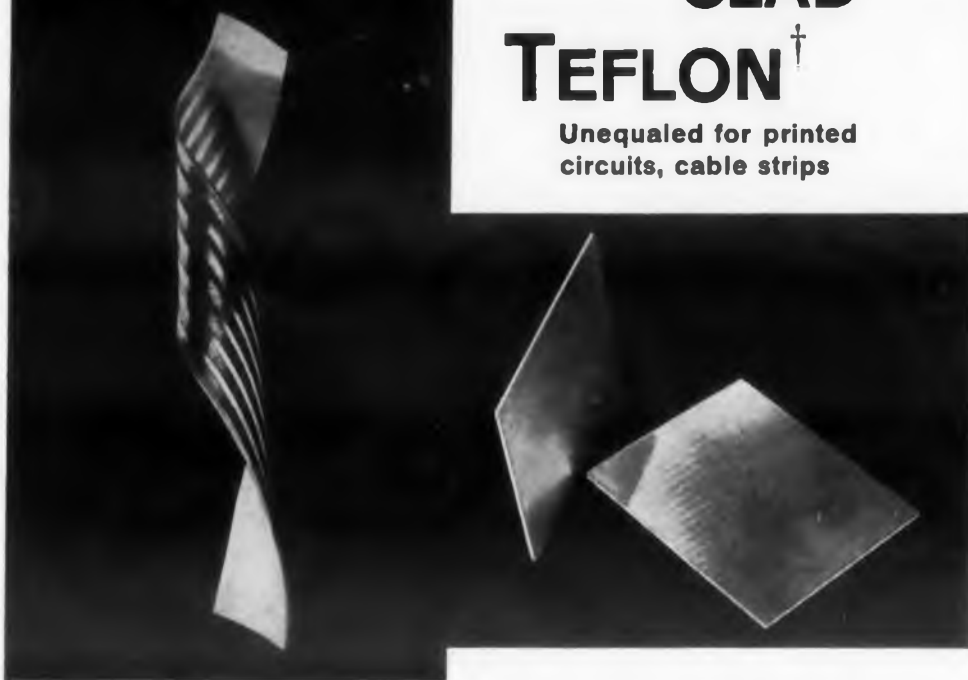
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CIRCLE 61 ON READER-SERVICE CARD

# CHEMELEC\*

## COPPER CLAD TEFLON†

Unequaled for printed  
circuits, cable strips



You can't go wrong with Chemelec Copper Clad TEFLON for printed circuits and cable strips. Here's why: TEFLON's dielectric constant is exceptionally low and uniform, water absorption is zero, no delamination is possible. Unlike glass, ceramic, and other plastics, TEFLON will not break under severe shock and vibration, thus assuring leak-proof operation. TEFLON is chemically inert and unaffected by 500° F solder. Its bond strength is greater than 7 lb/in. Copper Clad TEFLON Sheet (upper right) is available 18" wide, 36" long, and in TEFLON thickness to  $\frac{3}{16}$ " with 1 or 2 oz. copper on both sides. Copper Clad Tape (upper left) comes 12" wide, 36" or 150" long, up to .060" thick, with 1, 2, or 3 oz. copper on one or both sides. Heavier copper is available on request.



\*Registered Trademark  
†DuPont Trademark

### TEFLON Spaghetti Tubing now comes in three grades

Realize tremendous cost savings with TEFLON Spaghetti. Eliminate purchase of excess weight tubing by specifying exactly what you want from a choice of three grades and ten colors. In all sizes, Chemelec Spaghetti Tubing retains the superb features of TEFLON; in addition, it is flexible and free from leaks due to cracks or perforations. Available grades include *thin wall* (wire gauge from 30 to 0, wall thickness from .009 to .015), *standard wall* (wire gauge from 24 to 0, wall thickness from .012 to .020), *heavy wall* (wire gauge from 22 to 5, wall thickness from .016 to .032). Standard RMA colors.

For further information, write for Catalog EC-358.  
FLUOROCARBON PRODUCTS, INC.,  
division of United States Gasket Co., Camden 1, New Jersey.

*Fluorocarbon Products Inc.*

CIRCLE 62 ON READER-SERVICE CARD

## NEW LITERATURE

### Resistance Bridge Potentiometer 63

This one-page data sheet describes a portable battery-powered instrument to calibrate and measure the dc output of resistance bridge transducers or strain gages. Complete technical data is covered. Datran Electronics, 1836 Rosecrans Ave., Manhattan Beach, Calif.

### Plating 64

Information on chromium plating of small parts is provided in this series of information bulletins. An illustrated bulletin on the firm's services and facilities is included. Whyco Chromium Co., Inc., U.S. Route 8, Thomaston, Conn.

### Instruments and Components 65

This 4-page, 2-color catalog presents the firm's line of conical helix antennas, crystal video detector mounts, optimum linear microwave horns, pulse generators, transistor curve tracers, video amplifiers and electronic batteries. American Electronic Laboratories, Inc., 121 N. 7th St., Philadelphia 6, Pa.

### Power Supplies

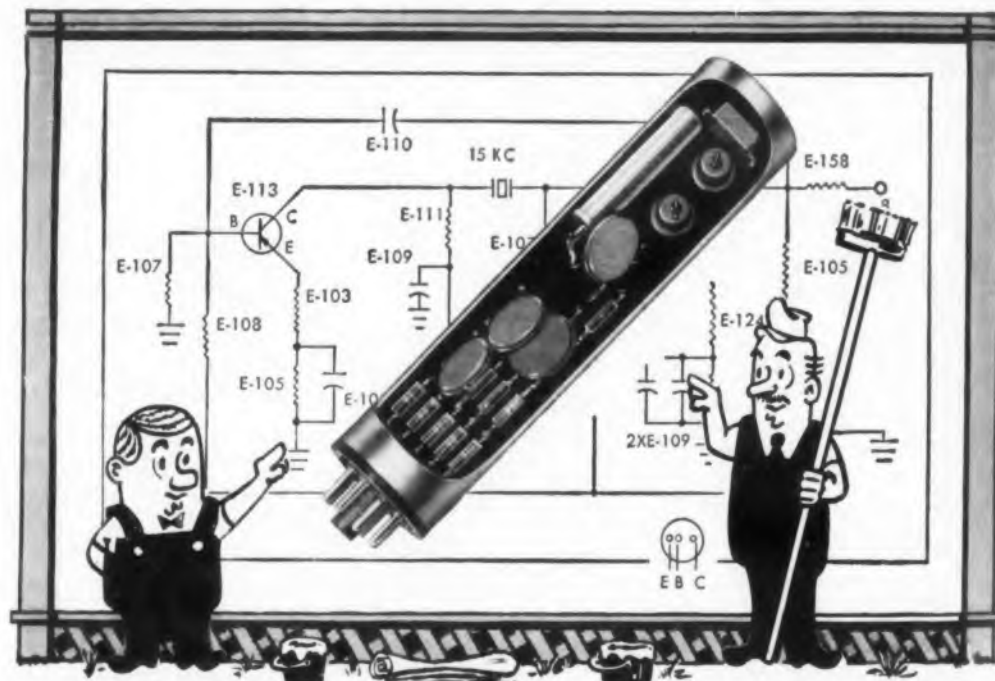
Bulletin PS-2009 describes a series of all solid-state regulated dc power supplies primarily intended for built-in applications. Nine fully variable regulated solid state dc power supplies are covered in Bulletin PS-2010. Deltron Inc., 2005 N. Leithgow St., Philadelphia 33, Pa.

### Voltage Divider

Bulletin C-25, 4 pages, provides complete data in graph and chart form on the performance of a transformer voltage divider. Called the Dekatran, Model DT-72, the unit is a seven decade, rack mount, transformer-type ac voltage divider with an accuracy of better than ppm. Electro-Measurements, Inc., 753 S.W. Macadam, Portland 19, Ore.

### Power Components

This catalog on dc power supplies, line voltage regulators, airborne radio power supplies and static inverters and converters is 12 pages. Labeled NE 59A, the catalog contains pictorial material and provides complete technical data on the units. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.



"They're sure compact, K.C." ..... "You bet, M.C., only 1 1/4 by 6 1/2 inches!"

## NEW REEVES-HOFFMAN TRANSISTOR OSCILLATORS

WRITE FOR  
BULLETIN RH-OS.



New Reeves-Hoffman oscillators are transistorized for compactness and crystal controlled for unerring accuracy. Each oscillator is produced and tested with exacting care by skilled craftsmen using the most modern equipment and facilities available. Reeves-Hoffman will manufacture these units in volume to your specifications.

DIVISION OF DYNAMICS CORPORATION OF AMERICA  
CARLISLE, PENNSYLVANIA

CIRCLE 69 ON READER-SERVICE CARD

CIRCLE 77 ON READER-SERVICE CARD



# Anaconda EPOXY Magnet Wire for outstanding compatibility at high temperature



Epoxy's unique combination of dependable characteristics makes it suited to use in such equipment as totally enclosed motors, above; hermetically sealed relays, encapsulated dry-type transformers, below.



Anaconda Epoxy Magnet Wire is particularly well suited to use in oil-filled transformers. Epoxy's excellent behavior in transformer oils is but one of its many outstanding chemical characteristics.



The compatibility, chemical stability, and thermal stability, of Anaconda Epoxy have been proved by some three years of actual field experience, plus seven years of research and development, in both military and civilian applications.

Anaconda Epoxy (130°C AIEE Class B) magnet wire is compatible with most well known insulations. It offers excellent resistance to moisture, transformer oils, acids, and alkalis. Tests of Anaconda Epoxy magnet wire with all impregnating varnishes tried to date have resulted in chemically compatible systems—with no thermal deterioration of the Epoxy film.

Epoxy's unique combination of dependable characteristics makes it suited to a wide variety of difficult applications. Its outstanding dielectric strength, its heat-shock, adherence, and flexibility properties make it an "all around" magnet wire for use up to 130°C in either open or closed systems.

**ROUND, SQUARE AND RECTANGULAR.** Anaconda Epoxy magnet wire is available in the full range of round, square and rectangular sizes. It can also be furnished in combination with glass servings.

If you have a difficult Class B application or a troublesome job at lower temperature that might benefit from some other characteristic of Epoxy, see the Man from Anaconda. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

64346

ASK THE MAN FROM **ANACONDA**® about EPOXY MAGNET WIRE

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

**ATHERM** 155°C (AIEE Class F)  
high temperature resistance



**NYFORM** 105°C (AIEE Class A)  
superior windability



**VITROTEX** 130°C (AIEE Class B)  
glass-insulated, high heat resistance

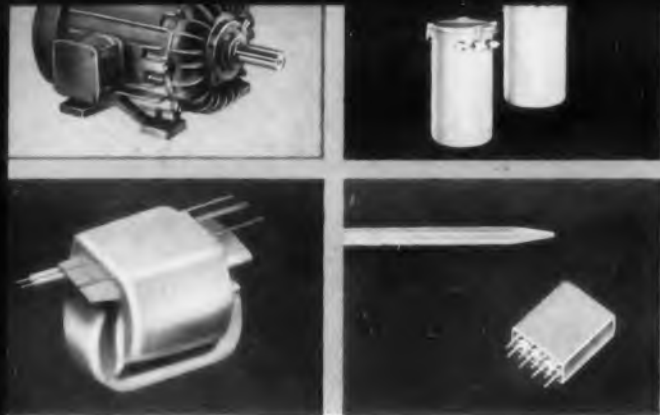


**FORMVAR** 105°C (AIEE Class A)  
proven dependability



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





# MAGNET WIRE DATA SHEET

from  
Anaconda Wire & Cable Co.

## IMPORTANT FACTS FOR YOUR WORK...

### ... about Anaconda Epoxy 130°C (AIEE Class B) Magnet Wire

Anaconda Epoxy film-coated magnet wire is suitable for use in 130°C (Class B) hottest spot operation. It meets MIL-W-19583 requirements. Epoxy is compatible with other insulations and performs excellently in oils. It offers unusual resistance to moisture and has a higher resistance to heat shock than other Class B wires. This unique combination of properties makes it applicable to a wide variety of difficult applications.

#### SUGGESTED APPLICATIONS

Oil filled transformers • Air conditioning systems where moisture is a problem • Refrigeration machines for operation with fluorinated hydrocarbon refrigerants • Totally enclosed motors, transformers, alternators • Encapsulated windings of virtually any type.

#### MECHANICAL PROPERTIES

Epoxy offers outstanding adherence and flexibility. It meets the exacting demands of abrasion resistance called for in high-speed winding machines.

#### ELECTRICAL PROPERTIES

Epoxy magnet wires exhibit high dielectric strength—a minimum of 2000 volts per mil under dry test conditions. The following are dielectric constant and dissipation factor measurements at 25°C and 50% RH:

Frequency Cycles per Second	Dissipation Factor %	Dielectric Constant
60	0.37	4.63
1,000	0.48	4.60
10,000	0.96	4.55
100,000	1.95	4.45

#### CHEMICAL PROPERTIES

Epoxy offers outstanding chemical characteristics. The Epoxy resins are characterized by their resistance to attack by compounds they may come into contact with when used in electrical apparatus. Epoxy shows exceptional resistance to 5% potassium hydroxide, 5% sulphuric acid, VM&P naphtha, ethyl alcohol, xylol, toluol. Epoxy wire has given excellent results in test programs designed to determine the effects of fluorinated hydrocarbon refrigerants. Scrape abrasion resistance is high under Freon. Freon 22 does not blister and attack the coating. Epoxy does not hydrolize in closed systems.

Epoxy is outstanding in its behavior in transformer oils. It will also withstand the action of lubricating oils at high tem-

ED-59

**ANACONDA WIRE & CABLE COMPANY**  
25 BROADWAY, NEW YORK 4, NEW YORK

Please send me a copy of your Epoxy Magnet Wire Booklet.

NAME & TITLE.....

COMPANY.....

ADDRESS.....

CITY..... ZONE..... STATE.....

perature. In fact, such oils sealed in glass tubes with Epoxy wire and heated to 150°C do not damage the insulation, even when the oils have been contaminated by long use.

#### THERMAL PROPERTIES

Epoxy is a 130°C (Class B) magnet wire. This rating is based on AIEE test procedures. The wire is also intended for use at lower temperatures where the choice may be made to take advantage of some other characteristic. It also can be used at higher temperatures for shorter life or in some special applications. Please refer to the thermal stability chart.

**THERMOPLASTIC FLOW.** Epoxy magnet wire meets the 200°C minimum requirement of Specification MIL-W-19583 for 130°C systems.

**RETENTION OF FLEXIBILITY.** Epoxy magnet wire can be heated for 168 hours at 125°C and then wound on its own diameter without cracking.

**HEAT SHOCK.** Epoxy magnet wire offers outstanding heat shock characteristics, as indicated by the following table (Wires are stretched or not stretched, then wound on mandrels having X times the diameter of the wire and placed in an oven at 155°C for one hour):

Prestretch %	1X	3X	5X	10X
0	Pass	Pass	Pass	Pass
10	Fail	Pass	Pass	Pass
15	Fail	Pass	Pass	Pass
20	Fail	Pass	Pass	Pass
25	Fail	Fail	Pass	Pass

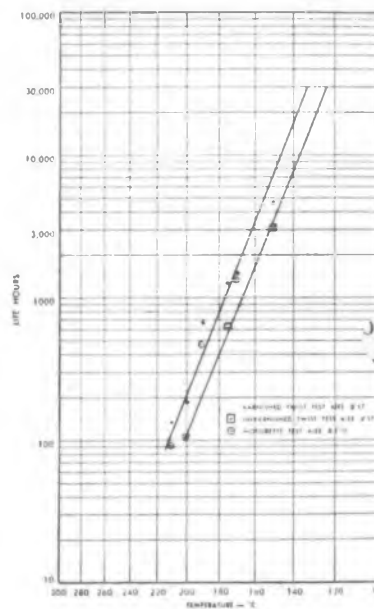
#### MOISTURE RESISTANCE

Epoxy magnet wire can be used when sealed in electrical apparatus where water is contained in other materials. Small coils in water at room temperature for 18,000 hours (2.1 years) maintained a very high insulation resistance between the copper and water. Epoxy wires sealed in glass tubes with a small amount of water can be heated for a month at 150°C without destruction of the enamel coating.

**All-Epoxy insulation systems.** Materials are now available to make possible complete Epoxy systems that offer superior thermal and chemical stability and maximum environmental protection. Detailed information available on request.

SEE THE MAN FROM

**ANACONDA**  
FOR MAGNET WIRE



Thermal stability, Epoxy round magnet wire

TEAR OUT FOR YOUR FILE

Stranded  
Chart Z  
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tions for v  
The char  
smaller ga  
the cross-  
Alpha Wi  
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ized paper  
in ±10% c  
scribed in  
Type 114P  
available in  
±5% and a  
2221A, 2  
North Ada

CIRCLE 77 ON



## Stranded Wire 70

Chart ZK-4, one page, facilitates determining the available stranding combinations for various sizes of conductor wire. The chart also shows the number of smaller gage wire necessary to make up the cross-sectional area of a conductor. Alpha Wire Corp., 200 Varick St., New York 14, N.Y.

## Electronic Tubes 71

This 12-page condensed catalog contains both pictures and technical specifications of: traveling wave tubes; cw amplifier klystrons; pulsed amplifier klystrons; reflex oscillator klystrons; and multiplier klystrons. Sperry Gyroscope Co., Great Neck, N.Y.

## Capacitors 72

Type 143P drawn metal case metallized paper capacitors are now available in  $\pm 10\%$  capacitance tolerance and described in Bulletin No. 2220A, 2 pages. Type 114P metallized capacitors are now available in tolerances of both  $\pm 10\%$  and  $\pm 5\%$  and are described in Bulletin No. 2221A, 2 pages. Sprague Electric Co., North Adams, Mass.

## Servo Motor 73

Model RBC-2407 servo motor is described in bulletin MO 3.13. The two-phase motor is available as a basic servo unit, or in four different gear types to meet various application requirements. National Pneumatic Co., Inc., Holtzer-Cabot Motor Div., 125 Amory St., Boston, Mass.

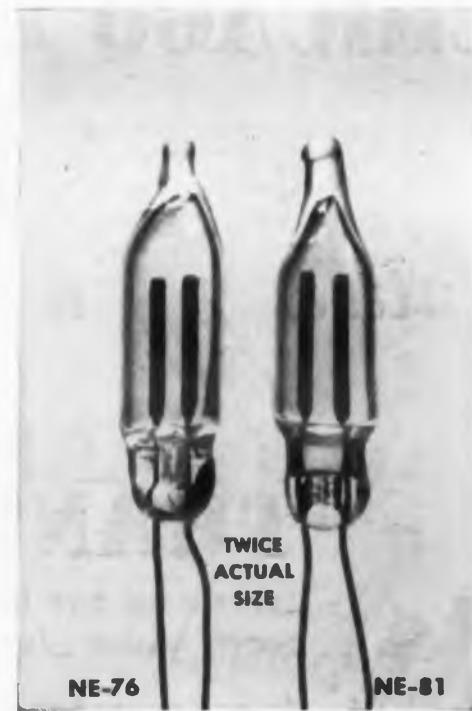
## Machinable Ceramic 74

Bulletin 118, one-page, describes grade HT-2-M, readily machinable, high-temperature, heat-shock resistant ceramic. The material can be used up to 2200 F. Duramic Products, Inc., 262-72 Mott St., New York 12, N.Y.

## Rotary Components 75

Standard types of servo motors, motor generators, synchros and resolvers are described in this 16-page brochure. Detailed electrical parameters are tabulated for 190 different rotary components and brief descriptions of the types available, their operation, and their application are given. Photographs and outline drawings are also included. Kearfott Co., Inc., 1500 Main Ave., Clifton, N.J.

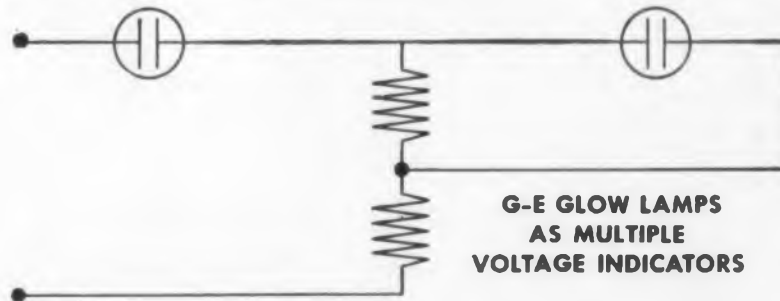
# Here are two G-E Glow Lamps that have critical starting voltages



*Two components of predetermined and stable characteristics for your circuit designs*

**G-E NE-76**—Pre-aged, stabilized glow lamp has closest starting voltage tolerances of any General Electric Glow Lamp ( $\pm 4$ -volts d-c). Same tolerance is held on operating voltage. G-E NE-76 will perform well in: Switching circuits, logic matrices, gating circuits and similar applications. The leads are plated for easy soldering and the lamps are treated by the G-E Dri-film process for high leakage resistance in humid areas. A *red dot* near the anode lead indicates polarity.

**G-E NE-81**—Similar to the G-E NE-76—has slightly wider starting voltage tolerances ( $\pm 8$ -volts d-c). Has plated leads to permit easy soldering and the G-E Dri-film process insures maximum leakage resistance under high humidity conditions. The same mild radioactive additive used in the NE-76 is used here to reduce dark effect. A *white dot* near the anode lead indicates this glow lamp's polarity.



### DIRECT CURRENT CHARACTERISTICS

	NE-76	NE-81
Starting Volts . . . . .	72 $\pm$ 4-volts d-c	72 $\pm$ 8-volts d-c
Operating Volts . . . . .	57 $\pm$ 4-volts d-c	50 to 60-volts d-c
Extinction Volts (in series with .25 megohm or more) . . . . .	50-volts d-c	50-volts d-c
Design Current . . . . .	0.4 m.a. d-c	0.3 m.a. d-c
Leakage Resistance (at high humidity) . . . . .	100 megohms	100 megohms
NE-76 Life To stay within above specifications for at least 1,000 hours when operated at 0.4 m.a.		
NE-81 Life Change in Starting and Operating Voltage At .3 m.a. . . . .		+ 5-volts in 6,000 hours

For further information write for free booklet entitled "Glow Lamps as Circuit Control Components". General Electric Co., Miniature Lamp Dept. M-901, Nela Park, Cleveland 12, Ohio.

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

## From 350 to 450 CPS Frequency Range — SPECIFY CML NARROW BAND GENERATORS

This outstanding CML Narrow Band Generator, Model 1422-E, will meet the following specifications:

1. Regulated Voltage Output: Nominal 120 VAC. Variable from 90 to 130 volts.
2. Regulation: less than 1% change — no load to full load in better than 0.5 second.
3. Total Harmonic Distortion: Less than 2% at full load.
4. Noise and Hum Level: Better than 45 db below max. output.
5. Standard Frequency Ranges: Variable: 350-450 CPS. Fixed: 300 to 2000 CPS. Other ranges upon request.
6. Frequency Stability: 0.25% after 30 minute warmup. Fixed frequency models to .001%.



MODEL 1422-E

**WHERE DEPENDABILITY IS OF PRIME CONCERN**

**OUTPUT—250 VA  
SIZE—11" h x 22" w  
x 17" d  
SHIP. WT.—150 lbs.  
PRICE—Cabinet Model \$900.00**

**Rack Mounted Models; Standard 19" panels with WE notching.**

Write for Complete Catalog With All Details and Specifications



**COMMUNICATION MEASUREMENTS LABORATORY, INC.**  
350 LELAND AVENUE, PLAINFIELD, NEW JERSEY

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CIRCLE 77 ON READER-SERVICE CARD

# CHICAGO

*ultra* *miniature*

## TRANSISTOR TRANSFORMERS

**Stocked for immediate delivery from your electronic parts distributor**

**Encapsulated — designed and built in accordance with MIL-T-27A**

Here are 27 hermetically sealed units designed especially for use in transistor circuits. Remarkably efficient for their size, these transformers have excellent frequency response with low harmonic distortion.

Leads are embedded in plastic to withstand a 12 pound pull and are individually spaced for printed circuit board insertion. The Chicago UME Series transformers measure .312" x .400" x .420" and weigh approximately 1/10 ounce. Detailed specifications and performance curves are given in Chicago Bulletin CT-46. Write for your free copy.

CHICAGO Part No.	Application	Pri. Impedance In Ohms	Sec. Impedance in Ohms
UME-12	output	500/600	50/60
UME-13	output	1000/1200	50/60
UME-14	output	600	3.2
UME-15	output	1200	3.2
UME-16	output	10,000	3.2
UME-18	choke	3 hy @ 2 Macd	—
UME-19	output or driver	10,000 CT/12,500 CT	500 CT/600 CT
UME-20	driver	10,000/12,500	1200 CT/1500 CT
UME-21	driver	10,000/12,500	2000 CT/2500 CT
UME-22	single or PP output	150 CT/200 CT	12/16
UME-23	single or PP output	300 CT/400 CT	12/16
UME-24	single or PP output	600 CT/800 CT	12/16
UME-25	single or PP output	800 CT/1070 CT	12/16
UME-26	single or PP output	1000 CT/1330 CT	12/16
UME-27	single or PP output	1500 CT/2000 CT	12/16
UME-28	single or PP output	7500 CT/10,000 CT	12/16
UME-29	output	300 CT	600
UME-30	output	500 CT	600
UME-31	output	900 CT	600
UME-32	output	1500 CT	600
UME-33	interstage	20,000 CT/30,000 CT	800 CT/1200 CT
UME-34	input	200,000 CT	1000 CT
UME-35	interstage	10,000 CT/12,000 CT	1500 CT/1800 CT
UME-36	choke	6 hy @ 2 Macd	—
UME-37	choke	1 hy @ 2 Macd	—
UME-38	choke	12 hy @ 0 dc	—
UME-39	choke	20 hy @ 0 dc	—



# RIQAP

Since 1955, Chicago Standard Transformer Corporation has been operating continuously under RIQAP, the U.S. Army Signal Corps' Reduced Inspection Quality Assurance Plan. When you specify Chicago Standard transformers, delivery time is reduced and incoming inspection is at a minimum. You are assured of the highest quality units for military application.

**CHICAGO STANDARD TRANSFORMER CORPORATION**  
 3518 WEST ADDISON STREET CHICAGO 18, ILLINOIS  
 CIRCLE 78 ON READER-SERVICE CARD

### Klystron Power Supply 79

This two-page bulletin describes the type 812 universal klystron power supply, giving complete performance specifications, including electrical, modulation and mechanical. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y.

### Hysteresis Synchronous Motors 80

Catalog 101, Series A, 4 pages, describes hysteresis synchronous motors for tape recorders and precision turntables, instrument controls and data process control. Pictures, mechanical data and electrical data are included. Beau Electronics Inc., 1060 Wolcott Rd., Waterbury, Conn.

### Standoff Insulators 81

JAN ceramic standoff insulators are described in this catalog which lists physical specifications and prices on 14 basic styles. Over 75 different standoffs with the JAN type designation are contained in Form 42-18IR3. Centralab, A Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

### Plastics

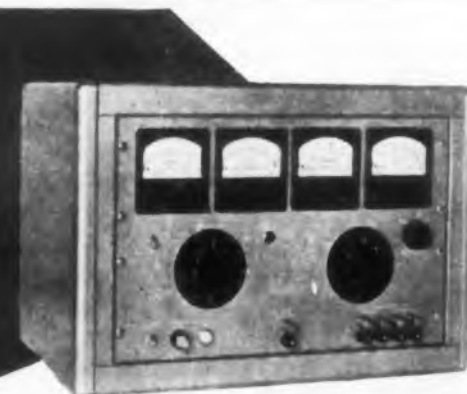
This literature describes an electrically conductive polyvinyl chloride compound. Described as a "semi-conductor," the material has an electrical volume resistivity of 11 ohms per cubic centimeter. Designated Abbey 100, the material has suggested applications in: replacing copper braid in communications wire, semi-conductive electrical tape shielding on microphone cable, and shielded wire for use on coaxial and high voltage cables. Abbey Plastics Corp., Dept. C, Hudson, Mass.

### Transistor Comparison Chart

This transistor characteristic comparison chart simplifies the selection procedure for equipment applications. The dynamic collector resistance and common emitter current gain are used as common denominators. The chart also indicates the type (pnp or npn), relative power handling capacity, material (silicon or germanium), and the recommended application. Copies of the 17 x 22 in. chart may be had by sending \$1.00 to American Machine & Foundry Co., Alexandria Div., Dept. ED, 1025 North Royal St., Alexandria, Va.

## \* Dynamic Semiconductor Rectifier Analyzer

by  
**WALLSON**



WALLSON MODEL 138A

**\*Dynamic tests performed under simulated 60 cycle operating conditions!**

A completely self-contained Dynamic Rectifier Test Set with Forward Current adjustable from 0 to 5 amperes independently of Reverse Voltage, which is adjustable between 0 and 1,000 volts. This analyzer measures Forward Voltage Drop and Reverse Current of any type of semiconductor rectifier in accordance with the proposed JEDEC specifications.

#### Other WALLSON Products

- Automated High Vacuum Exhaust Equipment
- TWT Power Supplies
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Write for Technical Bulletin 104 today!

## WALLSON ASSOCIATES, INC.

35 East Runyon Street — Newark 8, N. J. — TALbot 4-2600

CIRCLE 83 ON READER-SERVICE CARD



**Instruments****84**

Catalog C-59, 16 pages, covers vacuum meters, four types of power supplies, precision dc potentiometric voltmeters, and a precision dc-ac differential voltmeter. Pictorial material, electrical specifications and descriptive material is included. John Fluke Mfg. Co., Inc., 1111 W. Nickerson St., Seattle 99, Wash.

**Capacitors****85**

This 46-page general capacitor catalog covers the firm's entire line of tubular, ceramic disc and subminiature electrolytic capacitors. Technical data and other specifications are included, along with pictures. Good-All, 112 West 1st St., Ogallala, Neb.

**Instruments Catalog****86**

This revised catalog describes digital voltmeters, digital ohmmeters, digital ratimeters, input and output modules, X-Y recorders and DC amplifiers now available. The 16-page, M190, catalog gives complete specifications and covers features and advantages. Electro Instruments, Inc., 3540 Aero Court San Diego 11, Calif.

**Cables****87**

Flat cables and other special types of cables are described in this 12-page brochure. Pictures and other technical specifications on the products are provided. Spectra-Strip & Cable Corp., P.O. Box 415, Garden Grove, Calif.

**Displacement Gyro****88**

Design characteristics and installation drawings of a ruggedized displacement gyro are described in this four-page brochure. The 1080 series provides pictures of the unit's parts and summarizes its erection system and vibration endurance. Lear Inc., Grand Rapids Div., 110 Ionia Ave., N.W., Grand Rapids 2, Mich.

**Reliability Data****89**

This 2-page bulletin provides data on the Variables Sampler which offers a method of fulfilling the requirements of the acceptance sampling procedures specified in MIL-STD-414. The inspection tool reduces inspection time by up to 60%. American Research and Manufacturing Corp., 920 Halpine Ave., Rockville, Md.

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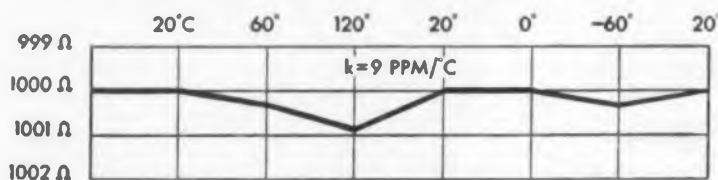
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**NEW LITERATURE****Drawing Reproductions 93**

Techniques for getting sharp, clean and fast reproductions of engineering drawings are described in Bulletin 103. Hampton Processes, Inc., Newton, N.J.

**Power Supplies 94**

In 15 pages this catalog, B591, describes a complete line of voltage and current regulated power supplies, including transistorized, magnetic and vacuum tube types. Pictorial material is included and some of the data is given in tabular form. Kepco Labs, Inc., 131-38 Sanford Ave., Flushing 55, N.Y.

**Impulse Counters 95**

Panel-mounted predetermined electric impulse counters are illustrated and described in this four-page bulletin. Included are: a description of the operating principle, construction details, a description of the presetting mechanism and its operation, illustrations of the use of the predetermining contact, as well as complete dimensional and electrical data. Landis & Gyr, Inc., 45 W. 45th St., New York 36, N.Y.

**Digital Recording Systems 96**

Bulletin 311, 4 pages, describes modular elements designed to be used to build up complete operating digital systems of varying complexity. Included are pictures and block diagrams. The building block elements covered include encoders, a programmer, and a translator. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

**Inertial Guidance 97**

A 3-axis drive servo test table, a pendulum unit, an integrating gyro and microsynchron units are described in this 4-page brochure. Electrical and mechanical information is given. Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, N.Y.

**Microwave Components 98**

A newly developed varactor and some of its many uses are covered in this 14-page brochure. The data is of primary interest to design engineers working in the 30 mc region and higher in frequency. Pictures, graphs, explanatory information, and technical specifications are included. Microwave Associates, Inc., Burlington, Mass.

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For full technical data on this or any other Machlett tubes, write:  
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### Choke Data Sheet 110

This data sheet on rf chokes, with sub-miniature characteristics, contains a detailed description of the electrical parameters for the complete line of Wee-Ductors. They are available in a range of inductances from 0.10 to 1000  $\mu$ h. The sheet lists parameters for 50 units. Essex Electronics, 550 Springfield Ave., Berkeley Heights, N.J.

### Transistorized Chopper 111

Data on the model 60 solid state electronic chopper is included in this 4-page bulletin. Mechanical, technical and operation information is included, along with applications and block diagrams. Solid State Electronics Co., 8158 Orion Ave., Van Nuys, Calif.

### Power Supplies 112

A line of compact, high voltage power supplies designed for such applications as cathode ray oscilloscopes, radar displays, image intensifiers, dielectric insulation testers, electron optical devices, storage tubes and nuclear applications is described in this bulletin. Del Electronics Corp., 521 Homestead Ave., Mount Vernon, N.Y.

### Magnetic Servo Amplifiers 113

This eight page color brochure entitled "High Power Transistor Magnetic Servo Amplifiers" is illustrated with photographs, diagrams and charts. The booklet, designated No. S-961, describes the manufacturer's amplifiers built for industrial and military use. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N.Y.

### Coatings And Impregnants 114

Bulletin 581 describes electrically conductive compounds for electronic and electrical manufactured products. Uses of colloidal graphite dispersed in resins, solvents, oils, or water are also covered. Applications include: printed circuits, resistors, tubes, and cable. Graphite Products Corp., Brookfield, Ohio.

### Microwave Catalog 115

In this short form catalog waveguide components, coaxial components, instrumentation and high-power pulse modulators are described and listed separately. Sufficient technical data and illustrations are included for the microwave engineer's basic information. FXR, Inc., 26-12 Borough Pl., Woodside 77, N.Y.

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1N561	1000	500	250	5	1.3v at 250ma	10	300
1N588	1500	25	10		10v at 10ma	5	100
1N589	1500	50	25		5v at 50ma	5	100

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# Nonlinear and Parametric Phenomena

**Part 20**  
**A. A. Kharkevich**  
(Translated by J. George Adashko)

**Chapter 4**

## Parametric Phenomena

In this chapter we consider certain phenomena and processes that occur in systems with variable (time dependent) parameters so that they are mathematically describable by linear equations with variable coefficients. The theory of such equations is relatively complicated and not fully developed, with the exception of the Hill equation

$$x'' + [a + q f(t)] x = 0$$

where  $f(t)$  is a periodic function. The special case of the Hill equation

$$x'' + [a + 2q \cos 2t] x = 0$$



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called the Mathieu equation. Some of the theory Mathieu's equations will be given in Section 40. First, however, we shall consider only parametric phenomena describable by algebraic equations.

### 38. Synchronous Detection

We begin the investigation of synchronous detection with synchronous rectification as the simplest example. Consider a circuit consisting of an ac voltage source  $E$ , a load resistance  $R$ , and a synchronous switch  $K$  (Fig. 135). The switch is operated independently, but in synchronism with the source frequency. The switch alternately closes the circuit for a time equal to half the ac cycle, and opens the circuit for an equal length of time. Thus, the admittance of the circuit is either zero or  $R$ , depending on whether the switch is open or closed. Under these circumstances current flow in the circuit is rectified, as illustrated in Fig. 136.

It must be emphasized immediately that this rectification differs in principle from the conven-

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1-4-8

## RUSSIAN TRANSLATIONS

tional type. In the usual rectification the admittance of the circuit is also a variable quantity, but it depends on the rectifier voltage. Thus, the ordinary rectifier circuit is nonlinear.

In the synchronous rectifier considered here, the alternating admittance depends on the time, and consequently we deal with a circuit with variable parameters which can be described by a linear equation with variable coefficients.

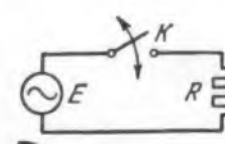
The features of synchronous rectification can be recognized readily by noting that while the switch operation is independent (although synchronous), the phase of the switching is arbitrary. It is easy to see that a 180 deg change in the phase of the switching reverses the polarity of the rectified voltage across the resistance  $R$ .

If the phase is shifted by 90 or 270 deg, no rectification is obtained at all. This is illustrated in Fig. 137. We see that a phase shift of 90 deg, that is, a time shift of  $T/4$ , results in a current without a dc component. This dependence of the rectifying action on the phase is a characteristic of synchronous rectification and of synchronous detection. The consequences of this property will be discussed later.

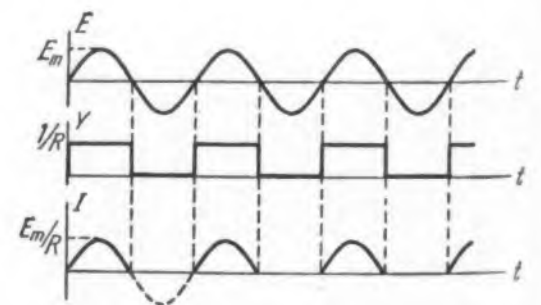
We now turn to synchronous detection of an am signal. The purpose of detection is to re-establish the low-frequency modulating signal. Consider a modulated voltage of the type

$$E = E_0 [1 + m f(t)] \sin \omega_0 t. \quad (1)$$

Let us apply this voltage to a circuit containing an alternating resistance (Fig. 138) that varies peri-



**Fig. 135.** If the switch closes in synchronism with alternate half cycles, this circuit becomes a simple, synchronous rectifier.



**Fig. 136.** With the circuit of Fig. 135, the current is rectified when the admittance is  $1/R$  and if the switch closes in synchronism with alternate half cycles.





odically at the same frequency  $\omega_o$ . The admittance of the circuit can then be written

$$Y = Y_o (1 + n \sin \omega_o t), \quad (2)$$

i.e., we assume that the admittance varies synchronously and in phase with the carrier frequency. Multiplying (1) by (2) we obtain for the current in the circuit

$$I = EY = E_o Y_o \left\{ [1 + m f(t)] \sin \omega_o t - \frac{n}{2} [1 + m f(t)] \cos 2 \omega_o t + \frac{n}{2} [1 + m f(t)] \right\}$$

The first term represents the initial modulated signal with a high frequency spectrum that is symmetrical about the frequency  $\omega_o$ . The second term has an analogous spectrum (but  $n/2$  times smaller in density) about the frequency  $2 \omega_o$ . Finally, the third term is the modulating low-frequency signal.

The high-frequency components are readily separated by suitable filters, which must be provided in any detector circuit. It is just as easy to eliminate the dc component. After such filtering, we obtain the current component

$$I = \frac{1}{2} n m E_o Y_o f(t), \quad (3)$$

which is indeed the desired result of detection.

Let us see now what happens when the phases are unequal. Unlike the foregoing,

$$Y = Y_o [1 + n \sin (\omega_o t + \phi)]. \quad (4)$$

Multiplying (1) by (4), we get

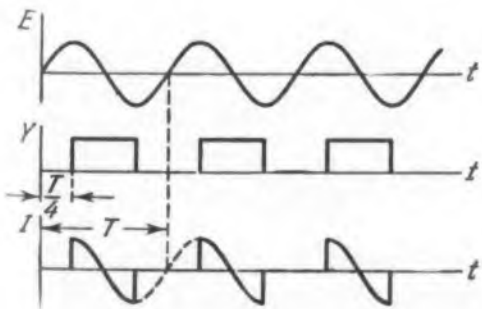


Fig. 137. If the switch closure in Fig. 135 is 90 or 270 deg out of phase with the applied voltage, rectification does not take place.

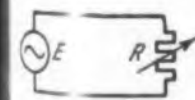


Fig. 138. A modulated voltage applied to a resistance which varies at the rate of the carrier frequency.



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LEAF ACTUATOR

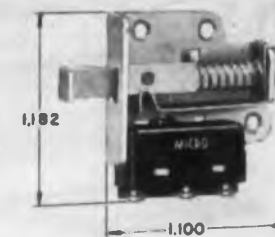
ROLLER LEAF ACTUATOR

Auxiliary actuators add to the versatility of application. Two are shown. Others are pivoted lever and pivoted roller lever. All are stainless steel.

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The 2TM1-T offers considerable reductions in space and weight in manual control of compact equipment. Weight— $4\frac{1}{2}$  grams. Only  $\frac{1}{2}$ " square at the base. Dependable operation from  $-65^\circ$  to  $+200^\circ$ F. Low circuit resistance. Rating: 7 amps. resistive, 28 vdc. DPDT. Data Sheet 158.



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188	4697	69.5	29.0	1200	50	Extruded Teflon or Fused Teflon Tape	SC	.060
195	4698	69.5	15.0	1500	95	Extruded Teflon or Fused Teflon Tape	SC	.102
196	4699	69.5	29.0	1000	50	Extruded Teflon or Fused Teflon Tape	SC	.034

\*duPont's trade name for Polytetrafluoroethylene  
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## RUSSIAN TRANSLATIONS

$I = EY = E_o Y_o [1 + m f(t)] [1 + n \sin(\omega_o t + \phi)] \sin \omega_o t$

After completing the multiplication and discarding the high-frequency and the dc component, we find that the current component of interest to us, containing the signal  $F(t)$ , is

$$I = \frac{1}{2} n m E_o Y_o f(t) \cos \phi. \quad (5)$$

We see that the detection is most effective if  $\phi = 0$  (or  $\pi$ ), when (5) goes into (3). If, on the other hand,  $\phi = \pm\pi/2$ , there is no detection at all.

Finally, we must explain what happens if there is no synchronism. We find in this case that the synchronous detector has selectivity. To investigate this property let us consider a specific circuit with a very simple RC filter (Fig. 139).

It is assumed that the resistance  $r$ , from which the voltage  $U_1$  is picked off, is sufficiently small and that the addition of the RC element does not change the operating conditions in the principal synchronous-rectifier circuit. We have

$$U_1 = Ir = EYr \quad (6)$$

Put

$$E = E_o \sin \omega_o t, \quad (7)$$

$$Y = Y_o (1 + n \sin \omega t), \quad (8)$$

where  $\omega$  is an arbitrary frequency. For a certain frequency  $\Omega$ , we get for the complex output voltage

$$U_2 = U_1 \frac{1}{1 + j\Omega RC} \quad (9)$$

Let us determine  $U_1$

$$U_1 = EYr = E_o Y_o r (1 + n \sin \omega t) \sin \omega_o t$$

$$= E_o Y_o r \left[ \sin \omega_o t + \frac{n}{2} \cos(\omega_o - \omega) t - \frac{n}{2} \cos(\omega_o + \omega) t \right]$$

We thus have at the output of the RC network three voltages with frequencies  $\omega_o$ ,  $\omega_o - \omega$ , and

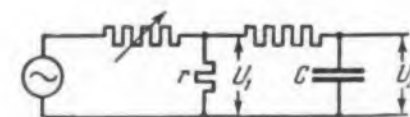


Fig. 139. A basic synchronous detector with a simple RC filter.



$\omega_0 + \omega$  and with respective complex amplitudes  $E_0 Y_{or}$ ,  $j(n/2) E_0 Y_{or}$ , and  $-j(n/2) E_0 Y_{or}$ . Inserting these quantities into eq (9), we obtain the following values for the complex amplitudes of the output voltage  $U_2$ , for the three foregoing components:

$$E_0 Y_{or} \frac{j \frac{n}{2} E_0 Y_{or}}{1 + j \omega_0 RC} + \frac{-j \frac{n}{2} E_0 Y_{or}}{1 + j (\omega_0 - \omega) RC} + \frac{j \frac{n}{2} E_0 Y_{or}}{1 + j (\omega_0 + \omega) RC}$$

If the detuning is slight, i.e., if  $\omega \cong \omega_0$ , and the time constant is large, i.e., when

$$\omega_0 RC \gg 1,$$

we can neglect the first and third quantities compared with the second one, so that, approximately

$$U_2 \cong \frac{E_0 Y_{or} n}{2RC} \frac{1}{\sqrt{(\omega_0 - \omega)^2 + \frac{1}{R^2 C^2}}}$$

But this is exactly the expression for the ordinary resonance curve. The distinguishing feature of this case is that the measure of attenuation is the quantity  $1/RC$ . Consequently, the greater the time constant  $RC$ , the sharper "the resonance curve" of the synchronous detector. However, maximum sensitivity is obtained when the differential frequency  $\omega_0 - \omega$  vanishes, i.e., in the synchronous mode.

It is impossible to use the asynchronous mode for reception of arbitrary modulated signals. In fact, assume that instead of the sinusoidal voltage (7) we have amplitude-modulated voltage

$$E = E_0 [1 + m f(t)] \sin \omega_0 t.$$

Setting up the product

$$U_1 = E Y_r = E_0 Y_{or} [1 + m f(t)] (1 + n \sin \omega t) \sin \omega_0 t \\ = E_0 Y_{or} [1 + m f(t)] \left[ \sin \omega_0 t + \frac{n}{2} \cos (\omega_0 - \omega) t - \frac{n}{2} \cos (\omega_0 + \omega) t \right],$$

we see that the spectrum of the voltage  $U_1$  duplicates the spectrum of  $E$  about the frequencies  $\omega_0$ ,  $\omega_0 - \omega$ , and  $\omega_0 + \omega$  as carriers, as shown in Fig. 140a. We see that under the conditions of Fig. 140a we obtain not detection but frequency conversion. At small frequency deviations, when  $\omega_0 - \omega$  is less than the width of the spectrum of the modulating function, distortion occurs. Only when  $\omega = \omega_0$ , i.e., in the synchronous mode, is correct detection obtained (Fig. 140b).

We note, in conclusion, that if the input voltage  $E$  is periodic, it is possible, by changing the fre-

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Junction Temperature	95°C
TYPICAL CHARACTERISTICS (25°C)	
Typ. Collector Diode Current $I_{co}$ $V_{cb} = 40$ volts	50 $\mu$
Current Gain ( $V_{ce} = -2$ volts, $I_c = 100$ Ma)	70
Current Gain ( $V_{ce} = -2$ volts, $I_c = 1/2$ A)	30
Saturation Resistance	0.3 ohms
Cutoff Frequency (Common Emitter)	17 kc
Thermal Resistance	12° C/Watt

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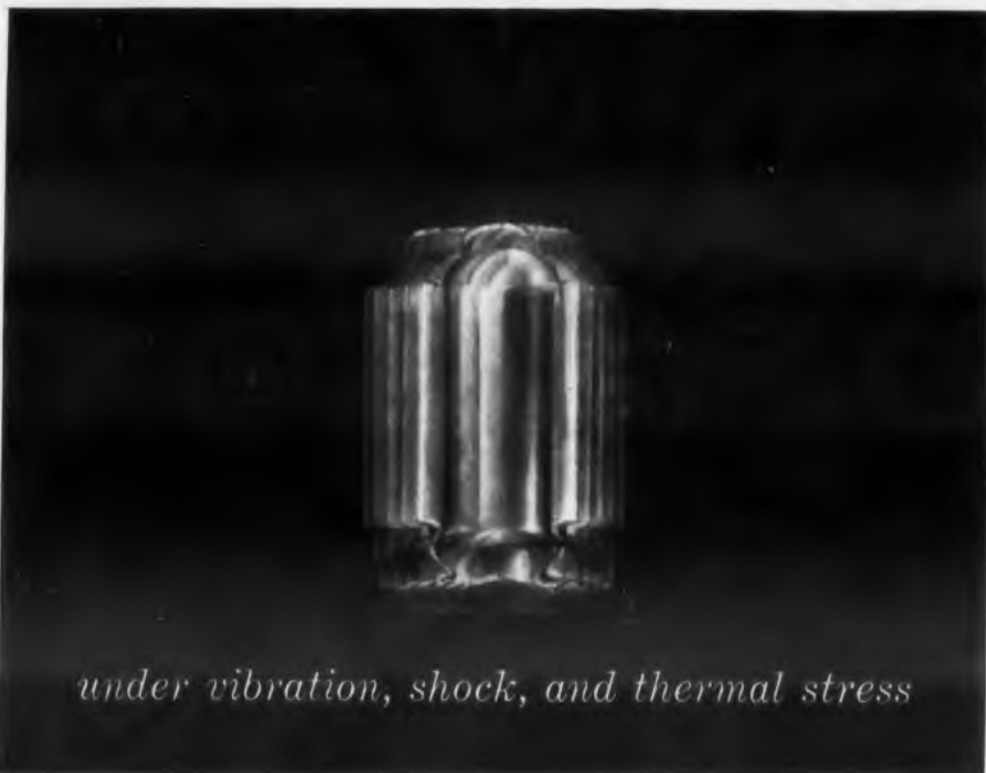
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  - insertion-withdrawals had no effect on dynamic holding power
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CIRCLE 136 ON READER-SERVICE CARD

## RUSSIAN TRANSLATIONS

quency  $\omega$ , to separate and measure alternately the harmonic components of  $E$ . In this case the synchronous detector operates essentially as a harmonic analyzer.

The resolving power of such an analyzer, i.e., the ability to distinguish and measure harmonic components that are close to each other on the frequency scale, depends on the time constant  $RC$  and can be made very large.

### 39. Phase Detection and Phase Separation

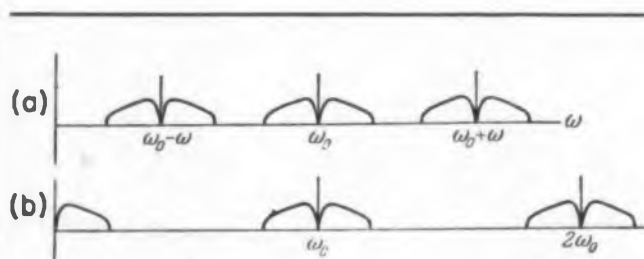
The sensitivity of the synchronous detector to the phase of the detected voltage, noted in the preceding section, can be applied in practice.

Let us examine first the reception of phase-modulated radio-telegraph signals. We deal with a signal in which the phase of the carrier frequency changes abruptly, as shown in Fig. 141, every time the telegraph key is closed or opened.

The first line shows the variation of the phase when the letter "A" is transmitted in Morse code. The second line shows the modulated voltage. The third line shows a plot of the admittance, assuming that the simple synchronous-switch circuit of Fig. 135 is used. The fourth line shows the resultant current.

After averaging, i.e., after filtering, we reproduce, with some approximation, the transmitted telegraph signal. It must be explained immediately that the diagram shows only one cycle of the carrier corresponding to each telegraph dot, something that does not occur in practice (this ratio is chosen only to make the diagram clear). Actually the carrier frequency may be, say, ten thousand times greater than the manipulation frequency, i.e., each dot may correspond to some 10,000 cycles of the carrier.

If the modulation is effected by changing the



**Fig. 140.** When there are frequency deviations (a) frequency conversion results instead of detection. Proper detection (b) obtains only in the synchronous mode.



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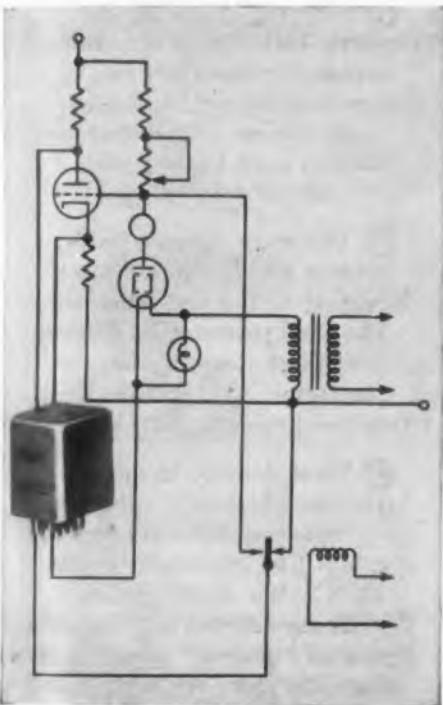
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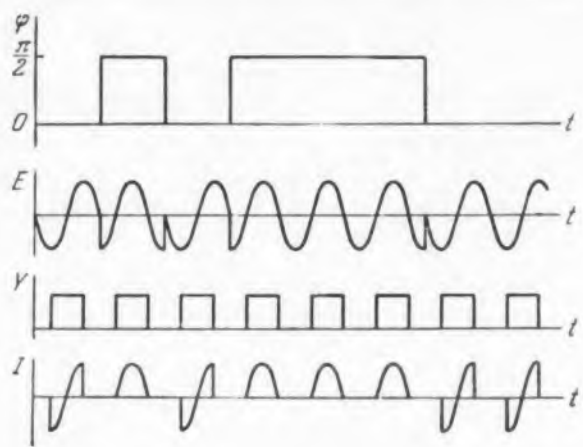


Fig. 141. A phase modulated Morse Code "A", the resulting modulated voltage, the admittance (using the synchronous switch of Fig. 135), and the current.

phase not by  $\pi/2$  but by  $\pi$ , the result is as shown in Fig. 142, which needs no explanation. Thus, a circuit with a periodically varying admittance can be used as a phase detector.

Let us now turn to phase separation. The problem of signal separation arises in multichannel communication, when several different signals are transmitted simultaneously on a single line.

At the receiving end of a multichannel system, it is necessary to unscramble the incoming mixture of signals and to isolate the signal belonging to each given channel. In the frequency-sharing system of multichannel communication, signals belonging to different channels are transmitted on separate carriers (or sub-carriers), one for each channel. In this case it is possible to place the signal spectra of each channel in such a location on the frequency scale, that the signals do not overlap.

Ordinary band filters are then used at the receiving end to separate the signals. In phase separation, the carriers have the same frequency, but are shifted in phase. Let us analyze the feasibility of phase separation.

Let the signal of one channel be  $f_1(t)$  and that of the other  $f_2(t)$ .

Let us use one signal to modulate a carrier of the form

$$E_1 = E_{01} \sin \omega_1 t,$$

and let us choose, for the second signal, the carrier

$$E_2 = E_{02} \sin (\omega_1 t + \psi).$$

we then obtain at the receiving end the composite modulated voltage

$$E = E_{01} [1 + m_1 f_1(t)] \sin \omega_1 t + E_{02} [1 + m_2 f_2(t)] \sin (\omega_1 t + \psi)$$

$$= a(t) \sin \omega_1 t + b(t) \sin (\omega_1 t + \psi). \quad (1)$$



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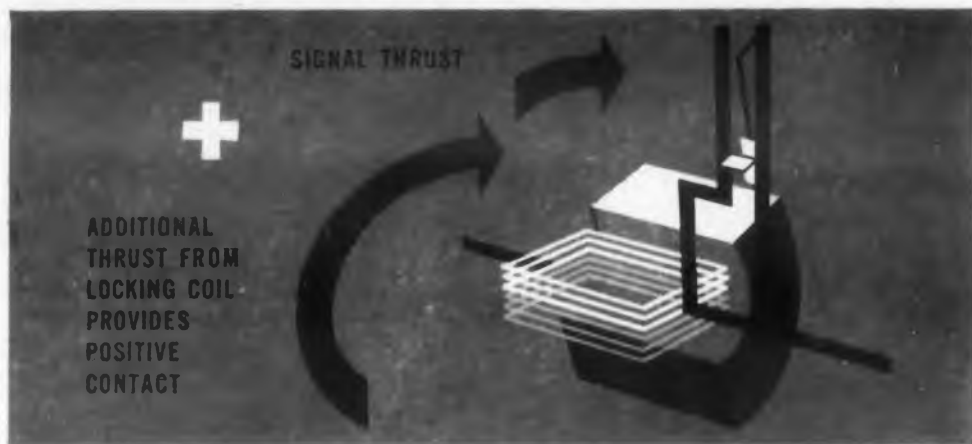
Capacitance in mmfd Standard Values in			Color Bands			Max. Body Length	Capacitance in mmfd Standard Values in			Color Bands			Max. Body Length
20%	10%	5%	1st	2nd	3rd		20%	10%	5%	1st	2nd	3rd	
.10	.10		Brown	Black	Gray	.400	1.5	1.5	1.5	Brown	Green	White	.281
	.12		Brown	Red	Gray	.400		1.6	1.6	Brown	Blue	White	.281
	.15		Brown	Green	Gray	.350		1.8	1.8	Brown	Gray	White	.281
	.18		Brown	Gray	Gray	.281		2.0	2.0	Red	Black	White	.281
		.20	Red	Black	Gray	.281	2.2	2.2	2.2	Red	Red	White	.230
		.22	Red	Red	Gray	.281		2.4	2.4	Red	Yellow	White	.230
		.24	Red	Yellow	Gray	.281		2.7	2.7	Red	Violet	White	.230
		.27	Red	Violet	Gray	.281		3.0	3.0	Orange	Black	White	.230
		.30	Orange	Black	Gray	.281	3.3	3.3	3.3	Orange	Orange	White	.230
	.33	.33	Orange	Orange	Gray	.281		3.6	3.6	Orange	Blue	White	.230
		.36	Orange	Blue	Gray	.281		3.9	3.9	Orange	White	White	.230
		.39	Orange	White	Gray	.281		4.3	4.3	Yellow	Orange	White	.230
		.43	Yellow	Orange	Gray	.281	4.7	4.7	4.7	Yellow	Violet	White	.230
	.47	.47	Yellow	Violet	Gray	.281		5.1	5.1	Green	Brown	White	.230
		.51	Green	Brown	Gray	.281		5.6	5.6	Green	Blue	White	.230
		.56	Green	Blue	Gray	.281		6.2	6.2	Blue	Red	White	.230
		.62	Blue	Red	Gray	.281	6.8	6.8	6.8	Blue	Gray	White	.230
	.68	.68	Blue	Gray	Gray	.281		7.5	7.5	Violet	Green	White	.230
		.75	Violet	Green	Gray	.281		8.2	8.2	Gray	Red	White	.230
		.82	Gray	Red	Gray	.281		9.1	9.1	White	Brown	White	.230
		.91	White	Brown	Gray	.281	10.	10.	10.	Brown	Black	Black	.230
1.0	1.0	1.0	Brown	Black	White	.281		12.	12.	Brown	Red	Black	.230
		1.1	Brown	Brown	White	.281		15.	15.	Brown	Green	Black	.230
		1.2	Brown	Red	White	.281		18.	18.	Brown	Gray	Black	.230
		1.3	Brown	Orange	White	.281							

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**RUSSIAN TRANSLATIONS**

Let this voltage be applied to a circuit with an admittance

$$Y = Y_0 (1 + n \sin \omega_0 t) \quad (2)$$

To obtain the current we multiply (1) by (2)

$$\begin{aligned} I = EY &= Y_0 (1 + n \sin \omega_0 t) [a(t) \sin \omega_0 t + b(t) \sin (\omega_0 t + \psi)] \\ &= Y \left[ a(t) \sin \omega_0 t + b(t) \sin (\omega_0 t + \psi) + \frac{n}{2} a(t) \right. \\ &\quad \left. - \frac{n}{2} a(t) \cos 2 \omega_0 t + \frac{n}{2} b(t) \cos \psi - \frac{n}{2} b(t) \right. \\ &\quad \left. \cos \psi 2 \omega_0 t + \frac{n}{2} b(t) \sin \psi \sin 2 \omega_0 t \right] \end{aligned}$$

We see that in addition to the high-frequency components, grouped about  $\omega_0$  and  $2 \omega_0$ , the current contains components that are proportional to  $a(t)$  and  $b(t)$ . But we must separate  $a(t)$  from  $b(t)$  at the receiving end. The above formula shows that this can be done if  $\psi = \pi/2$ . Then, after filtering the high-frequency components we get

$$I = \frac{n}{2} Y_0 a(t)$$

Thus, to separate two channels by synchronous detection, we must choose the carrier, to be of the following form

$$E_1 = E_{01} \sin \omega_0 t, \quad E_2 = E_{02} \cos \omega_0 t.$$

It is necessary to install, on the receiving end, two synchronous detectors, whose admittances also vary as the sine and cosine, respectively. Under these conditions we obtain at the filter outputs the separated signals  $a(t)$  and  $b(t)$ , as shown in the block diagram of Fig. 143.

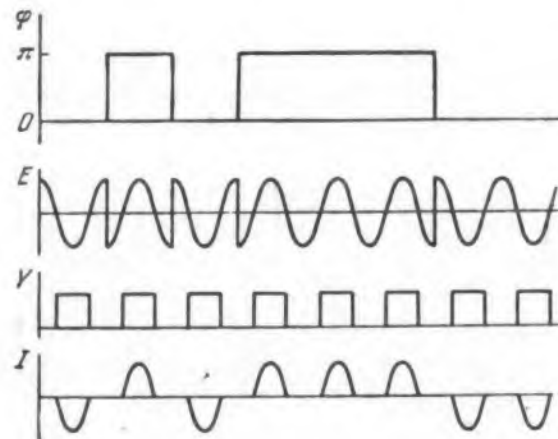


Fig. 142. A phase modulated Morse Code "A", when the phase is changed by  $\pi$ , not by  $\pi/2$ .

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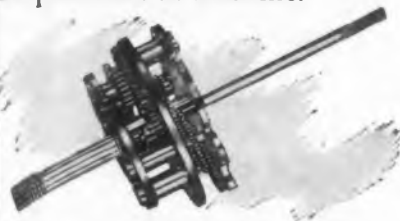
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It follows that the method described can yield only a two-channel transmission system. If phase variation is used in conjunction with some other separation method (for example, frequency or time separation), the number of channels can be doubled.

It must be noted in conclusion that the practical realization of synchronous detection and separation involves many specific technical difficulties which will not be discussed here.

### 40. Brief Information on the Mathieu Equation\*

The general solution of the Mathieu equation

$$x'' + (a + 2q \cos 2\tau) x = 0 \quad (1)$$

consists of two independent solutions and can be written as

$$x = x_1 + x_2 = A e^{\mu\tau} \Phi_1(\tau) + B e^{-\mu\tau} \Phi_2(\tau) \quad (2)$$

Here A and B are arbitrary constant,  $\Phi_1$  and  $\Phi_2$  are periodic functions of time with a period  $\pi$  or  $2\pi$ . These periodic functions can be expressed in terms of a corresponding trigonometric series, but this aspect of the problem does not interest us.

From the point of view of our problems, the most important is the question of the stability of the solutions of the Mathieu equation. It is readily seen that if  $\mu$  is a real number not equal to zero, one of the terms of solution (2) increases without limit with increasing  $\tau$ , meaning that the solution is unstable. The exponent  $\mu$  depends on the coefficients  $a$  and  $q$ . It can be shown that the boundaries of the stability regions are determined by the condition  $\mu = 0$ . Fig. 144 shows graphically the stability regions plotted in the  $(a, q)$  plane. The instability regions (shaded in the diagram) are bounded by curves that converge on the  $a$  axis at the points  $a = 1, 4, 9, 16$ , etc. The picture is symmetrical about the  $a$  axis.

The equation of a lossless tank circuit with a periodically varying parameter, say the capacitance, reduces to eq (1). But the equation of a real tank circuit has initially the form

$$y'' + 2\alpha y' + (b + 2q \cos 2\tau) y = 0 \quad (3)$$

and the problem consists of reducing this equation, too, to the standard form (1). For this purpose we take

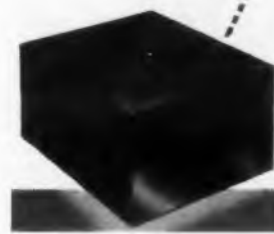
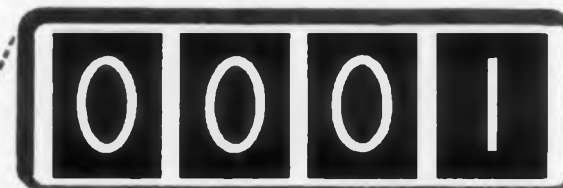
$$y = e^{-\alpha\tau} x \quad (4)$$

\*This section is purely informative. We cite here in ready form (without derivation) only data that will be used subsequently.

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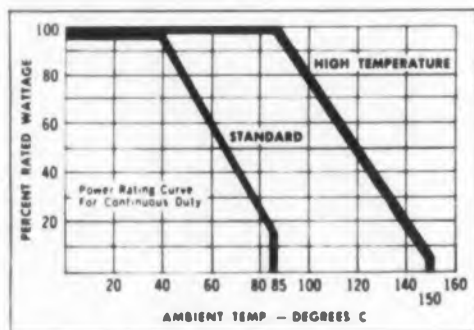
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## RUSSIAN TRANSLATIONS

This substitution yields eq (1), in which we must put

$$a = b - \alpha^2 \quad (5)$$

Comparing (2) and (4), we see that the solution of eq (3) is of the form

$$y = A e^{(-\alpha+\mu)\tau} \Phi_1(\tau) + B e^{(-\alpha-\mu)\tau} \Phi_2(\tau). \quad (6)$$

The solution becomes unstable not when  $|\mu| > 0$ , but when

$$-\alpha + |\mu| > 0; \quad (7)$$

i.e., when

$$|\mu| > \alpha$$

Consequently, the instability region for eq (3) is bounded not by the curve  $\mu = 0$ , but by the curves

$$\mu = \alpha$$

These curves no longer reach the  $a$  axis; the distances between the lower cusps and the  $a$  axis increases with increasing  $\mu$ . The dotted lines of Fig. 144 show the instability regions for eq (3) with  $\alpha = 0, 1$ , i.e., when the equation of the boundary lines is of the form

$$\mu = \alpha = 0, 1$$

The system becomes unstable most readily at the lowest value of  $q$ , i.e., under conditions corresponding to the minima of the boundary curves. We must therefore find the coordinates of the minima. An exact solution of this problem is very cumbersome. But if we assume that in eq (1)  $a \gg q$  (which indeed corresponds to the case which we will encounter subsequently), we can make certain approximations. We expand the relationships of interest to us in powers of  $q$  and discard the higher order terms.

We assume that the minimum lies in the midpoint of the horizontal segment that joins two curves of  $\mu = 0$  in the instability region. We then obtain the data shown in Table 2 ( $m$  denotes the number of the instability region, and  $a_m$  and  $q_m$  are the coordinates of the minimum of the boundary curve).

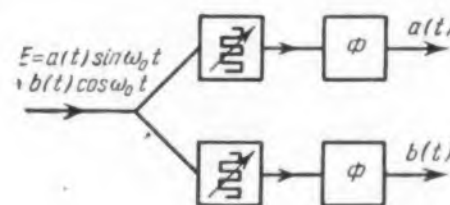
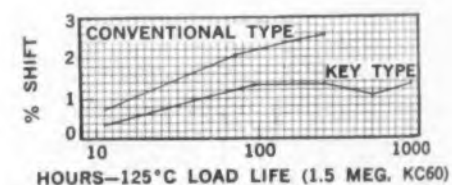


Fig. 143. Block diagram of a phase separator using two synchronous detectors.



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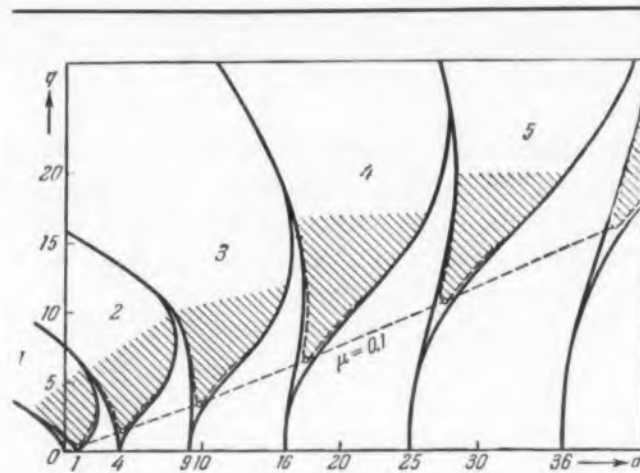


Fig. 144. A graphic representation of the solutions of the Mathieu equation. The instability regions are shaded.

The points with the coordinates indicated in Table 2 are shown in Fig. 144 for  $\mu = 0.1$ . They lie on a curve that passes through the origin and deviates little from a straight line.

$m$	1	2	3	4	5
$a_m$	$1 - \mu^2$	$4 + \frac{8}{3}\mu$	$9 + (6\mu)^{3/2}$	$16 + \frac{16}{5}(2\mu)^{5/2}$	$25 + \frac{4}{3}(45\mu)^{7/2}$
$q_m$	$\frac{1}{2}\mu$	$4\mu^{1/2}$	$4(6\mu)^{3/2}$	$4(72\mu)^{5/2}$	$8(45\mu)^{7/2}$

This means that, for a given value of  $\mu$ , the greater the value of  $a$ , the greater variation in the parameter is needed to disturb the stability. This information is enough to help us analyze parametric excitation.

### 41. Parametric Excitation

In this section we consider the mechanism of oscillations that can take place in a tank circuit if any one of its parameters, say the capacitance of the inductance) varies periodically. Let us emphasize at the outset that we deal here with a unique phenomenon.

Usually oscillations occur in a tank circuit under the influence of some electromotive force. In this case however there are no electromotive forces at all. The diagram of the experiment is shown in Fig. 145.

This immediately raises the question of where the energy required for excitation and maintenance of the oscillation comes from. Here, too, general energy consideration will enable us to explain the mechanism of the phenomenon.

The point is that in order to change the capacitance (we shall confine ourselves henceforth to this particular case only) it is necessary, generally



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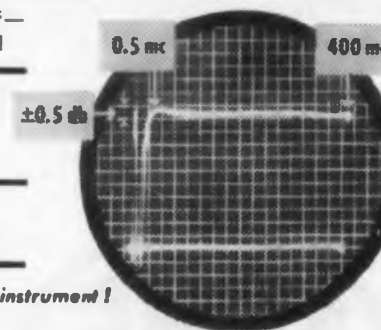
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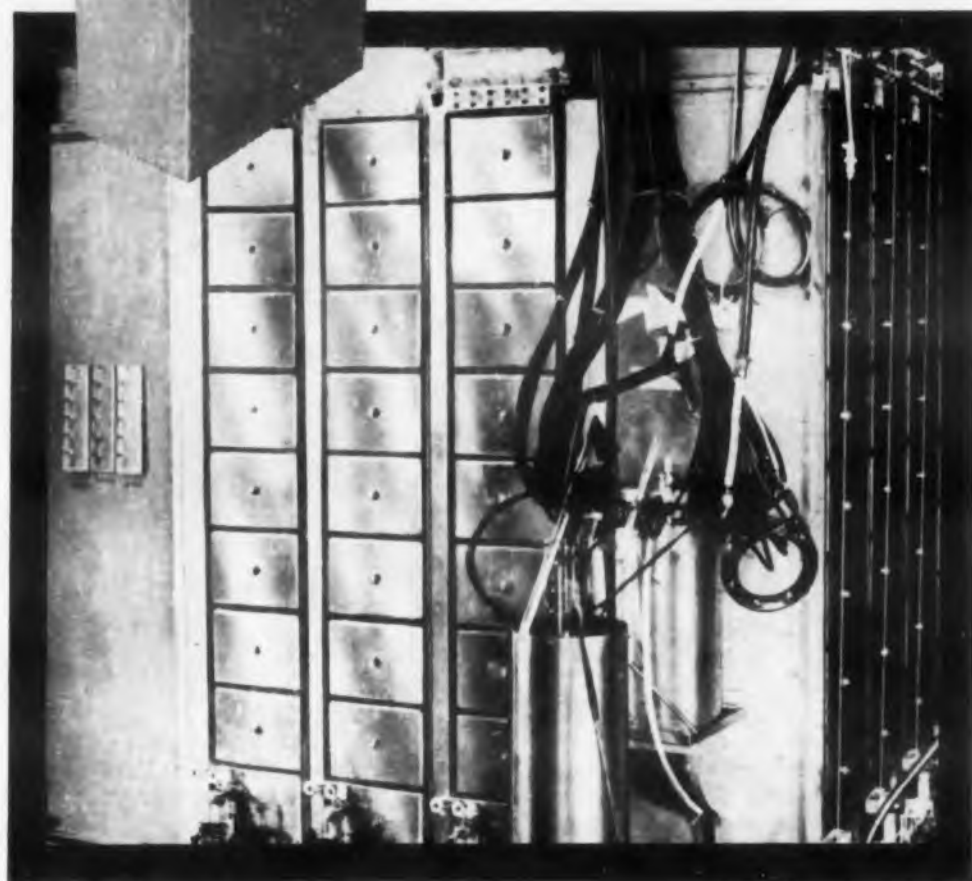
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## RUSSIAN TRANSLATIONS

speaking, to do work against the attraction forces between the capacitor plates. Let us assume that the oscillations have already been established in the tank circuit and that an alternating voltage exists across the capacitor.

We move the capacitor plates apart at the instant when the voltage is maximum, and bring them together when the voltage is zero. During each cycle, we thus perform a definite amount of work, i.e., we put into the system a certain amount of energy in mechanical form. The mechanical energy is transformed in the system into electrical energy, and this is how the system is supplied from the outside.

To explain the mechanism by which mechanical energy is transformed into electrical energy we recall certain laws of electrostatics. Let an insulated capacitor  $C$  be charged to voltage  $U$ . The energy stored in the electric field of the capacitor is

$$\xi = \frac{U^2 C}{2}$$

The mechanical force with which the plates are attracted to each other is

$$F = \frac{\xi}{2d}$$

where  $d$  is the distance between plates. If the plates are moved a distance  $\Delta d$  apart, the mechanical work done is

$$\Delta A = F \Delta d = \frac{1}{2} \xi \frac{\Delta d}{d}$$

The potential energy of the electric field should increase by the same amount. We rewrite the energy equation as

$$\xi = \frac{Q_0^2}{2C}$$

where  $Q_0 = UC$  is the initial charge, which remains unchanged during this experiment (since the capacitor is insulated). The capacitance is

$$C = \frac{\epsilon S}{d}$$

where  $\epsilon$  is the dielectric constant and  $S$  the area

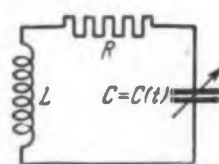


Fig. 145. Oscillations can take place in this tank circuit with a periodically varying capacitor—without emf's.

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of the plates. Using this relation we get

$$\mathcal{E} = \frac{Q_0^2 d}{2 \epsilon S}$$

If  $d$  changes, the energy increment is

$$\Delta \mathcal{E} = \frac{Q_0^2}{2 \epsilon S} \Delta d = \frac{Q_0^2}{2C} \frac{\Delta d}{d} = \frac{1}{2} \mathcal{E} \frac{\Delta d}{d}$$

which equals, as we see, the work performed,  $\Delta A$ . The increased capacitor energy manifests itself in an increase in voltage

$$\Delta U = U \frac{\Delta d}{d}$$

The relative change in voltage thus equals the relative change in distance between plates.\*

Having made these general physical observations, we turn to the circuit of Fig. 145. The following voltage equation can be written

$$LQ'' + RQ' + \frac{1}{C(t)} Q = 0 \quad (1)$$

If the capacitance varies about its average value  $C_0$  so that

$$C(t) = C_0 + C_1 f(t) = C_0 \left[ 1 + \frac{C_1}{C_0} f(t) \right] = C_0 [1 + n f(t)]$$

if  $n = C_1/C_0 \ll 1$  we can rewrite (1) as

$$Q'' + 2\alpha Q' + \omega_0^2 [1 - n f(t)] Q = 0 \quad (2)$$

where

$$\omega_0^2 = \frac{1}{LC_0}$$

Let us change variables;

$$Q = ye^{-\alpha t}$$

This eliminates the term with the first derivative

$$y'' + [\omega_1^2 - \omega_0^2 n f(t)] y = 0$$

where

$$\omega_1^2 = \omega_0^2 - \alpha^2$$

is the square of the resonant frequency of a tank circuit with constant parameters  $L$ ,  $R$  and  $C_0$ . Let now

$$f(t) = \cos \omega t$$

Denoting  $\omega t = 2\tau$  and replacing the derivative with respect to  $t$  by the derivative with respect to  $\tau$ , we get

$$y'' + 4 \left[ \frac{\omega_1^2}{\omega^2} + \frac{\omega_0^2}{\omega^2} n \cos 2\tau \right] y = 0 \quad (3)$$

\*We must not forget that all the above relations result from a linearized equation and represent a first approximation, which holds when

$$\frac{\Delta d}{d} \ll 1$$

The quantities  $\Delta U/U$  and  $\Delta \mathcal{E}/\mathcal{E}$  are of the same order of smallness.



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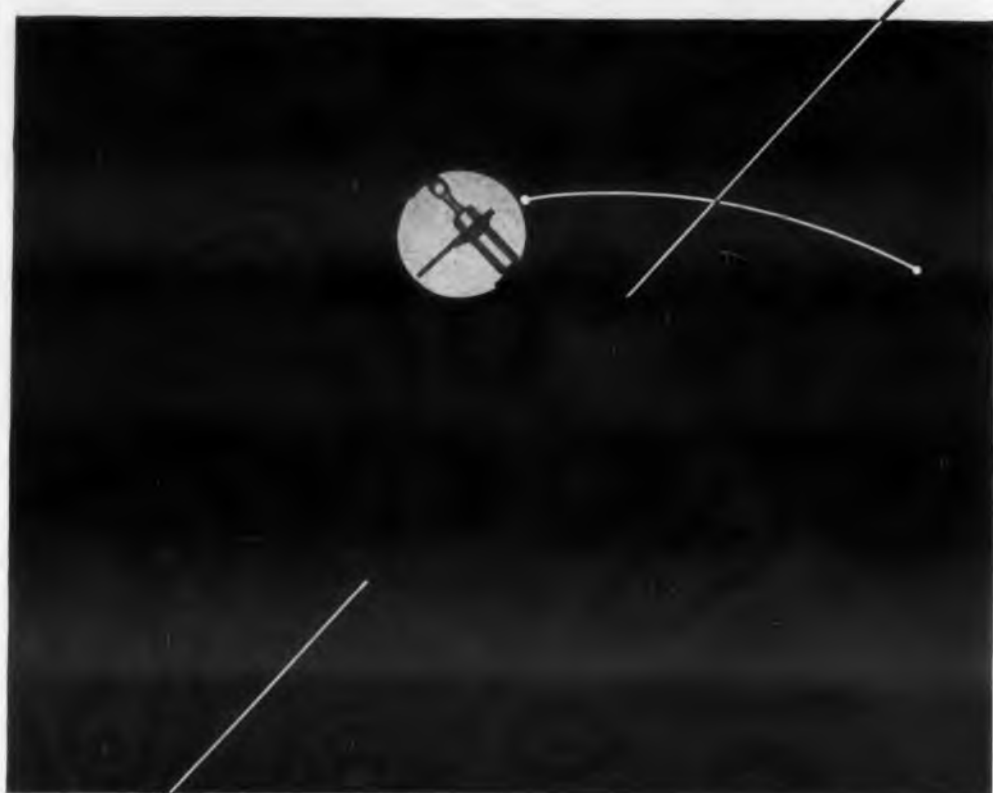
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## RUSSIAN TRANSLATIONS

which is indeed the Mathieu equation. The problem of finding the conditions under which oscillations can be excited in the tank circuit now reduces to the mathematical problem of determining when the Mathieu equation has unstable solutions. We know the solution to the latter problem (see Section 40): an unstable solution is obtained when

$$x = \frac{2\alpha}{\omega} < \mu \quad (4)$$

We have the following values of the coefficients

$$q = n \frac{2\omega_0^2}{\omega^2}; \quad a = 4 \frac{\omega_1^2}{\omega^2}$$

or, if the attenuation is small and can be neglected

$$a \cong 4 \frac{\omega_0^2}{\omega^2}$$

Thus, the coefficient  $q$  expresses the relative change in the parameter, and the coefficient  $a$  the ratio of the tank-circuit frequency to the modulation frequency. Excitation occurs most readily at the points where the boundary curves have their minima. For the first instability region we have (see Section 40)

$$a = 1 - \mu^2, \quad q = 2\mu$$

Since  $\mu \ll 1$ , we can put

$$a = 1$$

hence

$$\omega_0 = \frac{1}{2} \omega$$

i.e., the oscillations are most readily excited at a frequency equal to half the modulation frequency. Inserting

$$\mu = \frac{1}{2} q$$

into the excitation condition (4), we get

$$\frac{2\alpha}{\omega} < \frac{1}{2} q = n \frac{\omega_0^2}{\omega^2}$$

Transforming this inequality, we obtain

$$\frac{2\alpha}{\omega} = d \frac{\omega_0}{\omega} < n \frac{\omega_0^2}{\omega^2}$$

but since in our case  $\omega_0/\omega = 1/2$ , the excitation condition is finally written

$$n > 2d \quad (5)$$

Consequently, parametric oscillations can be excited in a tank-circuit with given damping if

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the capacitance is varied periodically, provided the relative change in the capacitance is sufficiently large. The smaller the damping, the smaller the needed relative variation

$$n = \frac{C_1}{C_0}$$

We have derived the excitation condition for the first instability region at  $\omega_0 \cong \frac{1}{2} \omega$ . Excitation is possible also for other frequency ratios, i.e., for other instability regions. However, at other frequency ratios it is more difficult to excite the oscillations, i.e., it is necessary to have a greater depth of modulation. For the second instability region, the coordinates of the minimum of the boundary curves are

$$q = 4\mu^{1/2}, \quad a = 4 + \frac{8}{3} \mu$$

Let us put approximately

$$a = 4$$

i.e.

$$\omega_0 = \omega$$

Inserting into (4)

$$\mu = \frac{1}{16} q^2 = \frac{1}{4} n^2 \frac{\omega_0^4}{\omega^4} = \frac{1}{4} n^2$$

we get

$$d < \frac{1}{4} n^2$$

i.e.

$$n > \sqrt{2d}$$

For the third instability region, the coordinates of the minimum are

$$q = 4(6\mu)^{1/3}, \quad a = 9 + (6\mu)^{2/3} \cong 9$$

hence

$$\frac{4}{2} \omega_0^2 = 9, \quad \omega_0 = \frac{3}{2} \omega, \quad \mu = \frac{1}{384} q^3$$

Inserting into (4) we get

$$n = \frac{8}{3\sqrt[3]{3}} \sqrt[3]{d} \cong 1.84 \sqrt[3]{d}$$

and so on.

The simplest result represented by formula (5) need not be derived from the theory of the Mathieu equation for it also follows from energy considerations, for which we already have laid the groundwork. We now derive the excitation condition on an energy basis, since such a derivation will help explain the physical nature of the phenomena that occurs in parametric excitation.

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## RUSSIAN TRANSLATIONS

of the energies stored in the magnetic field of the coil and in the electric field of the capacitor. In the absence of losses and in the absence of an external signal, the energy remains constant and is merely transferred periodically from the coil to the capacitor and vice versa, which essentially causes the free oscillations.

In the presence of losses, i.e., if the active resistance  $R$  is taken into account, the energy diminishes. From the energy loss, taken as a function of time and averaged over one period, we obtain the power loss

$$P_{-} = \left( \frac{d\mathcal{E}}{dt} \right) = \frac{1}{2} I_m^2 R$$

where the superior bar indicates averaging over the period, and

$$I_m = \omega_0 Q_m = \omega_0 C U_m$$

is the amplitude of the current, which can also be expressed in terms of the maximum amplitudes of the charge ( $Q_m$ ) and of the capacitor voltage ( $U_m$ ). Thus

$$P_{-} = \frac{1}{2} \omega_0^2 C^2 R U_m^2 = \omega_0^2 R C \mathcal{E} = \omega_0 d\mathcal{E} \quad (6)$$

where  $d$  is the damping of the tank circuit. Oscillations can be maintained if the power loss is replenished from the outside. This is accomplished by varying the capacitance periodically. We have

$$\mathcal{E} = \mathcal{E}_L + \mathcal{E}_C$$

Let us find the energy increment due only to the change in capacitance

$$d_C \mathcal{E} = \frac{\partial \mathcal{E}}{\partial C} dC$$

Since the energy in the inductor is independent of  $C$ , we have

$$\mathcal{E}_C = \frac{U^2 C}{2}$$

so that

$$d_C \mathcal{E} = \frac{1}{2} U^2 dC$$

Dividing both sides by  $dt$  we get

$$\frac{d_C \mathcal{E}}{dt} = \frac{1}{2} U^2 \frac{dC}{dt} \quad (7)$$

We assume that the oscillations are sinusoidal, so that

$$U = U_m \cos \omega_0 t$$

Inserting this value into (7) we and

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$$\frac{dc \xi}{dt} = \frac{1}{4} U_m^2 (1 + \cos 2 \omega_0 t) \frac{dC}{dt} \quad (8)$$

We now note that the average value  $\frac{dc \xi}{dt}$  is none other than the power delivered to the tank circuit. In order for this power not to vanish it is necessary to rewrite the formula

$$C(t) = C_0 + C_1 f(t)$$

by putting

$$f(t) = \sin 2 \omega_0 t$$

and then

$$\frac{dC}{dt} = 2 \omega_0 C_1 \cos 2 \omega_0 t \quad (9)$$

Actually, inserting (9) into (8) we get

$$\frac{dc \xi}{dt} = \frac{1}{2} U_m^2 \omega_0 C_1 (\cos 2 \omega_0 t + \cos^2 2 \omega_0 t),$$

$$\begin{aligned} P_+ &= \left( \frac{dc \xi}{dt} \right) = \frac{1}{4} U_m^2 \omega_0 C_1 \\ &= \frac{1}{4} U_m^2 \omega_0 C_0 \frac{C_1}{C_0} \\ &= \frac{1}{2} n \omega_0 \xi \end{aligned} \quad (10)$$

To prevent attenuation it is obviously necessary to satisfy the inequality

$$P_+ > P_-$$

From this we find, using (6) and (10),

$$n > 2 d$$

which is identical with (5).

In conclusion we note that we have considered parametric excitation of oscillations as a linear problem; we have found the approximate self-excitation condition for  $\omega_0/\omega = 1/2$  but so far we know nothing about the steady-state amplitude of the oscillation. The steady-state mode can be determined only if the non-linearity is taken into account.

Since the circuit of Fig. 145 contains no non-linear elements, the amplitude of the oscillations can increase theoretically without limit. In practice the voltage in a circuit of this kind becomes rapidly large enough to break the capacitor down. It is therefore necessary to introduce into the circuit nonlinear resistances to limit the oscillation amplitude.

(The translation of Kharkovich's book will be concluded in the next issue of ELECTRONIC DESIGN. Shortly thereafter, the entire translation will be available in a handsome book. For more information, turn to the Reader-Service Card and Circle 800).

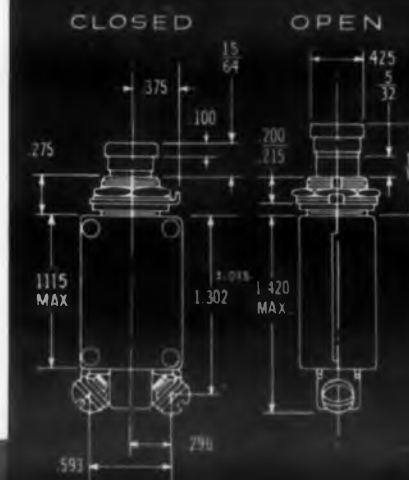
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## GERMAN ABSTRACTS

# Germanium Diode Detectors

E. Brenner

IN THE region above breakdown in the reverse direction (Fig. 1a) the volt-ampere curve of a germanium diode can be represented as the terminal pair characteristics of the combination of an ideal exponential diode and the linear resistance shown in Fig. 1b. The ideal diode characteristics are given by the equation

$$i/I_s = \exp(v/V_T) - 1 \quad (1)$$

where  $V_T = kT/\lambda q$ , the value of  $\lambda$  is an empirical curve fitting factor which is determined from the slope of the volt-ampere curve at  $v = 0$ . The resistance  $R_1$  (of the order of 50-500 ohms) represents the ohmic resistance of the crystal in the forward direction while  $R_2$  (50kohms to 5Mohms) is the resistance in the reverse direction.

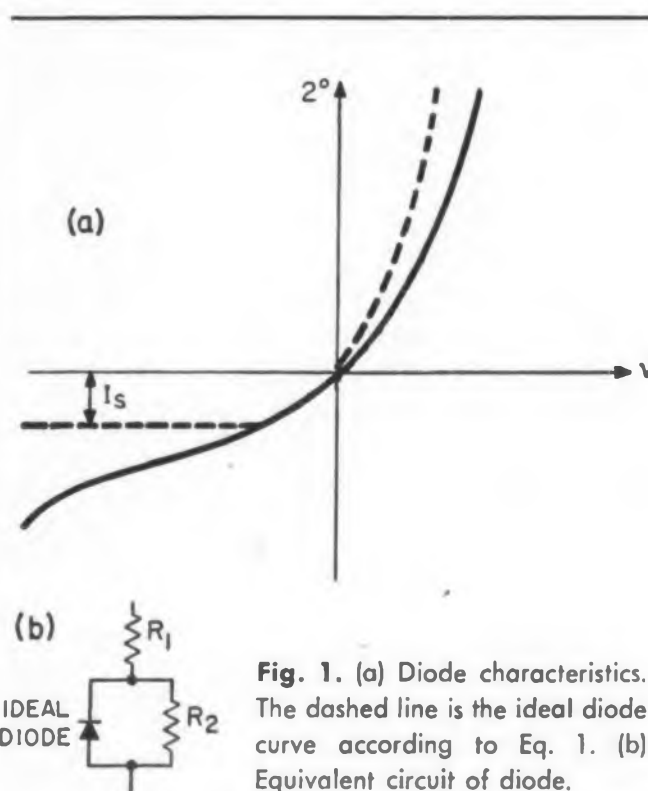


Fig. 1. (a) Diode characteristics. The dashed line is the ideal diode curve according to Eq. 1. (b) Equivalent circuit of diode.

ward direction while  $R_2$  (50kohms to 5Mohms) is the resistance in the reverse direction.

The basic relationship from which detector performance is deduced is the expression for the average current which flows through the ideal diode when the voltage across it has the form  $v = V_o + V_1 \sin \omega t$ . This form is introduced in Eq. 1, the result averaged over a period of the sinusoid. The resulting average current is

$$I_{av}/I_s = \exp(V_o/V_T) \cdot J_0(jV_1/V_T) - 1 \quad (2)$$

where  $J_0(jV_1/V_T)$  is the first order Bessel function of order zero and argument  $(jV_1/V_T)$ . (This function is also referred to as the "modified" Bessel function,  $J_0(jx) = I_0(x)$ ). The contribution to the average value due to the ac component of voltage is  $\Delta I_{av}$ :

$$\Delta I_{av} = I_s \exp(V_o/V_T) [J_0(jV_1/V_T) - 1] \quad (3)$$

If the average current is maintained constant then an ac component  $V_1$  produces a decrease in dc open circuit voltage  $\Delta V_o$  given by

$$\exp(\Delta V_o/V_T) = J_0(jV_1/V_T) \quad (4)$$

Two typical detector circuits are shown in Fig. 2. It is assumed that  $R_L \gg R_1$  and that the output impedance of the source  $Z_o$  is very large at the resonant frequency (i.e. the detector is fed from a tuned amplifier) but negligibly small compared to  $R_L$  at dc. With these assumptions one defines  $R_p = R_2 R_L / (R_2 + R_L)$ , then the dc component of the current results in the voltage  $\Delta V = I_{av} R_p$ . Since this voltage is across the diode in the reverse direction, the relationship to the ac amplitude  $V_1$  is

$$\Delta V_o - \Delta V = V_T \ln(\Delta V/I_s R_p + 1) \quad (5)$$

where  $\Delta V_o$  is defined through Eq. 4. This implicit



olution can be approximated with error of less than 1 per cent if  $V_T/I_s R_p < 0.1$ , for all  $\Delta V/V_T$ ,

$$\Delta I \approx \Delta V_o - V_T \ln (\Delta V_o/I_s R_p + 1) \quad (6)$$

For other cases the region in which the approximate formula holds is shown in Fig. 3.

The resistance which the ideal diode presents to the ac component of the voltage, is found by replacing  $v$  with  $-\Delta + V_1 \sin \omega t$  in Eq. 1 and calculating the fundamental frequency component of  $i$ . The result is,

$$R = \frac{V_1}{2I_s \exp(-\Delta V_1/V_T) \cdot [(-jJ_1(jV_1/V_T))]} \quad (7)$$

The values given by Eq. (7) range from  $V_T/I_s$  when  $V_1/V_T \ll 1$  to approximately half the resistance of the parallel combination of  $R_p$  and  $V_1/I_s$ . Abstracted from an article by J. Meinhardt, *Schrichtentechnik*, Vol. 8, No. 11, November 1958, pp 489-495.

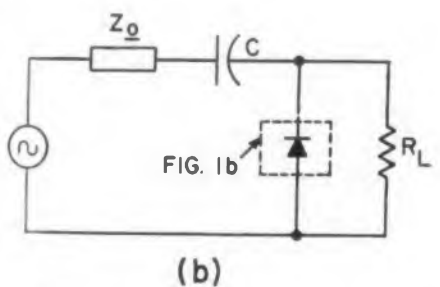
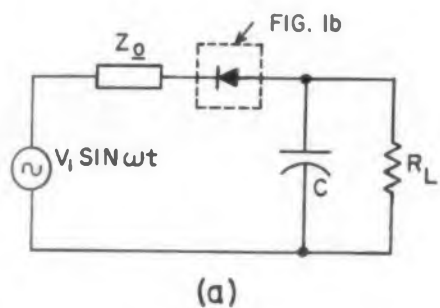


Fig. 2. Typical detector circuits.

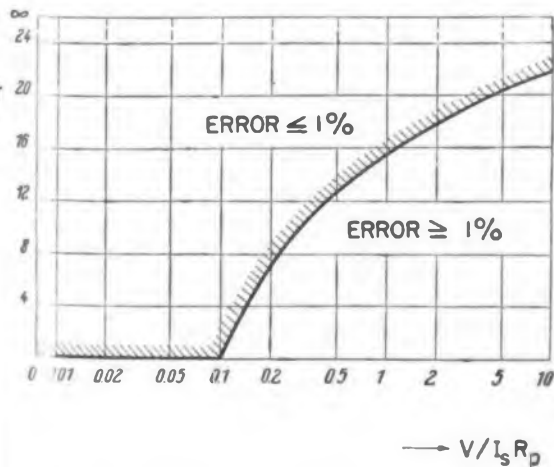


Fig. 3. Restrictions of the validity of the approximate Eq. 6.

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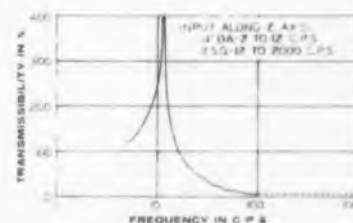
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## REPORT BRIEFS

### Input Impedance of a Yagi Antenna

A solution for the input impedance of a two-element Yagi antenna is obtained by using the variational principle. Current trail functions are chosen and the resulting stationary expression for the input impedance is obtained. The solution is applicable for any choice of element lengths and separation and can be extended to any number of elements. Numerical results for a two-element case is presented. *Back-Scattering Cross Section of an Antenna Part 3 of 3. A Variational Solution For The Input Impedance of a Yagi Antenna*, Henry J. Juda and Yuch-Ying Hu, Syracuse University Research Inst., N. Y., Oct '54-Oct '56, 31 pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 13518 from Library of Congress, Washington 25, D. C.

### Expansible Waveguide

A review of the phases leading to the final development of an expansible waveguide assembly in the RG 109/U size (2.840" × 1.004") in accordance with the requirements as outlined in Bureau of Ships Specification #SHIPS-W-1753. *Expansible Waveguide*, J. W. Hamilton, T. N. Anderson and others, Airtron, Inc., Linden, N.J., July 56, 16pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 135 245 from Library of Congress, Washington 25, D.C.

### Electroforming of Linear Accelerator Structures

The techniques and equipment used at Stanford University for electroforming copper linear accelerator structures are described. The author states that the electroforming method is preferred over mechanical fabrication techniques (such as shrink-fitting copper discs in copper pipes) because it allows baking the structure at high temperatures for outgassing and sealing off the vacuum-tight accelerator tube. The electroformed structures consist of hollow round tubes periodically loaded with copper discs. A circular aperture in the discs provides a path for the flow of rf power and the electron beam. Electroforming gives a stress-free final structure and thus provides more dimensional stability which is important in accelerator operation. Other reported advantages are: (1) the ability to fabricate long accelerator sections with good accuracy (five feet length electroformed to date of report with feet considered feasible); (2) the relative ease of fabricating accelerator structures of non-uniform dimensions. *Electroforming of Linear Accelerator Structures*, J. A. Pope, Stanford University for the Office of Naval Research, June 1957, 22 pp, \$0.50. Order PB 131944 from OTS, U. S. Department of Commerce, Washington 25, D.C.



## Maser Multipole Separator

A Maser in an apparatus utilizing a molecular beam in which molecules in the excited state of a microwave transition are selected and then directed into a microwave cavity. In this report a device is described that is used to select and, at the same time, focus molecules in certain quantum states. *Multipole Separator For Masers*, F. O. Lombini, Army Signal Engineering Labs, Fort Monmouth, N.J., April 57, 25pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 135 528 from Library of Congress, Washington 25, D.C.

## Preparation of Transistor Grade Silicon

A technique for continuous preparation, fractionation, and decomposition of silane to produce high-purity silicon suitable for use in transistors was developed. The process, which produced quantities of 2 to 15 grams, is said to have the advantage of preparing larger amounts of the high-purity silicon quicker than by the technique of decomposition of batches of silane. In addition, the total quantity of silane present at any time in the system is low, since decomposition occurs before high concentrations of silane are accumulated. A separate fractional condensation operation is unnecessary, and the rate of silane formation and decomposition can be controlled. Another accomplishment was production of 94 to 100 percent silane by reduction of silicon tetrachloride with various hydrides. Also studied were the reactivity of silane with substances which showed promise as purifying agents; various "Lewis base" reagents in respect to their influence on reaction rate and purity of silane; variables in the thermal decomposition of silane; and the effect of the particle size of the deposition medium and a hydrofluoric acid leach process on the purity of silane. *The Preparation of Transistor Grade Silicon From Silane or Analogous Compounds*, H. C. Kelly, J. Flynn, C. W. Davis, S. Johnson, Metal Hydrides Inc. for Air Research and Development Command, U. S. Air Force, Aug. 1957, \$2.00, 11 pp. Order PB 131875 from OTS, Department of Commerce, Washington 25, D.C.

## Evaluation of Electronic Gate

A crystal diode gate suitable for sampling accurately small changes in resistance—0.1 per cent at the level of  $10^5$  ohms—is investigated. The gate may be a part of a multichannel signal sampling system. Careful selection of the gate components and reasonable control of the ambient temperature lead to satisfactory gate performance. *Investigation and Evaluation of an Electronic Gate*, Earl P. Manley, Naval Ordnance Lab., White Oak, Md., Feb. 1957, 81 pp, Microfilm \$4.80, Photocopy \$13.80. Order PB 135438 from Library of Congress, Washington 25, D.C.

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Designs are presented of experimental models of broadband ridged waveguide components which were developed for the 1- to 4-kmc range. The experimental models consisted of slotted sections; ridged-to-rectangular adapters for the RG-48/U, RG-69/U, and RG-104/U waveguides; matched terminations; waveguide-to-coaxial adapters; tunable crystal-bolometer mounts; slide screw tuners; directional couplers; variable precision attenuators; and single-to-double ridged waveguide adapters. The performance of all components is satisfactory and meets specifications. *Broadband Ridged Waveguide Components*, Leonard I. Kent, F-R Machine Works, Inc., Woodside, N.Y., 10 Nov 55-10 Oct 56, 62pp, Microfilm \$3.90, Photocopy \$10.80. Order PB 135 120 from Library of Congress, Washington 25, D.C.

### Traveling-Wave Amplifiers

Empirical data showing the effect of some of the externally variable parameters on the operating characteristics of three typical S-band traveling-wave-tube amplifiers are given. Operating characteristics of a dual-rf-output traveling-wave-tube amplifier are presented for an amplifier with minimum small-signal gain of 20 and 40 db. The difference of input power levels to produce beam saturation at the respective couplers is then 13 db. Measurement of two intermodulation effects in a traveling-wave-tube amplifier is presented graphically. *Typical Operating Characteristics of Traveling-Wave Amplifiers*, J. R. Arnold, Stanford Electronics Labs., Stanford U., Calif., July 5, 1957, 20 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 135278 from Library of Congress, Washington 25, D.C.

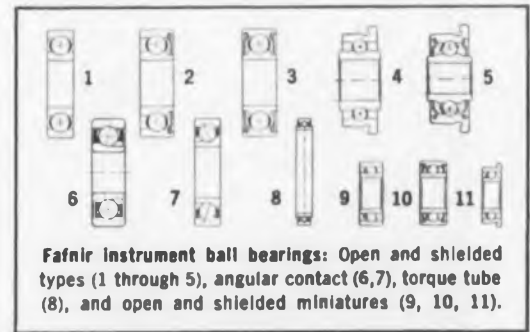
### Reduction and Prevention of UHF Interference

The origin and methods for reducing interference generated within UHF multichannel communication equipments such as the AN/ARC-5 are outlined in this report. The principal types of interference encountered were (1) intermodulation from the action of the nonlinearities in the early stages of the receiver and (2) spurious signal generation from the local spectrum-generator system. Nonlinearities considered were those found in the UHF amplifier tubes and first mixer tube. *Study Program For Investigation To Aid In Reduction And Prevention Of UHF Interference*, Robert Meek, Howard L. McKinley and others, Georgia Inst. of Tech. Engineering Experiment Station, Atlanta, Nov 56, 116pp, Microfilm \$6.00, Photocopy \$18.30. Order PB 135 260 from Library of Congress, Washington 25, D.C.



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Fafnir instrument ball bearings: Open and shielded types (1 through 5), angular contact (6,7), torque tube (8), and open and shielded miniatures (9, 10, 11).



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## Topological Network Theory

Methods of linear algebra and combinatory topology are applied to yield precise versions of certain portions of electrical network theory. Those portions deal primarily with the existence and uniqueness of currents in resistive networks and in passive lumped parameter networks and with the determination of such currents by rigorous algorithms. *Topological Network Theory*, A. Nerode and H. Shank, Chicago U., Ill., Nov 57, 34pp, \$1.00. Order PB 151 416 from OTS.

## Twin-Channel Radio Direction Finder

By properly sampling and averaging the data of two separate channels, the need for the bearing shifter is eliminated. It is shown theoretically that the Separate Channel Averaging System contributes the same order of error due to wave interference as existing systems, provided certain conditions are satisfied. *Separate Channel Averaging in a Matched Twin-Channel Radio Direction Finder*, A. D. Bailey and A. J. Wavering, Electrical Engineering Research Lab., U. of Illinois, June 57, 35pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 135 119 from Library of Congress, Washington 25, D.C.

## Mutual Coupling Rectangular Waveguide

For a large number of cases, the internal reflection and transmission coefficients and the radiation patterns of two nearby shunt slots in the broadface of standard waveguide have been measured and the results compared with theory both including and neglecting mutual coupling (i. e., coupling by other than the dominant waveguide mode). *Mutual Coupling of Shunt Slots in the Broadface of Standard Rectangular Waveguide*, Alan F. Kay and Alan Simmons, Technical Research Group, New York, N. Y. microfilm \$5.40, photocopy \$15.30. Order PB 135215 from Library of Congress, Washington 25, D. C.

## Elapsed-Time Recorders

Two types of equipment have been developed which record propagation data in a form permitting direct analysis by statistical techniques. For both equipments, the data recorded represent continuously totalized measurements of the length of time during which the amplitude of an rf voltage remains above various predetermined levels. Thus a distribution of the fluctuation in signal intensity as a function of time can be obtained directly from the recorded data. *Multiple Channel Elapsed-Time Recorders of Voltage Amplitudes*, R. K. Loyce, Naval Research Lab., Washington, D.C., No. 21, 1958, 30 pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 135644 from Library of Congress, Washington 25, D.C.



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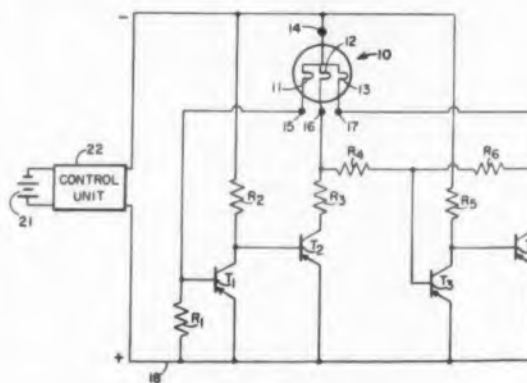
# PATENTS

## Transistorized Current Transfer Apparatus

Patent No. 2,874,331. Fred B. Olto. (Assigned to Sylvania Electric Products, Inc.)

In a multi-filament lamp circuit, each filament is lighted in succession as previously-lighted filaments burn out.

Lamp 10 is powered by control unit 22 and the filaments are in series with transistors  $T_1$ ,  $T_2$ , and  $T_4$ . With transistor  $T_1$  conducting, filament 11 is lighted, and transistors  $T_2$  and  $T_4$  are cut off by the voltage drop across resistor  $R_2$  and re-



sistor  $R_3$  respectively. When filament 11 opens, transistor  $T_1$  cuts off and filament 12 current is carried by transistor  $T_2$ . Transistor  $T_4$  meanwhile is cut off by the voltage drop across resistor  $R_4$ . Finally, when filaments 11 and 12 are open, transistor  $T_3$  cuts off and transistor  $T_4$  conducts to light filament 13.

Typical circuit components are specified to operate each filament at 0.46 amp at 6.2 v.

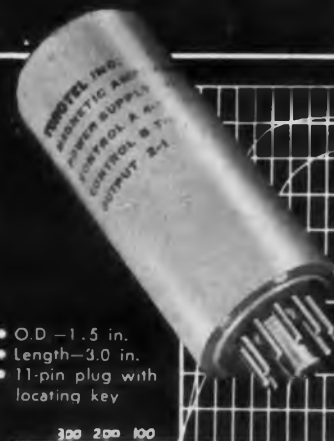
## Frequency—Stabilized Oscillator

Patent No. 2,871,356. Peter G. Sulzer (Assigned to United States of America)

A phase error detection and correction system maintains minimum phase shift in the amplification element of an oscillator resulting in a very high order of frequency stability. In operation, the phase shift is amplified by a second amplifier of moderate phase stability which exerts reactive phase compensation.

Amplifier VI, bridge 5 and feedback

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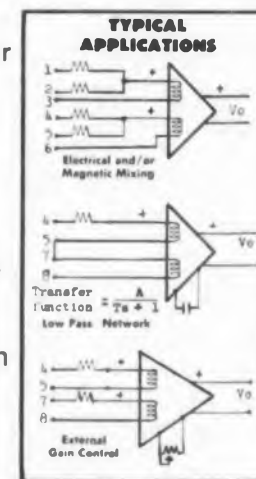


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- Length—3.0 in.
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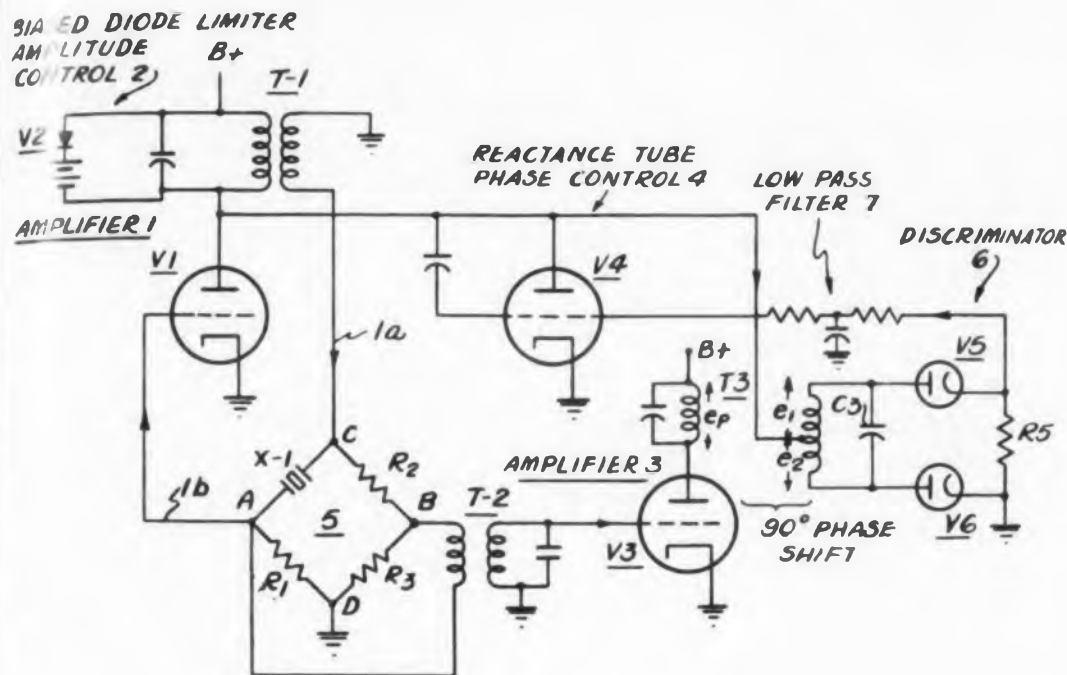


**TOROTEL, INC.**  
5512 EAST 110th STREET KANSAS CITY, MO.

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ELECTRONIC DESIGN • June 10, 1958





transformer *T-1* comprise a Meacham crystal-controlled oscillator. Frequency range off resonance, due to phase shift amplifier *V1*, produces a reactive component in the bridge output 90 deg out phase with the input, sensed by the primary of transformer *T2*. As a result amplifier *V3* current, leading or lagging the input to the bridge, becomes a reac-

tive load on amplifier *V1* to decrease the phase shift in the latter.

Invention lies in the novelty of overcoming the losses of the frequency selective network by means of one amplifier and independently adjusting the gain of a second amplifier, of moderate phase stability, to compensate for phase shift in the first amplifier.

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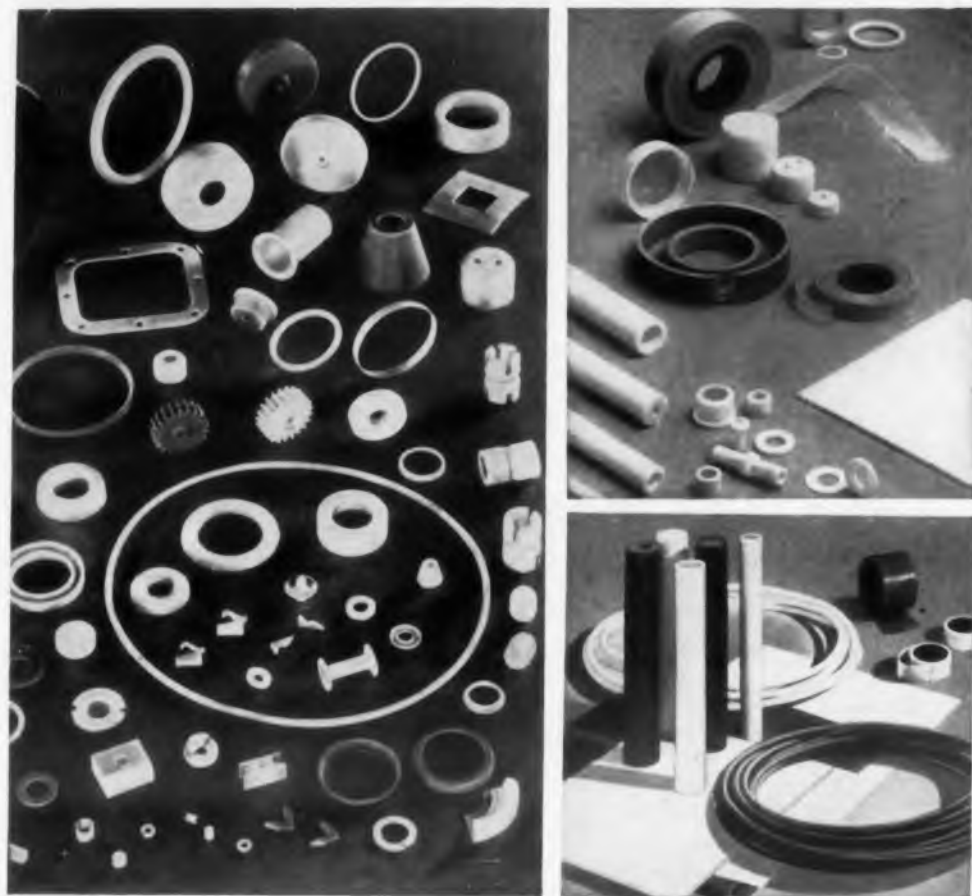


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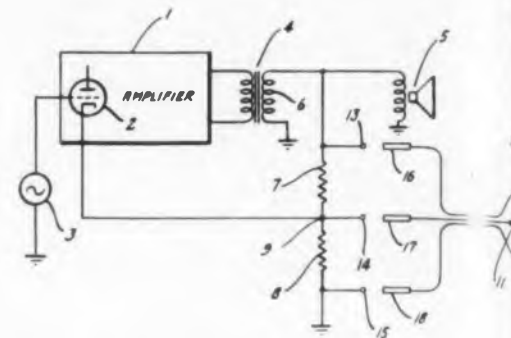
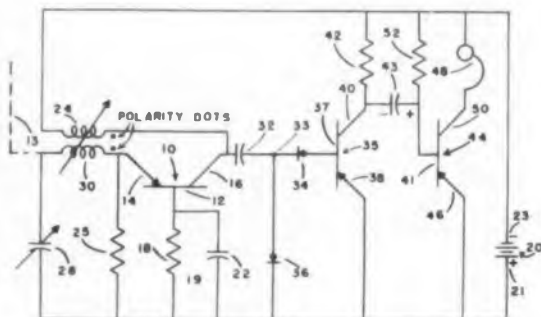
## PATENTS

### Transistorized Radio Receiver

Patent No. 2,873,359. Paul W. Cooper and Joseph F. O'Brien.

An extremely miniature radio receiver (1 x 1.5 x 0.3) weighing one ounce delivers 1 milliwatt output for 50 microvolts input. The radio may be attached to the wrist or used as a locket.

Point-contact transistor 10 amplifies the radio-frequency signal in a tuned, adjustable Q regenerative stage. After detection, the modulation is amplified by PNP transistors 35 and 45 to drive ear-piece 48. Typical circuit components are tabulated.



### Remote Control

Patent No. 2,871,304. Charles W. Dollschek. (Assigned to Philco Corporation.)

A voltage divider across the output of an amplifier determines the feedback to the input. With a remote potentiometer in shunt with the voltage divider, the feedback may be changed to vary the output as desired.

### Hall Effect Amplifier

Patent No. 2,877,309. Heinz K. Henish. (Assigned to Sylvania Electric Products, Inc.)

Hall-effect amplifier output is increased by combining carrier concentration and carries deficiency signals in proper phase.

An H-shaped thin semiconductor body is connected at one side by battery 20

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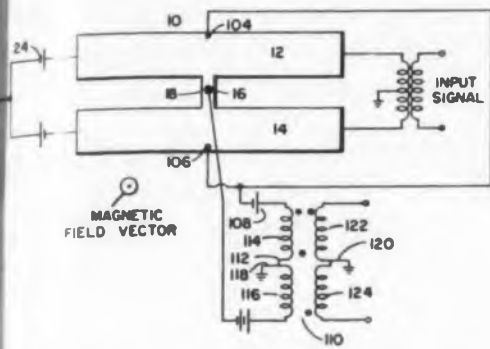
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and the signal is applied at the other side. V. Doll negative and positive charges flow in opposite directions in legs 12 and 14. When the magnetic field is applied, the carriers in both legs concentrate in the region about p-n junction 18. In addition, a carrier deficiency exists at p-n junctions 10 and 106 connected in parallel. Center-tapped transformer 110 connects the Hall-effect current to the load.

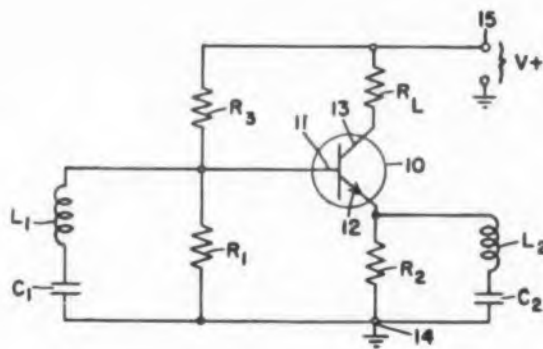
#### Stable Transistor Oscillator

Patent No. 2,878,386. Woo F. Chow and Donald A. Paynter. (Assigned to General Electric Company.)

Series tuned inductance-capacitance networks in the emitter and base circuits of a NPN transistor stabilize the frequency

of oscillation to the order of 7 parts per million per 12 per cent variation of supply voltage.

Resistors  $R$ ,  $R_2$ ,  $R_3$  and  $R_L$  are selected for good dc stabilization and, in addition,  $R_L$  is small compared to the transistor output impedance at the tuned frequency. Capacitor  $C_2$  is selected to provide a capacitive reactance at the frequency of oscillation compared to the combined impedance of inductance  $L_2$  and input resistive components of the resistor. Subject to these conditions, the frequency of oscillations is fixed solely by the values of the external inductances and capacitances and is independent of changes in transistor parameters or supply voltage.



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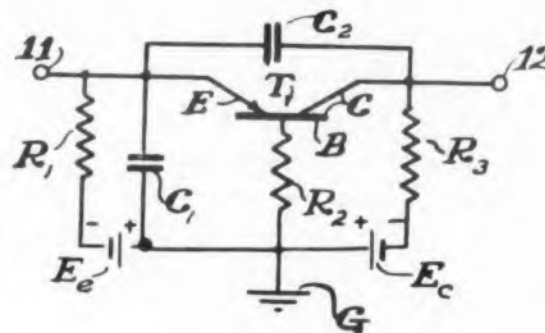
## PATENTS

### Transistor Frequency Dividers

Patent No. 2,869,002. J. G. Sperling. (Assigned to Emerson Radio & Phonograph Corp.)

Stable frequency division is obtained over a temperature range of 60 degs, independent of interchange of transistors, using a monostable relaxation oscillator. The circuit is a divider when the saturation period of the transistor is long compared to the period of the applied pulses.

A positive-input pulse changes capacitor  $C_1$  and  $C_2$  to permit a rapid increase in emitter current at substantially constant emitter voltage. With the transistor sat-



urated, the capacitor discharges through resistor  $R$ , until the emitter voltage drops to flip back the oscillator to the quiet state.

Capacitor  $C_2$  feeds back the output voltage to the input to increase the sensitivity and temperature stability of the network.

### Symbol Generator for Cathode Ray Tubes


Patent No. 2,873,405. Marvin C. Luerts. (Assigned to Bell Telephone Laboratories.)

Position and velocity of a target are displayed on the face of a cathode ray tube by alternately applying deflection and intensity modulation signals to the appropriate electrodes. A special designed three deck switch rotates in synchronism with the radar antenna to make and break the individual circuits without arc over or crosstalk.

Analog computer 1 gives the coordinates of the present position of the target; these signals go directly to the secondaries of the output transformers 35 and 36. Deck 15 is open to cause CRT 11 to cut off and tubes 25 and 26 conduct to dis-

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ZIP-90: polyvinyl bonded to woven fiberglass sheet per MIL-I-3190A. For rough usage, abrasion resistance, and high-temperature uses to 130°C.

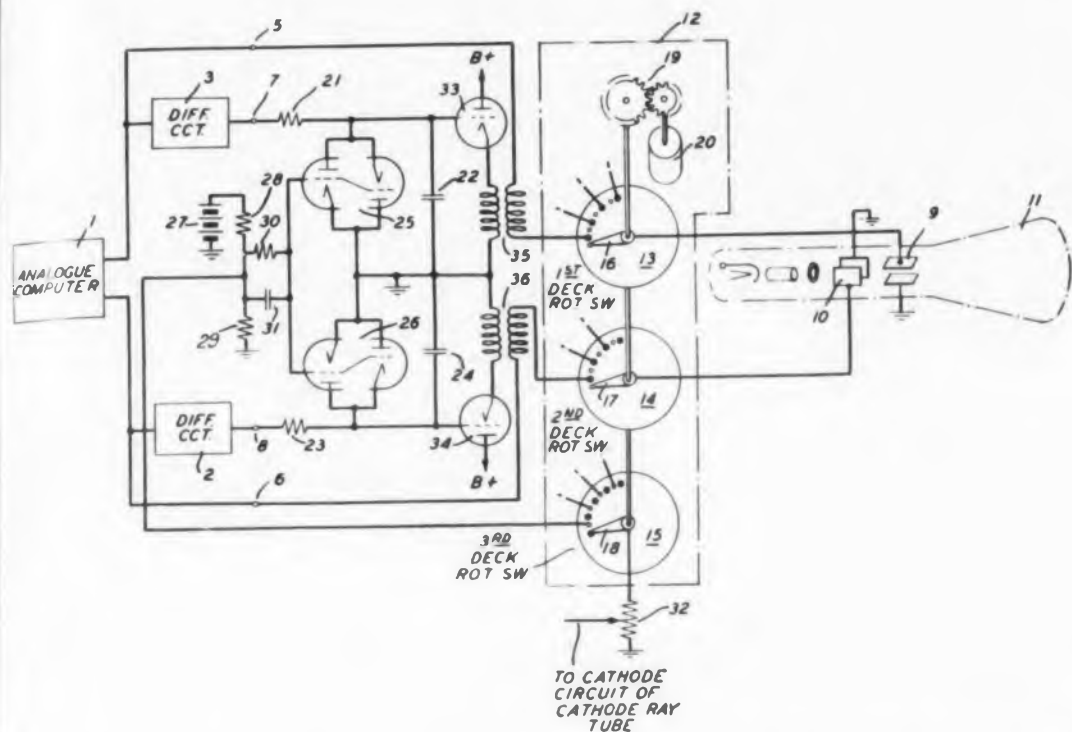
ALPHLEX  TUBING

Division Alpha Wire Corporation  
200 Varick Street  
New York 14, N. Y.

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ELECTRONIC DESIGN • June 10, 1959





charge capacitors 22 and 24.

Switch 12 moves to the next position and blade 18 inserts potentiometer 32 to shut off tubes 25 and 26 and to put the CRT beam "on". Position data is differentiated in circuits 2 and 3 and the coordinates of velocity charge capacitors 22 and 24 feeding the cathode followers

33 and 34. Position and velocity signals combine in the transformer secondaries to produce a linear display originating at the present target position and directed to its predicted path.

Switch 12 moves to the next position and the cycle repeats to maintain the persistence of the display.

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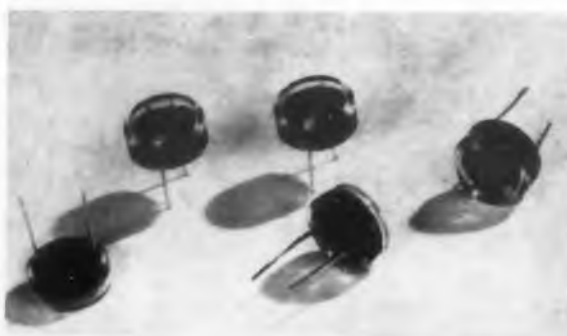
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This light dependent resistor has a resistance ratio in excess of 25,000 to 1 for a light intensity change from total darkness to 1400 ft-c. The unit consists of a cadmium sulfide cell with silver electrodes. It eliminates the need for high amplification stages and has an interminable service life. Among its applications is the control of cathode ray tube brightness.

Ferroxcube Corp. of America, Dept. ED, Saugerties, N.Y.

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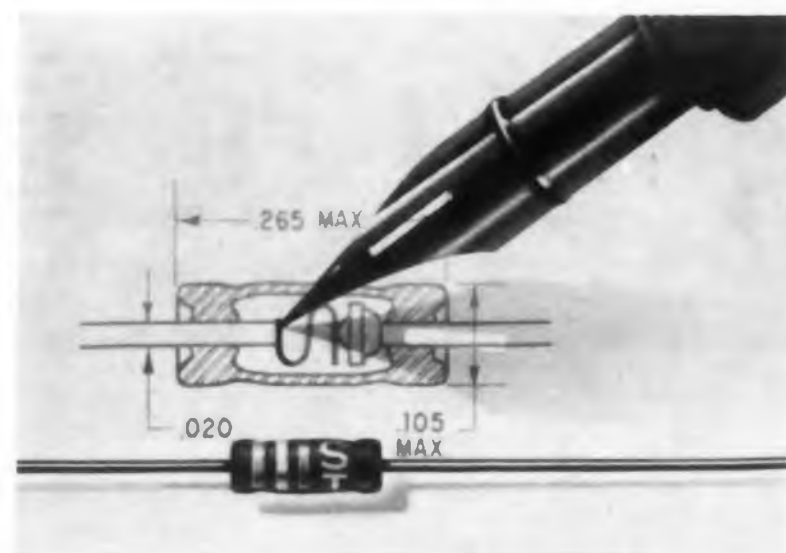


## Oscillators Designed for Telemetry

Models 0-7A, 0-7B and 0-8 silicon transistor, voltage controlled subcarrier oscillators are designed for aircraft and missile telemetry applications. The first unit is available in all seven 0.5% IRIG channels with a 5 v input range sensitivity for full channel deviation. It weighs less than 5 oz and is about 3 cu in. in size. The model 0-7B is a printed card version for plug-in card rack applications. The 0-8 unit is a subminiature unit, about 1 in. cu, and provides for the remote location of alignment controls.

Dorsett Laboratories, Inc., Dept. ED, 401 Boyd St., Box 862, Norman, Okla.

CIRCLE 178 ON READER-SERVICE CARD



## Low Leakage Silicon Diodes Operate at 200 C

These diodes can be used in ambient temperatures up to 200 C. Hermetically sealed, they have low leakage at 150 C. Maximum working voltage is 300 v and forward conductance ranges up to 200 ma at  $\pm 1$  v. The diodes are designed specifically to meet military high reliability programs.

Silicon Transistor Corp., Dept. ED, Carle Place, N.Y.

CIRCLE 180 ON READER-SERVICE CARD



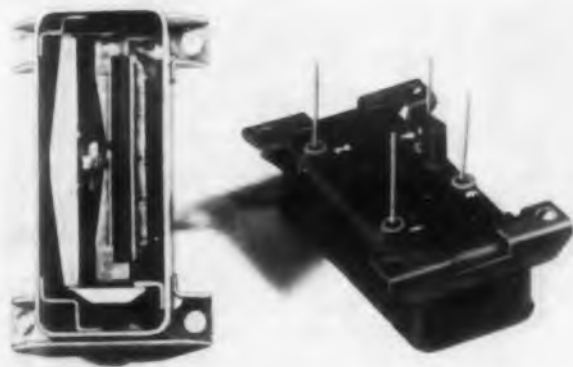


### Meter Fits in 1/2 in. Mounting Hole

Having a 1/2 in. barrel diameter, the model S-10 panel meter is available for both voltage and current measurements. Its ranges are: 0 to 200 and 500  $\mu$ amp dc; 0 to 1, 5, 10 and 20 ma dc; 0 to 15 and 100 v dc; and 0 to 150 v ac. The unit has a clear plastic front measuring 5/8 x 5/8 in. and a shielded moving coil movement. It is adaptable to miniature transistorized circuits.

Alco Electronics Mfg. Co., Dept. ED, 3 Wolcott Ave., Lawrence, Mass.

CIRCLE 181 ON READER-SERVICE CARD



### Thermal Relay Takes 50 g Shock

Able to take 50 g shock for 11 msec, the type PT thermal time delay relay has an operating time delay of from 3 to 60 sec. It can operate under vibration of 20 g up to 2000 cps and has no resonance below 2000 cps. Delay of unit is set within  $\pm 5\%$ . Effects of temperature are held within  $\pm 15\%$  over the range of  $-65$  to  $+125$  C. Hermetically sealed in a 1-3/16 x 2-1/2 x 3/4 in. case, the relay weighs a maximum of 2-1/4 oz.

G-V Controls Inc., Dept. ED, Okner Parkway, Livingston, N.J.

CIRCLE 182 ON READER-SERVICE CARD



PRECISION  
TRIMMER  
PISTON  
CAPACITORS

UNCOMPROMISING DESIGN AND CONSTRUCTION  
UNCOMPROMISING ACCURACY AND RELIABILITY



Precision bore special process glass or quartz dielectric cylinder with specially fitted tuning piston provides the minimum air gap (.0002" maximum) for linear tuning.

(No compromises here that must be compensated for by substitution of expanding core type piston.)

Painstaking assembly of precision-machined bushing and full-threaded anti-backlash adjusting mechanism insures perfect coaxial alignment of piston inside cylinder for all adjustments. Result: No tuning reversals. Absolute repeatability.

(No compromise here with direct traveling mechanism that requires additional encumbering parts leaving no

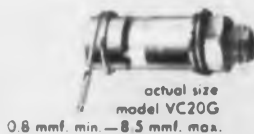
room for vital anti-backlash spring . . . or square adjusting shaft threaded only at corners and having short rotational life.)

Gold plating over special JFD alloy plating enables all metal parts to withstand 50 hour salt spray test and provides superior R.F. conductivity.

(No compromise here with porous silver-plating which permits corrosion of base metal.

Screwdriver adjust slot (or hex socket) recessed within well for ease of location and blind hole tuning.

(No compromise here with protruding adjusting shaft which adds to overall length of capacitor and lacks ease of tuning.)



actual size  
model VC20G  
0.8 mmf. min. — 8.5 mmf. max.



actual size  
SEALCAP  
model SC133  
0.8 mmf. min. — 8.5 mmf. max.

Same fine features of model VC20G  
Plus permanently sealed interior  
construction that seals out moisture  
and humidity.

There's more to trimmer design and construction than meets the eye. Look inside and see why JFD precision-engineered Trimmer Capacitors speak for themselves . . . in ultra tuning linearity . . . in high stability . . . in tuning repeatability . . . in shock and vibration resistance . . . in smooth, uniform tuning resolution . . . in compactness and high Q. Millions in daily use in thousands of proven applications best tell their story of uncompromising performance.

Write today for engineering data bulletins describing Models VC20G and SC133, and all other JFD Trimmer Capacitors.

# JFD

PHONE DEWEY 1-1000

Pioneers in electronics since 1929

## JFD ELECTRONICS CORPORATION

6101 Sixteenth Avenue, Brooklyn 4, New York

JFD International, 15 Moore Street, New York, New York • JFD Canada Ltd., 51 McCormack Street, Toronto, Ont., Canada

CIRCLE 183 ON READER-SERVICE CARD



# RUGGED

**IN THE ROUGHEST, TOUGHEST RIDES,  
LEAR SERIES 1080 GYROS ASSURE CONTROL**

*Demanded by extreme vibration in missile environment: a small, rugged, reliable vertical gyro providing maximum performance.*

*Successfully engineered by Lear: a compact two-degree-of-freedom vertical gyro with proven high quality at low cost.*

SERIES 1080 GYROS WILL MEET YOUR APPLICATION REQUIREMENTS FOR DIRECTIONAL OR FREE GYROS AS WELL AS VERTICAL GYROS.

## LEAR 1080 SERIES DISPLACEMENT GYRO



# LEAR

**GRAND RAPIDS DIVISION**

110 IONIA AVE., N.W., GRAND RAPIDS 2, MICHIGAN

G-5

## NEW PRODUCTS

### Precision Frequency Standard

Has  $5 \times 10^{10}$  per day stability



Precision frequency standard model JKFS-1100T has a stability of  $5 \times 10^{10}$  per day. It is fully transistorized with a double proportional control oven and operates from 24 to 32 v unregulated dc. Output is 1 v into 50 ohms at 1 mc and 100 kc. Dimensions are 6 x 4-3/16 x 12-1/2 in.; and weight is 9 lb. A companion power supply, the JKFS-1100TP, is available to operate from 115 v ac with self-contained standby batteries.

The James Knights Co., Dept. ED, Sandwich, Ill.

CIRCLE 184 ON READER-SERVICE CARD

### Electrically Variable Delay Lines

Provides delays to 12  $\mu$ sec

For carrier or pulse type applications, these electrically variable delay lines are rated at frequencies to 40 mc and provide delays to 12  $\mu$ sec. The delay-bandwidth product ranges from 2 to 6 mc- $\mu$ sec. Infinite steps of delay variation up to 50% of total delay are provided by a control winding, using either dc or ac current. The units can perform the phase of frequency modulation function in mobile or fixed transmitters. They may also be used in self-correcting or feedback systems permitting the automatic adjustment of time delay or pulse position.

General Electric Co., Heavy Military Electronics Dept. Dept. ED, Court St. Plant, Syracuse, N.Y.

CIRCLE 185 ON READER-SERVICE CARD

CIRCLE 186 ON READER-SERVICE CARD



## Magnetic Multiplexer

### High speed

This multiplexer can sample low level voltages at a rate of 5000 channels per sec. It has an operating life of 20,000 hr and takes up a minimum of space, with a 1000 channel unit occupying 12 cu in. and weighing 5 lb. The device can be used in the high speed multiplexing, without preamplification, of strain gages, thermocouples, and potentiometers. It can also be used in missile telemetry, aircraft logging systems, and automatic check-out systems. At present, the unit is available for operation in restricted temperature environments.

Cubic Corp., Dept. ED, 5575 Kearny Villa Rd., San Diego 11, Calif.

CIRCLE 187 ON READER-SERVICE CARD

## DC to DC Converter

### Has 150 w output

This hermetically sealed, static dc to dc converter is designed for use in portable test, emergency, and airborne equipment. It has a maximum multiple output of 150 w, line regulation of  $\pm 1\%$ , and a 28 v dc input. It is short circuit proof and measures 5 x 3.5 x 3.7 in.

Magnetic Research Corp., Dept. ED, Hawthorne, Calif.

CIRCLE 188 ON READER-SERVICE CARD

## Pigtail Connectors

### Solderless

These nylon insulated solderless connectors are closed end devices for pigtail splicing of two or more wires. The inserted wires are crimped in a single operation, and the splice is permanently anchored and insulated. Type NC-1610 takes any number and combination of wires totaling 16 through 10 AWG, and type NC-2214 accepts wire totaling 22 through 14 AWG.

Electric Terminals & Connectors, Inc., Dept. ED, 990 E. 67th St., Cleveland 3, Ohio.

CIRCLE 189 ON READER-SERVICE CARD

CIRCLE 190 ON READER-SERVICE CARD



## ESC delay lines take off with America's talking satellite

On December 18, 1958, the world entered a new era of communications with the successful orbiting of an Atlas ICBM—the Talking Satellite that broadcast President Dwight D. Eisenhower's Christmas message to the world. Circling the earth at a speed of more than 17,000 mph, the Talking Satellite repeated the President's message, erased it, and received and rebroadcast new messages in both voice and code.

ESC Corporation is justifiably proud that its delay lines were selected to aid in this electrifying triumph for America and her electronics industry. Especially designed by ESC, these delay lines were used in the timing sequence for propulsion, the guidance system and the telemetering system.

As America's largest manufacturer of custom-built and stock delay lines, ESC has continually met the responsibility of leadership by providing virtually every type of delay line needed by defense and industry. If you have a delay line problem, let ESC's design staff suggest a custom-built answer.



# ESC

WRITE TODAY FOR COMPLETE TECHNICAL DATA.

exceptional employment opportunities for engineers experienced in computer components    excellent profit sharing plan

**CORPORATION** 534 BERGEN BOULEVARD PALISADES PARK, NEW JERSEY

Distributed constant delay lines • Lumped constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers • Pulse transformers • Medium and low power transformers • Filters of all types • Pulse forming networks • Miniature plug in encapsulated circuit assemblies



## NOW EXCLUSIVELY VACUUM MELTED KARMA High Resistance Alloy THERLO Glass Sealing Alloy

This dramatic "first" in the manufacture of nickel alloys by Driver-Harris has been achieved by expanded vacuum melting capacity. It is still another example of our continued leadership in producing electrical and electronic nickel alloys of the highest purity.

D-H vacuum melting produces alloys of higher ductility and tensile properties. These are achieved by greatly reducing inclusions, especially oxides and nitrides. Other direct bene-

fits are elimination of gas, not only from the surface but from the entire mass, and general improvement in the electrical, electronic and mechanical properties to meet critical specifications.

For additional information about Karma, Therlo and the other 130 high-nickel alloys manufactured by Driver-Harris, write for a copy of the D-H Alloy Manual.

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



### VACUUM MELTED KARMA\* High Resistance Wire

The temperature coefficient of superior KARMA resistance wire has been improved to less than  $\pm 10$  parts per million from  $-60^{\circ}\text{C.}$  to  $+125^{\circ}\text{C.}$  Higher stability and linearity are added to these important properties.

- Low thermal EMF against copper (equaled only by Manganin)
- Improved ductility
- High resistance to oxidation
- Wire sizes down to .0005"
- 800 ohms per circular mil foot



### VACUUM MELTED THERLO\* Glass Sealing Alloy

Improved workability is the major result of vacuum melting THERLO... the long established cobalt, nickel, iron alloy for sealing to hard or thermal shock resistant glass.

- THERLO also:
- Produces a permanent vacuum-tight seal with simple oxidation procedure
  - Resists mercury
  - Is readily machined and formed—deep drawn or spun
  - Can be welded, soldered, brazed
  - Is available as rod, wire, strip, sheet foil—and in special shapes

## DRIVER-HARRIS\* COMPANY

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville

Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES

CIRCLE 191 ON READER-SERVICE CARD



## NEW PRODUCTS

### Electronic Switching Device

For scanning transducers



For use in scanning transducers, the Sequi Switch has applications in telemetering, dynamic force and pressure studies, and multipoint data gathering. The device uses a 10 channel beam switching tube that switches at a preselected rate up to 1 mc. The switching pulses provide a carrier for transducers. The unit has a high signal to noise ratio and may be used with linear displacement or torque transducers, strain gages, thermistors, and capacity pickups. It can be adapted for printed readout or used with an oscilloscope.

Control Devices, Inc., Dept. ED, 925 S. Eton, Birmingham, Mich.

CIRCLE 192 ON READER-SERVICE CARD



### Latch

Stays flat against container

The Hook-Lock is a springless latching device for use on military cases and commercial containers. Standard units provide a closing pressure of 200 lb and a load carrying capacity of 750 lb. Open or closed, the Hook-Lock lies flat against the container on which it is mounted, extending 7/16 in. at its thickest point. It is impact and shock proof and withstands high impact blows directly on the fastener. It is unaffected by arctic temperatures.

Simmons Fastener Corp., Dept. ED, N. Broadway, Albany 1, N.Y.

CIRCLE 193 ON READER-SERVICE CARD



## Frequency Converter

Has 15 cps to 40 kc range



Type 2A improved frequency converter has a 15 cps to 40 kc range and an output current up to 2 ma. It is adaptable to all types of pulse generating transducers, and, with the output current range extended, it can be used for recorders, computers, digital indicators, millimeters, and data handling equipment. It has  $\pm 0.1\%$  stability, 0.2% overall accuracy, and a 0.5 msec time constant. Power requirements are 115 v, 60 to 1000 cps and 35 w, and line voltage may vary  $\pm 10\%$  without affecting accuracy. The unit is mounted on a chassis 5 x 11-1/2 x 6 in. and is also available in 19 in. relay racks 3-1/2 in. high and 9 in. deep.

George L. Nankervis Co., Cox Instruments Div., Dept. ED, 15300 Fullerton Ave., Detroit 27, Mich.

CIRCLE 194 ON READER-SERVICE CARD



## Power Inverter

Transistorized

Transistorized power inverter model 801 furnishes a square wave output of 20 va at 117 v ac when operating from a 12 v dc source. Designed for airborne and ground support equipment, it has 85% overall efficiency and 5% load regulation from half to full load and  $-55$  to  $+95$  C. Standard units have miniature 7-pin plug-in type headers, but hook or eyelet types can be supplied. The epoxy encapsulated components are packaged in a MIL-T-27A Type EB case 2-7/16 x 1-5/16 x 1-5/16 in. The inverter meets MIL-E-5272B requirements and weighs 1 lb.

Metrolab Corp., Dept. ED, 169 N. Halstead St., Pasadena, Calif.

CIRCLE 195 ON READER-SERVICE CARD

PIN PLUNGER - type S2A6A1

LEAF-SPRING - type S2A6B1

ROLLER LEAF - type S2A6C1

HINGED RIGID LEVER - type S2A6D1

LONG HINGED ROLLER LEVER - type S2A6E1

SHORT HINGED ROLLER LEVER - type S2A6F1

STUB PLUNGER - type S2A6G1

PANEL-MOUNT PLUNGER - type S2A6H1

# NEW HiPAC PRECISION SWITCHES

Series S2A



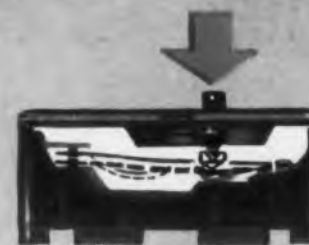
take on *high current*  
in control and indicating  
circuits

Hetherington's new HiPAC Precision Switches represent the latest refinements of the switch-makers' art. Compact and precision made in every detail, these small high-current switches provide carefully controlled force and movement characteristics for unsurpassed repeatability in critical applications. One-piece blade actuators of selected beryllium copper operate against solid silver contacts to give long, stable mechanical and electrical life with uniformly low contact resistance.

Here's a capsule run-down on the new Series S2A Switches: rated at 20 amps., 125/250 volts ac, 1 and 2 horsepower ac; U.L. Inspected; SP-DT

circuit; unusually rigid ammonia-free phenolic case; interchangeable with other precision switches of equivalent ratings; built-in safety limit to prevent over-travel damage to blade; molded-in barriers to provide long creepage paths and positive separation between terminals and leads.

HiPAC Precision Switches are available with any of eight actuators. Prompt delivery of samples may be obtained from over 50 leading electronic parts distributors — use part numbers shown above to order. For complete specifications, write for Hetherington Bulletin S-9.



UNIQUE BRACING  
PREVENTS BLADE  
DAMAGE



RIGID CASE  
ASSURES  
DISTORTION-FREE  
MOUNTING



MOLDED-IN  
BARRIERS  
POSITIVELY  
SEPARATE  
TERMINALS

**HETHERINGTON INC.**

• Folcroft • Pa. •

A CONTROLS COMPANY  
OF AMERICA SUBSIDIARY

CIRCLE 196 ON READER-SERVICE CARD



## A POUND OF PERFORMANCE IN A 0.4-OUNCE UNIT

Into its diminutive Crystal Case Relay Wheelock Signals packs a bipolar magnetic coil structure, a DPDT contact assembly, low coil power and superior environmental stability.

The entire assembly is terminated in a superior glass-to-metal header and the case is then secured to the header by positive hermetic seal techniques.

Observe! The end product is an astounding item of space age engineering providing a full measure of performance and reliability . . . as light as an autumn leaf as tiny as an elf with the survival potential of a bulldog and the consistent reliability of Tuesday.

In your airborne equipment, isn't there a place now awaiting these functional benefits?

Crystal Case Relays by Wheelock Signals are available in a wide selection of voltage ratings, termination styles and meet a variety of mounting methods.

Write for Bulletin 160-1.

*Wheelock* SIGNALS  
INC.



LONG BRANCH, N. J.

CIRCLE 197 ON READER-SERVICE CARD

## NEW PRODUCTS

### DC Power Supplies

Fast response



Series TRM dc power supplies have magnetic amplifier regulation and high speed response. They cover a range of voltages between 5 and 160 v for loads of up to 120 amp. A static load change from zero to rated maximum causes the dc output voltage to deviate less than 0.1% or 50 mv, whichever is greater. Regulation is the same for line voltage variations of  $\pm 10\%$ . Capacitor banks range from 0.03 to 1.6 f, and ripple is less than 1% rms in all models. A pair of 4-1/2 in. rectangular 2% accuracy meters is standard equipment.

NJE Corp., Dept. ED, 345 Carnegie Ave., Kenilworth, N.J.

CIRCLE 198 ON READER-SERVICE CARD

### Ferrite

For magnetic cores



Highly permeable and machinable, ferrite MN-30 is suitable for use in magnetic cores at frequencies up to 500 kc. It can be furnished in virtually any size and shape with dimensional tolerances of  $\pm 0.001$  in. Density ranges from 4.9 to 5 g per cc; initial permeability at 21 C and 5 kc is 3000; and maximum permeability at 2000 gauss is 6000. Flux density at 7 oersteds is 4250; Curie temperature, 180 C; and loss factor,  $7.5 \times 10^{-6}$  at 50 kc and  $30 \times 10^{-6}$  at 500 kc.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

CIRCLE 199 ON READER-SERVICE CARD



## Signal Generator

Provides  $\pm 0.05\%$  rf settability

Signal Generator type 225-A affords rf settability of better than  $\pm 0.05\%$ ; rf stability of 0.001% for 5 min and 0.001% at 30% am; and fm modulation from an external oscillator. It incorporates a backlash free gear drive and a precision machined piston attenuator. Because of its fm modulation above 130 mc, this general purpose unit may be used for testing and calibrating fm communication systems in the 160 and 450 mc bands. It has a 10 to 500 mc rf range; a 0.1  $\mu$ v to 0.1 v rf output range; and a 0 to 30% am range. The fm range is 0 to between 5 and 60 kc deviation, depending upon frequency, in the 130 to 500 mc range.

Boonton Radio Corp., Dept. ED, Boonton, N.J.

CIRCLE 200 ON READER-SERVICE CARD

## Pressure to Frequency System

Operates on IRIG and higher bands

Model PFS-2 pressure to frequency system measures a wide range of absolute, gage, or differential pressures and is furnished for use at any of a number of IRIG bands as well as still higher frequencies. The stable fm system is shock and vibration resistant and linear within  $\pm 1\%$ .

Ultradyn, Inc., Dept. ED, P.O. Box 3308, Albuquerque, N. Mex.

CIRCLE 201 ON READER-SERVICE CARD

## Sweep Frequency Test Set

Measures gain, loss, and vswr

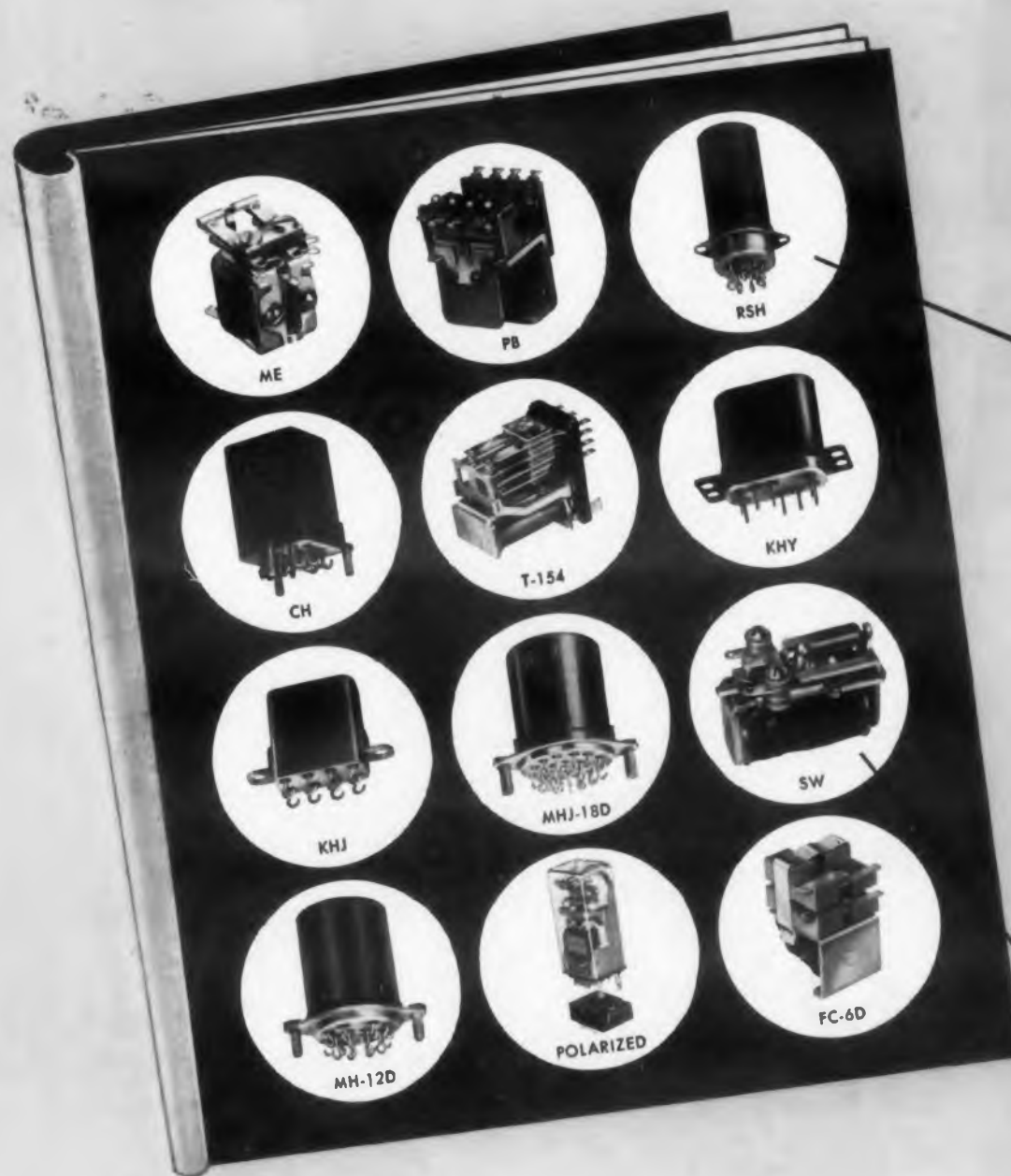
Sweep frequency test set 1707 provides accurate quantitative and comparative measurements of gain, loss, and vswr in terms of dbm, power, voltage, and the db difference between two levels. It includes a crystal controlled marker generator, a precision sweep generator, and a voltage comparator.

Jenold Electronics Corp., Dept. ED, 5th and Lehigh Ave., Philadelphia 32, Pa.

CIRCLE 202 ON READER-SERVICE CARD

CIRCLE 203 ON READER-SERVICE CARD

# 2 ALLIED CONTROL Sensitive Relays



TYPE RSH—ACTUAL SIZE

Designed as a rugged sensitive relay Allied's type RSH is available with a variety of mountings including plug-in connections. Although the contact rating is 2 amperes special contacts are available for low level applications.



TYPE SW—ACTUAL SIZE

Sensitive, dependable and reasonably priced, Allied's type SW incorporates a metal to metal hinge piece giving maximum sensitivity in a small compact construction. This relay is available with a variety of mountings including plug-in construction or solder type terminals.

### GENERAL SPECIFICATIONS

	TYPE RSH	TYPE SW
Sensitivity	SPDT—22 milliwatts DPDT—40 milliwatts	SPDT 3 to 50 milliwatts SPDT 12 to 50 milliwatts
Contact Rating	2 amperes resistive at 29 volts d-c or 115 volts a-c	1 to 5 amperes resistive at 29 volts d-c or 115 volts a-c
Vibration	10-55 cps at .06" double amplitude 55-500 cps at 10 g	10-55 cps at .02" to 0.1" double amplitude
Shock	50 g	10 to 40 g
Temperature Range	-65°C to +125°C	-55°C to +71°C
Enclosure	Hermetically sealed	Hermetically sealed, dust cover or open
Overall Dimensions	1 3/8" x 2 7/32" x 1 1/32"	2 3/4" x 1 7/16" x 1 3/8"
Values will vary depending on sensitivity		



# ALLIED CONTROL



ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.



# NEW LOW-NULL MOTOR GENERATORS

HOLD DOWN OUTPUT NULL TO 0.003 AND 0.006 V.

Daystrom Transicoil has whittled the null output voltages of its Size 9 and 11 Motor Generators down to a slim 0.003 and 0.006 respectively. Signal to noise ratio gets a big boost up to 120:1 for Size 9 and 100:1 for Size 11. Linearity is within .25%. A wide range of gear ratios can be furnished.

Complete specifications with drawings and charts are yours for the asking. Other types and sizes of motor and motor generators are also available. And be sure to get complete details on our new synchro

line. Daystrom Transicoil, Division of Daystrom, Inc., Worcester, Montgomery County, Pa. Phone: JUNO 4-2421. In Canada: Daystrom, Ltd., 840 Caledonia Rd., Toronto 19, Ont. Foreign: Daystrom International Div., 100 Empire St., Newark 12, N.J.



**DAYSTROM TRANSICOIL** DIVISION OF DAYSTROM, INC.

*Representatives in Canada and Other Foreign Countries*

CIRCLE 204 ON READER-SERVICE CARD

## NEW PRODUCTS

### Current Governor

For piv measurements



Designed for piv measurements, the model CS-120 current governor is a programmable constant current source with a 0.1  $\mu$ a to 10 ma range from 0 to 2200 v dc. Current is set to five places by decade knobs arranged to provide a digital in-line readout. Line and load regulation are better than 0.05%. Peak inverse and Zener voltage measurements on rectifiers can be made at controlled current, and dynamic impedance can be measured by modulating the current and measuring ac voltage across the diode. The unit is 19 x 8-3/4 x 13 in. and weighs 40 lb.

North Hills Electric Co., Inc., Dept. ED, 402 Sagamore Ave., Mineola, N.Y.

CIRCLE 205 ON READER-SERVICE CARD

### Delay Line Boxes

Provide delays to 12.6  $\mu$ sec



Model 443 binary delay line boxes are lumped constant delays which may be set to any delay with a precision of 0.8% of the maximum value. The switching arrangement disconnects the unused portion of the delay, thereby eliminating reflections. Seven models are available providing delays to 12.6  $\mu$ sec, impedances of 100 and 500 ohms, and rise times of 0.3, 0.1, and 0.05  $\mu$ sec. The units may be used in laboratory instrumentation or as substitute delay line components.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

CIRCLE 206 ON READER-SERVICE CARD



## Random Wave Equalizing System

For vibration testing

For fast accurate equalization of random or complex wave energy during a vibration test, this system consists of the model ESD-20 equalizing system and the model ASD-20 analyzing system. The ESD-20 divides the spectrum of random or complex vibration signals into 26 separate frequency bands, each continuously and independently adjustable in amplitude. The up and down position of vertical motion attenuators show the approximate spectrum of the equalized system. The ASD-20 analyzes the average acceleration power spectral density of 20 separate frequency-bands in the output response of a vibration test system.

Ling Electronics, Inc., Dept. ED,  
937 W. Jefferson Blvd., Culver  
City, Calif.

CIRCLE 207 ON READER-SERVICE CARD

## Pressure Transducer

Has Bourdon tube movement

Model 717 pressure transducer has a Bourdon tube movement to assure operation to 35 g at 2000 cps vibration. It has a  $-65$  to  $+200$  F temperature range, 0 to 400 to 0 to 5000 psia pressure ranges, 1 to 10 K resistances, and a 1.5 w rating at 65 F.

Bourns Labs, Inc., Dept. ED, P.O.  
Box 2112, Riverside, Calif.

CIRCLE 208 ON READER-SERVICE CARD

## Silicone Rubber

For capacitor seals

Type MS 90C00 is a tear resistant silicone rubber meant for capacitor seals. It has a low compression set and high hardness and will not contaminate dielectric fluids. Bushing and washer type seals can be furnished in molded-to-shape or extruded and-cutoff forms.

Moxness Products, Inc., Dept.  
ED, Indiana St., Racine, Wis.

CIRCLE 209 ON READER-SERVICE CARD

CIRCLE 210 ON READER-SERVICE CARD

**NEW** in looks, new in efficiency, and forerunner of a great new line of MB vibration exciters...that's the new Model C125.

Once again leading the way, MB has achieved a radical step-up in magnetic circuit efficiency. This new shaker, barely larger than its predecessor, develops 10,000 pounds force output...a 43% gain! Conversely, it calls for less amplifier power than any other electrodynamic shaker of comparable force.

Leading companies in missiles, aircraft and electronics look first to MB for progress in complete vibration test systems. It has been that way for almost 15 years. Our "encyclopedia" of vibration experience is yours to draw on...as is the largest, national, field service staff of specialists. Send for full data.

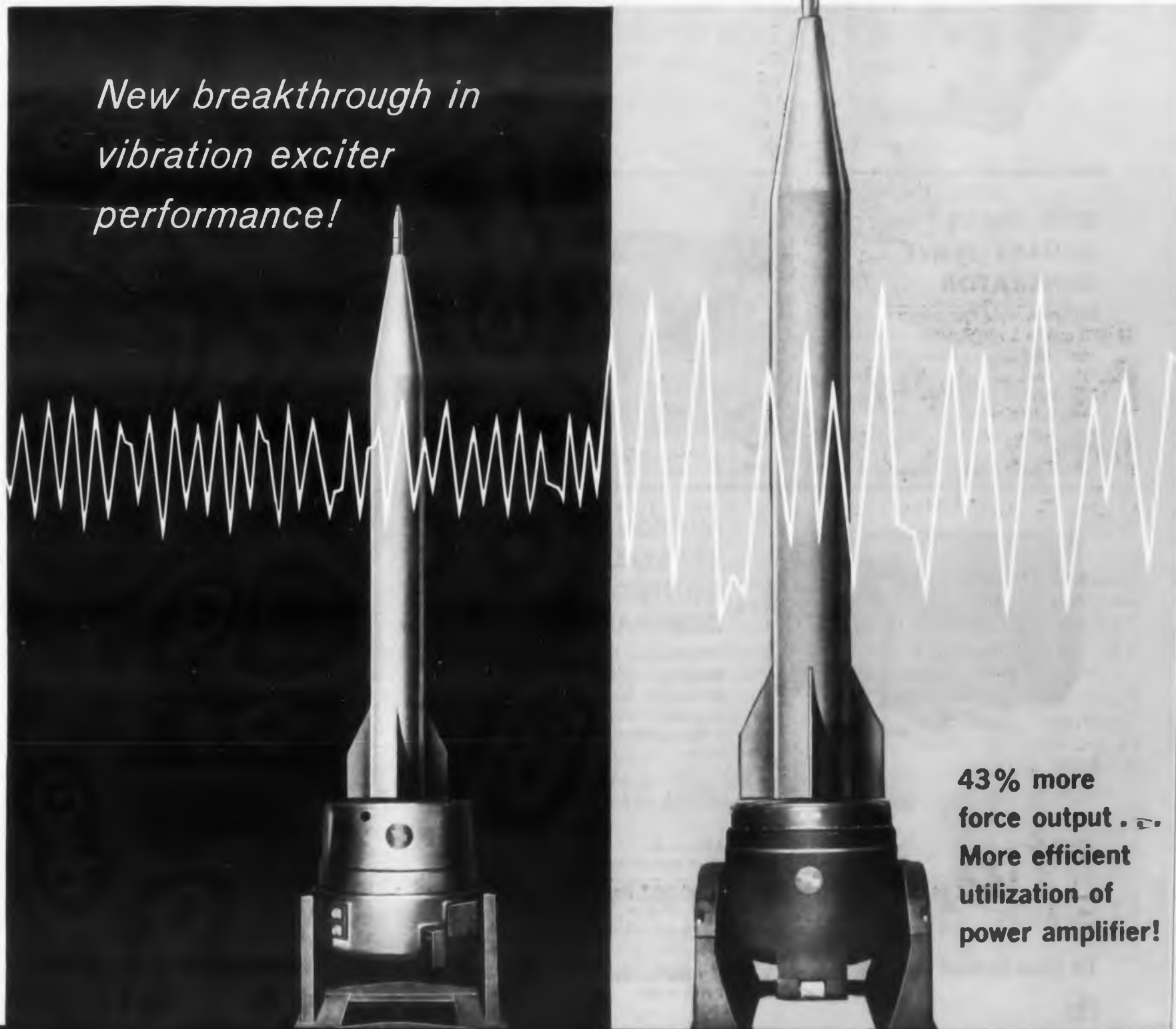
Pioneer and leader in the field of vibration

**MB MANUFACTURING COMPANY**

A DIVISION OF TEXTRON INC., 1058 State Street, New Haven 11, Conn.



*New breakthrough in  
vibration exciter  
performance!*



**43% more  
force output . . .  
More efficient  
utilization of  
power amplifier!**



MODEL 1715

### NEW SQUARE WAVE GENERATOR

Frequency range of 1 cps to 1 megacycle.  
Rise time of 0.02 microseconds.  
Highly stable.  
Voltage regulated.  
New centerline construction improves reliability.

\$300

### SINE-WAVE SQUARE-WAVE GENERATOR

Covers a wide frequency range of 20 cps to 1 megacycle—both sine-wave and square-wave. Sine wave total harmonic distortion is below 1%. Square wave rise time is less than 0.1 microseconds.

\$495



MODEL 710



MODEL 295X

\$554

### MICROVOLT and CRYSTAL CONTROLLED GENERATOR

Continuous frequency coverage from 125 kilocycles to 175 megacycles on fundamentals. Direct reading. Vernier tuning. Metered output from 0.1 to 100,000 microvolts—No external pad required.

Crystal controlled RF oscillator 400 kilocycles to 20 megacycles—to 250 megacycles on harmonics.

A demonstration or technical literature is available at your request



**RD INSTRUMENTS**  
FOR RESEARCH AND DEVELOPMENT

The Hickok Electrical Instrument Company • 10514 Dupont Ave. • Cleveland B, Ohio

CIRCLE 211 ON READER-SERVICE CARD

## NEW PRODUCTS

### Digital Indicator and Force Calibrator

Has direct readout



Portable model 170 digital indicator and force calibrator is a self-contained, continuously and automatically balanced digital servo indicator that uses no batteries or standardization. It can serve as a highly accurate field indicator or as a calibration standard for weight, force, and thrust measuring systems.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

CIRCLE 212 ON READER-SERVICE CARD

### Relays

Rated up to 10 amp



Type W relays are rated up to 10 amp and are available from spdt to 3pdt in all standard ac or dc voltages. They can be supplied hermetically sealed or open for ambient to 125 C or in a dustproof polystyrene case with an 8 or 11 pin base. Open size is 1.75 x 0.937 x 1.187 in. and dustproof size is 2 x 1.4 x 1.4 in.

Globe Electrical Mfg. Co., Dept. ED, 1729 W. 134th St., Gardena, Calif.

CIRCLE 213 ON READER-SERVICE CARD



**NEW!**  
**KAY**  
*DRD Meters*  
DIRECT-READING  
DIGITAL FREQUENCY  
METERS

Type No.	Freq. Range	Connection Available with Delivered Coupling Elements	Price*
SL 7510	1.10-1.70 kmc	Coaxial only, plus crystal diode	\$550.00
SL 5815	1.55-2.50 kmc	Same as SL 7510	495.00
SL 5212	2.50-4.00 kmc	Waveguide, coaxial, crystal diode and combinations	450.00
SL 5590	3.30-4.90 kmc	Same as SL 5212	450.00
SL 5174	3.80-5.90 kmc	Same as SL 5212	450.00
SL 5585	5.40-8.60 kmc	Same as SL 5212	425.00
SL 7100	7.05-11.2 kmc	Waveguide, coaxial, crystal diode and combinations	425.00
SL 5205	8.20-12.4 kmc	Same as SL 7100	325.00
SL 7095	12.4-18.0 kmc	Waveguide only	395.00

Accuracy: Better than  $\pm 0.1\%$ .  
Temperature Coefficient: Zero at midband;  $\pm 8.10\%/^{\circ}\text{C}$  at upper and lower ends.

\*Prices are f.o.b. factory and include all coupling elements available for that frequency meter. Write for prices of meters alone or with selected coupling elements.

Write for  
Kay Catalog  
1959-A

**KAY ELECTRIC COMPANY**

Dept. ED-6 Maple Avenue Pine Brook, N. J. Capital 6-4000

CIRCLE 214 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959



**PRINTED CIRCUIT CAPACITORS.**—Series LZ operate from  $-70$  to  $+175$  C without derating, have  $0.0005$  to  $0.25$   $\mu\text{f}$  capacitances with  $\pm 20$  to  $\pm 1\%$  tolerances. Voltage rating is 15 wvdc. Units meet MIL-C-25A, are available hermetically sealed or epoxy dipped with axial, radial, or dual leads. Extended temperature type T<sub>1</sub> and T<sub>2</sub> operate to 200 and 250 C.

Balco Research Labs, Capacitor Div., Dept. ED, 49-53 Edison Place, Newark 2, N.J.

CIRCLE 215 ON READER-SERVICE CARD

**INSULATED RODS.**—These rods are insulated with a high strength, paper base Insurok laminated plastic sheathing. They are designed to solve the torque problem common to variable transformers and other equipment requiring insulated shafts that withstand the mounting of components and operate under high resistance. Available in a wide range of sizes and varying degrees of insulation thickness.

The Richardson Co., Dept. ED, 2860 Lake St., Melrose Park, Ill.

CIRCLE 216 ON READER-SERVICE CARD

**HANGING CONNECTION JACK.**—For use where the lead is hot, Press-Fit type SKT-13C1 jack measures less than 1/8 in. diameter and provides a single female contact receptacle that fits a type FT-SM-125 feed-through mounted in the chassis.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

CIRCLE 217 ON READER-SERVICE CARD

**GROUND RECEPTACLES.**—These U-shaped, 2-wire, 3-pole units have a grounded third pole to conform to electrical code requirements. Ratings are 15 amp, 125 v and 15 amp, 250 v. Three models are available: general duty type ZAFP, weather-tight type ZAFT, and water-tight type ZAFE.

The Pyle-National Co., Dept. ED, 1334 N. Kostner Ave., Chicago 51, Ill.

CIRCLE 218 ON READER-SERVICE CARD

**CLOSED CIRCUIT TV SYSTEM.**—The Dial-Data system gives any number of offices instantaneous access to records, files, schedules, and other data subject to constant change. The data is stored in racks in a console, and an automatic dial system selects the rack to be viewed.

Thompson Ramo Wooldridge, Inc., Dage Television Div., Dept. ED, Michigan City, Ind.

CIRCLE 219 ON READER-SERVICE CARD

**ANTIBACKLASH GEARS.**—In these miniature units, for servos, an internal spring is used, and the floating gear is prewound and restrained. Gear assembly is meshed by displacing the floating portion 1/2 tooth. The units meet MIL-E-5400 requirements and have 60 to 110 teeth. Standard units are 96 pitch with 0.09, 0.12, or 0.125 bores. Overall length is 5/16 in. in the clamp-on version.

Precision Mechanisms Corp., Dept. ED, 577 Newbridge Ave., East Meadow, N.Y.

CIRCLE 220 ON READER-SERVICE CARD

Stamp on top of bulb clearly shows date Bell Laboratories installed Tung-Sol/Chatham 5R4WGY rectifier tubes. September 9, 1958, five years, over 43,000 hours later, the tubes were removed.



## Tung-Sol/Chatham tubes operate 43,000 hours — more than five years

Bell Laboratories, Murray Hill, New Jersey — research and development center for new and better telephone components — recently removed two Tung-Sol/Chatham 5R4WGY rectifier tubes, forerunner of the improved 5R4WGB, after more than five years of unbroken, high-quality operation.

Records revealed that on March 20, 1953, Bell Laboratories installed the rectifier tubes in a frequency distribution amplifier operated at Murray Hill. Removal date: September 9, 1958, more than five years and 43,000 service hours later. Comparison with the normal 5R4WGY warranty of 500 hours underscores the extraordinary performance of these Tung-Sol/Chatham tubes.

More and more tube users in all areas of industry are gaining similar benefits of long-life reliability found throughout Tung-Sol/Chatham tubes. You can too! When you need replacements . . . the next time you order new electronic equipment, specify Tung-Sol/Chatham tubes! For further information, to fill a special socket, contact: Chatham Electronics, Division of Tung-Sol Electric Inc., Newark 4, New Jersey.

 **TUNG-SOL®**

CIRCLE 221 ON READER-SERVICE CARD



Now available as a wirewound or film type trimmer that is moisture proof, subminiature in size and withstands a temperature of 225°C., in a higher resistance range.

#### FEATURES:

Type RTW (wirewound) Resistance Range 100 ohms to 100,000 ohms

Type RTF (film) Resistance Range 100 ohms to 25,000 ohms, providing infinite resolution

25 turn lead-screw adjustment

Unique stop-override safety mechanism

Housing of High Temperature Molded Plastic

Variety of mountings: Printed Circuit Lugs  
Printed Circuit Wires  
Tinned Leads

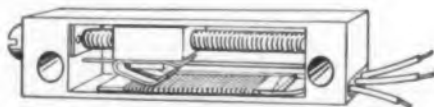
Virtually hermetic sealed meets Mil std. 202 Procedure 106 Humidity Test with rated power applied

Precious metal take off and end tabs

Dual stainless steel contacts on winding and slip ring for extra reliability

Power rating of .83 watts at 80° C., .1 watt at 200° C.

Engineered, quality controlled manufacture and environmental tested to meet the exacting demands of missile and other military applications, make these new low cost trimmers a long-sought contribution to design and production problems.



Write wire or call for full details and technical data.

**TECHNOLOGY INSTRUMENT CORP.**

555 Main St., Acton, Mass., COlonial 3-7711

North Hollywood, California

POplar 5-8620

STanley 7-0286

CIRCLE 222 ON READER-SERVICE CARD

## NEW PRODUCTS

### Timing Motor

Moisture proof



Low cost, moisture proof model MP11 timing motor is designed for chart drives, timing devices, and other instrumentation applications. Completely sealed, it is a heavy duty permanent synchronous type with a torque of 30 oz-in. at 1 rpm. Synchronization is maintained over a range of 103 to 132 v ac. The unit

is available for 120 or 240 v operation at 50 or 60 cps and has standard shaft speeds between 1/60 and 60 rpm.

General Time Corp., Haydon Div., Dept. ED, 245 E. Elm St., Torrington, Conn.

CIRCLE 223 ON READER-SERVICE CARD

### Triode Tube

Low mu

For use in Class AB amplifiers, the WL-6379 is a low amplication factor triode tube rated at 150 kw, 17.5 kv dc plate voltage. It is especially adapted for service in shaker table power supplies or as a series voltage regulator tube in high voltage power supplies.

Westinghouse Electric Corp., Electronic Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.

CIRCLE 224 ON READER-SERVICE CARD



### NOW - 48-56 Gauge Wire Coils built to YOUR specifications

Whatever your application—from hearing aids to missile systems—Deluxe Coils' new fine wire plant can supply the miniature coils you need . . . built to your specifications for precision and accuracy.

Deluxe Coils' newest facility spans 15,000 sq. ft. It is air and sound conditioned and completely equipped to produce all types of miniature fine wire coils, 40-47 gauge, ultra fine wire coils, 48-56 gauge, and components.

Write for information on Deluxe Coils' fine wire production capabilities—and how they can be put to work for you, right away.

**DELUXE COILS, INC.**

POST OFFICE BOX 318

WABASH, INDIANA

CIRCLE 225 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1958



# most complete

- Design Forum
- Product Features
- Ideas for Design
- Engineering Review
- Standards and Specs
- Russian Translations
- Background for Design



More and more electronic engineers report: "I read *Electronic Design* first. It's complete, timely, easier to read, and I can depend upon getting all the new product information."

*Electronic Design's* 8 full time editors, plus staff of assistants, contributors, and correspondents scan the electronic horizons to bring you the complete design picture.

With reading time at a premium, *ED's* every-other-week frequency assures the prompt delivery of topical material; keeps up with this rapidly moving industry.

## ELECTRONIC DESIGN

a HAYDEN publication  
83 Third Ave., New York 22, N. Y.  
PLaza 1-5530

**TELEPHONE SWITCHBOARD LIGHT BULBS.**—These flat-top bulbs provide greater light output with no increase in bulb wattage.

Sylvania Electric Products Inc., Sylvania Lighting Products Div., Dept. ED, Salem, Mass.

CIRCLE 226 ON READER-SERVICE CARD

**COPPER FINISH FOR CLAD LAMINATES.**—The Altori finish assures uniform coverage by all types of resist inks and permits good solder buildup and coverage. It needs no treatment before being processed into printed circuits. Copper-clad laminated plastics furnished with the finish are phenolic resin, paper base grade XP; phenolic resin, paper base, cold punch grade XXXP-242; and epoxy resin, glass fabric flushable grade GEC-500.

Taylor Fibre Co., Dept. ED, Norristown, Pa.

CIRCLE 227 ON READER-SERVICE CARD

**DUAL PHOTOCCELL AMPLIFIER.**—Model T878 is a standard panel mounted unit used for converting photocell phase sensitive signals to momentary relay on-off signals.

Sterling Precision Corp., Instrument Div., Dept. ED, 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 228 ON READER-SERVICE CARD

**ELECTRONIC TUBES.**—Expanded line of miniature tubes for entertainment, commercial, and military use. Includes 6J4WA, 5840, and 5639 manufactured under the U. S. Army Signal Corps Reduced Inspection Quality Assurance Program.

Sonotone Corp., Dept. ED, Elmsford, N.Y.

CIRCLE 229 ON READER-SERVICE CARD

**JEWELERS TYPE TORQUE SCREWDRIVER.**—For tightening miniature screws in delicate electronic instruments and assemblies, the Tiny Torque measures 0 to 0.3 in.-oz. torque. It can also be made to read from 0 to 0.6, 0.8, or 1 in.-oz torque. Designed for 0 to 2-56 screws, it can be made to fit screw sizes from 0 to 4 by changing the screwdriver blade.

Apco Mossberg Co., Dept. ED, 1001 Lamb St., Attleboro, Mass.

CIRCLE 230 ON READER-SERVICE CARD

**AUTOMATIC PRESSURIZATION KITS.**—For coaxial or microwave transmission lines, these systems use no heat for reactivation. They provide complete oil rejection and low dew points down to  $-180$  F. They require minimum maintenance, eliminating electric or steam heating facilities.

Trinity Equipment Corp., Dept. ED, Cortland, N.Y.

CIRCLE 231 ON READER-SERVICE CARD

**10-TURN POTENTIOMETER.**—Model A standard linearity has been reduced to  $\pm 0.25\%$  for resistances from 100 ohms to 100 K.

Beckman Instruments, Inc., Helipot Div., Dept. ED, 2500 Fullerton Rd., Fullerton, Calif.

CIRCLE 232 ON READER-SERVICE CARD



## When low noise level is vital...

Microwave Associates — developers of the famous low noise "E" series silicon diodes — now brings you

## COAXIAL DIODES

with noise figure improvement of:

1.5 db at 16 KMC with the 1N 78B  
3 db at 25 KMC with the 1N 26A  
3 db at 35 KMC with the 1N 53B

Simple substitution of these new coaxial diodes for existing types should improve your overall receiver noise figures as shown. No holder or IF amplifier redesign is required to realize system improvements with these improved versions of the standard coaxial mixer diodes.

Microwave Associates is now delivering these diodes as well as the new tripolar types. Typical of these breadboard types is the 1N630 which covers the frequency range of 1 KMC to 12.4 KMC.

Our factory or the sales representative nearest you will gladly handle your specific requests by wire, phone, or mail.



**MICROWAVE ASSOCIATES, INC.**

BURLINGTON, MASSACHUSETTS • BRowing 2-3000  
CIRCLE 233 ON READER-SERVICE CARD

# STEMCO THERMOSTATS

for precise, sensitive temperature control



STEMCO manufacturing company, inc.  
P. O. Box 1007, Mansfield, Ohio

**STEMCO**

**THERMOSTATS**

1, 2, TYPE C semi-enclosed (1), hermetically sealed (2). Small, positive acting with electrically independent bimetal strip for operation from  $-10^{\circ}$  to  $300^{\circ}\text{F}$ . Rated at approximately 3 amps, depending on application. Hermetically sealed type can be furnished as double thermostat "alarm" type. Various terminals and mountings. Bulletin 5000.

3, 4, TYPE M semi-enclosed (3), hermetically sealed (4). Electrically independent bimetal disc types for appliance and electronic applications from  $-20^{\circ}$  to  $300^{\circ}\text{F}$ . Rating: 8 amps at 115 VAC, 4 amps at 230 VAC and 28 VDC. Semi-enclosed with virtually any type terminal, hermetically sealed with pin or solder terminals, wire leads, various mounting brackets. Bulletin 6000.

5, 6, TYPE MX semi-enclosed (5), hermetically sealed (6). Snap acting miniature units to open on temperature rise for missile, avionic, electronic and similar uses.  $2^{\circ}$  to  $6^{\circ}$  differentials available. Rated at 3 amps to 1 amp, depending on duty cycle, at 115 VAC and 28 VDC for 250,000 cycles. Semi-enclosed types with metal or ceramic bases; hermetically sealed in circular or CR7 cans. Various terminals, mountings, brackets, etc. Bulletin 6100.

7, 8, TYPE S\* adjustable (7), non-adjustable (8). Positive acting with single stud or nozzle mounting. Operation to  $600^{\circ}\text{F}$ . Rated at 15 amps at 115 VAC, 7 amps at 230 VAC. Spade, screw or elevated terminals, various adjusting stems, etc. Bulletin 1000.

9, TYPE SA\* adjustable (9) or non-adjustable. Snap acting with electrically independent bimetal. Also single-pole, double-throw. Single stud or nozzle mounting. Non-inductive-load rating: 15 amps at 115 VAC, 10 amps at 230 VAC. Spade or screw terminals. Bulletin 2000.

10, TYPE SM\* manual reset (10). Electrically same as Type SA (above) except for manual reset feature. Bulletin 2000.

11, TYPE B adjustable (11) or non-adjustable. For uses where heat generated by passage of current through bimetal strip is desirable. Various terminals, single stud or nozzle mounting. Operation to  $400^{\circ}\text{F}$ . Nominal rating:  $5\frac{1}{2}$  amps at 115 VAC of 40 cycles and higher. Bulletin 9000.

12, 13, 14, TYPE A\* semi-enclosed (12, 13), hermetically sealed (14). Insulated, electrically independent bimetal disc gives fast response and quick, snap action control for appliance, electronic and apparatus applications from  $-20^{\circ}$  to  $300^{\circ}\text{F}$ , or higher on special order. Rating: 3 to 4 amps, depending on duty cycle, at 115 VAC, 2 amps at 230 VAC and 28 VDC. Various enclosures and mountings, including brackets. Bulletin 3000.

15, TYPE R\* sealed adjustable (15), sealed non-adjustable. Positive acting for operation to  $600^{\circ}\text{F}$ . Rated at 15 amps at 115 VAC, 4 amps at 230 VAC. Screw terminals. Bulletin 7000.

16, TYPE W\* adjustable (16), or non-adjustable. Snap action bimetal strip type for operation to  $300^{\circ}\text{F}$ . Rated at 5 amps at 115 VAC, 3 amps at 230 VAC. Screw or nozzle mountings; spade, solder or screw terminals. Bulletin 4000.

17, TYPE H† adjustable. Positive acting for fry pans, skillets, sauce pans, etc. Fail-safe, open in low to  $500^{\circ}\text{F}$  in high. Rated at 1650 watts at 115 VAC. Bulletin 10,000.

18, TYPE D\* automatic (18), or manual reset. For laundry dryers or other surface and warm air applications. Snap acting disc type U.L. approved for operation to  $350^{\circ}\text{F}$ . Open or enclosed styles. Rated at 25 and 40 amps at 120-240 VAC. Screw or spade terminals. Bulletin 8000.

Illustrations, for general information only, do not necessarily show size comparisons. Fully dimensioned and certified prints on request. Manufacturer reserves right to alter specifications without notice. AA-7230

\*Refer to Guide 400 ED for U.L. or C.S.A. approved ratings.  
†Patent Applied For.

## NEW PRODUCTS

### Modular Power Supplies

Have 0.05% regulation



Designed as modules for original equipment, these compact power supplies mount in small spaces on conventional chassis cutouts. They are available in a wide choice of overlapping current and voltage ranges from 125 v at 50 ma to 425 v at 400 ma and have one piece cast aluminum housings and JAN hardware. Regulation for all models is 0.05%, ripple is less than 1 mV rms, and transient response is under 25  $\mu\text{sec}$ . The 425 v, 400 ma module measures  $9\frac{3}{4} \times 6\frac{1}{2} \times 6\frac{1}{2}$  in.

NYT Electronics, Inc., Dept. ED,  
2979 Ontario St., Burbank, Calif.

CIRCLE 234 ON READER-SERVICE CARD

### In-Line Silicon Rectifiers

High efficiency

These in-line diffused-silicon rectifiers have dense alumina ceramic cases and provide 1.5 amp average rectified forward current at 50 C. When placed on a 2 x 2 in. heat sink, they rectify up to 3 amp at 50 C. Free from weld-flange projections they may be clipped to a heat sink or mounted horizontally or vertically on a printed circuit board. The insulated cases will withstand a potential in excess of 17 kv. Rated 200 to 600 piv, the units operate from  $-65$  to  $+150$  C.

Texas Instruments Incorporated  
Semiconductor-Components Div.  
Dept. ED, P.O. Box 312, Dallas, Tex.

CIRCLE 235 ON READER-SERVICE CARD

CIRCLE 239 ON READER-SERVICE CARD



## Precision Potentiometer

Has 3/8 in. case length



In a machined aluminum case 2 in. in diameter and 3/8 in. long, the model 304 single-turn potentiometer has a life of 500,000 cycles and a linearity to 0.3%. Rated 2 w at 50 C, it operates to 125 C and withstands 20 g vibration and 30 g shock. Model 314, a high temperature version in the same size case, operates from -55 to +250 C.

Daystrom Pacific, Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.

CIRCLE 236 ON READER-SERVICE CARD

## Power Transistors

Driver and switching

These three transistors complete a line of power units. Types 2N1159 and 2N1160 are for switching, and the 0.5 to 1 amp germanium 2N1172 can be used as a driver unit for medium power audio output.

General Motors Corp., Delco Radio Div., Dept. ED, Kokomo, Ind.

CIRCLE 237 ON READER-SERVICE CARD

## Control Panel Enclosures


Multidoor

Made to NEMA Type 2 and JIC electrical standards, these oil and dust tight control panel enclosures are three, four, and five doors. They are 86 in. high, 14 in. deep, and up to 15-1/2 ft long.

Hoffman Engineering Corp., Dept. ED, Anoka, Minn.

CIRCLE 238 ON READER-SERVICE CARD

CIRCLE 870 ON READER-SERVICE CARD >



# FRANKLIN "ONE FLUID" and the IONOSPHERE

Creative Imagination enabled Benjamin Franklin to orient all the observed electrical phenomena to his own "one fluid" theory—the basis of all our comprehension of electricity today.

At National Co. creative imagination is continuing to broaden our comprehension of the physical universe and apply it to the realization of such new means of communication as Ionospheric scatter systems.

The implications and applications of such new means of communication are vast.

National Co. is a community of minds and talents that enjoys the challenge and the prestige of success in such advanced fields as multipath transmission, noise re-

duction, correlation techniques for signal processing, Tropospheric scatter systems, Ionospheric scatter systems, molecular beam techniques, long range microwave transmission, and missile check-out equipment using microwave and digital techniques.

National Co. has grown with the Tradition of New England electronics. Your needs and problems receive exceptional attention at National Co. because, here, *creativity is required, recognized and rewarded.*

Write or phone

*Tuned to tomorrow* **National** 

National Company, Inc., Malden, Mass.

MANUFACTURERS OF MATERIEL AND EQUIPMENT FOR U. S. DEFENSE



Type FC-4 4-pole  
double-throw.

Type FC-6 6-pole  
double-throw.

These Improved MISSILE RELAYS  
**withstand 30G vibration  
at 2,000 cycles**

... up to 60G shock without contact opening  
... and 2,000 ft.-lbs. shock without  
contact transfer

Backed by more than ten years of intensive development and refinement, these rugged, precision-built Struthers-Dunn FC relays have the high reliability required for missile uses. The outstanding characteristics indicated above typify performance that meets or exceeds the operational and environmental requirements of MIL-R-5757C and MIL-R-25018. Thanks to simplified design, S-D FC Relays, are priced materially lower than other types frequently used to meet these exacting specifications.

MAKERS OF THE  
WORLD'S LARGEST  
ASSORTMENT OF  
RELAY TYPES



NEW BULLETIN AVAILABLE...  
giving full details and electrical and mechanical specifications. Ask for FC Relay Bulletin.

**STRUTHERS-DUNN, Inc.**  
Pitman, N. J.

Sales Engineering Offices in: Atlanta • Boston • Buffalo • Chicago • Cincinnati  
Cleveland • Dallas • Dayton • Detroit • Kansas City • Los Angeles • Montreal • New  
Orleans • New York • Pittsburgh • St. Louis • San Francisco • Seattle • Toronto

CIRCLE 240 ON READER-SERVICE CARD

## NEW PRODUCTS

### Molded Mica Capacitor

0.37 x 0.19 x 0.11 in.

The Missilmite molded mica capacitor meets MIL-C-5A and MIL-C-11272A requirements and comes with C, D, and E characteristics, 5 to 250  $\mu$ mf capacitances, and  $\pm 2$  to  $\pm 20\%$  tolerances. It is rated at 500 wvdc at 85 C, 300 wvdc at 125 C. Weight is 1/2 g; size, 0.37 x 0.19 x 0.11 in.

Micamold Electronics Mfg. Corp.,  
Dept. ED, 1087 Flushing Ave.,  
Brooklyn 37, N.Y.

CIRCLE 241 ON READER-SERVICE CARD

### Switching Transistors

Have 70 mc frequency cutoff

Series HA-9000 silicon transistors are double diffused pnp types for medium and low level switching. They are available in voltage ranges greater than 50 v and dc current gains greater than 60. Rise times

are typically 50  $\mu$ sec, frequency cutoff is 70 mc, and saturation resistance is 30 ohms. The units operate from  $-65$  to  $+150$  C.

Hughes Aircraft Co., Hughes Products, Dept. ED, International Airport Sta., Los Angeles 45, Calif.

CIRCLE 242 ON READER-SERVICE CARD

### Molding and Potting Resin

Stays flexible at  $-180$  C

A polyurethane molding and potting resin, Scotchcast XR-5010 cures in 4 to 8 hr at 120 C and remains flexible at  $-180$  C. It has good resistance to oils and solvents. Two pound units are supplied in cube shaped polyethylene bags with built-in pouring spouts.

Minnesota Mining and Mfg. Co., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.

CIRCLE 243 ON READER-SERVICE CARD

## ENGINEERS

Newport Beach, Southern California . . .

**Holds The Key To Your Future!**

FORD MOTOR COMPANY'S young and rapidly expanding subsidiary, Aeronutronic Systems, Inc. is now offering outstanding opportunities for an exciting and highly rewarding career to Computer Engineers capable of making significant contributions to advanced computer technology.

AERONUTRONIC—a dynamic new name in science and research—is moving into the future fast. The first phases of a new Research Center are nearing completion at Newport Beach, where California living can be enjoyed at its finest. You'll work in an intellectual atmosphere—in a community away from congestion, yet close to most of Southern California's cultural and educational centers.

These positions are now open:

Systems Engineers	Logical Designers
Magnetic Memory Engineers	Circuit Engineers
Communications Engineers	Mechanical Engineers
Digital Computer Programmers	Optical Engineers
Transistorized Circuit Engineers	

Qualified applicants are invited to send resumes or inquiries to Mr. L. R. Staple, Aeronutronic Systems, Inc., Box NJ 486, Newport Beach, California.

COMPUTER DIVISION

**AERONUTRONIC**

a subsidiary of Ford Motor Company

Newport Beach • Glendale • Santa Ana • Maywood, California

CIRCLE 871 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1958



**TEFLON INSULATION STRIPPER.**—This tool strips wires from the smallest sizes up to 20 AWG with no damage to the wires. It has an adjustable stop to permit accurate stripping up to 3/4 in. in length. No adjustment is needed for wire size. Western Electronic Products Co., Dept. ED, 655 Colman St., Altadena, Calif.

CIRCLE 245 ON READER-SERVICE CARD

**HEAT SINK.**—Model 2KW1 is designed to permit full load operation of the GE type C35 silicon controlled rectifier without exceeding the rectifier's maximum allowable junction temperature of 125 C. It has 6 fins 0.02 in. thick, measures 3-1/2 x 3-1/2 x 1-1/2 in., and weighs 9 oz. Fairfield Engineering Corp., Dept. ED, 934 Hope St., Springdale, Conn.

CIRCLE 246 ON READER-SERVICE CARD

**MINIATURE TUBE AND TRANSISTOR SOCKET.**—For compression mounting into chassis holes, the Chemelec SS-428 is self-fastening and requires no additional hardware or assembly operations. The 0.018 in. diameter, countersunk contacts have a contact retention factor of 4 oz per pin. Fluorocarbon Products Inc., Dept. ED, Camden, N.J.

CIRCLE 247 ON READER-SERVICE CARD

**RELAY DUST COVER.**—Snap-on metal dust covers are available for the company's type Q ac or dc chassis mounted telephone relays. Dimensions are 1.25 x 1.75 x 2. Globe Electrical Mfg. Co., Dept. ED, 1729 W. 84th St., Gardena, Calif.

CIRCLE 248 ON READER-SERVICE CARD

**ANTI-MAGNETIC TV CAMERA HOUSING.**—For the company's TG-2 and TE-6 industrial TV cameras, this housing will also accommodate many other closed circuit TV cameras. The unit is 11-1/2 in. diameter and 21 in. long and weighs 33 lb. It assures protection against 40 gauss in a dc field and 10 in an ac. General Electric Co., Technical Products Dept., Dept. ED, Electronics Park, Syracuse, N.Y.

CIRCLE 249 ON READER-SERVICE CARD

**ABLE CLIP.**—The one piece Speed Clip secures small diameter armored control cables at any location. It can be reused indefinitely. Tinnerman Products, Inc., Dept. ED, P.O. Box 188, Cleveland, Ohio.

CIRCLE 250 ON READER-SERVICE CARD

**EMENT.**—An electrically conductive cement containing silver powder, 50% Terminal Cement has good electrical, temperature, and adhesive characteristics and may be used for the electrical and mechanical components and certain electrical devices. Graphite Products Corp., Dept. ED, Brookfield, Conn.

CIRCLE 251 ON READER-SERVICE CARD

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

Radio Receptor silicon diodes

# IN ANY COMBINATION OF CHARACTERISTICS

high speed • high conductance • high temperature  
high voltage • high back resistance

Including the industry's most versatile diode with uniform excellence in all parameters

## 1N658

General Instrument semiconductor engineering has made possible these Radio Receptor diodes with a range of characteristics never before available to the industry.

The types listed here are just a small sampling of the complete line which can be supplied in volume quantities for prompt delivery. Write today for full information.

GENERAL PURPOSE TYPES		FAST RECOVERY TYPES	HIGH CONDUCTANCE TYPES	
1N456	1N461	1N625	1N482	1N484A
1N457*	1N462	1N626	1N482A	1N484B
1N458*	1N463	1N627	1N482B	1N485
1N459*	1N464	1N628	1N483	1N485A
		1N629	1N483A	1N485B
			1N483B	1N486
			1N484	1N486A

\* JAN Types

PLUS a large group of special DR numbers developed by General Instrument Corporation with characteristics that far exceed any of the standard types listed above!

GI

AUTOMATIC

RR

Semiconductor Division

GENERAL INSTRUMENT CORPORATION

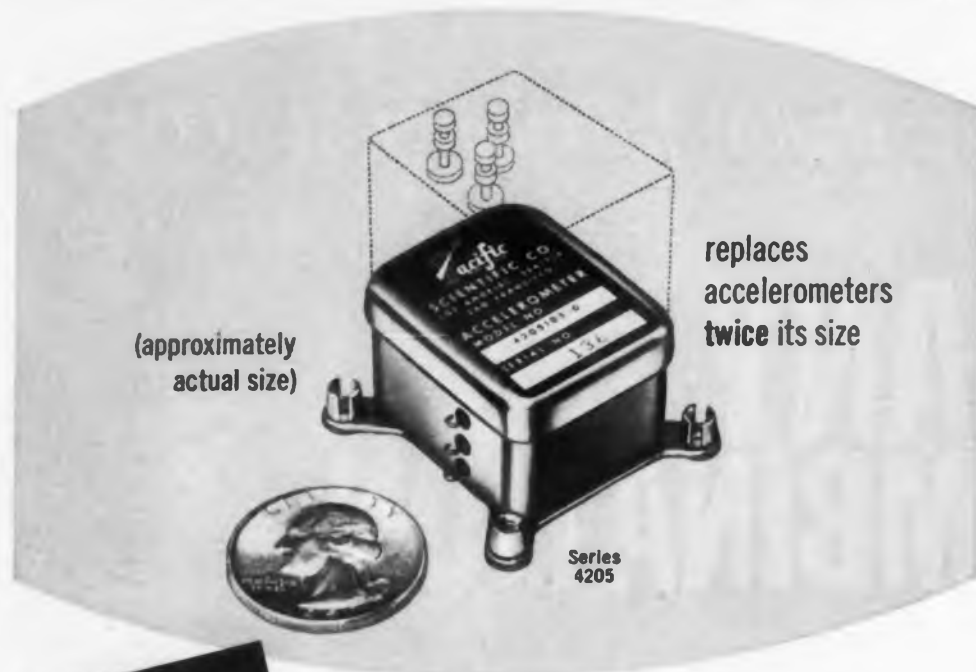
65 Gouverneur Street, Newark 4, N. J.

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC. AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

GENERAL INSTRUMENT DISTRIBUTORS: Baltimore: D & H Distributing Co. • Chicago: Merquip Co. • Cleveland: Pioneer Electronic Supply • Los Angeles: Valley Electronics Supply Co. • Burbank: Milwaukee Radio Parts Co., Inc. • New York City: Hudson Radio & Television Corp. • Sun Radio & Electronic Co. • Philadelphia: Herbach & Raleman, Inc. • San Diego: Shank & Wright, Inc. • San Francisco: Pacific Wholesale Co. • Seattle: Seattle Radio Supply • Tulsa: Oil Capital Electronics

CIRCLE 252 ON READER-SERVICE CARD

LATEST ADDITION TO THE PACIFIC FAMILY OF ACCELEROMETERS...



new!

smallest on the market!

**Pacific's**  
inexpensive

POTENTIOMETER-TYPE MODEL 4205

## ACCELEROMETER

Replacing another accelerometer twice its size in an air to air missile, this tiny new addition to Pacific's family of accelerometers delivers 2% accuracy over a -10 to +30G range, and has the smallest envelope on the market - measuring only 1.1" W x 1.5" L x .8" D! Designed as an inexpensive instrument for telemetering and control it features silicon fluid damping for unsurpassed shock and vibration immunity.

Each of Pacific's basic models illustrated is representative of a series of similar units that vary only in output characteristics. They are fully tooled, tested and approved production models that can meet most acceleration measurement requirements.

In the design and production of accelerometers and other electro-mechanical components - Pacific's creative ability, engineering skills, experience and production facilities, can save you money - and time!



Creative Manufacturing  
and Development  
in Airborne Controls

\*TRADE MARK



CIRCLE 253 ON READER-SERVICE CARD

replaces  
accelerometers  
twice its size

Series  
4205



Series  
4202

Unique Torsion Bar Suspension and restraining system provides very low hysteresis with exceptionally rugged, long life. Automatic caging mechanism. Single or dual potentiometer pick-off and/or switches provide versatility. Available in a wide variety of G ranges.



Series  
4201

Lightweight, Miniature - combines wide flexibility of design and performance characteristics with a proven, high production instrument. Potentiometer pick-off... wide selection of G ranges with an operating range of 0-±1G to 0-±50G.



Series  
4206

For Increased Accuracy to 1% or less under rugged environmental conditions. Originally designed for use in an anti-missile missile, this unit features temperature compensated damping mechanism using silicon fluid.

### PACIFIC SCIENTIFIC COMPANY

P. O. Box 22019, Los Angeles 22, Calif.

SAN DIEGO • SAN FRANCISCO  
SEATTLE • PORTLAND, ORE.  
ARLINGTON, TEXAS

REPRESENTATIVES: Eastern U. S. - Aero Eng. Co.  
Canada - Garrett Mfg. Corp.

## NEW PRODUCTS

### Deposited Carbon Resistor

Has 0.06 in. diameter

Covering a range of 50 ohms to 330 K, this deposited carbon resistor is 0.22 in. long and 0.06 in. in diameter and weighs about 0.04 g. Temperature coefficient is -250 to -500 ppm per deg C and power rating is 0.1 w at 60 C, 0.05 w at 85 C, and 0.02 w at 100 C.

British Radio Electronics Ltd., Dept. ED, 1833 Jefferson Place, N.W. Washington 6, D.C.

CIRCLE 254 ON READER-SERVICE CARD

### Miniature Toroids

High inductance

These miniature, high inductance toroids are machine wound with a 50 AWG wire 0.001 in. thick. Tolerances are controlled to within ±0.005 in.; ID is 0.037 in.; OD is 0.28 in.; and height is 0.125 in. The units are designed for transistorized

circuits such as chokes, transformers, inductors, and saturable reactors.

C. G. Electronics Corp., Dept. ED, 15000 Central East, Albuquerque, N. Mex.

CIRCLE 255 ON READER-SERVICE CARD

### Miniature Sequence Timer

Battery operated

Miniature battery operated sequence timer type AGS-C is a cam operated microswitch type driven by an enclosed fractional watt motor with a speed regulation accurate to ±1% over a voltage drop to 50%. A screw adjusts from 0 to 180 deg to provide a wide range of timing intervals. The units are available with a 5 or 20 amp capacity switch and are wound for operating voltages of 3 to 24 v.

Brailsford & Co., Inc., Dept. ED, Milton Point, Rye, N.Y.

CIRCLE 256 ON READER-SERVICE CARD

## HOPKINS

metallized Mylar\*  
film capacitors

— high performance  
in small size



These film-wrapped units are built to meet exacting requirements. For example:

**High insulation resistance**—100,000 megohms is typical.

**Operating temperature**—units operate to 125°C.

**Sub-miniature size**—a Hopkins .1 mfd capacitor rated at 200 volts is only 5/32" thick x 7/32" wide x 3/4" long.

**Construction.** These units have copperweld leads for maximum vibration resistance... are built with the highest quality materials available, and produced under rigid quality control.

**Available** as film-wrapped types, and in all case styles in hermetically sealed brass tubes and bathtubs. Rated .005 to 8 mfd., 200 to 600 VDC. Prompt deliveries. Send for catalog C-103A.

**HOPKINS** Engineering **COMPANY**

\*DuPont Trade Name

12900 Foothill Blvd., San Fernando, Calif. • Tel. EMpire 1-8691  
CIRCLE 257 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1961



## Transistorized Power Supply

For airborne use

The TPC-15 transistorized power supply was designed for airborne use. It features a bridge-transistor circuit using low-voltage transistors to deliver 300 v dc at 150 ma, or 50 v dc at 300 ma from the aircraft's 28 v dc battery source. Regulation is better than 5% over the entire output range (no load to full load) and efficiency is better than 85%. Output is virtually free from ripple and noise. The unit is stressed to withstand the shock and vibration of the airborne environment over a -40 to +65 C temperature range. Southwestern Industrial Electronics Co., Dept. ED, 10201 Westheimer, Houston, Tex.

CIRCLE 258 ON READER-SERVICE CARD

## Temperature Vibration Chamber

Portable

Portable temperature vibration chamber model FBV-8 has a hydraulic lift that raises or lowers it to accommodate a vibration exciter head through the bottom. With an accessory adapter diaphragm, it can accept an exciter at the side. Range 800 F to ambient temperature, or with liquid CO<sub>2</sub> cooling, to about -100 F.

Conrad, Inc., Dept. ED, 141 Jefferson St., Holland, Mich.

CIRCLE 259 ON READER-SERVICE CARD

## Precision Potentiometers

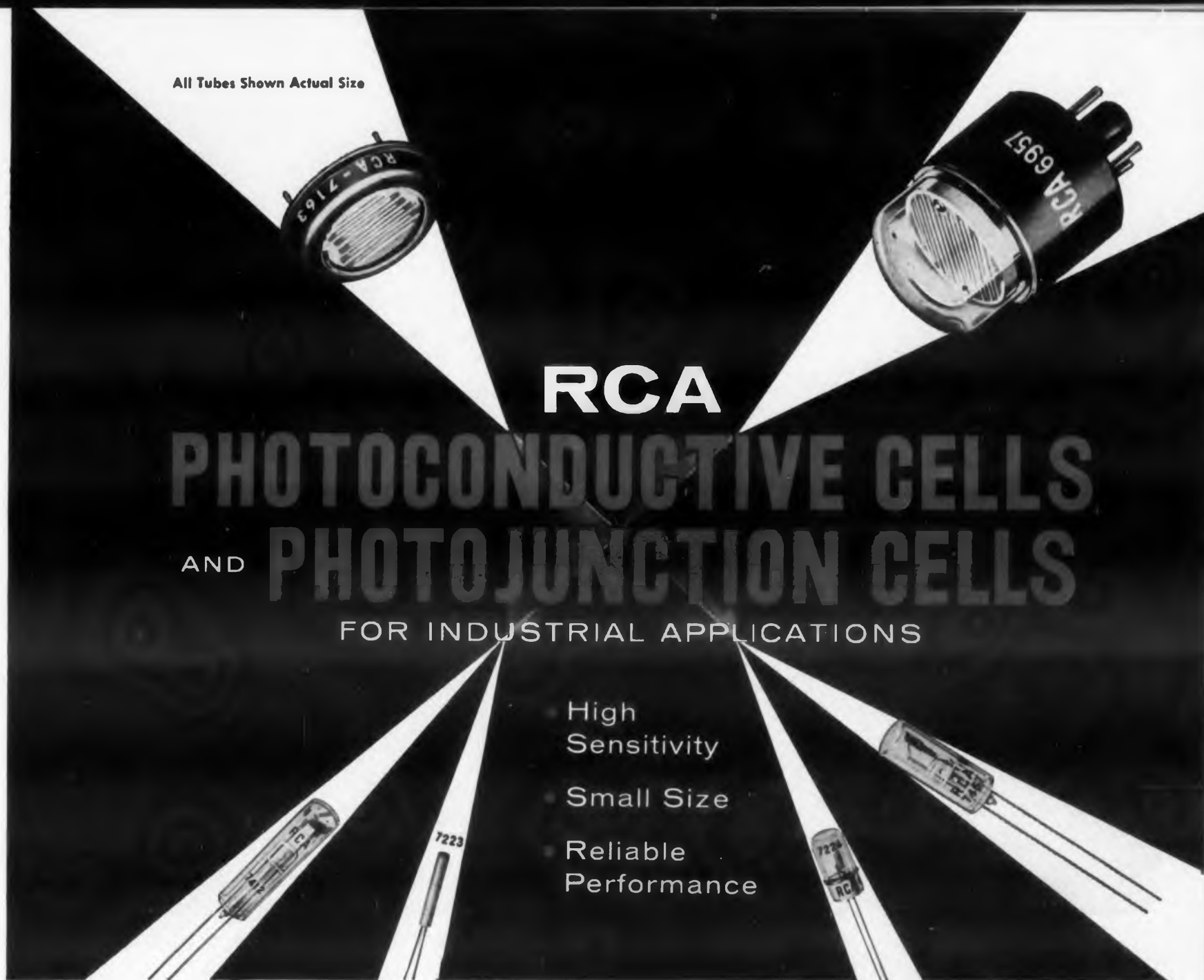
Miniature

Series 57 miniature precision potentiometers have a nickel-silver body and a thermally compatible cover assembly with terminals soldered in place. Rated 1.5 w at 25 C, they are 1/2 in. in diameter and 1 1/2 in. long and come in values from 50 ohms to 50 K. There are two different bushing and shaft configurations, standard and shaft locking. Clarostat Mfg. Co., Inc., Dept. D, Dover, N.H.

CIRCLE 260 ON READER-SERVICE CARD

CIRCLE 261 ON READER-SERVICE CARD

All Tubes Shown Actual Size



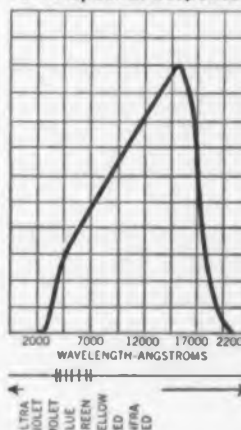
If your control problems involve a light source, look to RCA for the solution. RCA-designed Photoconductive and Photojunction Cells are manufactured under the strictest quality controls to assure dependability and long life. So for applications ranging from street-lighting control to high-speed

computers, contact your RCA Field Representative for complete information about RCA Photoconductive Cells and RCA Photojunction Cells. Or for technical data on specific types, write RCA Commercial Engineering, Section F-18-Q-1, Harrison, N. J.

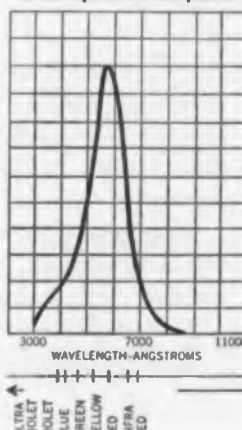
RCA Type	Description	Spectral Response	Wave-length of Max Spectral Response angstroms	Maximum Ratings Abs. - Max. Values			Characteristics at 25°C				
				Voltage Between Terminals volts	Power Dissipation mw	Ambient Temperature Range °C	Voltage Between Terminals volts	Radiant Sensitivity μA/μW	Luminous Sensitivity mA/lumen	Illumination Sensitivity μA/lc	Max Dark Current μA
6957	Cadmium sulfide, head-on photoconductive cell for street-lighting control and other light-operated relay applications.	S-15	5800	250	500	-75 to +60	50	580	1640	4000	20
7163	Compact, cadmium sulfide, head-on photoconductive cell for street-lighting control and other light-operated relay applications.	S-15	5800	250	300	-75 to +60	50	290	820	2000	40
7223	Very tiny photojunction cell of the head-on type. Employs germanium p-n alloy junction. For computer and sound pickup-from-film applications. Infrared sensitive.	S-14	15000	50	25	+50 Max.	2.5	0.68*	-	0.2	35
7224	Very small photojunction cell of the side-on type. Employs germanium p-n alloy junction. For sound pickup-from-film and computer applications. Infrared sensitive.	S-14	15000	50	30	-40 to +50	45	0.52	14	0.7	35
7412	Small cadmium sulfide, head-on photoconductive cell for industrial light-operated relay applications.	S-15	5800	200	50	+60 Max.	12	1580	4500	300	0.1
7467	Very small, photojunction cell of the side-on type. Employs germanium p-n alloy junction. For sound-pickup-from-film and computer applications.	S-14	15000	50	30	-42 to +50	45	0.52	14	0.7	35

\*μA/watt/meter<sup>2</sup>

S-14 Spectral Response



S-15 Spectral Response



RCA FIELD OFFICES

- \* 744 Broad St., Newark 2, N. J., HUmboldt 5-3900
- \* 6355 E. Washington Blvd., Los Angeles 22, Calif., RAymond 3-8361
- \* Suite 1154, Merchandise Mart Plaza, Chicago 54, Ill., WHitehall 4-2900
- \* 714 New Center Bldg., Detroit 2, Mich., TRinity 5-5600

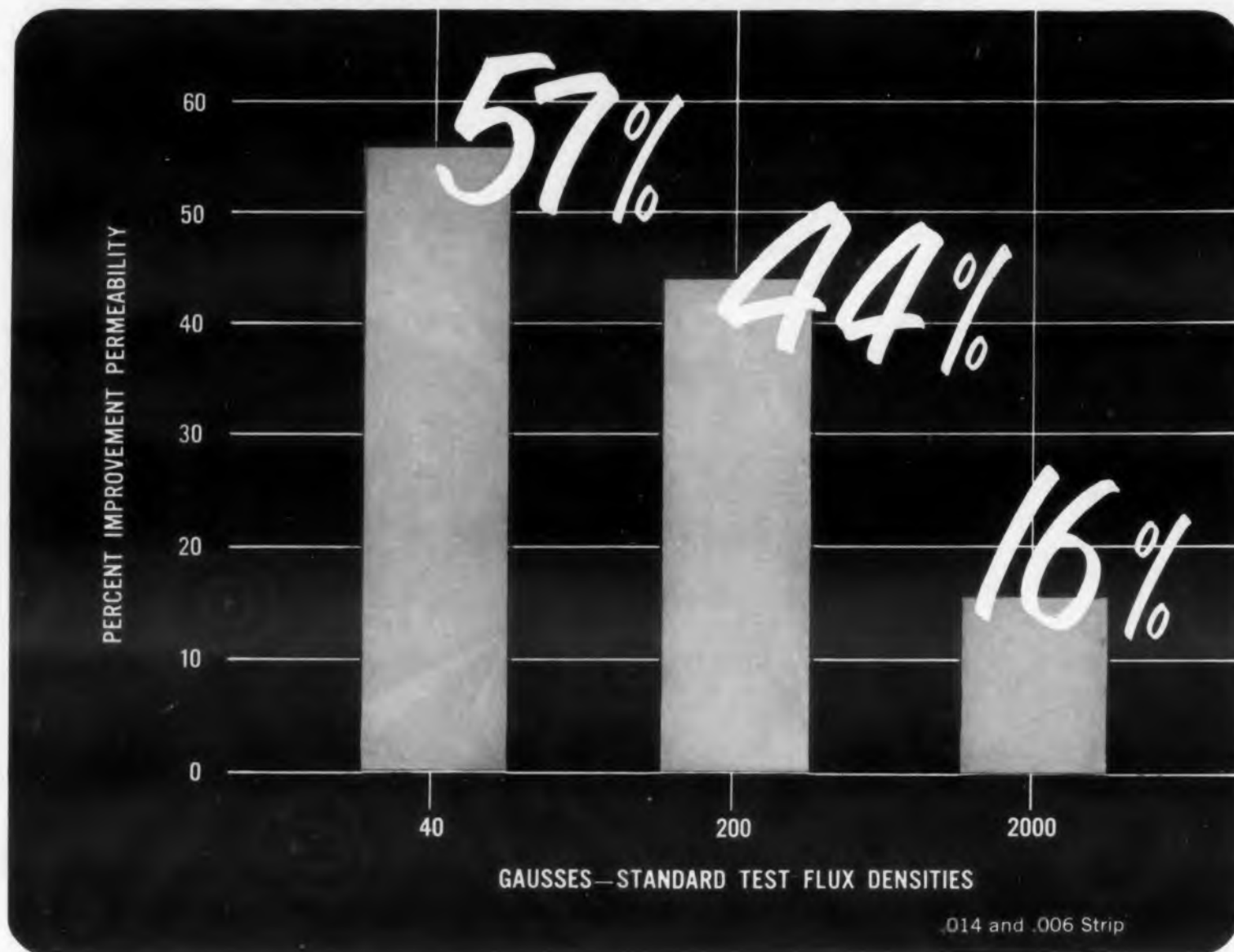
GOVERNMENT SALES

- \* 744 Broad St., Newark 2, N. J., HUmboldt 5-3900
- \* 244 N. Wilkinson St., Dayton 2, Ohio, BAldwin 6-2366
- \* 1625 "K" Street, N. W., Washington 6, D. C., DIstrict 7-1260



**RADIO CORPORATION OF AMERICA**  
Electron Tube Division  
Harrison, N. J.

Experience—the added alloy in **A-L Electrical Steels**



## Greater permeability for Allegheny Ludlum's AL-4750...and it's guaranteed

promises more consistency, higher predictability for magnetic cores

AL-4750 nickel-iron strip now has higher *guaranteed* permeability values than ever before. For example, at 40 induction gaussses AL-4750 now has 57% higher permeability than in the past, using the standard flux density test.

This greater permeability means better consistency and predictability for magnetic core users . . . and allows careful, high performance design.

This improvement in AL-4750 is the result of Allegheny Ludlum's continuing research on electrical alloys and

nickel-bearing steels. Moly Permalloy has been similarly improved in permeability. A-L constantly researches silicon steels, including A-L's well-known grain-oriented silicon, Silectron, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available at Allegheny Ludlum. And A-L's technical know-how guarantees you close gage tolerance, uniformity of gage throughout the coil and minimum spread of gage across the coil-width.

If you have a problem on electrical steels, laminations or magnetic material, call A-L for prompt technical assistance. Write for blue sheet EM-16 for complete data on AL-4750. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. ED-18.*

WSW 7491

## ALLEGHENY LUDLUM

STEELMAKERS TO THE ELECTRICAL INDUSTRY

Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17

Export distribution, Laminations: AD. AURIEMA, NYC 4

CIRCLE 262 ON READER-SERVICE CARD



## NEW PRODUCTS

### PDM Display Adapter

Permits bar graph presentation



The model AD-2S pdm display adapter makes it possible to present standard pdm telemetry data in bar graph form on any standard, laboratory type oscilloscope. The unit occupies 3-1/2 in. of rack space and features silicon transistor circuitry, missing channel correction, and a precision slice amplifier for cleaning up raw signals at the output of receivers. The unit requires 10 w of 60 or 40 cps power.

Kauke and Co., Dept. ED, 1632 Euclid St. Santa Monica, Calif.

CIRCLE 263 ON READER-SERVICE CARD

### Expanded Scale Voltmeter

Has  $\pm 0.5\%$  accuracy

This expanded scale voltmeter has an accuracy of  $\pm 0.5\%$  or better, input impedances of 1000 to 1700 ohms per volt, and scale expansions of 4:1 or greater. Ac and dc models are available and special scales can be provided. Both panel mounted and cased units are available. No external power source is required.

The Magnavox Company, Dept. ED, 2111 Bueter Rd., Fort Wayne, Ind.

CIRCLE 264 ON READER-SERVICE CARD

### Latching Relays

Stand shock of 100 g

Designated the Model R650, these postage stamp size relays exceed requirements of MIL-5757C with vibration immunities of 10 to 55 g at a total excursion of 0.200 in. and 55 to 200 cps at 30 g, and shock immunities of 100 g. The units, with contact rating of 2 amp resistive, 28 v dc or 115 v ac, have a minimum life of 100,000 operations at 125 C. The relay is activated by a 5 msec pulse of 300 mw.

Iron Fireman Mfg. Co., Elect. Div., Dept. E, 2838 S. E. 9th Ave., Portland 2, Ore.

CIRCLE 265 ON READER-SERVICE CARD



## Harmonic Generator Diode

Has 20 db conversion efficiency at 70 kmc



The model MA-435 millimeter wave harmonic generator diode has a minimum conversion efficiency of 20 db at 70 kmc. An rf input in the 26.5 to 40 kmc range generates harmonic power over the 53 to 80 kmc range, and 50 mw of rf drive can produce 1 mw output at 70 kmc. Broadband response is achieved by mounting the diode across a section of ridged RG-98/U waveguide. Integral tapers match the ridged section to the input and output for coupling to UG-600/U and UG-385/U waveguides.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 266 ON READER-SERVICE CARD

## Miniature Electrolytic Capacitors

For low voltage applications

This line of THR capacitors are applicable to transistorized low voltage power supplies and airborne uses requiring extreme reliability. A series of ratings from 75  $\mu$ f 3 v dc to 100  $\mu$ f 25 v dc is available in 3/8 in. diam cases from 3/4 to 1 1/2 in. long, fitted with No. 20, tinned, axial leads. Capacity tolerance is -10 to +100%; temperature range is -40 to +85 C.

P. R. Mallory & Co. Inc., Dept. ED, Indianapolis 6, Ind.

CIRCLE 267 ON READER-SERVICE CARD

## Power Relay

Contacts rated to 25 amp

Identified as Type U, this power relay has single coil construction, employing a box-type magnetic field. Movable contact springs are mounted on molded phenolic insulating bars, providing positive contact alignment. Contacts of 1/4 in. in diameter are available in either silver or silver cadmium oxide, rated singly at 10 to 25 amp, 110 vac, non-inductive. Maximum contact pressures are 35 g.

Con ar Electric Co., Dept. ED, 3349 Addison St., Chicago 18, Ill.

CIRCLE 268 ON READER-SERVICE CARD

an Epsco transistorized

# TRANSICON DATRAC<sup>®</sup> ANALOG-DIGITAL CONVERTER

can solve your data  
conversion problem . . .  
economically!



designed FOR YOUR SYSTEM by system specialists who have pioneered the field of high-speed, reversible analog-to-digital conversion . . .

■ **PRODUCTION ENGINEERED** to be the lowest-cost transistorized converters available anywhere.

■ **MODULARIZED**—plug-in building-blocks permit assembly of over 50 standard models.

■ **EASY TO USE**—no adjustments

■ **HIGH SPEED**—up to 25,000 conversions/sec analog-to-digital; up to 100,000 conversions/sec digital-to-analog

■ **HIGH POWER DIGITAL OUTPUTS**

■ **DIGITIZES BOTH CURRENTS AND VOLTAGES**

■ **PARALLEL AND SERIAL CODED OUTPUTS**

■ **BUILT-IN EXPANDABILITY**—8-bit converters to 10, 12 or 14 bits; changing codes from binary to binary-coded decimal; making an analog-to-digital converter from a digital-to-analog unit

. . . and an Epsco Exclusive: **PROVEN RELIABILITY** One million hours of operation in hundreds of installations around the world have proven DATRAC reliability. Now an all solid state TRANSICON DATRAC assures even greater performance.

New 6-page, 2-color brochure available with complete description of TRANSICON DATRACS. Write, wire or phone your local Epsco representative or contact, in the East: Epsco, Inc., Equipment Division, 588 Commonwealth Avenue, Boston 15, Massachusetts; in the West: Epsco-West, 125 E. Orangethorpe Ave., Anaheim, California.

CIRCLE 269 ON READER-SERVICE CARD

## TRANSICON ANALOG-TO-DIGITAL CONVERTERS FOR . . .

Data Logging Systems  
Telemetry Data Reduction  
Digital Transmission over Telephone Lines  
Analog Digital Computer Linkages  
Wind Tunnel Instrumentation

## TRANSICON DIGITAL-TO-ANALOG CONVERTERS FOR . . .

Driving Analog Plotters from Digital Sources  
Analog Displays on Meters and Oscilloscopes from Digital Codes  
Analog Computer Inputs  
Radar Display Drivers  
Fire Control Simulators

## TRANSICON ALARM LIMIT MONITORS FOR . . .

Automatic Checkout Systems  
High-speed Fault Analyzers  
Power Plant Monitors  
Industrial Process Controllers

**Epsco**   
First in data control



**MODEL AVS 321**  
Precision AC Power Supply  
1 volt to 1000 volts AC  
35 cycles to 10 KC  
Digital set voltage to  $\pm 0.1\%$

**MODEL AVS 320**  
Fixed voltage regulator. Four fixed voltages between 1 volt and 300 volts at all frequencies 35 cycles to 20 KC. Will make any power amplifier. A precision voltage supply.



## PRECISION A.C. VOLTAGE INSTRUMENTATION



**MODEL 30 Power Amplifier**  
30 Watts 0.1% Distortion  
Output 1 to 300 volts AC  
35 cycles to 20 KC

**MODEL AVA 500 Power Amplifier**  
500 Watts 2% Distortion  
Output 115 - 230 volts  
300 cycles to 2 KC



**MODEL AO .1 Audio Oscillator**  
20 cycles to 20 KC  
1 volt RMS Output with short term stability of 0.05%  
frequency stability  $\pm 1\%$   
Distortion 0.1%  
The ideal oscillator for A.C. voltage measurements

Complete details and specifications on HOLT Precision AC Voltage Instrumentation are yours upon request . . . Write Today.

*Holt* **INSTRUMENT  
LABORATORIES**  
O C O N T O • W I S C O N S I N



CIRCLE 270 ON READER-SERVICE CARD

## NEW PRODUCTS

**WATER SOLUBLE SOLDER FLUX.**—Developed for automatic soldering of printed circuit boards, type 14-E flux is mildly acid at soldering temperatures, yet completely soluble in water before and after soldering, eliminating any conductive or corrosive residues. It will not penetrate the boards.

Fuson Engineering, Dept. ED, 17921 Roseland Ave., Cleveland 12, Ohio.

CIRCLE 271 ON READER-SERVICE CARD

**ADHESION AID FOR TEFLON INSULATED WIRE.**—When applied to Teflon insulated wire and tubing, Polymercoat solution promotes the adhesion of potting compounds without adversely affecting the characteristics of the Teflon.

Hitemp Wires, Inc., Dept. ED, 1200 Shames Dr., Westbury, N.Y.

CIRCLE 272 ON READER-SERVICE CARD

**INSULATED THERMOCOUPLE WIRE CABLE.**—These thermocouple and extension wire cables are insulated with a perfluorocarbon resin that is an extrude of Teflon-FEP. The resin is waterproof and chemically inert and can be used continuously from  $-200$  to  $+225$  C.

Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Dept. ED, Wayne and Windrim Aves., Philadelphia, Pa.

CIRCLE 273 ON READER-SERVICE CARD

**MINIATURE TERMINALS.**—Teflon Kwik-Term line includes standoffs, feed-troughs, probes and plugs, and connectors and test jacks with a wide variety of pins and platings.

Cannon Electric Co., Dept. ED, P. O. Box 3765, Terminal Annex, Los Angeles 54, Calif.

CIRCLE 274 ON READER-SERVICE CARD

**MINIATURE MATCHED MAGNETIC AMPLIFIERS.**—For all insulation classes, these precision molded units occupy 3 cu in. They are resistant to thermal shock, vibration, and moisture.

Keystone Products Co., Dept. ED, 904-6 23rd St., Union City, N.J.

CIRCLE 275 ON READER-SERVICE CARD

**PUNCH.**—The 1804 Ratchet Knockout Punch Driver punches holes through up to 10 gage metal for 1/2 to 3 in. conduit. One revolution of the handle does the cutting. The tool weighs 6-1/2 lb and comes in a metal carrying case.

Greenlee Tool Co., Dept. ED, Rockford, Ill.

CIRCLE 276 ON READER-SERVICE CARD

**HIGH MEG TRIMMER POTENTIOMETER.**—This unit has resistance values to 500 meg and is designed for use in timing or control circuitry, instrumentation, and other equipment where a high range control is necessary.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 277 ON READER-SERVICE CARD

**Burroughs**  
NIXIE®  
NUMERICAL  
READOUT  
TUBE



*Now!* ultra  
long life

**DYNAMIC LIFE — 25,000 HOURS**

**STATIC LIFE — 5,000 HOURS**  
(on one number)

**ALL ELECTRONIC IN-LINE READOUT  
CONTAINING TEN DIGITS "0" THRU "9"**

The Ultra Long Life Nixie Tube offers increased life for those applications requiring continuous display of one of the ten characters for extended periods of time. Under these stringent conditions a minimum of 5000 hours life on one numeral can be expected. Where the display is changed sequentially, even as infrequently as every 100 hours, life in excess of 25,000 hours can be expected.

**NIXIE Tube Exclusive Features:**

- ALL ELECTRONIC
- LOWEST COST
- LOWEST POWER
- LIGHTEST WEIGHT
- MOST READABLE FOR NUMBER SIZE
- SMALLEST VOLUME AND NUMBER SIZE
- MAXIMUM TEMPERATURE, SHOCK AND VIBRATION SPECS
- AND NOW, LONGEST LIFE

ANOTHER ELECTRONIC CONTRIBUTION BY  
**Burroughs Corporation**

ELECTRONIC TUBE DIVISION  
Plainfield, New Jersey

CIRCLE 278 ON READER-SERVICE CARD

CIRCLE 279 ON READER-SERVICE CARD



use beam switching tubes for DISTRIBUTING  
 use beam switching tubes for .. SWITCHING  
 use beam switching tubes for ... SAMPLING  
 use beam switching tubes for ..... CODING  
 use beam switching tubes for ..... TIMING  
 use beam switching tubes for **counting**

Beam Switching Tubes are 10-position high vacuum electronic tubes. Each tube may replace twenty or more transistors, tubes, or other components since a single cathode controls an electron beam to any one of the ten constant current output positions each with "Automatic" memory and high impedance switching.

#### BEAM SWITCHING TUBES CAN:

- switch sequentially or at random.
- be reset from any position in less than 1  $\mu$ sec.
- be preset to any position.
- be interconnected as a distributor of ANY number of positions.
- be operated as a word generator.
- be used as a wide band noise generator to 1000 Mcs.
- operate as a static device or at speeds over 20 Mcs.
- operate compatibly with tubes, transistors, cores and relays.
- directly operate BOTH local and remote Nixie® tube readout.
- directly supply outputs of several hundred volts.
- meet severe shock, vibration and temperature requirements.
- meet long life requirements (potential of 10,000-50,000 hours).
- convert binary to decimal and binary to analogue.

Catalog No. 1158 covering tube types and available literature will be sent by return mail on request.

In contrast to other types of components, Beam Switching Tubes will directly operate both Master and Remote Nixie indicator tubes at a lower cost and higher reliability. Even "all" transistor systems are using Beam Switching Tubes to perform digital functions.

MASTER  
READOUT

153  
024  
571  
406

ANOTHER ELECTRONIC CONTRIBUTION BY  
**Burroughs Corporation**

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

### Tapped Delay Line

#### Ultrasonic

Providing various delays from one input signal, this ultrasonic tapped delay line may be used for data processing and analysis of digital and analog information. The number of taps and delays per tap are available to specification, and counting rates to 2 million pulses per sec can be achieved.

Andersen Labs, Inc., Dept. ED, 501 New Park Ave., West Hartford 10, Conn.

CIRCLE 280 ON READER-SERVICE CARD

### Voltage Standard

Has 0.01% calibration accuracy

The model 401 Voltloc voltage standard has a 1 v dc, open circuit output that stays constant within 1  $\mu$ v over the 100 to 150 v, 400 cps input range and through shock, acceleration, vibration, humidity, and -65 to +125 C temperatures. Temperature coefficient per deg C is 0.005% and calibration accuracy is 0.01%. The output terminals are floating with respect to ground so that either polarity may be obtained. The unit is 1-5/16 x 1-5/16 x 2-3/8 in. and weighs 5 oz.

Jackson Electronic & Mfg Co., Dept. ED, 695 Johnston St., Akron 6, Ohio.

CIRCLE 281 ON READER-SERVICE CARD

### Cathode Ray Tube

#### High resolution

A high resolution radar picture tube, crt model WX-3798 is designed for use with transistorized video amplifiers. Drive requirements are 5 to 10 v for peak brightness. The tube is 13-1/2 in. long, has electrostatic focus and magnetic deflection, and produces a scanning line 0.0015 in. wide. It can achieve video bandwidths to 20 mc.

Westinghouse Electric Corp., Electronic Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.

CIRCLE 282 ON READER-SERVICE CARD

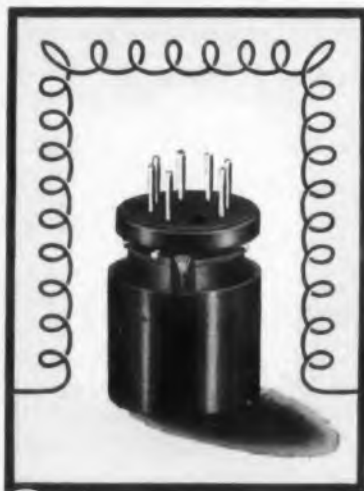
# New all-epoxy E-PAK<sup>®</sup> system drastically cuts encapsulation costs!

Assembly Time and  
Reject Rate Greatly Reduced



Soldering of leads is quick, simple, safe—never a cracked glass or broken seal because it's all epoxy. And with rugged epoxy covers, your lead wires can be made of any metal. No coefficient-of-expansion problem.

②



The entire package is then heated; the pellet automatically melts and cures, embedding the component and sealing the cover. In cases where encapsulation is desired without embedment, a self-sealing epoxy cover is available.

④

The E-Pak System consists of an all-epoxy header with embedded lead wires, a cured epoxy shell and a premetered epoxy pellet. The three may be custom-made for your component and are available from one source.

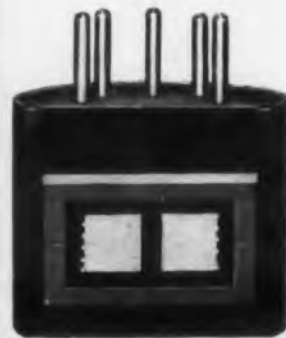


①



After the component is soldered to the epoxy header, a premetered pellet is dropped into the cured epoxy shell. The cover and component are then inserted into the shell.

③



You now have a solid, chemically-inert seal from within; there is no solder, no flux, no acid to endanger component reliability. Your component is hermetically sealed and embedded in cured epoxy forever.

⑤

Write today for complete information and samples.

## EPOXY PRODUCTS, INC.

A Division of Joseph Waldman & Sons

137 Coit Street, Irvington, New Jersey

ESsex 5-6000

CIRCLE 283 ON READER-SERVICE CARD

## NEW PRODUCTS

### Rate Gyros Fluid filled



For missile and aircraft use, miniature series A2015 and B2015 rate gyros are fluid filled to minimize the effects of shock and vibration. The units have temperature ranges between  $-65$  and  $+185$  F and have rates ranging from 45 to 100 deg per sec. Both ac and dc pickoffs are available.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

CIRCLE 284 ON READER-SERVICE CARD

### Power Supply

Has dc/ac output

Called the Handivolt, this dc/ac power supply features high power, small size high efficiency at all voltage settings, smooth stepless control, and choke type filter for low ripple content. The unit is manufactured in many voltage and amperage combinations to handle every laboratory and electronic need. Series B units are isolated from line and have a voltmeter to monitor dc voltage output. All models are rated for heavy duty. Variable ac output is brought out to line receptacle.

Nutron Manufacturing Co., Inc., Dept. ED, 67 Monroe Ave., Staten Island 1, N.Y.

CIRCLE 285 ON READER-SERVICE CARD

### Synchros

Withstand up to 450 F

These synchros come in both size 11 and size 23 frames. The size 11 unit is capable of withstanding a 450 F ambient temperature and meeting normal MIL-S-2335 requirements as to accuracy, etc. Models are now made in the 115-torque transmitter and control transformer types. The size 23 synchro can withstand an ambient temperature of 350 F, and also meets the requirements of MIL-S-2335 in all of the respects.

Bendix Aviation Corp., Montrose Div., Dept. ED, S. Montrose, Pa.

CIRCLE 286 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1958



## Console Cabinets

### For modular systems

Designed for modular console systems, Prem-O-Rak two-tone cabinets can be assembled in a wide variety of arrangements. The line includes sloping cabinets, pedestal frames, work tops, writing shelves, turrets, and sliding drawers. These units can be used with the company's PR and POR series racks.

Premier Metal Products Co., Dept. ED, 337 Manida St., New York 59, N.Y.

CIRCLE 287 ON READER-SERVICE CARD

## Thermosetting Plastic Resin

### Crystal clear

Furnished as a low viscosity liquid, Maraglas 655 is a transparent thermosetting resin that is easily cast and permanently solidified after a brief heat cure. Castings made from the resin have 90% light transmission, high strength, and good electrical properties. They can be used for structural parts, tubes, and encapsulation for electronic apparatus.

Marlette Corp., Dept. ED, 37-31 30th St., Long Island City 1, N.Y.

CIRCLE 288 ON READER-SERVICE CARD

## Zero Speed Switches

### Operate from -20 to +250 F

Redesigned series 2100 DAZIC switches are shaft driven electrical controls with magnetically actuated contacts operated by a hydraulically driven mechanism. They will open or close signal circuits on shaft speed acceleration of 15 rpm and can be driven at speeds to 3800 rpm. They operate from -20 to +250 F and have totally enclosed Micro Switch spdt snap action contacts with UL ratings of 10 amp at 125, 250, or 460 v ac, 0.5 amp at 125 v dc, and 0.25 amp at 250 v dc.

Winterburn Mfg. Co., Dept. ED, Putnam, Conn.

CIRCLE 289 ON READER-SERVICE CARD

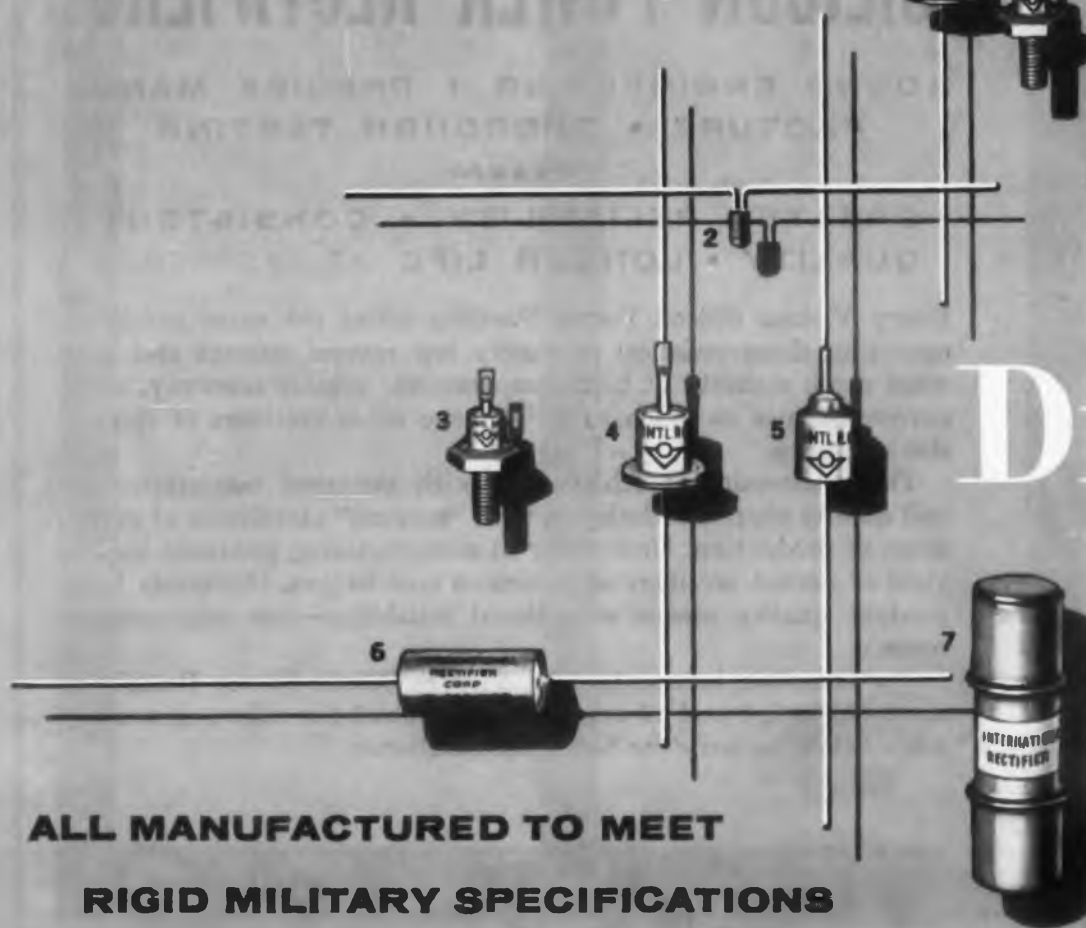
CIRCLE 290 ON READER-SERVICE CARD

## ALL SILICON TYPES...

## ZENER VOLTAGES REGULATORS...

## SELENIUM SUB-MINIATURES...

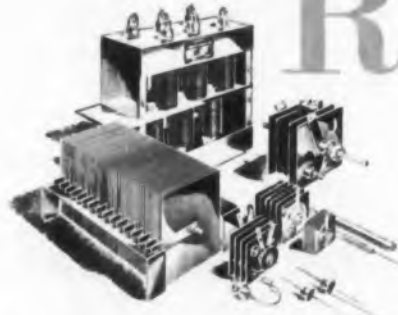
50 to 16,000 Volts PIV Microamps to 1 ampere!



ALL MANUFACTURED TO MEET  
RIGID MILITARY SPECIFICATIONS

# International

# Rectifier Corp.



The diodes listed are typical of the wide selection available at International Rectifier to solve your rectification problem...with excellent reliability! Your letterhead inquiry will bring the bulletin you specify and—if you include the details of your project—a recommendation stating the diode best suited to your need. The illustration at left suggests the scope of our complete line of selenium, germanium and silicon rectifiers for all dc needs from microwatts to megawatts, literally the widest range in the industry.

INTERNATIONAL RECTIFIER CORP. • EL SEGUNDO, CALIF. • OREGON 8-6281 • CABLE ADDRESS: RECTUSA  
BRANCH OFFICES: NEW YORK: 132 EAST 70TH ST., TRAFALGAR 9-3330 • CHICAGO: 205 W. WACKER DR., FRANKLIN 2-3888 • NEW ENGLAND: 17 DUNSTER ST., CAMBRIDGE, MASS., UNIVERSITY 4-6520 • PENNSYLVANIA: SUBURBAN SQUARE BUILDING, ARDMORE, PENNA., MIDWAY 9-1428 • MICHIGAN: 1799 COOLIDGE HIGHWAY, BERKLEY, MICH., LINCOLN 8-1144  
IN CANADA: INTERNATIONAL RECTIFIER OF CANADA, LTD., 1581 BANK ST., OTTAWA 1, ONTARIO • PHONE: REGENT 3-6880

WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS • SELENIUM • GERMANIUM • SILICON

### 1 Silicon Zener Diodes

Rating: From 600 milliwatts to 16 watts

A complete series in 6 types. Miniature single junction types, multiple junction types and double anode units. 750 milliwatt and 1 watt types: Bulletin SR-251, 3.5 and 10 watt types: Bulletin SR-252, Multiple junction 5 watt types: SR-253, Double anode types: SR-254.

### 2 Selenium Sub-Miniature Diodes

Rating: 20 to 100 volts • 100 $\mu$ a to 11 ma.

Ideal components for bias supplies, sensitive relays, computers etc. High resistance, (10 megohms and higher at -10 volts). Excellent linear forward characteristics. Extremely small. Low in cost. Encapsulated to resist adverse environmental extremes. Specify Bulletin SR-18.

### 3 Stud Mounted Silicon Power Diodes

Rating: 50 to 600 volts PIV • 400 ma. to 1 amp.

Industrial and military types including the 1N253, 1N254 and 1N255. Stud mounted, hermetically sealed, all-welded construction. Operating temperature range: -55°C to +150°C. Designed and manufactured to meet most rigid military specifications. Bulletin SR-130C.

### 4 Silicon Power Diodes - Pigtail

Rating: 50 to 600 volts PIV • 250 to 750 ma.

An extensive line of silicon power diodes for military and industrial applications featuring all-welded, hermetically sealed construction. Designed and manufactured to meet the most rigid military requirements. For information on types for your application Contact Factory.

### 5 High Voltage Silicon Power Diodes

Rating: 500 to 2400 volts PIV • 100 to 125 ma.

Three types available. Hermetically sealed, pigtail construction. Style J rated at 600 to 1000 volts PIV at 125 ma. Bulletin SR-130E. Styles K and L with PIV ratings from 600 to 2400 volts at 100 ma. dc output current are described in technical detail—Bulletin SR-137.

### 6 Sub-Miniature Silicon High Voltage Cartridge Types

Rating: 600 to 10,000 volts PIV • 75 to 250 ma.

JEDEC types 1N2373 thru 1N2381. Ceramic encased, hermetically sealed. Design prevents arcing and corona effect at extremely high altitudes. Ideal for airborne and missile instrumentation. Write for Bulletin SR-227.

### 7 High Voltage Cartridge Types

Rating: 1500 to 10,000 volts PIV @ 45 to 440 ma.

Especially suited for miniaturized military equipment where optimum reliability is a prime factor. Standard types for normal convection cooling and high current types for forced air or oil cooling. Hermetically sealed, metallized ceramic housing. Request Bulletin SR-228.



# UNIFORM-UNIFORM-UNIFORM



## VICKERS®

### SILICON POWER RECTIFIERS

SOUND ENGINEERING • PRECISE MANUFACTURE • THOROUGH TESTING  
*assure*

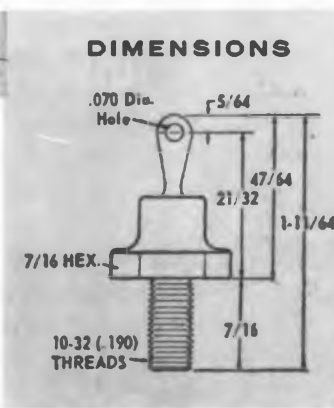
GREATER RELIABILITY • CONSISTENT QUALITY • LONGER LIFE *AT LESS COST*

Every Vickers Silicon Power Rectifier offers the same excellent operating characteristics: extremely low reverse current and forward drop; stability at high temperatures; greater economy, with current ratings as much as 25% above other rectifiers of similar size and price.

This uniformity is achieved through stringent manufacturing and quality control techniques, with "surgical" cleanliness at every stage of production. Uniformity in manufacturing produces higher yield of perfect rectifiers at minimum cost to you. Uniformly high product quality means exceptional reliability—low maintenance costs.

For complete information on Vickers Silicon Power Rectifiers, available in 2, 8 and 12 ampere sizes, contact the sales engineering office below, or write for Series 3300 Bulletins.

VOLTAGE	CATALOGUE NUMBERS		
	2 AMPERES	8 AMPERES	12 AMPERES
100 V	AA 10	BA 10	CA 10
200 V	AA 20	BA 20	CA 20
300 V	AA 30	BA 30	CA 30
400 V	AA 40	BA 40	CA 40
500 V	AA 50	BA 50	CA 50
600 V	AA 60	BA 60	CA 60



EPA 3300-2



**VICKERS INCORPORATED**  
DIVISION OF SPERRY RAND CORPORATION  
**ELECTRIC PRODUCTS DIVISION**

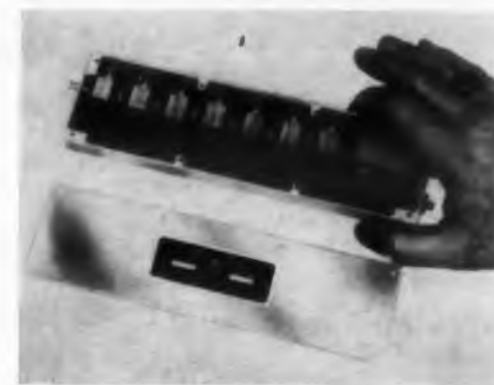
1841 LOCUST STREET • SAINT LOUIS 3, MISSOURI

**Sales** ST. LOUIS—Central 1-5830      **CHICAGO**—JUniper 8-2125      **CLEVELAND**—EDison 3-1355  
**Engineering** DETROIT—KEnwood 4-8070      **NEW YORK**—LEnox 9-1515      **LOS ANGELES**—DAvenport 6-8550  
**Offices** WASHINGTON, D. C.—EExecutive 3-2650      **BOSTON** (Representative)—CEdar 5-6815

CIRCLE 291 ON READER-SERVICE CARD

## NEW PRODUCTS

### I-F Amplifiers Transistorized



Models T-330A and T-330B are fully transistorized i-f amplifiers with source and output impedances of 50 ohms. The T-330A has a minimum gain of 80 db with a center frequency of 30 mc and a 10 mc bandwidth. It uses stagger-tuned circuitry and has a 10 db noise figure, a +5 dbm output, and 12.5 mean stage gain. The T-330B provides 100 db minimum gain and has a 30 mc center frequency with 3 mc bandwidth. Noise figure is 9 db, output is +10 dbm, and mean stage gain is 14 db. It has synchronously tuned circuitry.

Instruments for Industry, Dept. ED, 101 New South Rd., Hicksville, N.Y.

CIRCLE 292 ON READER-SERVICE CARD

### DC Voltmeter

Measures 10  $\mu$ v to 1 kv



Transistorized dc voltmeter model 2900A measures dc voltages over nine decade ranges from 10  $\mu$ v to 1 kv with an error of less than 3% of full scale. A zero-center meter movement with a mirror scale provides polarity indication of an input voltage without switching or lead reversal. On the 10  $\mu$ v range, noise level is less than  $\pm 0.4 \mu$ v referred to the input, and in a two hour period the zero drift of the needle is under  $\pm 1 \mu$ v. The unit has a full scale power sensitivity of  $10^{-14}$  w.

Convair, Div. of General Dynamics Corp., Dept. ED, 3595 Frontier St., San Diego 12, Calif.

CIRCLE 293 ON READER-SERVICE CARD

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ELEC TR



## Transistor Transformers

Weigh 1/2 oz.



These five transistor transformers are available in round hermetic cases with glass bead headers or epoxy molded construction. They are about 1/2 cu in. and weigh 1/2 oz.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N.Y.

CIRCLE 294 ON READER-SERVICE CARD

## Film Resistors

Tolerance is  $\pm 1\%$

The complete line of these precision film resistors exceeds the requirements of MIL-R-10509B. It includes all five MIL sizes, RN60 thru RN80, as well as the new KC50 and KC55. Rated at 0.1 w and 0.125 w respectively, with a standard tolerance of  $\pm 1\%$ , they are applicable to transistorized circuitry. Their oil filled construction insures maximum reliability under extreme environmental conditions as well as the ultimate in long term stability.

Key Resistor Corp., Dept. ED, 321 W. Redondo Beach Blvd., Gardena, Calif.

CIRCLE 295 ON READER-SERVICE CARD

## Winding Compensated Resolvers

In size 8

These size 8 winding-compensated resolvers weigh only 1.2 oz. and have a frame diameter of 0.750 in. with maximum frame length of 1.241 in. They are designed for the 26 v, 400 cps input signals in aircraft and missile instrumentation systems. Null voltage of these units does not exceed 1 mv per v output. Maximum fractional error is held to 0.1%. The slip ring and wiper assembly is designed to withstand shock loads up to 45 g at 2000 cps. Other features include corrosion resistant frames, and two phase rotor/stators with no sacrifice of critical characteristics.

American Electronics Inc., Instrument Div., Dept. ED, 9504 W. Jefferson Blvd., Culver City, Calif.

CIRCLE 296 ON READER-SERVICE CARD



**Wonders in Miniature.** Snowflakes are excellent examples of how Nature uses tiny things to achieve great effects. Individually, these microscopic crystals are masterpieces of symmetrical beauty. Collectively, they have a decided influence on this planet's living conditions. Man follows Nature's lead by using miniaturization as a powerful force of action.

**Miniature Pressure Switch,** approximately 1 3/4" long, has exceptionally high resistance to radiation. It maintains performance characteristics and calibration at 1000°F and in a reactor environment, operating in lines up to 10,000 PSI, with no seepage or leaks. Construction includes two MPB bearings to support movement of highly sensitive member.

**Man With Miracles.** Gordon Colson, an MPB Sales Engineer, worked closely with the firm producing the small high-pressure switch. He provided technical assistance for their engineers in selecting exactly the right bearings. To aid in solving your engineering problems with miracles in miniaturization, an experienced MPB technician is available.

## New Miracles in Miniaturization

ACTUAL SIZE OF THE BEARINGS IN PRESSURE SWITCH SHOWN ABOVE

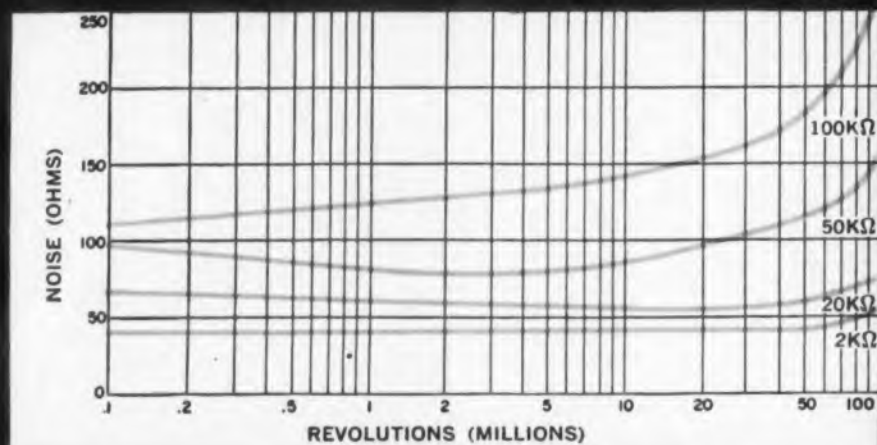
Reaching new heights, in outer space or in everyday industrial efficiency, calls for a good deal of new equipment, which usually calls for new miracles in miniaturization. And which, in turn, calls for experience like MPB's in making smaller bearings to meet greater scientific and industrial needs. MPB

has specialized in this and produces over 500 types and sizes of bearings, ranging down to 1/10" O.D., with specials as required. Our catalog will bring you complete facts on these. For catalog, or engineering advice, or both, write **Miniature Precision Bearings, Inc.,** 906 Precision Park, Keene, N. H.

MINIATURE PRECISION  
**MPB**  
BEARINGS, INC.

Helps you perform miracles  
in miniaturization

CIRCLE 297 ON READER-SERVICE CARD



# 50 MILLION REVOLUTIONS



The capability of maintaining low noise operation for millions of cycles is inherent in the design of Markite Conductive Plastic Potentiometers. The noise curves above are typical of the reliability and performance that can be expected of all Markite potentiometers.

In addition to reliable and predictable performance, Markite Conductive Plastic Potentiometers also provide:

- Infinite resolution.
- Independent linearity to 0.05% in 1 $\frac{1}{16}$  inch dia. units.
- Operation in ambient temperatures up to 200°C.
- Shock and acceleration resistance in excess of 100g.
- Vibration resistance in excess of 70g.
- Rotational speeds up to 1,000 rpm and beyond.
- Operation under applicable Military Specifications.

Write for Design Data and Catalog for Rotary and Rectilinear Potentiometers

**MARKITE PRODUCTS CORPORATION**  
155 Waverly Place • New York 14, N. Y.

CIRCLE 298 ON READER-SERVICE CARD

## NEW PRODUCTS

### All Purpose Relay Has nylon blade lifter



Model RH relay, an all purpose unit, has a nylon blade lifter to assure long life and dependable operation. Suited for industrial control uses, the relay provides a large amount of contact wipe and high contact pressure. Available in all voltages up to 230 v ac and 110 v dc, the unit can be supplied with contact arrangements up to 4pdt with a choice of 5 or 10 amp contacts. Weighing about 3 oz, it

measures 2 x 1 x 1-11/16 in.  
Artisan Electronics Corp., Dept.  
ED, 171 Ridgedale Ave., Morris-  
town, N.J.

CIRCLE 299 ON READER-SERVICE CARD

### Variable Transformers High current

Series H-C Powerstat variable transformers have high current capacities and are suited for heavy duty applications. Both 200 and 360 amp types are available. The units have zero waveform distortion, good regulation, and smooth control. They incorporate a re-entry ring and helical coil construction which permits fine voltage adjustment with low voltage drop.

The Superior Electric Co., Dept.  
ED, Bristol, Conn.

CIRCLE 300 ON READER-SERVICE CARD

## STODDART COAXIAL TERMINATIONS operate from -450°F to +440°F

Resistive elements of these units are made of thin platinum films fired at high temperatures on ceramic forms and treated with a protective coating of silicone varnish. These elements do NOT become superconductors at temperatures at least as low as 4.2° Kelvin. Due to the temperature coefficient of the element, however, a unit having a resistance of 60-ohms at room temperature will become a 50-ohm element at this low temperature.

Temperatures as high as +440°F may be induced inside the terminations by an electrical overload of at least 3 times the rated average power dissipation, which is 1 watt. No permanent damage to any part of the termination is produced when subjected to such rigorous treatment.

#### SPECIFICATIONS:

Frequency range is dc to 3000 mc. 50 or 70-ohm resistance, types "N" or "C" male or female connectors, VSWR is less than 1.2 to 3000 mc and average power dissipation is 1 watt.

Send for literature on complete line of coaxial line terminations, coaxial attenuators and 2, 6 and 10-position turret attenuators.

Immediate delivery



**STODDART**  
AIRCRAFT RADIO CO., INC.

6644 SANTA MONICA BOULEVARD  
HOLLYWOOD 38, CALIF., HOLLYWOOD 4-9292

CIRCLE 301 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959





New  
space-saving,  
lightweight

## differential DC amplifier

*amplifies low-level  
telemetry signals  
with high efficiency*

**Smallest size available**—only 2½" long x 1¾" square. Weighs only 8 ounces. ±10 millivolts "in"... ±5 volts "out."  
**Excellent linearity.** From null to 5 VDC output, the linearity is 0.5%. From null to 2.5 VDC, it's 0.25%.

**High stability**—1% of gain and null value in 5 minutes from a cold start. Unit is stable over the full environmental range, and over power input variations.

**Sources floating**—input, output and power sources are completely isolated from one another.

**Meets MIL-E-5272A** for humidity, vibration and shock. Designed with magnetic amplifier reliability.

*Write for complete data.*



**NETWORKS  
ELECTRONIC  
CORPORATION**

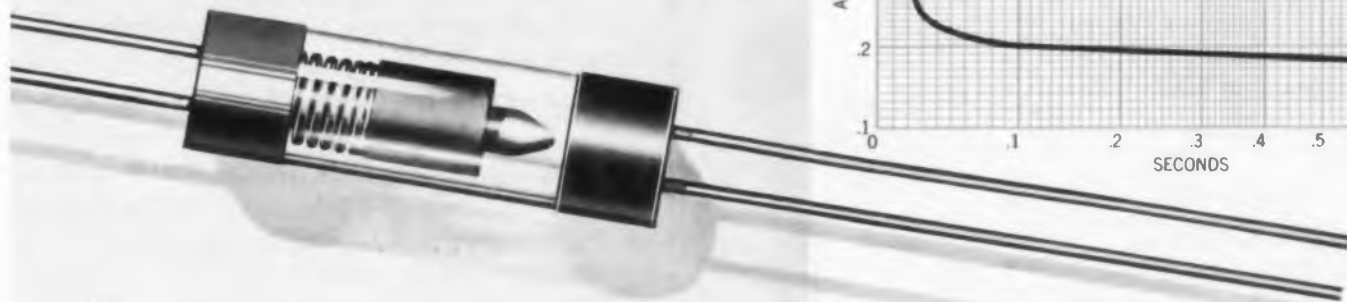
1806 Oxnard Street, Van Nuys, Calif.  
Telephone: STate 2-3114  
CIRCLE 500 ON READER-SERVICE CARD

## NETWORKS ELECTRONIC

*—originators of the  
glass-enclosed thermal relay*

*—announce  
a NEW*

## LOW-CURRENT THERMAL RELAY



FOR  
SOLID  
STATE  
APPLICATIONS

*—miniature size...hermetically  
sealed, and 99.99% proven reliability*

Protect your costly transistors with this tiny new N.O. thermal relay, only .0125 cubic inch in volume. It fires positively at .180 amp. For higher firing currents see graph for time delays obtainable. The fuse supports .120 amp. max. continuous current without burning. Operation is based on the "fuse burnout" principle which gives wide latitude to systems designers. The N.C. type fires positively at .350 amp. and supports .230 amp. max. continuous current without burning.

**Hermetically sealed in glass** by NETWORKS' exclusive method of bonding metal headers to glass housings which are resistant to heat and shock. The glass provides interior visibility—a great advantage over metal or potted types.

**Qualification tested** in the completely equipped NETWORKS' environmental laboratories. Normally-open type is tested to withstand:

**Temperature:** -100°F to +400°F

**Vibration:** 20 to 2000 cps at 15 G's

**Shock:** 50 G's for 2 to 4 MS

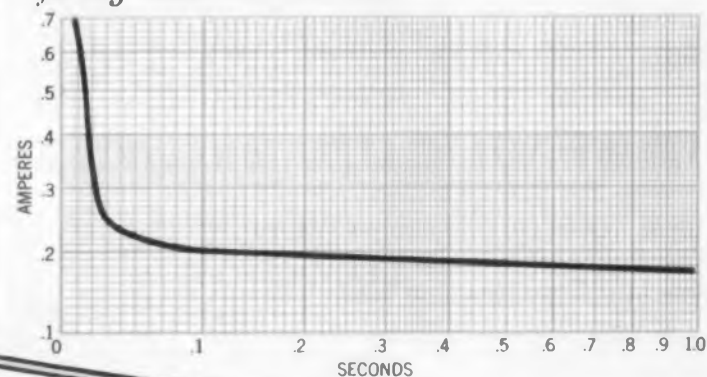
Higher ratings for Normally-closed type.

NETWORKS relays meet all pertinent Mil. Specs.

**99.99% reliability.** NETWORKS maintains continuous checks on daily production. If failure occurs in a lot, the entire lot is scrapped. There has been no failure in 1,000,000 delivered units.

**Designed for use** as a low-current sensing device, or for overload protection in guided-missile circuitry and complex electronic equipment. Used extensively to program parameters into pre-flight or flight computers.

*firing time vs current*

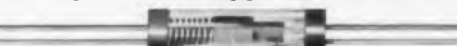


*normally open type* NO. M555 (Actual Size)



Maximum Dimensions: .165" dia. x .550" long

*normally closed type* NO. M449 (Actual Size)



Maximum Dimensions: .250" dia. x .860" long

*Send for complete data.*



**NETWORKS ELECTRONIC  
CORPORATION**

14806 OXNARD STREET • VAN NUYS, CALIFORNIA • STATE 2-3114

CIRCLE 302 ON READER-SERVICE CARD



## AIR-WOUND INDUCTORS

More than a quarter century of experience—the longest in the industry—is behind these outstanding coils. But we don't stop here: Custom coil designing to operating specifications has always been an essential part of our service, and we can produce efficiently in large or small quantities. If you must solve a special coil application in a hurry, our know-how is as close as your telephone. Call ST 8-5581.

### STANDARD COIL STOCK

Highly efficient air wound coils are stocked in a wide variety of sizes from 1/8" diameter. Coils up to 48" in diameter, 7' in length have been produced.



### ROTARY INDUCTORS

Ruggedly constructed units are available from stock and on special order. These inductors, fabricated of wire, tubing or edgewound strip, have found wide application in induction and dielectric heaters, antenna phasing networks and radio transmitters.



### FIXED INDUCTORS

Designed to performance specifications, for high power transmitters and RF heating applications. Coupling links may be internal, external, fixed or variable.



### BAND-SWITCHING PI-NETWORKS

For high efficiency and simplicity in construction of wide range band-switching amplifiers operating from 3.5 through 30 mc's. Designed for maximum "Q". Stock items.



### BALUNS AND BALUN COILS

Stock Items: Model 725 1 KW, frequency coverage 1.5 to 30 mc, matches 75 ohm unbalanced input to 300 ohm balanced output. Model 3976 Balun Coil Kit with mounting bracket. For either 75 ohm unbalanced to 75 ohm balanced or 75 ohm unbalanced to 300 ohm balanced. 250 watts AM—500 watts CW—1 KW SSB.



### PI-WOUND AND SOLENOID INDUCTORS

Designed and fabricated to specifications. Universal with single or multiple pi or progressive windings. IF, RF and oscillator coil assemblies, open, canned or hermetically sealed.



### TOROIDS

Open, impregnated, tape wrapped, encapsulated or metal cased. In sizes from 1/8" diameter center hole to any size specified. Inductances from a fraction of one micro-henry to several thousand. Tolerances: as close as 1% on special order. Designs to meet Grade 5 requirements of MIL T-27A.



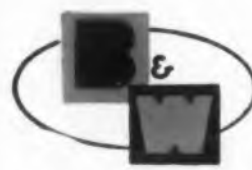
### FILTERS

Precisely constructed for any application, high-pass, low-pass, band-pass and band-suppression. Types to commercial standards or to meet MIL T-27A for military use, where temperature and humidity are vital factors.



### CHOKES

RF Filament Chokes for grounded grid amplifier applications, for operation on frequencies from 3.5 to 30 mc. RF plate transmitting chokes for series or shunt fed circuits.



**Barker & Williamson, Inc.**  
Canal Street & Beaver Dam Road, Bristol, Penna.

Specialists in Designing and building equipment to operating specifications

B&W also design and manufacture filters for: ANTENNAS RADIO INTERFERENCE•RADIO RANGE•UHF and VHF as well as many special types designed to performance specifications. Available to commercial or military standards.

CIRCLE 303 ON READER-SERVICE CARD

## NEW PRODUCTS

**CARDIAC MONITOR.**—This hand size unit provides visual and audible indications of the ventricular R wave from external chest electrodes and the ventricular R wave through internal heart wires. It also monitors the company's Pacemaker pulse. A level control adjusts for various inputs.

Medtronic Inc., Dept. ED, 818 19th Ave. N.E., Minneapolis 18, Minn.

CIRCLE 304 ON READER-SERVICE CARD

**LEAD FORMING TOOL.**—The Leedform quickly and precisely forms component leads for printed circuit assembly without danger of accidental deformation. The tool makes circular bends that increase the shock and vibration resistance of finished assemblies. It accommodates all axial-lead components.

A. G. Barstow Co., Dept. ED, 8420 Otis St., South Gate, Calif.

CIRCLE 305 ON READER-SERVICE CARD

**MISSILE-BORNE POWER SUPPLY.**—This turbine-driven electric power generator delivers 15 kva of 400 cps, 120 or 208 v, 3-phase power. It is 6-1/2 in. in diameter and 10-1/2 in. long and weighs 35 lb. Rated life in a vacuum exposed to missile skin radiation at 600 F is 20 min.

Bogue Electric Mfg. Co., Dept. ED, 52 Iowa Ave., Paterson 3, N. J.

CIRCLE 306 ON READER-SERVICE CARD

**MOLDED TRANSFORMERS.**—An expanded series of standard molds for small, light transformers permits fast delivery of special units up to 1000 va at 400 cps, single or three phase.

Sterling Transformer Corp., Dept. ED, 297 N. Seventh St., Brooklyn 11, N.Y.

CIRCLE 307 ON READER-SERVICE CARD

**CERAMIC RODS AND DISCS.**—Made from the company's Grade HT-2-M shock resistant ceramic that is suitable to 2200 F. Units can be readily machined and can be used as electrical and chemical insulators. Available in diameters from 9/16 to 2-1/4 in., lengths to 1 in., and also in custom shapes.

Duramic Products, Inc., Dept. ED, 262-72 Mott St., New York 12, N. Y.

CIRCLE 308 ON READER-SERVICE CARD

**PHOTO RECORDING PAPERS.**—In width and lengths to fit all oscillographs, Linagraph papers meet a complete range of instrument recording requirements. Type 77 has a relative tungsten speed of 100 and records at writing speeds to 50,000 ips. Type 44 has a relative tungsten speed of 20 and produces high trace density and contrast from low to high writing speeds.

Eastman Kodak Co., Dept. ED, Photo Recording Methods Sales Div., Rochester 4, N. Y.

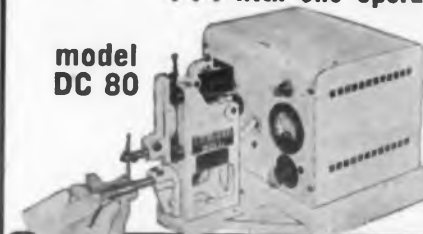
CIRCLE 309 ON READER-SERVICE CARD

## TWEEZER WELD

Precision  
Resistance Welding  
Equipment

**NOW** produce up to 6,000 welds per hour . . . automatically . . . with one operator.

model  
DC 80



**BENCH MOUNTED  
STORED ENERGY WELDER**

- New TW5 low friction welding head
- Stored energy panel of 80 Watt second capacity
- Discharge time of 0.0008 to 0.0012 second
- Permits welding of difficult materials, i.e.: copper, silver, tungsten, etc.
- Reliable welds without discoloration, deformation, metallurgical change



COMPACT  
SYNCHRONOUS  
WELDING  
TIMER  
6" wide  
10 1/2" high  
8 1/2" deep

model T-3

**TRANS-SYNC  
WELD-TIMER**

- 1 KVA capacity-utilizing semi-conductors.
- Also ideally suited with high speed automatic machinery.
- Operates at a rate up to 1200 welds per minute . . . welds partially oxidized materials with ease.
- Welding time: 1/2 cycle (8 milliseconds) to 10 cycles (160 milliseconds).

**FEDERAL TOOL ENGINEERING CO.**  
1400 Pompton Ave.  
Cedar Grove, New Jersey

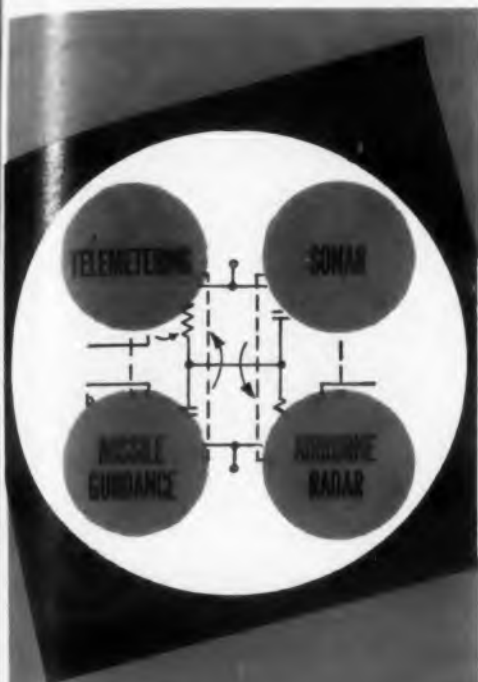


**WRITE FOR  
INFORMATION**

CIRCLE 310 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959





*Bendix-Pacific*

needs

**CIRCUIT  
DESIGN  
ENGINEERS**

**TELEMETERING...SONAR...**

**MISSILE GUIDANCE...AIRBORNE RADAR**

If you have had two or more years experience in Circuit Design in Telemetering, Sonar, Missile Guidance or Airborne Radar . . . and are interested in moving to a permanent, well paying position in Southern California—

Please write W. C. Walker your qualifications or fill in the coupon and mail today.

W. C. Walker, Engineering Employment Manager  
Bendix-Pacific, Bendix Aviation Corporation  
11620 Sherman Way, North Hollywood, Calif.

I am interested in \_\_\_\_\_ Engineering.  
I am a graduate engineer with \_\_\_\_\_  
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Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 872 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959

## Rectilinear Recording System

Has plug-in preamplifiers



With interchangeable plug-in preamplifiers the Meterite two-channel rectilinear recording system model BSA 200 can record almost any phenomena between dc and 200 cps. Chopper, carrier, ac, and low, medium, and high gain dc preamplifiers are available. The portable unit is 14 x 10 x 16 in. and has six chart speeds from 0.5 to 200 mm per sec.

Cohu Electronics, Inc., Massa Div., Dept. ED,  
5 Fottler Rd., Hingham, Mass.

CIRCLE 311 ON READER-SERVICE CARD

## Delay Lines

Have high storage density

These delay-line packages are semi-adjustable and can be provided with as much as 400  $\mu$ sec delay per cu in. A 3 x 3 x 3/8 in. can will contain as much as 1 msec of delay, which represents a storage capacity of about 150 bits per cu in. Such units have a temperature coefficient of delay of about 25 ppm per deg C over a temperature range of from -60 to +100 C. Pulse amplitude does not vary over the entire temperature range. Delay lines are available in a wide choice of sizes and housings and terminals arrangements.

Deltime, Inc., Dept. ED, 608 Fayette Ave.,  
Mamaroneck, N.Y.

CIRCLE 312 ON READER-SERVICE CARD

## Subminiature Switch

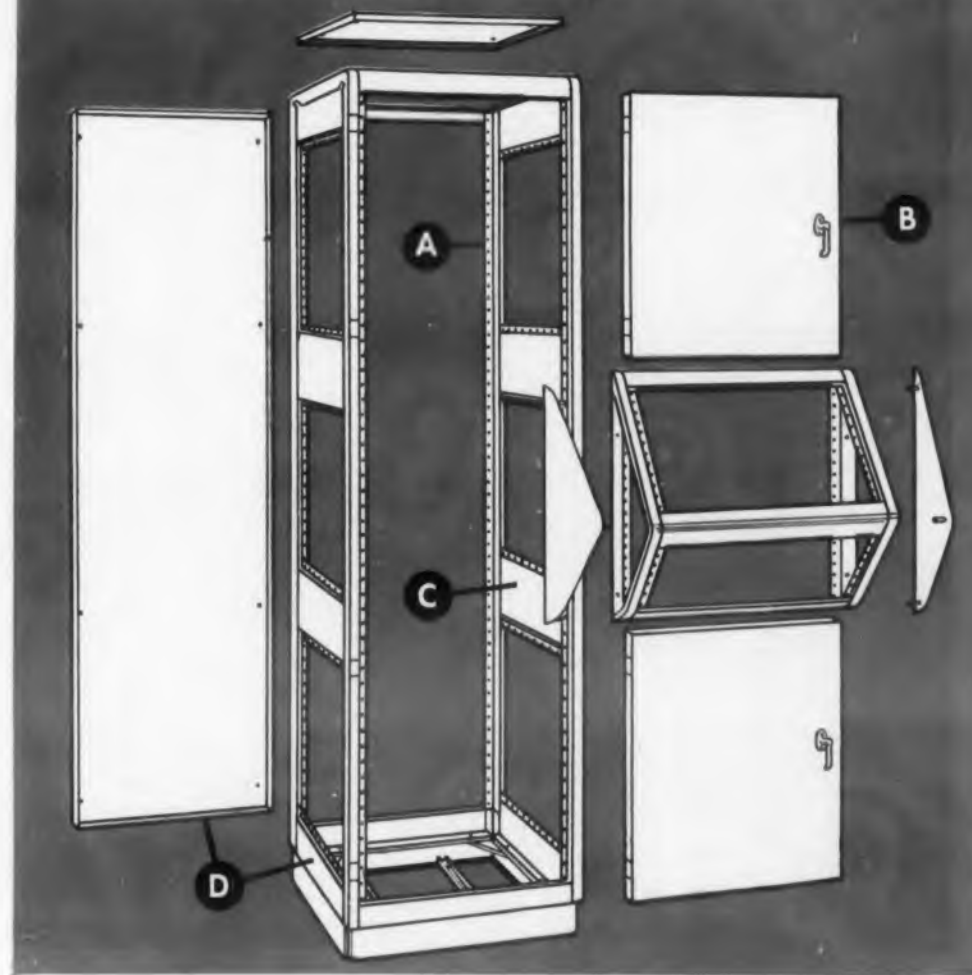
For high temperature use

This precision subminiature switch, No. 61151, was designed for operation under high temperature conditions. It measures 3/4 x 45/64 x 23/64 in. Operating temperature range is -65 to 700 F, throughout the life of the switch. Life at rated load is 25,000 cycles at 700 F. and 100,000 cycles at 450 F. The operating force is 10 to 20 oz and the electrical rating is 5 amp resistive, 3 amp inductive at 28 v dc.

Haydon Switch, Inc., Dept. ED, Waterbury 20,  
Conn.

CIRCLE 313 ON READER-SERVICE CARD

## INSIDE AND OUT



only **EMCOR**<sup>®</sup> gives  
you more quality features



- A** EQUIPMENT MOUNTING: Adjustable panel mounting angles on all vertical panel space openings allow for easy recessing of equipment.
- B** FRAME COMPONENTS: Choose from hundreds of components . . . doors, side panels, drawers, etc. . . . in louvered, perforated or plain styling.
- C** STURDY CONSTRUCTION: Heavy 14 gauge, prime quality, cold rolled steel offers rugged structural support . . . higher load carrying capacity.
- D** LONG LASTING FINISH: Light and dark gray metallic baking enamel applied over "BONDERITE" for a pleasing, dignified two-tone contrast designed to blend with equipment and colors in any application.

Over 700 frames that can be joined side-by-side, front-to-back, back-to-back, one above the other, or in any combination thereof for versatility in control center design.

WRITE FOR YOUR COPY OF CATALOG 100

Originators of the Modular Enclosure System

**ELGIN METALFORMERS CORP.**  
630 CONGDON, DEPT. 1221 • ELGIN, ILLINOIS

\*Registered Trademark of Elgin Metalformers Corporation

CIRCLE 314 ON READER-SERVICE CARD



For connections you  
must count on...

be sure, be safe with

### TWIN LOCK TERMINAL BLOCKS

Twin Lock terminal blocks offer the ultimate in terminal reliability, speed of assembly, and versatility of application. Molded of a lightweight phenolic base with reinforced barriers between cavities, the Twin Lock block will accommodate up to 40 connections quickly and surely. Twin Lock's exclusive, insert-and-tighten two-way locking action cuts harness assembly time to a fraction of that required by any other block. Twin Lock contact points, either tin plated, gold plated or plated to customer specification, assure lowest resistance connection. Wire end connectors, compatibly plated, can be supplied for manual or automatic assembly. Available in either vertical or side entry types, the Twin Lock block is applicable wherever a fast, positive, reliable electrical connection is required. For complete information on these remarkable new blocks, write for the T-1000 and T-1010 Terminal Block Brochure.



1024 West Hillcrest Blvd.  
Inglewood, California  
Coliseum Tower, 10 Columbus Circle,  
New York 19, New York

CIRCLE 315 ON READER-SERVICE CARD

#### SIMPLE

The terminal connector, crimped onto the wire end, slips easily into the block cavity. No screws or washers to remove, nothing to drop, just insert it.



#### SPEEDY

When connectors have been inserted, they're locked electrically and mechanically. Then, when the circuits have been checked, a few quick turns of the lock screw and they're double-locked.

#### SURE

When the connector has been inserted and tightened, the Twin Lock terminal block connection is positive—electrically and mechanically. Over 100 lbs. force is required to break this connection.

## NEW PRODUCTS

### PAM-PDM Decommutator

Solid state



Series 1000 telemetry pam-pdm decommutator is a solid state system that will accept all standard IRIG data trains. It has an overall accuracy of  $\pm 1\%$ . A 28 channel system weighs less than 35 lb and consumes under 10 w. Of modular construction, the systems may be packaged for fully portable operation, for standard rack mounting on a 5-1/4 x 19 in. panel, or in a cabinet.

Missile Electronics Engineering Co., Dept. ED, 14644 Keswick St., Van Nuys, Calif.

CIRCLE 316 ON READER-SERVICE CARD

### Lumped Constant Delay Line

3/8 x 1-7/16 x 5 in.



Lumped constant delay line model F341 has a total delay time of 2.4  $\mu$ sec, tapped at 0.8 and 1.75  $\mu$ sec. Its impedance is 300 ohms and its rise time 0.15  $\mu$ sec. Suited for adverse environments, the unit measures 3/8 x 1-7/16 x 5 in.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington Station, N.Y.

CIRCLE 317 ON READER-SERVICE CARD

### Transformers

Have transistor applications

Designed for transistor power supplies these four transformers are epoxy molded, and exceed MIL specs. Operating from 12.6 v dc supply, they are designated; TY-78, TY-79, TY-81 and



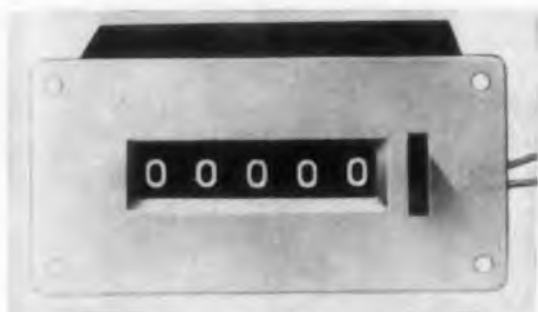
are rated at: 250 v at 100 ma; 300 v at 200 ma; 25 v at 150 ma; and 375 v at 200 ma respectively. Because of their toroidal configuration, they may be stacked on a mounting bolt, with series parallel connections, to produce an output equal to the sum of the combined units at only a slight loss in efficiency.

Triad Transformer Corp., Dept. ED, 4055 Redwood Ave., Venice, Calif.

CIRCLE 318 ON READER-SERVICE CARD

## Electric Counters

For ac applications



Model YE series of electric counters is now available for ac applications, for both the operating and reset coils. With speeds up to 1500 counts per minute, they are offered in four models, panel mounting and base mounting, with instant electric reset or push button instant reset that saves time in high speed operation.

Durant Mfg. Co., Dept. ED, 1993 North Bufum St., Milwaukee 1, Wis.

CIRCLE 319 ON READER-SERVICE CARD

## Three Speed Gear Motor

1/10 hp



This 24 v dc, centrifugally governed controlled three speed gear motor is rated 1/10 hp at 1920, 440, and 960 rpm with  $\pm 1\%$  variation. A fully enclosed, explosion proof unit, it is designed for 100 hr life and built to military specifications for camera and tape applications. It is adaptable to a range of speeds and measures 6-1/2 in. in length and 2 5/16 in. in diameter.

Western Gear Corp., Electro Products Div., 32 W. Colorado St., Pasadena, Calif.

CIRCLE 320 ON READER-SERVICE CARD



Westinghouse offers the industry's

most complete line of  
silicon rectifiers!

**Look to the leader** next time you require a quality-built, performance-proved silicon rectifier of any size or power-handling capacity. Westinghouse offers the industry's largest selection, from TV diodes to high-power 240 amp. rectifiers for all types of power applications. All diodes and rectifiers use high-purity silicon for high temperature operation, long life, and high efficiency. We can supply all standard configurations, or build to specification. Special devices, such as bridges in series or parallel, can be supplied on order. And since most products are in stock, we guarantee quick delivery.

**Transistor users note:** Westinghouse can also supply a large selection of silicon and germanium power transistors, as well as special semiconductor products.

**For complete technical data, call your Westinghouse Sales Representative.**

**YOU CAN BE SURE...IF IT'S** **Westinghouse**  
SEMICONDUCTOR DEPARTMENT, YOUNGWOOD, PA.

CIRCLE 321 ON READER-SERVICE CARD

## NEW PRODUCTS

**SERVO AMPLIFIER.**—Model T873 is a panel mounted unit suitable for controlling a rotary amplifier using a 400 cps gyro signal as the control.

Sterling Precision Corp., Dept. ED, Instrument Div., 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 322 ON READER-SERVICE CARD

**ROTARY SWITCHES.**—In eight combinations of 1, 2, or 3 spst switch positions, series 777 units have positive indexing, metal covers, molded nylon shafts and cams, and 3/16 in. wide spade terminals with holes for solder connections. UL ratings are 10 amp, 125 v ac; 1/3 hp, 125 or 250 v ac.

Controls Company of America, Dept. ED, 9555 Soreng Ave., Schiller Park, Ill.

CIRCLE 323 ON READER-SERVICE CARD

**SWITCH.**—Model E13-00A features 0.1 overtravel and is UL rated at 15 amp, 125 or 250 v ac; 3/4 hp, 125 v ac; 1-1/2 hp, 250 v ac. Case is environment resistant interlocking type with standard mounting dimensions.

Cherry Electrical Products Corp., Dept. ED, 1650 Deerfield Rd., Highland Park, Ill.

CIRCLE 324 ON READER-SERVICE CARD

**READOUT FORM PRINTER.**—Model 1941 has 12-decade capacity and automatic form ejector for recording automatic checkout data, logging instrumentation data, and recording quality control reports.

Clary Corp., Electronics Div., Dept. ED, 408 Junipero St., San Gabriel, Calif.

CIRCLE 325 ON READER-SERVICE CARD

**VIBRATION TEST FIXTURES.**—Auxiliary Tri-Mode fixtures are available in two sizes to accommodate the company's C25H and C10 vibration exciters. Of welded tubular steel, they may be used for vertical or horizontal testing. The larger unit, model TM25, permits vibration testing of specimens up to 66 x 44 in.

MB Mfg. Co., Dept. ED, Box 1825, New Haven 8, Conn.

CIRCLE 326 ON READER-SERVICE CARD

**BLANK PRINTED CIRCUIT CARDS.**—These blank plug-in cards are for use in fabricating small quantities of transistor plug-in circuits. Suitable mounting hardware is also available.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Rd., Nashville, Tenn.

CIRCLE 327 ON READER-SERVICE CARD

**FHP MOTOR.**—Available in any voltage from 6 to 220, model M-60 has a die cast frame and can incorporate reversing and dynamic braking. It can be supplied with either ball or sleeve bearings.

Rae Motor Corp., Dept. ED, 2005 Kewaunee St., Racine, Wis.

CIRCLE 328 ON READER-SERVICE CARD



THE RAW MATERIALS OF PROGRESS



## USING FLUOROCHEMICALS, TRANSFORMER DWARFED

Our age of miniaturization drops a challenge to the makers of electrical components—size and weight must go down. By using a 3M fluorochemical inert fluid, FC 75, as a dielectric coolant, the Raytheon Manufacturing Company has developed a transformer of improved electrical performance—reduced in volume by 75% and by 50% in weight. The miniaturized transformer is shown above, dwarfed by its old-fashioned counterpart. The reason? FC 75 permits the use of a much smaller transformer core and coils. And it reduces the space needed for insulation.

It has high dielectric strength, high heat transfer capability, is self-healing. It has wide liquid range with a pour point of  $-148^{\circ}\text{F}$  and low viscosity. It is thermally stable in excess of  $800^{\circ}\text{F}$ . As an evaporative coolant it is all these: nonexplosive, nonflammable, nontoxic, odorless, non-corrosive. Check the other properties at the right—then investigate FC 75, as well as the other 3M Chemicals made for the electronics industry: KEL-F® Molding Powders, KEL-F® Dispersions, KEL-F® Elastomers, Cardolite NC 513, KEL-F® Oils, Waxes and Greases, Acids and Alkanes.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW

CIRCLE 329 ON READER-SERVICE CARD



3M FLUOROCHEMICALS  
— $148^{\circ}\text{F}$   
— $148^{\circ}\text{F}$   
sure, with  
offers the  
electric s  
maintain  
repeated  
patible  
high tem  
mally st  
vents d  
equipme  
due to h

For free  
company  
uct inte  
3M CH  
Division  
WD-69,  
6, Minn

3M CHEMICALS  
Acids • I  
• Oils, W  
Coatings  
• Ine

CIRCLE 3  
ELEC RO





**3M FLUORO-CHEMICAL FC 75** pours at  $-148^{\circ}\text{F}$ . It has a wide liquid range of  $-148^{\circ}\text{F}$  to  $212^{\circ}\text{F}$  at atmospheric pressure, with low viscosity. In addition, it offers these useful properties: high dielectric strength of 37KV; self-healing, maintaining dielectric strength after repeated high voltage arcing. Compatible with most materials used in high temperature equipment. Thermally stable in excess of  $800^{\circ}\text{F}$ , it prevents development of hot spots in equipment. Prevents sludge formation due to hydrolysis or oxidation.

**ER DWARFED 75%**

bility,  
point  
ble in  
these:  
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then  
made  
wders,  
te NC  
kanes.

For free literature write on your company letterhead, specifying product interest, to 3M Chemical Division, Dept. WD-69, St. Paul 6, Minnesota.



**3M CHEMICAL DIVISION, MANUFACTURERS OF:**  
Acids • Resins • Elastomers • Plastics  
• Oils, Waxes and Greases • Dispersion  
Coatings • Functional Fluorochemicals  
• Inert Liquids and Surfactants.

CIRCLE 330 ON READER-SERVICE CARD

## Data Logging Amplifier

Has 0.1% linearity



Data logging amplifier model M-5301-D is a three stage, accurate, molded magnetic unit designed to deliver  $\pm 5\text{ v}$  at a linearity of better than 0.1%. Input and output are fully isolated, completely floating, and free of ground and power line. Voltage gains from 100 to 10,000 can be obtained with the use of external resistances. The unit draws 5 w from a 115 v, 400 cps line.

Airpax Electronics, Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

CIRCLE 331 ON READER-SERVICE CARD

## Line Voltage Regulator

For military applications

This ac line voltage regulator is designed for ground support and airborne equipment. Known as model LVR-150, its electrical characteristics include: input voltage, 90 to 135 v ac; output voltage, 115 v  $\pm 1\%$  for input of 90 to 135 v; frequency range, 50 to 65 cps (also available for 400 cps); response time, approx. 100 ms; rating, 150 va (available from 50 va to 2.5 kva). The unit is housed in a steel case and is completely encapsulated in epoxy.

Kavamil Co., Inc., Dept. ED, 1417 W. El Segundo Blvd., Compton, Calif.

CIRCLE 332 ON READER-SERVICE CARD

## Current Meter

For low level applications

Model 5902 MRC current meter combines fast response, high accuracy, low draft and a power sensitivity of 10 to 18 w. It is designed for low level current measurements. The low drop unit has nine full scale ranges of 0.1, 0.3, 1, 3, 10, 30, 100, 300 and 1,000  $\mu\text{a}$  dc. It permits measurements of 0.1  $\mu\text{a}$  full scale with less than 10  $\mu\text{v}$  drop across the input. Response time is 5 msec and basic accuracy is 1/2%.

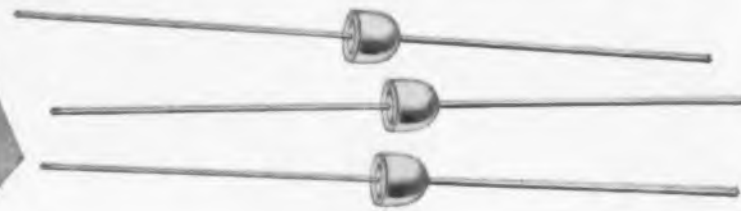
Measurements Research Co., Dept. ED, 3801 Castor Ave., Philadelphia 24, Pa.

CIRCLE 333 ON READER-SERVICE CARD

# 750 MILS TO 55°C-100 TO 600 PIV

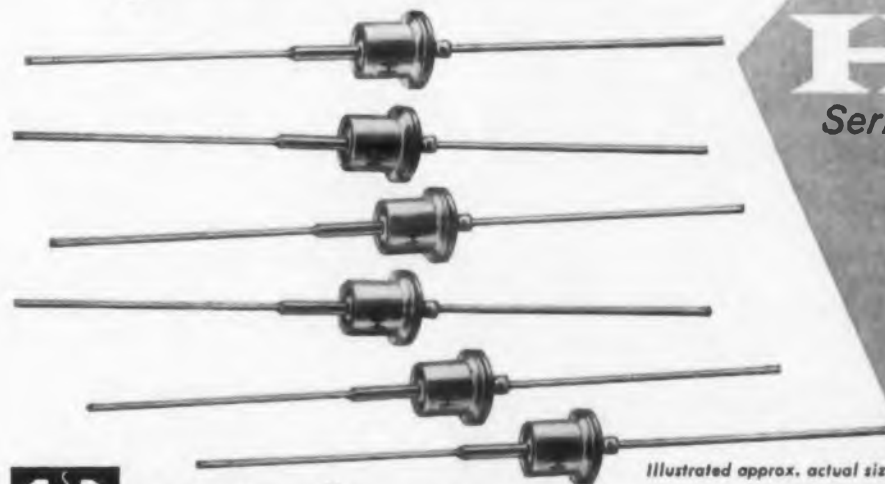
- Positive Environmental Seal
- Extra Heavy Duty Junction
- Axial Leads (No Heat Sink)
- Low Cost
- Low Forward Drop
- Low Reverse Current

**F**  
Series



- Heavy Duty Junction
- Hermetically Sealed (Double Seal)
- Axial Leads
- Low Forward Drop
- Low Reverse Current
- High Efficiency
- Low Cost

**H**  
Series



Illustrated approx. actual size

**Tarzian**

# F & H SERIES SILICON RECTIFIERS

## F SERIES—ELECTRICAL RATINGS—Capacitive Loads

S. T. Type	Max. Peak Inverse Volts	Max. RMS Volts	Current Ratings—Amperes											
			Max. D. C. Load			Max. RMS			Max. Recurrent Peak			Surge — 4MS Max.		
			55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C
F-2	200	70	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
F-4	400	140	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
F-6	600	210	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35

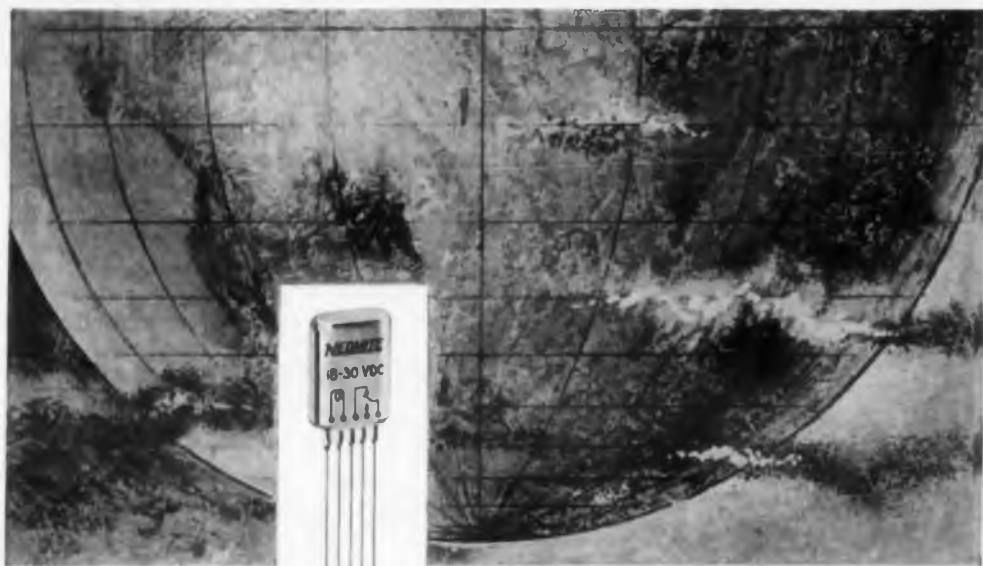
## H SERIES—ELECTRICAL RATINGS—Capacitive Loads

S. T. Type	Max. Peak Inverse Volts	Max. RMS Volts	Current Ratings—Amperes											
			Max. D. C. Load			Max. RMS			Max. Recurrent Peak			Surge — 4MS Max.		
			55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C
10H	100	35	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
20H	200	70	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
30H	300	105	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
40H	400	140	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
50H	500	175	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
60H	600	210	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35

Write for design notes No. 30 and 31

**SARKES TARZIAN, INC., Rectifier Division**  
DEPT. C-4, 415 NORTH COLLEGE AVE., BLOOMINGTON, INDIANA  
In Canada: 700 Weston Rd., Toronto 9, Tel. Roger 2-7535 • Export: Ad Auriema, Inc., New York City

CIRCLE 334 ON READER-SERVICE CARD



NM Series  
(actual size)

## ADVANCE "NEOMITE"

— smallest relay in the world ...  
in transistor-size can.  
Use it where there's no space left!

Compact circuitry needs the Neomite — a subminiature relay less than .05 cubic inch in size, and weighing only .09 ounce.

**Reliable** — recent tests have proven life of 1,000,000 operations minimum at rated load and 25°C.

**Sensitive** — the Neomite operates on only 100 milliwatts power ... switches .25 — ampere loads.

**Rugged** — relay withstands vibration of 10 G's to 500 cps. It's leak tested on RADIFLO equipment to insure long shelf life ... produced to military standards under RIQAP program approval.

**Versatile** — it can be used in printed circuits, or to switch dry circuitry. Neomites are offered in 5 resistance values: 50 ohms ... 200, 500, 1000, and 2000 ohms. Contact arrangement is SPDT. Several units can be used to provide a multiple-pole relay occupying small space.

*Our Applications Engineering Dept. will be pleased to work with you on your special application problems and on supplying built-up packages of Neomites and other components.*



**ADVANCE RELAYS**



A PRODUCT OF ELECTRONICS DIVISION  
ELGIN NATIONAL WATCH COMPANY  
2435 N. NAOMI ST., BURBANK, CALIFORNIA

CIRCLE 335 ON READER-SERVICE CARD

## NEW PRODUCTS

**DIGITAL BUILDING BLOCKS.**—Type DEC digital test equipment consists of a compatible set of 5 mc digital circuits from which custom test instruments can be quickly assembled. Each block has a graphic patch panel showing its logical contents.

Digital Equipment Corp., Dept. ED, Maynard, Mass.

CIRCLE 336 ON READER-SERVICE CARD

**PRECISION SOFT SOLDER PREFORMS.**—Available in discs, washers, spheres, and special shapes, these preforms are made from a wide range of solder alloys with melting points to 700 F.

Accurate Specialties Co., Inc., Dept. ED, 37-11 57th St., Woodside 77, N.Y.

CIRCLE 337 ON READER-SERVICE CARD

**MODULAR GEARHEAD.**—Available in any ratio up to 178 to 1, model T612 is designed for use in high accuracy computers, servo systems, and similar precision devices.

Sterling Precision Corp., Instrument Div., Dept. ED, 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 338 ON READER-SERVICE CARD

**DRAWING PENCILS.**—This Paramount line includes Diamond opaque lead pencils in 18 degrees; Star fine lead pencils in 10 degrees; and Chrome pencils in 10 colors.

Alvin & Co., Inc., Dept. ED, Windsor, Conn.

CIRCLE 339 ON READER-SERVICE CARD

**MODULAR DELAYS.**—With intervals variable in three scales from 0.25 to 500  $\mu$ sec and longer, the 5 mc model 1304 delay produces a level output signal which may be used as a variable width pulse. Several delays in series permit arbitrary timing of control pulses and provide complete flexibility in generating patterns for testing magnetic cores.

Digital Equipment Corp., Dept. ED, Maynard, Mass.

CIRCLE 340 ON READER-SERVICE CARD

**FIRE RESISTANT LAMINATED PLASTIC.**—Copper-clad, epoxy base EP-37 will not support combustion, minimizes risk of fire in computer printed circuits.

Formica Corp., Dept. ED, 4614 Spring Grove Ave., Cincinnati 32, Ohio.

CIRCLE 341 ON READER-SERVICE CARD

**AC POWER SOURCE.**—Model 15003-D-1 Invertron has a 15 kva, three phase output and a 350 to 450 cps variable frequency range. Input is 460 v, 60 cps, three phase. All other standard Invertron models are also available with power outputs to 15 kva.

Behlman Engineering Co., Dept. ED, 2911 Winona Ave., Burbank, Calif.

CIRCLE 342 ON READER-SERVICE CARD

## lacing tapes ENGINEERED for TEMPERATURE by GUDEBROD

### 375°C GUDE-GLASS

Flat braided of glass fibers, Gude-glass is recommended for use where high temperature is a factor. Available with special finishes for non-slip characteristics, it is non-toxic, resists fungus and is flexible within its complete range: -40°C to 375°C.

### 220°C TEMP-LACE

Manufactured of pure TEFLON\*, Temp-Lace is the latest addition to the Gudebrod line. Chemically inert, it is available in natural finish, with a fungistatic rubber coating or with a silicon dispersion finish. In five sizes, it is flexible from -40°C to 220°C.

### 160°C STUR-D-LACE H

Flat braided of DACRON\*\* with non-corrosive rubber finish or wax finish, Stur-D-Lace H meets the most severe requirements for fungus-resistance. It is non-toxic, knots tightly, is unaffected by most chemical solvents. In five sizes, all with high dielectric strength.

### 90°C GUDELACE

The original Gudebrod lacing tape, flat braided of nylon with special wax finish, Gudelace has become the standard where excessive high temperatures are not encountered. In seven sizes, Gudelace also comes in six colors for circuit coding.

Write for new Data Book with complete specifications of All Gudebrod Lacing Tapes.

\*Du Pont's trade mark for its TFP fluorocarbon fiber  
\*\*Du Pont's trade mark for its polyester fiber

**GUDEBROD  
BROS. SILK CO., INC.**

ELECTRONICS DIVISION  
225 West 34th Street, New York 1, N.Y.  
EXECUTIVE OFFICES  
12 South 12th Street, Philadelphia 7, Pa.

CIRCLE 343 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1955



## SPECIAL REPORT ON MINIATURIZATION OF SOLENOIDS:



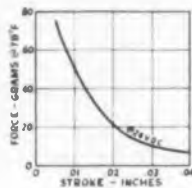
### 3/8" Diameter Solenoid Developed by PSP

A miniature solenoid, delivering 10 grams of pull at .030" stroke, has been developed by PSP Engineering Company, Maywood, California. The new 3/8" diameter solenoid complements PSP's existing line of miniature and sub-miniature solenoids.

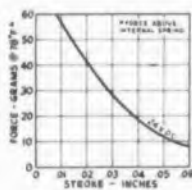
All PSP solenoids (800 designs) are made in general accordance with MIL-S-4040C specifications. Following are general specifications on representative types of PSP miniature solenoids and their accompanying force curves:

#### DC PULL, SINGLE COIL CONSTRUCTION TYPES

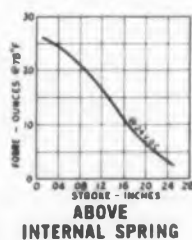
**PART NO. 4SD819-2**  
VOLTAGE RANGE: 24 to 30 VDC  
continuous duty  
CURRENT DRAIN: .030 amp @ 24 VDC @ 78°F  
TEMP. RANGE: -65°F to +160°F  
WEIGHT: Unit 9.2 grams, plunger 0.9 grams  
SIZE: 3/8" dia., 3/4" lgth.



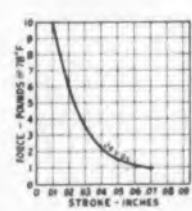
**PART NO. 5SD466-5**  
VOLTAGE RANGE: 24 to 29 VDC  
continuous duty  
CURRENT DRAIN: .100 amp @ 28 VDC @ 78°F  
TEMP. RANGE: -65°F to +240°F  
WEIGHT: Unit 9.6 grams, plunger 0.4 grams  
SIZE: 1/2" dia., 1/2" lgth.



**PART NO. 7SD756-2**  
VOLTAGE RANGE: 25 to 29 VDC  
intermittent duty  
(20 sec. on, 15 min. off)  
CURRENT DRAIN: .800 amp @ 24 VDC @ 78°F  
TEMP. RANGE: -32°F to +170°F  
WEIGHT: Unit 1.8 ozs., plunger 0.013 ozs.  
SIZE: 3/8" dia., 1 1/2" lgth.



**PART NO. 8SD328-4**  
VOLTAGE RANGE: 18 to 30 VDC  
continuous duty  
CURRENT DRAIN: .535 amp @ 24 VDC @ 78°F  
TEMP. RANGE: -65°F to +165°F  
WEIGHT: Unit 1.59 ozs., plunger 0.24 ozs.  
SIZE: 3/4" dia., 1 1/4" lgth.



Information on PSP solenoids, as well as complete information on synchro components and step-servo motors manufactured by our company, is available when requested on company letterhead.

**PSP engineering company**

**DIVISION OF  
INDUCTION MOTORS CORPORATION, N.Y.**  
6000 Walker Avenue, Maywood, California  
LUdlow 3-4785

Representatives in principal cities

CIRCLE 344 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959

## Solenoid

Withstands temperatures down to -280 F



Designed for the solenoid operated helium shut-off valve in Atlas missiles, the SD743 series solenoid withstands temperatures from -280 to +165 F. It is a dc pull, single coil type that is pressurized and leak proof. Diameter is 1.72 in.; length, 2.75 in.; and weight, 1.1 lb.

PSP Engineering Co., Dept. ED, 6058 Walker Ave., Maywood, Calif.

CIRCLE 345 ON READER-SERVICE CARD

## Limiter Amplifier

Fully transistorized

This fully-transistorized limiter amplifier, called the EPD-100, accepts input signal variation of 12 db, but limits the output signal to less than 2 db. It is designed for operation in the audio range of 50 to 15,000 cps, at temperatures from -55 C to +85 C, and for power supply variation of +5%. The unit accepts minimum inputs of 2 to 50 mv, peak to peak, with an input impedance of 500 to 4000 ohms, and provides an output of 0.5 v, peak to peak, ±1 db across a 3000 ohm load. This new limiter amplifier operates from a 28 v supply.

Otarian Listener Corp., Electronic Products Div., Dept. ED, Scarborough Pk, Ossining, N.Y.

CIRCLE 346 ON READER-SERVICE CARD

## Dry Battery

Has long life

Called the Dioxo Sulfate cell, this battery has high capacity, long life and stable output at low current drains. Among its applications are portable military and commercial communications equipment. It discharges at constant voltage throughout its life, and does not deteriorate during months of storage. It is inherently non-gassing and non-leaking. At low current drains, the cell delivers almost 100% of available capacity. No-load output is 1.36 v.

Mallory Battery Co., Dept. ED, 60 Elm St., N. Tarrytown, N.Y.

CIRCLE 347 ON READER-SERVICE CARD

## FILTERS for scatter systems



**W**HATEVER your requirements for large size filters, D. S. Kennedy can meet your most exacting specifications. Here are two recent developments for quadruple diversity scatter systems: *top* — a tunable low band duplexer for the 755-985 mc range. *Bottom* — a fixed-tuned double notch filter.

ANTENNA EQUIPMENT

**D. S. KENNEDY & CO.**

COHASSET, MASSACHUSETTS EVERgreen 3-1200

West Coast Affiliate . . .

**SATELLITE KENNEDY, INC. of CALIFORNIA**

P. O. Box 1711, Monterey, California — FRONTier 3-2481

Down-to-earth SOLUTIONS to out-of-this-world PROBLEMS

Tracking Antennas-Radio Telescopes-Radar Antennas

"Trans-Horizon" Antennas-Tropospheric Scatter

Ionospheric Scatter

CIRCLE 348 ON READER-SERVICE CARD

*"Fansteel's new 35 amp.  
Silicon Rectifier will be  
perfect for this job"*



*He's talking  
about the  
Fansteel 4A  
Silicon  
Power  
Rectifier.....*



It carries a full 35-amp. load—up to 105 amps. in bridge circuits—with rated peak inverse voltages from 50 to 400 V. in 50-volt multiples. It will operate in ambient temperatures up to 165°C and withstand storage temperatures up to 200°C.

The Fansteel Type 4A rectifier, ruggedly constructed with a true hermetic glass-to-metal seal, is designed particularly for magnetic amplifiers, industrial controls, d-c motor operation, battery charging equipment, utility, communication equipment, etc. where small size and high reliability are important.

It can be mounted in any position and is available with or without a flexible terminal.

Write for Bulletin 6.305

**FANSTEEL**

RELIABILITY

E597A

**FANSTEEL METALLURGICAL CORPORATION** North Chicago, Ill., U.S.A.

CIRCLE 349 ON READER-SERVICE CARD

## NEW PRODUCTS

**CONTINUOUS MOTION FILM MAGAZINES.**—For use with the company's Oscillotron cameras in recording transient phenomena from the face of cathode ray tubes. Available in 35 and 70 mm models, each accommodating 100 ft of negative film.

Beattie-Coleman, Inc., Dept. ED, 1000 N. Olive St., Anaheim, Calif.

CIRCLE 350 ON READER-SERVICE CARD

**FEEDTHROUGH INSULATOR.**—The series CF-405 has a hollow threaded metal body which fits through a bed plate and is secured by a hex nut. The entire unit ranges from 0.69 in. in length and has a rated capacitance of 2  $\mu$ f. The terminal, which passes through the hollow body, is spaced by a force-fitted Teflon plug.

Fluorocarbon Products Inc., Dept. ED, Camden 1, N.J.

CIRCLE 351 ON READER-SERVICE CARD

**SERVOMECHANISM KIT.**—Kit no. 1 contains all the mechanical parts and tools necessary to construct 1-7/8 in. diameter mechanisms such as computer components, indicators, and control elements. The completed mechanisms can be sealed into standard 2 in. diameter enclosures for airborne applications and prototype evaluation.

Servo Development Corp., Dept. ED, 567 Main St., Westbury, N.Y.

CIRCLE 352 ON READER-SERVICE CARD

**PRESSURE TRANSDUCERS.**—Series A-2 PowrAmp transducers are now available in lower, more sensitive full scale ranges of 0 to 1.5 and 0 to 3.8, gage or absolute, at operating pressures to 20 psig. Other models function at ranges to 0 to 2000 psi with maximum allowable operating pressures of 3000 psig. The high speed units are designed for electronic control and data readout systems.

Hagan Chemicals & Controls, Inc., Dept. ED, Route 60 at Campbell Run Rd., Pittsburgh 30, Pa.

CIRCLE 353 ON READER-SERVICE CARD

**MINIATURE CONNECTOR.**—The nylon model FM 101 weighs 0.053 oz and features snap-fit assembly. The male and female sections are 0.49 and 0.58 in. long, respectively, 0.306 in. wide, and 0.453 in. deep

Fluorocarbon Products Inc., Dept. ED, Camden 1, N.J.

CIRCLE 354 ON READER-SERVICE CARD

**PRESSURE TRANSDUCERS.**—Miniaturized model GP-15D converts pneumatic or hydraulic pressure into a proportional electric signal for measurement under both static and dynamic conditions. Ranges are 10 to 6000 psig. Model DP-15D is a differential pressure transducer with dual bleed screws. Ranges extend from  $\pm 5$  to  $\pm 5000$  psig at line pressures to 5000 psi.

BJ Electronics, Borg-Warner Corp., Dept. ED, 3300 Newport Blvd., Santa Ana, Calif.

CIRCLE 355 ON READER-SERVICE CARD



**a good way  
to measure  
0.00003 ohm**

The Keithley 502 Milliohmmeter offers speed, ease, and accuracy in the measurement of low resistances. Typical uses are corrosion tests, checking resistivity of metals, semi-conductors, printed circuits, switch and relay contacts.

Battery operation, a ruggedized meter, and protective cover make the 502 ideal for field tests of squibs, carbon bridges and other explosive devices. Features include:

- 13 overlapping ranges from 0.001 ohm to 1000 ohms full scale.

- accuracy within 3% of full scale; a four-terminal measuring system eliminates errors due to clip and lead resistance.

- 2 microwatts maximum dissipation across sample.

- no calibration or zero adjustments.

- instantaneous indication of resistance without zero drift or errors due to thermal EMF's.

- lightweight and portable. Furnished with protective cover and set of four test leads.

Details about the Model 502 Milliohmmeter are available in Keithley Engineering Notes, Vol. 6 No. 3. Write for your copy today.

**KEITHLEY  
INSTRUMENTS, INC.**

12415 Euclid Ave., Cleveland 6, Ohio

CIRCLE 356 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959



*New* ADVANCED  
DESIGN "B" LINE  
60 AND 400 CPS



## HIGH POWER TRANSISTOR MAGNETIC SERVO AMPLIFIER

For AC servo motor control —  
50 watts to 3000 watts

### FEATURING

- Extreme reliability
- Wider ambient temperature range
- Faster response
- Smaller size at higher power ratings
- Higher gains
- Improved core design
- Silicon rectifiers used exclusively
- Greater flexibility
- Ideally suited for operating with Diehl Servo Motors

Signal Input AC or DC  
Military Specifications  
Provisions for System  
Feedback • Completely  
Static • Output 115V AC  
Phase Reversible

For complete 60 cps and  
400 cps specs request Bul-  
letin S-961.



**MAGNETIC  
AMPLIFIERS, INC.**

100 TINTON AVENUE • NEW YORK 55, N. Y. • CYPRESS 2-6610

West Coast Division

100 WASHINGTON ST. • EL SEGUNDO, CAL. • OREGON 8-2465

CIRCLE 357 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959

## Miniature Dual Capacitors

Have common anode



Type SMTUCP miniature capacitors are dual units with a common anode and isolated cathodes. They can be used in place of two capacitors for dual filtering, by-pass, or coupling.

Illinois Condenser Co., Dept. ED, 1616 N. Throop St., Chicago 22, Ill.

CIRCLE 358 ON READER-SERVICE CARD

## Power Supply

Output is 12 v, 50 amp

This regulated dc power supply, model BE-1, supplies up to 50 amp at 12 v dc from a 115 v, 60 cps source, with a regulation of better than 0.1% from 0 to 50 amp. The unit has an output impedance of 0.001 ohm dc to 1 kc and a ripple of less than 1 mv at any load. The unit will provide an instantaneous surge current of 100 amp for operating non-linear resistance loads. A direct short on the output terminals cannot damage the unit.

Electrodynamic Instrument Corp., Dept. ED, 2508 Tanglely Rd., Houston 5, Tex.

CIRCLE 359 ON READER-SERVICE CARD

## Miniature Indicator Lights

Meet MIL specs

Known as series L14,000 and L15,000 these lights meet MIL-L-6723 (ASG), have two-terminal isolated ground circuits, anodized aluminum cases, and large-area plastic lenses which afford bright, 180 deg visibility. Designed for use with mid-gate flange base AN3140-type incandescent lamps, the series L14,000 measures only 1-11/64 in. long overall. It is available with lenses in a variety of translucent and transparent colors. Only slightly longer, the L15,000 Series features a built-in resistor and accommodates NE2D neon lamps for 115 v operation. Lenses in this series are available in transparent red, amber, and clear.

Hetherington, Inc., Dept. ED, Folcroft, Pa.

CIRCLE 360 ON READER-SERVICE CARD

THE

New

FANSTEEL

S·T·A

SOLID TANTALUM CAPACITOR

gives you...

- ✓ The most complete range of ratings...
- ✓ Consolidated into 4 subminiature case sizes conforming to proposed government specifications
- ✓ Inventory simplification

The new line of Fansteel Type STA Solid Tantalum Capacitors, with increased capacity and reduced case sizes, provides the most complete range of standard ratings available. A very important feature of the new line is that it very substantially reduces the quantity of different part numbers, thereby simplifying your inventory stocking problems (your Fansteel Representative will be glad to explain its full benefits to you).

Type STA Capacitors are available in capacity ranges of .0047 to 330 mfd—from 6 to 35 volts (wvdc) for applications where unfailing reliability, extremely small size, higher capacitance and extended operating temperatures (up to 125°C) are required.

Send for Bulletin 6.112



CIRCLE 361 ON READER-SERVICE CARD

"Use the Fansteel BLU-CAP\* . . .  
it's a good, reliable capacitor . . .  
and priced right  
for this job, too"



## FANSTEEL'S NEW BLU-CAP\* TANTALUM CAPACITOR

Here's an engineer who knows from past experience that the Fansteel BLU-CAP is the perfect tantalum capacitor for applications where wider capacity tolerance is permissible.

He has found out for himself the excellent qualities of the BLU-CAP—Long Operating Life—Long Shelf Life—Negligible Leakage—Excellent Stability—and most important their record of RELIABLE PERFORMANCE. This user is one of thousands who have recognized, in BLU-CAP, the best value in a completely dependable Tantalum Capacitor.

\*Trademark

Send for Bulletin 6.120



C597A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

CIRCLE 362 ON READER-SERVICE CARD

## NEW PRODUCTS

**SILICONE RUBBER COMPOUND.**—RTV-40 is a solvent free paste which cures to a tough silicone rubber at room temperature. Manufactured as a white compound, it can easily be colored to individual requirements. It can be used for sealing, caulking, potting, and encapsulating.

General Electric Co., Dept. ED, Silicone Products Dept., Waterford, N.Y.

CIRCLE 363 ON READER-SERVICE CARD

**CONTACT MAKING METER.**—This accurate meter, for controlling or regulating ac voltages, has a moving disc measuring element which detects voltage variations of 0.5 v. Contact action can be set with a knob and scale to occur at any increment between 100 and 130 v.

Technique Associates, Dept. ED, P.O. Box 91, Indianapolis 6, Ind.

CIRCLE 364 ON READER-SERVICE CARD

**MILL SHAPES.**—Made of Lexan polycarbonate resin, Polypenco forms include rod, tubing, plate, and discs which are readily fabricated into close tolerance finished parts. The units have high impact strength and good heat resistance, dimensional stability, and electrical properties.

The Polymer Corporation of Pennsylvania, Dept. ED, 2140 Fairmont Ave., Reading, Pa.

CIRCLE 365 ON READER-SERVICE CARD

**COMPOSITE SCREW.**—The Insul-Screw has a plastic exterior for good insulation and a metal core for high strength. It is shock resistant, vibration dampening, and chemically inert.

Austin Screw Products Co., Dept. ED, 4873 W. Armitage Ave., Chicago 39, Ill.

CIRCLE 366 ON READER-SERVICE CARD

**ACCELEROMETER PREAMPLIFIER.**—Briel & Kjaer model 1606 performs the functions of high input impedance preamplifier, of accelerometer calibrator by the chatter method, and of providing two steps of integration for measuring velocity or displacement with an accelerometer. It affords a sensitivity calibration of 3 to 5% accuracy.

B & K Instruments, Inc., Dept. ED, 3044 W. 106th St., Cleveland 11, Ohio.

CIRCLE 367 ON READER-SERVICE CARD

**CERAMIC CAPACITOR.**—Type 287 is potted with epoxy in a gold plated brass case and withstands severe shock, vibration, and moisture environments. Rated to 1200  $\mu$ f at 350 wvdc, it has an insulation resistance of 20,000 meg at 125 C, a low capacitance temperature drift, and an operating temperature range of -55 to +125 C. It is 2.5 cm long.

Maida Development Co., Dept. ED, 214 Academy St., Hampton, Va.

CIRCLE 368 ON READER-SERVICE CARD

## SOMETHING NEW IN SLOTTED SECTION IS



Actually, this is a new kind of Standing Wave Detector, which completely makes obsolete the 8-foot monsters, for impedance and VSWR measurements from 100 to 1000 mc/s.

The PRD Type 219 is only 8 inches long and weighs a "pocketable" four and one-half pounds.

As if these facts were not startling enough, the 219 also features:

- Direct reading of VSWR
- Direct reading of angle of reflection coefficient
- Direct reading of reactive component sign
- Matched load for self-calibration supplied
- Adaptability to most coaxial lines, including the LT and new TNC series
- Low cost
- Rugged construction

Listed below are a few of the important specifications.

Frequency Range:	100 to 1000 mc/s
Residual VSWR:	Less than 1.03
Minimum Input Signal:	Approx. 1V at 100 mc/s 0.1V at 1000 mc/s for measuring a matched load
Characteristic Impedance:	50 ohms
Detector:	Crystal included
RF Input Connector:	BNC jack
RF Output Connector:	Type N jack supplied Connector types available include types C, BNC, LT, TNC, 7/8" coax.
Audio Output Connector:	BNC jack
Dimensions:	8" L x 5" W x 5 3/4" H
Weight:	4 1/2 pounds

f.o.b. Brooklyn, New York

Note to owners of the new PRD Catalog E-8: Don't bother reading this ad. All the details and more can be found on page B-13. If you are unfortunate enough not to own a copy of this designers' workbook, send your request on your company letterhead please.

If all you want are specifications on the 219, fill out the inquiry card in this magazine.

**POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.**  
Factory & General Office:  
202 Tillary St., Brooklyn 1, N.Y.  
ULster 2-6800

Western Sales Office:  
2639 So. La Cienega Blvd., Los Angeles 34, Calif.  
TEXas 0-1940

CIRCLE 369 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 195



timesaving . . . cost-cutting

## first aid for the DESIGN LAB



**SERVOBOARD®** Electromechanical Assembly Kits are truly first-aid kits for the engineer with model-making problems.

These modern kits are scientifically designed and packaged by Servo Corporation of America to eliminate the majority of breadboarding headaches...swiftly, economically, and with precision.

Selection of components has been made by experts with years of servo systems design and production experience. Enough components are included in each kit to meet almost every model-making need. Extra components are always available out of open stock.

Exclusive **SERVOBOARD** features eliminate model shop costs and time lags inherent in usual model-making techniques. For example:

**PRECISION** — 1/2"-thick, anodized aluminum mounting board is absolutely rigid. Extraneous stresses cannot produce spurious results.

**SPEED OF ASSEMBLY** — Holes are tapped to receive captive screws on mounting clamps, permitting easy assembly from the top and eliminating underhanded fumbling.

**FLEXIBILITY** — Components may be assembled at any angle, not just parallel or at right angles. Kits include wide variety of co-ordinated components.

**ECONOMY** — Quick set-up and knock-down permit maximum re-use for new problem solving.

**SPACE-SAVING** — Mounting boards stack one above the other.

**EXPANDABLE** — No system too large.

Three sizes of kits are available, any one of which can begin eliminating design headaches immediately. Get full details (without obligation) by writing for free **SERVOBOARD** Electromechanical Assembly Kits Brochure. Do it today... **WRITE NOW!** Request TDS 1110-D.

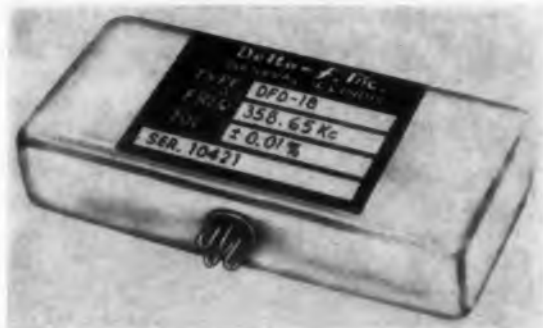
**SERVO CORPORATION of AMERICA**

20-20 Jericho Turnpike, New Hyde Park, L.I., N.Y.

CIRCLE 370 ON READER-SERVICE CARD

## Crystal Oscillator

Transistorized



For use at any specified frequency from 10 kc to 100 mc, the model DFO-18 transistorized crystal oscillator is fully encapsulated in a package 1/2 x 1-7/16 x 3-1/16 in. It is available with any type connector compatible with its size. Operating temperature range is -55 to +90 C with a frequency stability of 0.005% to 0.015%, depending on the specified frequency. Output power is 0.1 mw minimum and supply voltage is 20 to 30 v as specified.

Delta-f, Inc., Dept. ED, 113 E. State St., Geneva, Ill.

CIRCLE 371 ON READER-SERVICE CARD



## DC Motors

Permanent magnet

Type 810 permanent magnet dc motors are supplied to operate on any voltage from 3 to 30 v dc and to produce any no load speed from 5000 to 20,000 rpm. Maximum output without gear train is 0.7 oz-in.; working torques are 0.5 to 0.1 oz-in.

Cramer Controls Corp., Dept. ED, Centerbrook, Conn.

CIRCLE 372 ON READER-SERVICE CARD



## Lamps

Last 15 sec and 1 billion years

The larger of these two lamps is for use with an infrared device that traces the early flight of missiles. It provides intense light for 15 sec. The smaller lamp, 1/8 in. in diameter and 1/4 in. long, is for airplane instruments. It withstands voltage surges and vibration of any order and burns continuously at rated voltage for 1 million years.

Chicago Miniature Lamp Works, Dept. ED, 1500 N. Ogden Ave., Chicago 10, Ill.

CIRCLE 373 ON READER-SERVICE CARD

# ...AND ANOTHER Silicon Rectifier

FROM

# FANSTEEL



## 22 AMP. Silicon Power Rectifier

The 6A—just added to Fansteel's expanding line of dependable silicon rectifiers—carries a full 22 amp. load in half-wave circuits; up to 66 amps in bridge circuits. It has rated peak reverse voltages from 50 to 400 V. in 50-volt multiples.

The new 6A Rectifier operates at ambient temperatures up to 165°C. and is unaffected by storage temperatures from -65°C to 200°C.

This highly stable unit, with exceptional resistance to shock and vibration, is especially suited to high temperature operation in all types of power circuits where it will give dependable and trouble-free performance with long life. The 6A unit is hermetically sealed and is of extremely rugged construction. It is the most compact unit of its rating and can be mounted in any position.

Send for Bulletin 6,304

**FANSTEEL**

RELIABILITY

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

CIRCLE 374 ON READER-SERVICE CARD

## Microwave Component News



from SYLVANIA



# NEW Microwave Diodes withstand 150°C



2.0	NOISE RATIO (times)		
1.5			
1.0	500	1000	
5.5	CONVERSION LOSS (db)		
5.0			
4.5			

Average Storage Life At 150°C (1N23C)

**Sylvania develops new fabrication techniques that bring standard microwave diode heat capabilities up to 150°C at no increase in cost**

Now, microwave design engineers can get the high temperature advantages of specialized premium diodes without any of the cost or delivery disadvantages, by specifying Sylvania microwave diodes. Through improved processing techniques and high-temperature bonding agents, Sylvania has succeeded in raising the temperature capabilities of its S and X-Band microwave diode lines by 60°C!

For the design engineer, these new diodes can result in substantial reductions in air cooling equipment requirements and associated cabling. They also open new design possibilities in commercial applications where ruggedness and price can be controlling factors.

Contact your Sylvania representative now for full particulars on these new Sylvania microwave diodes or write the factory directly at the address below.

### Sylvania high temperature microwave diodes

Micro-Min Diodes	Forward-Reverse & Matched Pairs	Double Ended Diodes
1N830 (D4050)	1N21B 1N23B	1N416B 1N415B
1N831 (D4064)	1N21C 1N23C	1N416C 1N415C
1N832 (D4065)	1N21D 1N23D	1N416D 1N415D
1N833 (D4063)	1N21E 1N23E	1N416E 1N415E

**SYLVANIA**  
Subsidiary of  
GENERAL TELEPHONE & ELECTRONICS



Sylvania Electric Products Inc.  
Semiconductor Division  
100 Sylvan Rd., Woburn, Mass.

CIRCLE 375 ON READER-SERVICE CARD

## NEW PRODUCTS

### Resistance Soldering Tool

#### Eliminates arcing

This resistance soldering tool completely eliminates arcing and provides high speed, void free connections. It is fully automatic and adaptable to soldering multiple prong plugs.

General Electric Co., Industrial Heating Dept., Dept. ED, Schenectady 5, N.Y.

CIRCLE 376 ON READER-SERVICE CARD

### Bridge Rectifiers

#### Operate at 165 C

This series of subminiature silicon bridge rectifiers replace bulky vacuum tube bridge rectifiers in only 1/50 of the volume. They weigh less than 1/100 of equivalent tube circuitry, and measure 0.875 x 0.719 x 0.750 in. They are designed to provide extreme miniaturization in mis-

sile, airborne and ground system circuitry, and may be operated at temperatures up to +165 C. The units are available with ratings from 50 to 500 piv, with dc output currents up to 0.8 amp.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

CIRCLE 377 ON READER-SERVICE CARD

### Diffused Silicon Rectifiers

#### Heavy duty

These heavy duty diffused silicon rectifiers are stud mounted and rated at 50 and 30 amp at a stud temperature of 150 C. Recurrent piv's are 50 through 600 v in both 50 and 30 amp series. Operating range is -65 to +200 C.

Texas Instruments Incorporated, Semiconductor-Components Div., Dept. ED, P.O. Box 312, Dallas, Tex.

CIRCLE 378 ON READER-SERVICE CARD

## AC/DC RATIO STANDARD

For those who require an AC/DC RATIO STANDARD in a single package, Gertsch offers its Models 1001 and 1002. Like all GERTSCH RATIO STANDARDS (1000 Series), these units feature: heavy duty instrument switches, transient suppression, AC Ratios up to 1.1111, bold in-line readout and extra-heavy mechanical construction to insure TRUE STANDARDS PERFORMANCE.

	AC	DC
Linearity:	1 part per million (0.0001%)	10 parts per million (0.001%)
Resolution:	6 Place (0.0001%)	6 Place (0.0001%)



Information on AC Ratio Standards in the GERTSCH RATIO STANDARDS SERIES, Models 1000, 1003 and 1004, is also available.

GERTSCH PRODUCTS, Inc.

3211 South La Cienega Boulevard, Los Angeles 16, California  
Texas 0-2761 - Vermont 9-2201

*Gertsch*

CIRCLE 379 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 195



**FLEXIBLE TEFLON TUBING.**—This thin wall fused film tubing can be bent around a mandrel less than ten times its diameter without collapsing its walls. It has high dielectric strength and is available in sizes 13 to 28 AWG.

Inso Electronic Products, Inc., Dept. ED, Union, N.J.

CIRCLE 380 ON READER-SERVICE CARD

**ULTRASONIC CLEANER.**—Low cost Ultracleaner 60 is a fast cleaner with a selector switch that permits the operation of two tanks when a double step is required. It also has a load selector switch for operating two submersible transducers at once in a 5 gal tank. The 3/4 gal tank is 6 cu in., and the 9 lb generator is designed to hang on the wall.

Lawrence Mfg. Corp., Dept. ED, Belleville, N.J.

CIRCLE 381 ON READER-SERVICE CARD

**EPOXY FIBER GLASS TUBING.**—Phenolite Grade G-11-3680 or G-11-3681 tubing can be used alone or in combination with other layers in miniature coil forms, lightning arresters for power transformers, aircraft fuel gage probes, and other devices. The tubes have ID's from 1/8 to 11 in. and wall thicknesses from 0.01 to 5-1/2 in.

National Vulcanized Fibre Co., Dept. ED, 1059 Beech St., Wilmington 99, Del.

CIRCLE 382 ON READER-SERVICE CARD

**MILLIMICROAMMETER.**—Model MA-259 is designed to extend the range of the company's model DT-257 diode tester from 50 to 0.01  $\mu$ a to measure the low reverse current characteristics of silicon diodes. Used as a millimicroammeter, the instrument covers 0.01 to 1000  $\mu$ a. It is self contained and battery powered.

Teletronics Lab, Inc., Dept. ED, 54 Kinkel St., Westbury, N.Y.

CIRCLE 383 ON READER-SERVICE CARD

**FAST PULSE CAMERA.**—Model 360 can be run at pulsing rates to 18 frames per sec, at which rate the 50 ft of film in its standard 16 mm magazine lasts about 2 min. The unit can be used for data recording and can make slow motion movies of vibration tests or other cyclic subjects at speeds to 10 kc.

Chadwick-Helmuth Co., Dept. ED, 472 E. Duarte Rd., Monrovia, Calif.

CIRCLE 384 ON READER-SERVICE CARD

**SIGNAL CONDITIONING EQUIPMENT.**—Designed for telemetering, this modular system is also adaptable to wind tunnel engine research and to aircraft applications. The light aluminum frames can accommodate modules in any arrangement from one to several hundred. Presently available are a power supply regulator, vibration amplifier, carrier amplifier, and two dc amplifiers.

Magnetic Research Corp., Dept. ED, 3160 W. Segundo Blvd., Hawthorne, Calif.

CIRCLE 385 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959

# TANTALUM . . .

*The  
Fansteel  
Metallurgy  
Behind  
It . . . .*



A battery of vacuum sintering furnaces, designed and built by Fansteel engineers, used in the production of Capacitor Grade Tantalum.

**T**HE FIRST great step in making tantalum was the production of pure, ductile metal, which Fansteel's director of research, Dr. Clarence W. Balke, accomplished in 1922.

The second great step is still in progress. It is one thing to make a new metal; it is another thing to make it freely available in commercial quantities and to render technical assistance to its users. This metallurgical task will never be fully completed as far as Fansteel is concerned. For, our definition of metallurgy includes the making of metals for a particular end use.

Our work with tantalum capacitors has paralleled our development of tantalum itself. And,

from the many grades of tantalum, Fansteel metallurgists developed one grade which is particularly suited to capacitor manufacturing.

Fansteel Capacitor Grade Tantalum is a premium grade with properties especially useful in capacitor applications. It is unequalled for quality and uniformity, designed strictly to give outstanding capacitor performance and reliability.

Fansteel Capacitor Grade Tantalum is specified by all leading capacitor manufacturers. The outstanding performance of today's tantalum capacitor is directly attributable to Fansteel Capacitor Grade Tantalum. Fansteel Metallurgical Corporation, Rectifier-Capacitor Division, North Chicago, Ill.

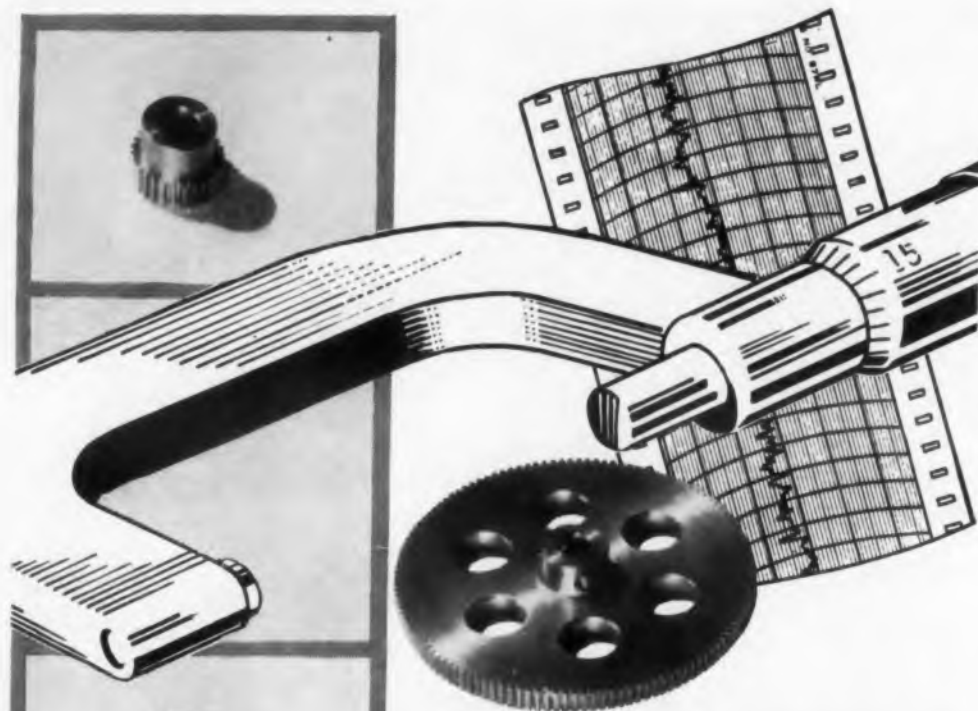
**FANSTEEL**®

**CAPACITOR GRADE  
TANTALUM**

A Premium Grade of Tantalum available to capacitor manufacturers in these forms:

FOIL • SHEET • STRIP • WIRE • RIB • FABRICATED WIRE LEADS  
SINTERED POROUS ANODES • METAL POWDER

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*Certified*

**APPCO PRECISION  
STOCK GEARS**

Precision gears of all types, pitches and sizes right out of stock. Each certified for accuracy . . . each meets or surpasses A. G. M. A. specifications.

APPCO Certified Precision Stock Gears are offered in 32, 48, 64, 72, 96 and 120 diametral pitches of 14½° and 20° pressure angles. Each gear is completely sealed on a shipping tray with a plastic cover . . . always "factory-fresh," free of dust, corrosion, and scratches.

APPCO Precision Gears are engineered and manufactured to allow for accurate assembly of precision units . . . held to tolerances that assure precise fits to standard instrument bearings, shafting, etc. according to accepted industry practice and A. G. M. A. specifications. For complete technical data and catalog write to Atlas Precision Products Co., Castor and Kensington Aves., Philadelphia 24, Pa.



Division of  
**PRUDENTIAL INDUSTRIES INC.**

CIRCLE 387 ON READER-SERVICE CARD

**NEW PRODUCTS**

**Paper Tape Reader**

**For any speed to 60 characters  
per sec**

A self-contained, bidirectional asynchronous paper tape reader, the model 424 handles any standard perforated tape of 5 to 8 levels. A panel mounted unit, it is also available in a console unit, model 424C. For any reading speed to 60 characters per sec, it requires 105 to 125 v ac, 60 cps at 0.4 amp to operate the drive motor. A 4.5 msec pulse of 48 v dc is applied to either directional drive clutch to move the tape.

Tally Register Corp., Dept. ED, 5300 14th Ave., N.W., Seattle 7, Wash.

CIRCLE 388 ON READER-SERVICE CARD

**Battery Chargers**

**For 10 to 63 cells**

Single phase Magnistrol silicon battery chargers are designed for

float charging battery installations, ranging from 10 to 63 cells in five basic amperage capacities in three voltage ranges. They adjust for charging lead acid, nickel-alkaline, or nickel-cadmium units.

Acme Electric Corp., Custom Equipment Div., Dept. ED, 226 Water St., Cuba, N.Y.

CIRCLE 389 ON READER-SERVICE CARD

**Environmental Test  
Chamber**

**Occupies 1-1/2 cu ft**

The Temp. Rac 19 is a 1-1/2 cu ft, self-contained environmental test chamber that fits into a standard 19 in. relay rack. The portable unit has an indicating controller, a forced air circulator, electric heating, and direct refrigeration.

Conrad, Inc., Dept. ED, 141 Jefferson St., Holland, Mich.

CIRCLE 390 ON READER-SERVICE CARD



**HIGH-Q**

**KELVIN TOROID INDUCTORS**  
rapid delivery on prototype and production quantities

High Q factors, excellent stability vs. temperature and current, and self-shielding effects are the main features of Kelvin toroid inductors wound on molybdenum permalloy dust cores.

The coils are supplied to the exact inductance required at no extra charge. Standard inductance tolerance is ±1%.

Available in three forms:

UNCASED, with protective wax coating.

HERMETICALLY SEALED in steel cases to MIL-T-27A specifications.

ENCAPSULATED in hi-temp plastic to withstand extreme humidity and severe mechanical shock.



**KELVIN  
ELECTRIC COMPANY**

Send for bulletin KT-1

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CIRCLE 391 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1955



## FLIGHT DATA and CONTROL ENGINEERS

Cross new frontiers in system electronics at The Garrett Corporation.

High-level assignments in the design and development of system electronics are available for engineers in the following specialties:

**1. ELECTRONIC AND FLIGHT DATA SYSTEMS AND CONTROLS** A wide choice of opportunities exists for creative R & D engineers having specialized experience with control devices such as: transducers, flight data computers, Mach sensors, servo-mechanisms, circuit and analog computer designs utilizing transistors, magamps and vacuum tubes.

**2. SERVO-MECHANISMS AND ELECTRO-MAGNETICS** Requires engineers with experience or academic training in the advanced design, development and application of magamp inductors and transformers.

### 3. FLIGHT INSTRUMENTS AND TRANSDUCERS

1) **DESIGN ANALYSIS** Requires engineers capable of performance analysis throughout preliminary design with ability to prepare and coordinate related proposals.

2) **DEVELOPMENT** Requires engineers skilled with the analysis and synthesis of dynamic systems including design of miniature mechanisms in which low friction freedom from vibration effects and compensation of thermo expansion are important.

**4. PROPOSAL AND QUALTEST ENGINEER** For specification review, proposal and qualtest analysis and report writing assignments. Three years electronic, electrical or mechanical experience required.

Forward resume to:

Mr. G. D. Bradley

**THE GARRETT CORPORATION**

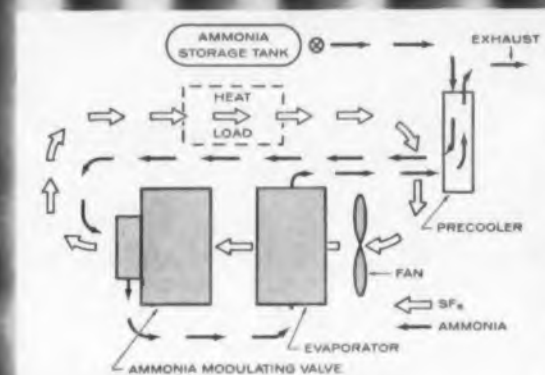
9851 S. Sepulveda Blvd.  
Los Angeles 45, Calif.

DIVISIONS:

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AiResearch Manufacturing—Phoenix  
AiResearch Industrial  
Air Cruisers • Airsupply  
Aero Engineering  
AiResearch Aviation Service

CIRCLE 873 ON READER-SERVICE CARD

# LIGHTWEIGHT airborne electronic cooling package



**PERFORMANCE CHARACTERISTICS—**  
Heat Rejection: 200 watts... Inlet Gas Temperature to Component Housing: 130°F...  
Weight of Fan, Evaporator and Controls: 1.25 lb.

## Spans the gap between direct ambient cooling and closed cycle systems

● This AiResearch open-cycle cooling unit is designed for environmental conditioning of electronic and electromechanical equipment in problems of low total heat dissipation aboard aircraft and missiles.

Much lighter and less complex in operation than closed cycle systems, this compact package is recommended when required total heat dissipation is low...large heat loads

for short periods of time, or small heat loads for long periods of time. It also replaces direct ambient cooling systems when ambient sink is not low enough or not easily available.

Ammonia in this expendable evaporative system cools sulfur hexafluoride ( $SF_6$ ) which passes over the hot electronic components. The  $SF_6$  then recirculates for cooling, and the ammonia is dumped overboard.

Applications of this system include: inertial guidance system cooling, missile transient cooling, and spot cooling where ambient sink is not available.

AiResearch has designed and manufactured cooling systems of all types...direct ambient, closed and open-cycle systems handling all magnitudes of cooling loads and utilizing various working fluids. We invite you to send us details of your problem.

**THE GARRETT CORPORATION**

**AiResearch Manufacturing Divisions**

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC NUCLEAR AND INDUSTRIAL APPLICATIONS

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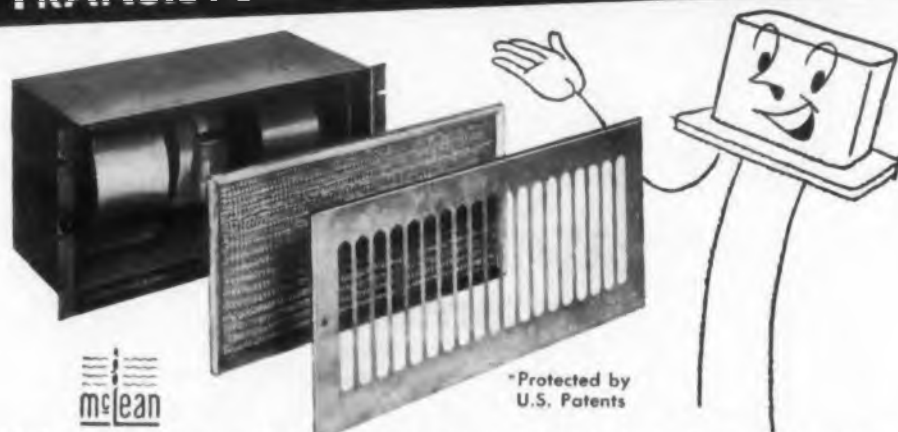
### MAKE NO MISTAKE...

... this New Universal Bridge is DIRECT READING on all 21 ranges. Results are obtained without calculation, the balance is sharp but easily found, the design is functional. Mistakes are almost impossible with Model 868A—a bridge you will enjoy using.

21 Ranges:  
 1 H to 100H. 1  $\mu$ F to 100 F. 0.1  $\Omega$  to 10M $\Omega$ .  
 Dual Frequency, 1kc & 10kc. 400 cps to order.  
 Built-in Oscillator and tuned VTVM Detector.  
 Variable Bridge Voltage, meter-monitored.



## TRANSISTORS NEED COOLING TOO!



### McLean Fans and Blowers\* Save Sensitive Components

Semi-conductors like tubes, require uniform temperatures for top efficiency. Excessive heat causes thermal runaway . . . destroys physical properties and calibration. A McLean fan or blower will extend component life and prevents system failure or inaccuracies. McLean's full line of packaged cooling units are smart, compact, easy-to-install and have a multitude of mounting possibilities. Many models in various panel heights and CFM's available. Mil. Spec. equipment for packaged cooling also available.

**McLEAN ENGINEERING LABORATORIES**  
 World Leader in Packaged Cooling  
 Princeton, New Jersey — WALnut 4-4440  
 TWX Princeton, New Jersey 636



#### FREE TECHNICAL DATA

- 24 Page Catalog
- 12 Page Article  
Forced Convection Cooling
- Specification Sheet on  
Reversible Fans

CIRCLE 394 ON READER-SERVICE CARD

## NEW PRODUCTS

### Silicon Rectifier

Rated 35 amp at 150 C

This stud mounted, heavy duty silicon rectifier is rated at 35 amp at 150 C case temperature. A standard 11/16 in. hex base encapsulation provides ease of mounting and an adequate heat sink. The unit has piv ratings from 50 to 400 v and can be operated or stored from -65 to +200 C.

Transitron Electronic Corp., Dept. ED, Wakefield, Mass.

CIRCLE 395 ON READER-SERVICE CARD

### Decade Resistance Sets

Have primary standard accuracy

Each of these stable decade resistance sets consists of 12 identical resistors of primary standard accuracy immersed in oil and housed in a hermetically-sealed metal case. By selective interconnection, resistance values over a 144 to 1 range

can be obtained to 0.0015% accuracy. Ratio standards can be synthesized over a 36 to 1 range, and the sets can be used as the 11 resistance stages required in a Kelvin-Varley decade. They may be used to calibrate bridges, transducers, components, and other laboratory or production equipment. The cases are 5 x 4-1/4 x 1-13/16 in. Three types are available: the DMR-104 with 1 K resistors rated at 10 ma; the DMR-105 with 10 K resistors rated at 2 ma; and the DMR-106 with 100 K resistors rated at 1 ma.

Julie Research Labs, Inc., Dept. ED, 556 West 168th St., New York 32, N.Y.

CIRCLE 396 ON READER-SERVICE CARD

### Precision Tachometer

Has 1.25% full scale accuracy

A direct reading 0 to 12,000 rpm tachometer, the model PTM 1200A

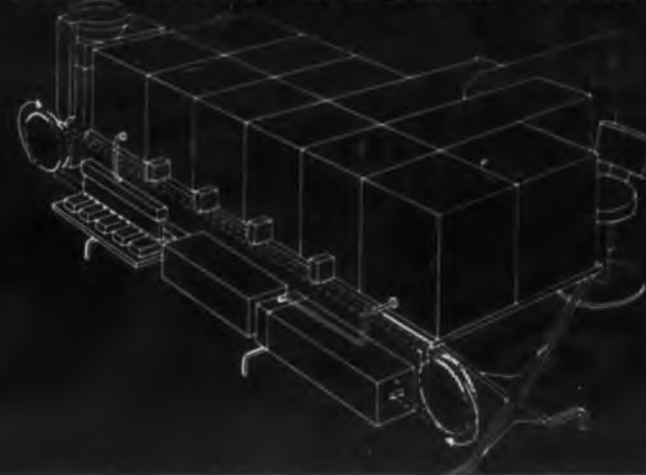
## CAL-TRONICS CORPORATION

A DIVISION OF ACME PRECISION PRODUCTS, INC.

Announces a new series of Automatic Diode Testers designed to increase product reliability, improve production schedules, and effect major savings in manufacturing labor, inspection and test time. Models now available include:

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| for production . . .           | Completely automatic equipment that will check 3600 diodes per hour and classify them into as many as 15 grades of performance.       |
| for reliability study . . .    | Semi-automatic tester with a capacity of 500 per hour; digital readout and permanent recording of relevant parameters.                |
| for receiving inspection . . . | Hand-loaded automatic equipment with a capacity of 1800 per hour to check 5 different parameters for go or no-go classification.      |
| for information contact . . .  | Donald L. Driscoll, General Sales Manager<br>Cal-Tronics Corporation ORegon 8-7141<br>11307 Hindry Avenue, Los Angeles 45, California |

## AUTOMATIC DIODE TESTERS



CIRCLE 397 ON READER-SERVICE CARD



has a 1.25% full scale accuracy and gives a continuous indication on one, two, or three 4-1/2 in. meters with 250 deg D'Arsonval movements. It is temperature compensated. The sensing unit operates from a 115 v, 60 cps source and may be mounted separately.

American Machine & Foundry Co., Alexandria Div., Dept. ED, 1025 N. Royal St., Alexandria, Va.

CIRCLE 398 ON READER-SERVICE CARD

## Strain Gage Printout System

### Expandable

By plugging additional 10 channel modules into existing receptacles, the model 10EC-C strain gage printout system is expandable to any capacity. On standard adding machine paper tape, it automatically records a two digit channel number, one digit for span or range, a plus or minus sign, and three digits of data for ranges of 1, 2, or 4. For

ranges of 10, 20, or 40, the data is followed by a zero to indicate a tens multiplier. For offscale conditions, an N or P is recorded in the sign position to show negative or positive offscale conditions. The system provides 1000 counts for a transducer output of 0.5 mv per v, and the data is recorded with a 0.1% system accuracy exclusive of the transducer.

Datran Electronics, Dept. ED, Manhattan Beach, Calif.

CIRCLE 399 ON READER-SERVICE CARD

## Frequency Inverters

### Have 380 to 2000 cps range

These frequency inverters convert 28 v dc to ac in the 380 to 2000 cps range. One model has a 300 va, three-phase output and the other a 100 va, single phase. The latter is also an ac to ac unit.

Cubic Corp., Dept. ED, 5575 Kearny Villa Rd., San Diego 11, Calif.

CIRCLE 400 ON READER-SERVICE CARD

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BE  
FOOLED  
BY  
LOOK-  
ALIKES



Adherence to tightest specifications by skilled assemblers—100% inspection for perfect construction—precision parts—closely controlled spacing guarantees **RELIABLE PERFORMANCE** in every SUPERIOR electron gun mount.

At your service for any type of electron gun mount. Samples, catalogs, prices available on request.



## Superior Electronics Corporation

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relays designed especially for

VIBRATION  
and SHOCK

The rotary-balanced armature design of Hi-G relays assures efficient operation of these important components even under severe vibration and shock — up to 20 or 30G out to 2000 cps. By design, very little momentum is built up in moving parts. For more complete information on the complete line of Hi-G relays, send for New 1959 Hi-G CATALOG.



HI-G THE ONLY COMPLETE LINE OF ROTARY BALANCED RELAYS

Hi-G offers complete engineering and production facilities to manufacture relays for specific applications. Your inquiries are invited.



S & R TYPES



SL TYPES



SM TYPES



HI-G INC.,

BRADLEY FIELD/WINDSOR LOCKS, CONN.

CIRCLE 402 ON READER-SERVICE CARD

## NEW! ENGRAVED Deep-Kut<sup>®</sup> PIN & PEG STAMPS are better than ordinary rubber 3 ways

★ ENGRAVED Deep-Kut is Acid-Proof

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★ ENGRAVED Deep-Kut has cushion-like resilience

Engraved Deep-Kut stamp faces are adaptable to any marking device. They can be used to stamp on every surface, metal, wood, fabric, paper, plastic, etc.



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THE PIN & PEG

KRENGEL MANUFACTURING CO., INC. Tel. CO 7-5714  
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CIRCLE 403 ON READER-SERVICE CARD

# NEW... UNIMAX CATALOGS



CATALOG No. 159



CATALOG No. 359

Catalog No. 159

Covers subminiature high-temperature (up to 650 F), commercial, MIL-type, environment-free, and toggle switches — 16 pages.

Catalog No. 359

Describes sealed, low-cost, general-purpose, low-force, high-sensitivity, environment-free, metal-cased, AN and JAN, direct-current, and reset precision snap-acting switches — 28 pages.

Complete engineering data: dimension drawings, force and movement specifications, electrical ratings, integral and auxiliary actuators, bases, terminals, circuit arrangements, and NEMA standard definitions of sensitive-switch terms.

Write today for your copy.

## UNIMAX SWITCH

Division, The W. L. Maxwell Corporation  
IVES ROAD, WALLINGFORD, CONNECTICUT

CIRCLE 404 ON READER-SERVICE CARD

168

## NEW PRODUCTS

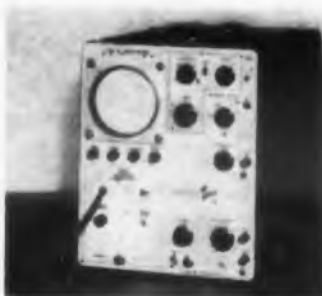


### Impedance Plotter Portable

The VILP portable vector impedance locus plotter continuously measures and plots the rectangular components, resistance, and reactance of the equivalent series complex impedance of any passive electrical element.

Chesapeake Instrument Corp., Dept. ED, Shadyside, Md.

CIRCLE 405 ON READER-SERVICE CARD



### Oscilloscopes Have 3.5 $\mu$ sec rise time

Type 581 and 585 oscilloscopes have a 3.5  $\mu$ sec rise time and a dc to 100 mc passband. Maximum calibrated deflection factor is 0.1 v per cm, and probe attenuator heads provide steps of 0.2, 0.5, 1, 2, and 5 v per cm. Sweeps are calibrated in 24 steps from 0.05  $\mu$ sec per cm to 2 sec per cm. The type 585 has a second time base generator which provides a calibrated sweep delay that is continuously adjustable from 1  $\mu$ sec to 10 sec.

Tektronix, Inc., Dept. ED, P.O. Box 831, Portland 7, Ore.

CIRCLE 406 ON READER-SERVICE CARD



### NPN Power Transistors

For push-pull and cascade circuits

These npn power transistors are designed for complementary push-pull and cascade circuits. They have collector voltages to 80 v, a maximum collector current of 2 amp, and a minimum cutoff frequency of 150 kc. They are built to MIL-19500A requirements. Types 2N326, LT-5163, LT-5164, and LT-5165 are for resistive loads; types LT-5163L, LT-5164L, and LT-5165L are for inductive loads.

CBS-Hytron, Dept. ED, Danvers, Mass.

CIRCLE 407 ON READER SERVICE CARD

## Coaxial Attenuators

## Terminations

## Impedance Transformers

DC to 2500 mcs.

using type BNC, TNC, and N coaxial connectors



ARI presents an integrated line of coaxial attenuators, terminations, and impedance matching transformers for use in the DC to 2500 mcs frequency range. To provide the user with a greater flexibility than heretofore realized, type BNC, TNC, and N coaxial connectors are incorporated in this family of attenuators and terminations. The impedance matching transformers use type BNC coaxial connectors.

The attenuators and terminations exhibit a nominal impedance of either 50 or 75 ohms and a maximum V.S.W.R. of 1.2 at the highest rated frequency.

The impedance matching transformers have been designed to match, with minimum loss, 50 to 75 ohms, 50 to 93 ohms, and 75 to 95 ohms, over the frequency range of DC to 1000 mcs.

### CHARACTERISTICS

Model	ATTENUATORS & TERMINATIONS				IMPEDANCE MATCHING TRANSFORMERS			
	NFA & NFT	NFA/T & NFT/T	NFA/N & NFT/N	NFAM	50	75	93	50, 75
Input/output impedance, ohms	50, 75	50, 75	50, 75	50, 75	50	50	75, 93	50, 75
Nominal attenuation (db)	1, 2, 3, 4, 6, 10, 12, 15, 20	1, 2, 3, 4, 6, 10, 12, 15, 20	1, 2, 3, 4, 6, 10, 12, 15, 20	1, 2, 3, 4, 6, 10, 12, 15, 20	minimum loss			
Frequency range (mcs)	DC-1000	DC-2000	DC-2500	DC-1000				
Maximum V.S.W.R.	1.2 at 1000 mcs	1.2 at 2000 mcs	1.2 at 2500 mcs	1.2 at 1000 mcs				
Connectors	Type BNC	Type TNC	Type N	Type BNC				

For full information and prices write to

## Applied Research inc.

76 SOUTH BAYLES AVENUE, PORT WASHINGTON, NEW YORK

CIRCLE 409 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 195

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ELECTR



## Angle Indicators

Precision



These precision angle indicators are complete servo systems for numerical presentation of angular positions. They are rack panel mounted and consist of an angle indicator, a motor, and a servo amplifier. Performance characteristics of a typical unit include: 0.6 min repeatability in either a clockwise or counterclockwise direction; 0.5 min readability from 0 to 360 deg;  $\pm 6$  min accuracy; 0.5 min maximum sensitivity; 115 v, single phase, 400 cps input.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

CIRCLE 410 ON READER-SERVICE CARD

## Transistor Breadboard

Tests design circuits



Designed to evaluate transistor characteristics, the model TB-1 breadboard can be set up to simulate any circuit in minutes. It checks frequency response and current gain, input and output impedances, linearity or distortion, and stabilization. It can also evaluate cascaded units and determine the best class of amplifier operation. Its seven small meters show all current and voltage values at once. Four cover 0 to 100 v dc and three 0 to 100 ma dc. The tester has six resistance and four capacitance substitution units which are knob selected and span 15 ohms to 10 meg and 0.0001 to 0.22  $\mu$ f. The meter connections and test and substitution points have snap fastener connections to match the furnished assortment of test leads and jumper cords.

Alrams Instrument Corp., Dept. ED, 606 E. Chippewa St., Lansing 1, Mich.

CIRCLE 411 ON READER-SERVICE CARD



Meter Relays: 2" and 3", AC and DC



Edgewise: Vertical, DC



Wide-Vue: 2 1/2", 3 1/2", 4 1/2", AC and DC

# These are Simpson panel instruments...



Round: 3", DC



Rectangular: 4", 4 1/2", 5 1/2", AC or DC, RF; 7" and 9", DC or RF



Front Adjust Relay: 2 1/2", 3 1/2", 4 1/2", DC. Rectangular also.

# engineered and built to stay accurate...



Elapsed Time: 3 1/2", 60-cycle AC



Fan Shape: 4 1/2", AC or DC



Modernistic: 2 1/2", 3 1/2", 4 1/2", 5 1/2", AC, DC, RF

## available from stock or custom-built

METERS FOR EVERY NEED  
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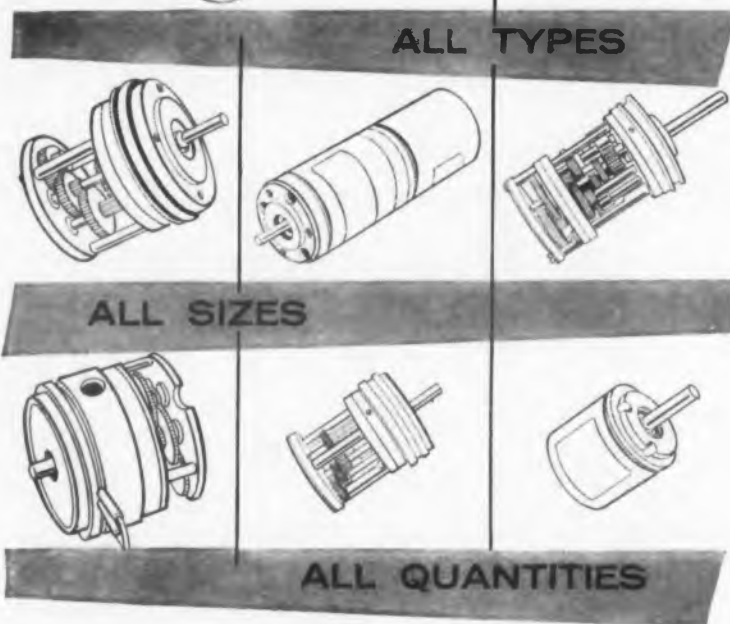
In Canada: Bach-Simpson Ltd., London, Ontario

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# BOWMAR



PRECISION SERVO  
GEARHEADS  
AND SPEED REDUCERS



ALL TYPES

ALL SIZES

ALL QUANTITIES

Bowmar designs and manufactures all types of precision geared components, assemblies and packages for all types of precision control systems. Dozens of semi-standard speed reducer and gearhead sizes are offered in most ratios; but these types may be altered, or entirely new types can be developed to fit new requirements. Typical of many Bowmar designs currently being manufactured —



TWO SPEED GEARHEAD X-709. Unit shown has speed reductions of 2400:1 and 24000:1 for fast approach and slow zeroing. Unit is electrically actuated and is completely self-contained. Typical of many Bowmar designs currently being manufactured.



PRECISION SERVO MOTOR GEARHEAD 750-GH (with housing). Standard ratios to 2000:1; Starting torque: .005 in.-oz.; Load torque: 5 in.-oz.; Backlash: 30 min. max.; Diameter: .750 in. Typical of many Bowmar designs currently being manufactured.



PRECISION MINIATURE SPEED REDUCER 1062. Standard ratios to 4000:1. Starting torque: .005 in.-oz.; Load torque: 25 in.-oz.; Backlash: 45 min. max.; Diameter: 1.062 in. Typical of many Bowmar designs currently being manufactured.



CONCENTRIC SHAFT SPEED REDUCER X-530. Single ended unit has optional internal slip clutch set to customer requirements. Most ratios available. Starting torque: .01 in.-oz.; Backlash: 30 min. max.; Diameter: 1.062 in. Typical of many Bowmar designs currently being manufactured.

**BOWMAR**

SEND NOW FOR DATA PACKAGE NO. 1158  
INSTRUMENT CORPORATION  
8000 Bluffton Road • Fort Wayne, Indiana

REPRESENTATIVES IN PRINCIPAL U. S. AND CANADIAN CITIES

CIRCLE 413 ON READER-SERVICE CARD

## NEW PRODUCTS

### Power Supply

Continuously adjustable



Type 1205-B is a continuously adjustable, 120 w power supply that provides uniform performance over a 0 to 300 v dc output range at 200 ma maximum. Output regulation is 0.1 v no load to full load and 0.75 v for  $\pm 10\%$  line voltage changes. Additional outputs are a bias voltage of -150 v fixed at 5 ma, with 0.5 v no load to full load regulation, and a pair of unregulated ac voltages of 6.3 v at 5 amp. A panel meter provides dc output voltage and output current readings at 2 and 5% accuracy, respectively.

General Radio Co., Dept. ED, West Concord, Mass.

CIRCLE 414 ON READER-SERVICE CARD

### Spectrum Analyzer

Has 200 cps resolution



Spectrum analyzer model SPA-2 has a 1 mc sweepwidth that is continuously adjustable down to 0; a 200 cps to 10 kc variable resolution; and a 1 to 60 cps variable sweep rate. It also features linear, 40 db log, and power amplitude scales and a choice of two stable tuning heads: the 50 to 250 mc RF-5 with -100 dbm sensitivity and the 220 to 4000 mc RF-6 with -100 dbm sensitivity on fundamentals. The unit is designed for analysis of standard fm and am systems, noise spectra, oscillator instabilities, and other dynamic phenomena.

Panorama Radio Products, Inc., Dept. ED, 520 S. Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 415 ON READER-SERVICE CARD

## METERED Variacs®



Type W5MT3W  
Metered Variac  
(Voltmeter-  
Wattmeter): \$110.  
(shown)



Type W5MT3A  
Metered Variac  
(Voltmeter-Ammeter)  
\$85.00  
(similar in appearance)

NEW cased Type W5 VARIACS are now available in two different models: one with a 0 to 150-volt output voltmeter and a 2-range ammeter for load currents of 0-1 or 0-5 amperes; another model with the same voltmeter and a 2-range wattmeter reading 0-150 and 0-750 watts.

Both include a W5 VARIAC, the meters, a current transformer, necessary switching and adequate meter shielding.

Three-wire line cord and 3-wire outlet receptacle (accepting parallel 2-wire plug) are provided. The ammeter and wattmeter range switches can be switched under load.

Write for Complete Data

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**GEE-LAR MFG. CO.**

Division of G-C Textron Inc.  
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CIRCLE 417 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959



## Heat Dissipators

For TO-3 type transistors



These heat dissipators are available in various heights for application to any power transistor in a TO-3 case. They consist of a vertical, cylindrical form with radiating fins and a shallow rimmed base for surface-to-surface mounting and maximum heat conduction from the transistor to the dissipator. A typical unit on a 2 x 2 in. aluminum plate can increase the operating capability of a germanium transistor with a 90 C junction temperature from 2-1/2 to 10 w.

International Electronic Research Corp., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.

CIRCLE 418 ON READER-SERVICE CARD

## Transistor Power Supply

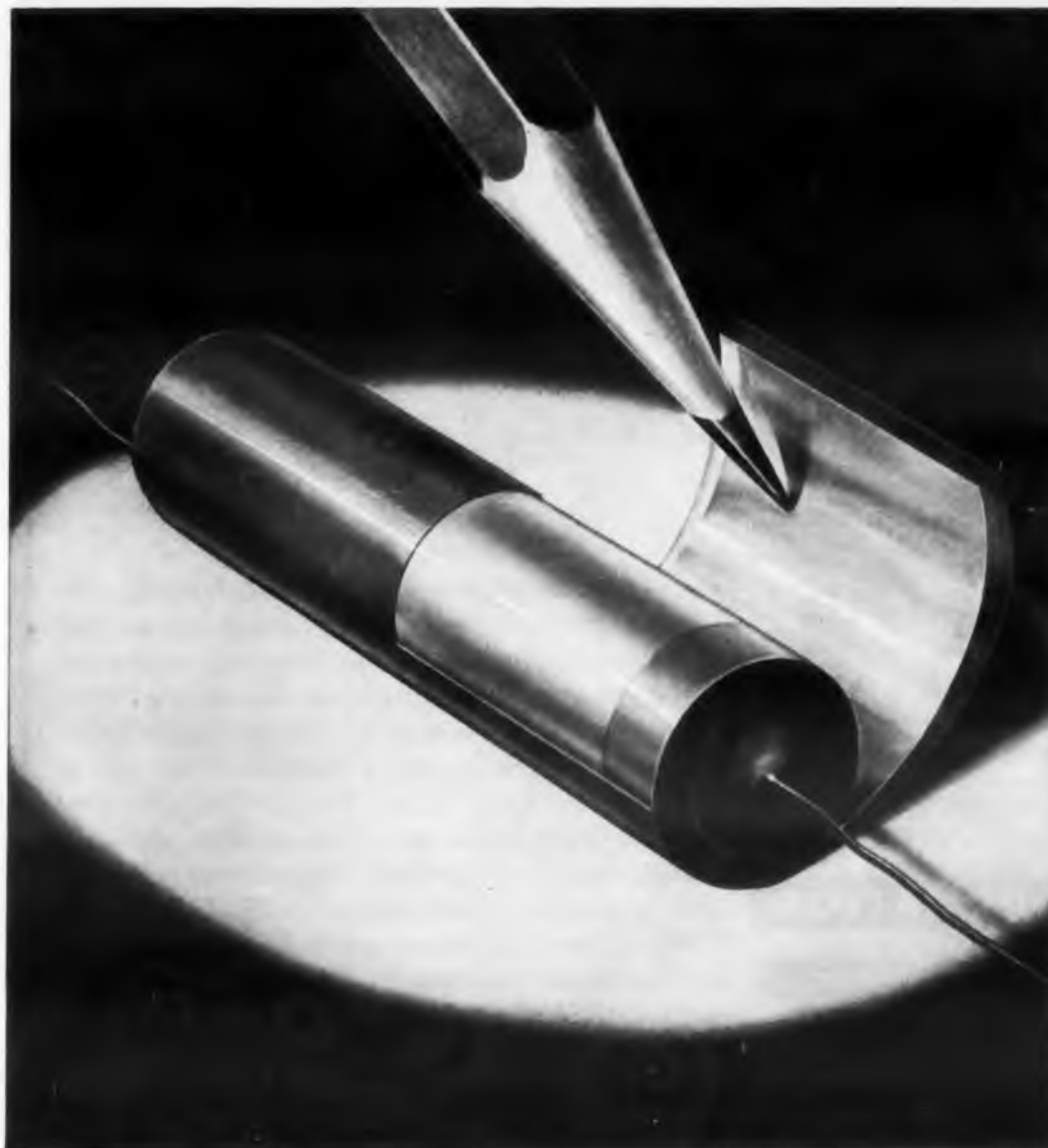
Dual range



Power supply model DV-III is a portable, low cost unit designed for transistor and laboratory development work. It provides continuously variable outputs of 0 to 60 v dc at 1 amp with 0.05% ripple, 0 to 30 v dc at 2 amp with 0.1% ripple, and 0 to 115 v ac at 1.2 amp. The unit has a two-range voltmeter and a two-range ammeter, both accurate to 2%. It measures 7 x 11 x 8-1/2 in. and weighs 24-1/2 lb.

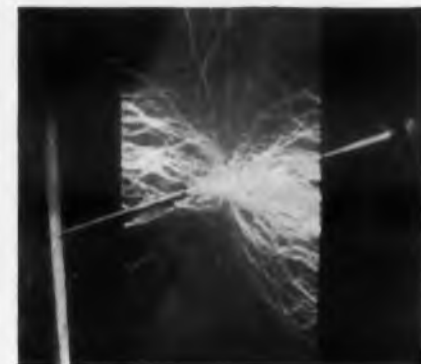
Model Rectifier Corp., Dept. ED, 1675 Utica Ave., Brooklyn 34, N.Y.

CIRCLE 419 ON READER-SERVICE CARD



## PROPERTIES OF "MYLAR"

"Mylar" offers a unique combination of properties that may help you improve performance and lower costs of your product. Here are two of the many important properties for evaluation.



**HIGH DIELECTRIC STRENGTH:** Average of 4,000 volts per mil... average power factor of 0.003 at 60 cycles.



**SUPERIOR CHEMICAL RESISTANCE:** Unaffected by oils, grease, most acids and alkalis, moisture and solvents.

Western Electric reports...

# Du Pont MYLAR® cuts capacitor costs

**PROBLEM:** Western Electric was searching for a dielectric material which, when used in film-foil construction, would lower manufacturing costs.

**SOLUTION:** Du Pont "Mylar" polyester film. According to Western Electric, the moisture resistance of "Mylar" minimized the need for costly encapsulation; high dielectric and physical strength in thin gauges helped reduce over-all size;

capacitance stability under normal voltage stress maintains long life.

**RESULTS:** Capacitors insulated with "Mylar" provide excellent performance for selected types of equipment produced by Western Electric. These new capacitors achieve high reliability and long life. Materials savings have been realized through reductions in size and use of less costly encapsulation.

**HOW CAN "MYLAR" HELP YOU?** Whether your product uses miniaturized capacitors or heavy-duty cables, it will pay you to investigate the performance benefits of "Mylar"... and products made with "Mylar". Component makers find this tough, thin polyester film will often cost less on an area basis than present insulating materials. For more detailed information, send in the coupon.



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**MYLAR**  
POLYESTER FILM

"MYLAR" is Du Pont's registered trademark for its brand of polyester film.

E. I. du Pont de Nemours & Co. (Inc.)  
Film Dept., Room ES-6, Nemours Bldg., Wilmington 98, Del.

Please send booklet listing properties, applications and types of "Mylar" polyester film available.

Application \_\_\_\_\_  
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Company \_\_\_\_\_  
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City \_\_\_\_\_ State \_\_\_\_\_

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modern, low-cost way  
to precision  
measurements...

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Units housed in heavy-duty, seamless steel cases with durable gray finish. All one size—5½" L x 3⅜" W x 2⅜" H. Black face plates with white markings. Highest value multiplier on left.

Available from all Aerovox Parts Distributors, write for descriptive literature...

**AEROVOX CORPORATION**

DISTRIBUTOR DIVISION

New Bedford, Massachusetts

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*how small is small?*

*how high is high?*

**SPECIFY  
Balco  
SUB-MINIATURE  
CAPACITORS**

FOR CONTINUOUS HIGH TEMPERATURE OPERATION TO 250°C WITHOUT DERATING!

**EXCEPTIONAL FEATURES EXCLUSIVE WITH Balco.**

- No reliability deterioration at 250°C and 140% rated voltage.
- Insulation resistance greater than 10<sup>14</sup> ohms.
- Temperature coefficients of approximately 100 PPM, 50 PPM and less.
- Dissipation factor less than .05%.
- Minimum (lowest dielectric) absorption .01%.
- Exceeds MIL shock and vibration requirements.
- Low capacitance tolerances to .1%.
- Transistor sizes.

**Balco CAPACITORS**  
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Telephone: Mitchell 3-5200

New, Comprehensive Color Catalog Complete With All Technical Data Now Available On Request.

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## NEW PRODUCTS

### Time Code Generator

Highly accurate



Accurate within several microseconds, the model 5631-82 time code generator supplies an output signal that may be recorded with other data or events. The instrument clock is a crystal oscillator that has a stability of  $\pm 3$  parts in 10<sup>7</sup> per week. The generator announces in military time and recycles to zero after 23:59:59. Readout is an in-line, in-plane display of hours, minutes, and seconds. The unit has connections for a WWV receiver and built-in WWV propagation delays from 0 to 99 msec.

Beckman Instruments, Inc., Systems Div., Dept. ED, 325 N. Muller Ave., Anaheim, Calif.

CIRCLE 423 ON READER-SERVICE CARD

### Printed Circuit Lights

Mount directly on boards



Transistor driven series PCL indicator lights mount directly on printed circuit boards, eliminating the need for separate lamps, transistors, and circuitry for maintenance indication. Completely encapsulated, they include a neon lamp and associated circuitry and may be dip soldered on boards as single components. They are available to fit almost all signal and voltage combinations in computers, data processors, and control systems. The units are 1/4 in. high and 7/16 in. wide. They mount on 1/2 in. centers.

Transistor Electronics Corp., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

CIRCLE 424 ON READER-SERVICE CARD

## ACE FABRICATED PLASTIC PARTS

FAST SERVICE LOW COST



BALLS  
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NAME PLATES  
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PLATES  
PLUGS  
RINGS  
SPACERS  
SPOOLS  
STANDS  
STRIPS

SIZES:  
1/8" to 2 1/4"  
LENGTHS:  
1/16" to 9"

New e-x-p-a-n-d-e-d production facilities now give you ACE PRECISION on all types of screw machine centerless ground parts and special shapes... all colors... all materials.

Write, wire, phone for samples, prices and Bulletin F listing stock items. Send specifications or blueprints for prompt quotations on specials.

Extrusion Molders  
and Fabricators

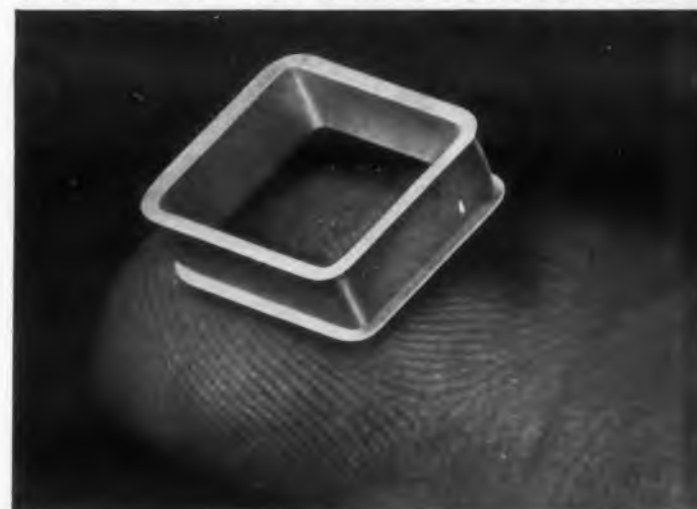


### ACE PLASTIC COMPANY

91-58 Van Wyck Expwy., Jamaica 35, N. Y. JAmaica 3-5500

CIRCLE 425 ON READER-SERVICE CARD

## VOLUME-PRODUCED TO TIGHT TOLERANCES



H&H close tolerance part—moving coil form, volume-produced for d'Arsonval galvanometers. Width .362 ± .002 • Length .4219 ± .001 • Depth .160 ± .001 • Wall thickness .008 ± .0005

### SPECIALIZED TUBULAR METAL PARTS

Want specialized metal tubular parts in extremely close tolerances? At lowest possible cost? H&H Machine Company volume produces an almost endless variety—to your specifications, in all commercial alloys, in sizes from .01 in. to 1/2 in. diameter. No production difficulties—we do the complete job from tooling up to rigid inspection. No design problems—we make our own tools and dies to meet specified tolerances precisely.

Write for literature, or send blueprint with quantities desired.



**H & H MACHINE COMPANY, INC.**

Noble & Jackson Sts. Norristown, Pa.  
Phone BRoadway 2-6453 BRoadway 9-2327

CIRCLE 426 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959



## SPECTROL PRECISION POTENTIOMETERS

## Meet the SPECTROL METAL MULTI-TURN



New type  
construction  
provides  
**150° C.  
OPERATION**

The Spectrol Model 590 ten-turn precision potentiometer features all metal construction of machined aluminum with the helical coil placed directly against the case for maximum heat dissipation. Aluminum case provides excellent dimensional stability, is non-hygroscopic and will operate in a relative humidity of 95%. The 1" diameter 590 is available in ranges from 25 to 120,000 ohms with a standard linearity tolerance of  $\pm 0.3\%$ . Tolerances to  $\pm 0.025\%$  on special order.

For complete technical information call your local Spectrol representative or write directly to the factory. Please address Dept. 196

SPECTROL

ELECTRONICS  
CORPORATION

"precision electronic components"

1704 South Del Mar Avenue, San Gabriel, Calif.

CIRCLE 427 ON READER-SERVICE CARD

## Spectrum Analyzers

Scan 3450 times a minute



Model MRFR-30-5 and MRFR-30-6 Rayspan spectrum analyzers have 100 filters to which the signal under analysis is applied simultaneously and continuously. The filter outputs are sampled in sequence at a rate of 3450 scans a minute. The MRFR-30-5 has 32 cps filters that analyze any 2.5 kc band between 50 cps and 100 kc. Resolution over the entire band is 75 cps with a dynamic resolving range of 35 to 40 db. Amplitude response variations are within  $\pm 3$  db. The 100 cps MRFR-30-6 analyzes any 7.9 kc band from 160 cps to 100 kc. Its resolution is about 250 cps.

Raytheon Co., Dept. ED, 520 Winter St., Waltham 54, Mass.

CIRCLE 429 ON READER-SERVICE CARD

## Electronic Functional Multiplier

Has four quadrant dc to 10 kc bandwidth



A laboratory instrument for electronic multiplication and division, the model 201 functional multiplier performs true instantaneous four quadrant multiplication of two electronic signals. It has a four quadrant dc to 10 kc bandwidth and a meter that provides an indication of any average product term. The unit can be used for automatically varying coefficients, raising to powers, modulation, detection, transcendental functions, reciprocals, measuring power transfer, and other computer and data processing functions. It will permit the solution of any equation requiring multiplication.

Potential, Inc., Dept. ED, Solana Beach, Calif.

CIRCLE 430 ON READER-SERVICE CARD

EVERYTHING  UNDER CONTROL

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Catalog "B"



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for specific recommendations.

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## GRC die cast WING & THUMB SCREW

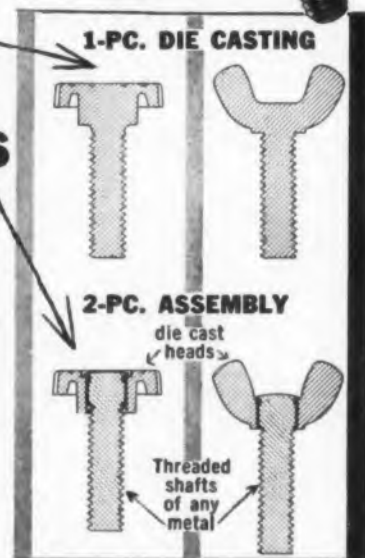
4 types  
to meet  
ALL needs

GRC offers you quality, quantity and economy PLUS your choice of two basic styles—one-piece zinc alloy die cast fasteners or assembled zinc alloy blanks with screw material of other metals.

Wing Screws have generous washer-type shoulders, patented recessed finger-grip wings.

Thumb Screws have exclusive wide heads for firm, comfortable grip; plain or shoulder type.

Clean accurate threads. Bright rust proof, noncorrosive finish. Wide range of styles, threads and lengths.



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Producer of Small  
Die Castings

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ELECTRONIC DESIGN • June 10, 1959



## ARNOLD/TOROIDAL COIL WINDER

sets up quickly...easy to operate...  
takes wide range of wire sizes

### SPECIFICATIONS:

- Min. finished hole size: .18 in.
- Max. finished toroid O.D.: 4.0 in.
- Winding speed: 1500 turns/min.
- Wire range: AWG 44 to AWG 26
- Dual, self-checking turns counting system
- Loading (wire length) counter
- Core range: 1/4" I.D. to 4" O.D. to 1 1/2" high

### LABORATORY USE

- Change wire and core size in 45 sec.

### PRODUCTION USE

- 1500 turns per minute
- Insert core and load in 20 sec.

includes all rings, counters and accessories



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REpublic 1-6344

CIRCLE 432 ON READER-SERVICE CARD

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FOR RESALE DEALERS

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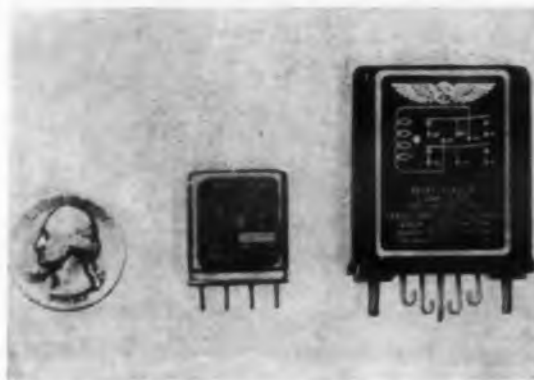
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## NEW PRODUCTS

### Crystal Can Relays

0.4 x 0.8 x 0.875 in.



Designed for control systems, computers, aircraft, and missiles, these hermetically sealed crystal can relays are 0.4 x 0.8 x 0.875 in., less than half the size of the company's nearest comparable relay. They weigh about 0.6 oz and withstand -65 to +125 C temperatures, 50 g shock, and 20 g 2000 cps vibration. The units are dpdt and rated at 2 amp. General purpose type 9200-4817 and magnetic latch type 9234-4550 have a bracket mounting and solder hook terminals; type 9200-5072 has a plug-in or printed circuit mounting; and type 9200-5091 has a stud mounting and solder hook terminal.

Leach Corp., Relay Div., Dept. ED, 18435 Susana Rd., Compton, Calif.

CIRCLE 434 ON READER-SERVICE CARD

### Flat Cable

For printed circuit assemblies



Highly flexible in one plane, these flat multi-conductor cables can be run around corners or used with drawer pull-out type printed circuit assemblies. They may contain any number of twisted multiconductors, coaxial cables, or single conductors in sizes down to 36 AWG. Primary insulation can be Teflon or PVC. Individual wires can be color coded and need not be of the same gage.

Tensolite Insulated Wire Co., Inc., Dept. ED, W. Main St., Tarrytown, N.Y.

CIRCLE 435 ON READER-SERVICE CARD

## New ESNA CLINCH NUT HANDBOOK



Here's a brand new design manual giving full information on ESNA's line of self-locking clinch type Elastic Stop® nuts. The manual covers such points as:

- Applications
- Design Features
- New Flush mounting Types.
- Insertion methods
- Correct part selection
- Plus: Materials, finishes and complete dimensional data

SEND TODAY for your copy.  
Write Dept. 519-0... Elastic  
Stop Nut Corporation of America,  
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This new flush mounting, miniature ESNA Clinch nut is easily installed by a simple flaring operation—becomes a permanent fastener.



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OF AMERICA

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ELECTRONIC DESIGN • June 10, 1959



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TEMPERATURE  
RANGE**

**Davohm Series 850  
Hermetically Sealed  
Metal Film Resistors...**

Can be used from  $-65^{\circ}\text{C}$  to  $150^{\circ}\text{C}$ . These resistors are sealed with 300° solder. The resistance element is a noble metal alloy deposited on the inner surface of a boro-silicate glass. All elements are unaffected by extreme temperature variations. All resistors from 2 ohms to 4 megohms have the same positive temperature coefficient.

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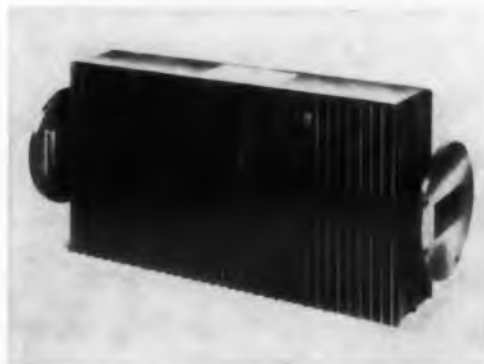
World's Largest Manufacturer of Attenuators



CIRCLE 437 ON READER-SERVICE CARD

**Harmonic Suppression Filter**

Handles up to 5 megawatts



Ruggedly constructed for military microwave applications, this filter is designed to suppress the typical harmonic and spurious signals generated by high power magnetrons, klystrons, and traveling wave tubes. It handles power levels to 5 megawatts and has an insertion loss below 0.2 db throughout its 2700 to 3100 mc pass band. Intended for use in the waveguide line between tube and antenna, the unit has over 25 db insertion loss for signals from 5400 to 10,000 mc. The vswr across both pass and stop bands is under 1.8. Two or more units can be cascaded to increase harmonic rejection.

General Electric Co., Power Tube Dept., Dept. ED, Schenectady 5, N.Y.

CIRCLE 439 ON READER-SERVICE CARD

**Frequency-Voltage Test Set**

Measures ac and dc voltages



The model 4B test set measures frequencies from 350 to 450 cps within  $\pm 1$  cps; dc voltages from 0 to 30 v with 1% full scale accuracy; and ac voltages from 0 to 150 or 0 to 300 v with 2% full scale accuracy. It incorporates an ARINC standard phase checker and a means for testing continuity. Self-contained in a molded Bakelite case, the 3 lb unit is burn-out proof throughout its indicated operating range. Dimensions are 5-5/16 x 7-7/8 x 3 in.

Airpax Electronics Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

CIRCLE 440 ON READER-SERVICE CARD

**this Howard  
fractional H. P.  
gear motor can  
be used for**



**BOTH  
universal and  
induction  
applications**

**RATIOS FROM 10:1 to 60:1**

**MODEL 2900: 2 Pole—4 Pole Induction with A26 Gear Unit**  
DIAMETER: 3 3/8"  
LENGTH: 7 3/4" to 8 1/4"  
HORSE POWER: 1/70 to 1/15 depending on length of stacking.  
TORQUE OUTPUT: Up to 60 in. lbs. depending on ratio.  
BEARINGS: Permanently lubricated and sealed ball bearings.

Check your specifications with Howard. Write for complete details and prices on these and other Howard gear motors and reduction units.

**MODEL 29-500: Universal AC/DC or Shunt with A26 Gear Unit**  
DIAMETER: 3 3/8"  
LENGTH: 7 3/4" to 7 7/8"  
HORSE POWER: 1/70 to 1/4 depending on length of stacking.  
TORQUE OUTPUT: Up to 60 in. lbs. depending on ratio.  
BEARINGS: Permanently lubricated and sealed ball bearings.

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*Critical  
Military*

*Applications  
demand:*

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In circuitry where slip rings must function with dependable precision and stand up under difficult operational conditions, BREEZE slip rings will do the job.

From 2-ring to 500-ring assemblies... currents as high as 350 amps continuous at 220 volts and 700 amps overload at 220 volts. Special high voltage designs available; radio frequency assemblies... high speed rotation for thermocouple and strain gage applications. Also segmented ring assemblies for accurate sequencing and timing.

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GENERATORS • STARTERS • STARTER GENERATORS • BELLOWS  
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BY POPULAR DEMAND!  
8 CU. FT. VOLUME  
... AT LOW COST

Large Volume Capacity, Reliable mechanical convection batch ovens for production and tests associated with electronic paint, steel, rubber, aircraft, chemical and other industries. Elimination of alloy interiors and wattage proportioning reduced our cost and yours. However, care has been exercised to provide an adequate design suitable for reproducing good uniformity and control action. Utilizing horizontal airflow, quality motor/blower, ETERNA heater banks on a relatively uncomplicated control system, we offer a good unit at reasonable cost.

BLUE M  
STABIL-THERM®  
BATCH TYPE  
OVENS with  
HORIZONTAL  
AIRFLOW



TEMPERATURE  
RANGES

100°F. to 300°F.

Model Number	Watts Max.	Voltage 60 cy. A.C.	Complete Price
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OV-587		230V/1 Ph.	498.00
OV-588	4000	230V/1 Ph.	575.00
OV-588A		230V/3 Ph.	598.00

100°F. to 500°F.



All Models: 24" x 25" x 24" (I.D.)

**BLUE M** Electric Company BLUE ISLAND, ILL.

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COMPLETE TEMPERATURE CONTROL EQUIPMENT

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CIRCLE 443 ON READER-SERVICE CARD

176

NEW PRODUCTS

0 to 1 KV Power Supply  
Has 1% accuracy



The model 240 power supply has a dial that selects outputs in 1 v steps from 0 to 1 kv and a variable control for settings between the 1 v steps. The dial setting is 1% accurate above 10 v. Output polarity is selectable and an output off position is provided to facilitate timed measurements. The unit has a ripple of under 3 mv rms above 5 cps and a load regulation of 0.02% at up to 10 ma. For rack or bench mounting, it can be used to test insulation, supply potentials for diode and capacitance leakage resistance measurements, calibrate meters, and check dc amplifier gains.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

CIRCLE 444 ON READER-SERVICE CARD

Strip Chart Recorder  
0 to 150 or 0 to 300 v ac range



This Rustrak strip chart recorder is available with a 0 to 150 or 0 to 300 v ac range. About the size of a Brownie camera, it is easy to load and holds a 63 ft roll of pressure sensitive paper. It provides inkless rectilinear recording at chart speeds to 30 in. pr hr.

Rust Industrial Co., Dept. ED, 130 Silver St., Manchester, N.H.

CIRCLE 445 ON READER-SERVICE CARD

ESPECIALLY DESIGNED FOR  
HIGH TEMPERATURE WORK

HEMINWAY  
& BARTLETT

TEFLON COATED  
**FIBERGLAS  
TAPES**

Withstand temperatures up to 600°  
In 1/4" and 1/2" widths

LACING CORDS AND TAPES OF  
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and DACRON**

are available in wax, wax-free and resin-coated finishes

- Fungus-proof
- Extra strong
- Tie easy, fast and tight
- Knots won't slip

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CIRCLE 446 ON READER-SERVICE CARD

**Newest  
MINIATURE  
FLEXIBLE  
COUPLING**

Life Saver size - only 7/16" x 3/4"



**Tinymite Coupling  
Actual Size**

Low cost for general application. Thousands of uses. 1/8" dia. x 1/2" long. For 1/8" and/or 3/16" shafts. No backlash. Insulating nylon center piece.

Renbrandt offers a complete line of ultra-compact, precision-made couplings featuring zero backlash, low inertia and high flexibility

Typical is the newest shown above which is Life Saver size. Specifications: bores in any diameter from 1/8" through 3/8", compensates for misalignments of ±5° angular and ±.015" linear, torque 30 inch ounces, weight .19 ounce, moment of inertia as low as .006 ounce inches<sup>2</sup>, materials and finishes to applicable government or MIL specs.

Long-life Renbrandt Couplings will solve many problems where space and weight are at a premium. Others available in a wide variety of sizes for 1/8" through 1/2" shafts.

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ELECTRONIC DESIGN • June 10, 1959



# PHAZOR PHASE METER

Par. Pend.



MODEL  
200 A

PRICE  
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NEW YORK

- HIGH ACCURACY
- MEASURES FROM 0 TO 360 DEGREES
- READINGS NOT AFFECTED BY NOISE AND HARMONICS
- PHASE SHIFTS OF THE ORDER OF .01° CAN BE MEASURED EMPLOYING SPECIAL CIRCUIT TECHNIQUES
- MEASURES IN-PHASE AND QUADRATURE COMPONENTS SEPARATELY

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**INDUSTRIAL TEST EQUIPMENT CO.**  
55 E. 11th ST. • NEW YORK 3 • GR. 3-4684

CIRCLE 448 ON READER-SERVICE CARD

## Multimeter

Measures dc voltage, current, and resistance



Multimeter model 412A measures 100  $\mu$ v to 1 kv dc with 1% full scale accuracy; 0.1  $\mu$ a to 1 amp with 2% full scale accuracy; and 0.02 ohms to 5000 meg. Maximum full scale sensitivities are 1 mv and 1  $\mu$ a. Used as an amplifier, the unit provides a maximum voltage gain of 1000 and an output that is proportional to the meter reading and suitable for operating potentiometer or galvanometer recorders. The instrument has three controls: a function selector, a 13 position range switch, and a lever type polarity switch. Because it is highly stable, it needs no zero adjustment.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Rd. Palo Alto, Calif.

CIRCLE 450 ON READER-SERVICE CARD

## Regulated DC Power Supplies

Plug-in



These plug-in dc power supplies are designed for individual or multiple mounting in panels and relay racks. Several vacuum tube and transistorized models are available with a variety of output currents and voltages. All units have 0.25% line and load regulation and less than 5 mv rms ripple. Mounted in appropriate frames, the modular units may be partially withdrawn under full power for testing and adjustment.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Rd., Nashville, Tenn.

CIRCLE 451 ON READER-SERVICE CARD

## MAMMOTH narda SONBLASTER

America's first mass-produced industrial-size ultrasonic cleaner!

**SAVE** 7 ways over costly solvent, alkaline or vapor degreasing:

- Clean faster, speed production!
- Cut rejects, eliminate bottlenecks!
- Save on chemicals & solvents!
- Eliminate expensive installation!
- Cut maintenance and downtime!
- Save on floor space!
- Release labor for other work!



**MAMMOTH  
5-GALLON  
TANK  
\$695**

G-1501 generator, NT-1505 tank.

Other models from \$175.

2-year guarantee on all units.

### SPECIFICATIONS

Interior Tank size (in.), 10W x 14L x 9½H. Tank Capacity, 5 gallons.

### Submersible Transducers

Model NT-604 — Hermetically sealed heli-arc welded stainless steel case. Radiating face: 27 sq. in. Effective plane of radiation: 40 to 50 sq. in. (approx. 10" x 5"). Effective cavitation of volumes: up to 1200 cu. in. at 24" tank height (5 gal.) and 2400 cu. in. at 48" tank height (10 gal.). Swagelok tube fitting on side or end for internal tank wiring.

Model NT-605 — Same as NT-604 except for bulkhead fitting on back for external wiring. Eliminates electrical conduits in solutions.

Now you can say goodbye to expensive chemicals, solvents, and degreasing equipment... reclaim valuable floor space... eliminate high installation costs... just by installing a Narda Series 1500 SonBlaster. At the same time, you'll get better, faster cleaning, and you'll need fewer people to do the job!

Get the tremendous activity of the new 200-watt Narda SonBlaster, with the largest transducerized tank ever made, at the lowest price in the industry! Choose from transducerized tanks or submersible transducers for use in any arrangement in any shape tank you desire. Up to 4 submersible transducers can be easily operated from the same generator at one time; load selector switch provided — an exclusive Narda feature.

Simply plug the SonBlaster into any 110-115 V AC line, and flip the switch. In seconds, you'll clean 'most any mechanical, optical, electrical, medical or horological part or assembly you can think of. Perfect, too, for brightening, polishing, radioactive decontaminating, pickling, quenching and plating; emulsifying, mixing, sterilizing, impregnating, degassing, and other chemical process applications.

Mail the coupon for free help in determining the model that's best for you.

The SonBlaster catalog line of ultrasonic cleaning equipment ranges from 35 watts to 2.5 KW, and includes transducerized tanks as well as immersible transducers. If ultrasonics can be applied to help improve your process, Narda will recommend the finest, most dependable equipment available — and at the lowest price in the industry!

The Narda Ultrasonics Corporation  
118-160 Herricks Road  
Mineola, L. I., New York  
Department ED-6

Gentlemen:

Please send me more information about

- Series 1500 SonBlasters  
 The complete Narda line

Name \_\_\_\_\_  
Organization \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_  
Zone \_\_\_\_\_ State \_\_\_\_\_

**the narda** ultrasonics  
corporation  
625 MAIN STREET WESTBURY, L I N Y  
Subsidiary of The Narda Microwave Corporation

CIRCLE 452 ON READER-SERVICE CARD

## MEET 2 MORE L & R QUALITY PRODUCTS



### POWER NOFOME INSTRUMENT CLEANING SOLUTION

Especially developed to remove oil, grease, dirt and foreign matter from delicate metal parts • flash point 118°, TOC • water-free solvent base • non-toxic • does not contain chlorinated solvents

When writing, ask for information on our ultrasonic cleaning equipment and specially-formulated cleaning chemicals as well as the products shown. In requesting data, please give details on the particular cleaning problem and sizes of components.

### INSTRUMENT RINSING SOLUTION

Specifically developed to remove L & R Power Nofome Cleaning Solution after cleaning • flash point over 106°, TOC • does not contain any chlorinated solvents or benzol • non-toxic

**L & R MANUFACTURING COMPANY**  
889 Elm Street, Kearny (Arlington), New Jersey

CIRCLE 449 ON READER-SERVICE CARD



**AMPHENOL** *Quick-Crimp*  
**BNC CONNECTORS**

**CUT ASSEMBLY TIME  
IN HALF!**

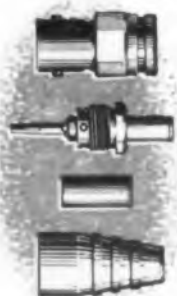
AMPHENOL's new *Quick-Crimp* Series BNC connectors\* obsolete just about every other BNC now on the market. Here's why:

- 1 QUICK ASSEMBLY** Only three basic parts (plus an optional boot) for you to assemble and crimp, as compared to as many as ten parts in a standard BNC! Assembly time is cut in half!
- 2 INCREASED RELIABILITY** Critical assembly operations have been eliminated; inspection is easier, faster, reliable. Cable retention and strain relief is greatly improved. Connectors are weather-proof.

The *Quick-Crimp* family consists of 19 connectors: Plugs, Right Angle Plugs, Jacks, Bulkhead Jacks and Cable Terminations. *Quick-Crimps* mate with standard BNCs. Center contacts are gold-plated, have AMPHENOL's patented captivated contact\*\* construction. Voltage rating is 500 V. peak. VSWR is low up to 10K mc.

\*U.S. PATENT PENDING    \*\*U.S. PATENT 2,870,470

*Body Assembly, Ferrule Clamp  
Nut Assembly, Outer Ferrule and Boot  
—Only Four Parts to Assemble!*



**AMPHENOL** CONNECTOR DIVISION

AMPHENOL-BORG ELECTRONICS CORPORATION Chicago 50, Illinois

**NEW PRODUCTS**

**Limit Switch**

Operates to 800 F



The Klixon 21135-1 spdt limit switch weighs 1 oz and survives 25,000 cycles at 800 F with 5 amp on both contacts. Rated 5 amp, 30 v dc, resistive, it stands 20 g, 2000 cps vibration.

Metals & Controls Div., Texas Instruments Inc., Dept. ED, Attleboro, Mass.

CIRCLE 453 ON READER-SERVICE CARD

**10-Turn Precision  
Potentiometer**

7/8 in.



A 7/8 in., 10-turn, precision wire-wound potentiometer, model 510 is available in ranges from 25 to 120 K and operates from -55 to +105 C. Linearity tolerance is  $\pm 0.25\%$  in standard units or  $\pm 0.1\%$  in special units. Shaft diameter is 1/4 in.

Spectrol Electronics Corp., Dept. ED, 1704 S. Del Mar Ave., San Gabriel, Calif.

CIRCLE 454 ON READER-SERVICE CARD

**Parametric Amplifiers**

For 220 and 450 mc

These 220 and 450 mc parametric amplifiers have, respectively, 13 and 11 db gain, 500 and 900 kc bandwidth, and 1.5 and 2 db noise figure. Pump power is 100  $\mu$ w at 800 mc for the first, 4 mw at 1300 mc for the second.

Motorola Inc., Military Electronics Div., Dept. ED, 8201 E. McDowell Rd., Phoenix, Ariz.

CIRCLE 455 ON READER-SERVICE CARD

CIRCLE 456 ON READER SERVICE CARD

**"go"/"no-go"**  
*voltage measurements*

— specify **VOLTRON**  
for high accuracy, high  
reliability, and low cost.



**VOLTRON**

VOLTAGE  
INDICATOR

— tells the operator whether or not the monitored voltages are within predetermined limits. Indicator has an expanded scale, with each scale marked in arbitrary units. Meter can be programmed to represent a wide range of voltages.

Accuracy: DC - 0.25%, AC - 0.5%

Temperature Range: -55 to 71°C for Military meters; 0 to 50°C for Industrial meters.

Vibration, Humidity, Shock: Military meters meet MIL-M-10304A



**VOLTRIP**

VOLTAGE  
COMPARATOR

— built with an amplifier and relay instead of the indicating meter. The relay operates when the voltage falls outside of predetermined limits. Unit can be programmed by either analog or digital methods.

Signal Voltage Range: DC: -500 to -1.0, and +1 to +500 volts. AC: 5 to 500 volts.

Accuracy of Trip Point: MILITARY VOLTRIPS: DC: 0.25% of voltage programmed AC: 0.5% of voltage programmed from -55°C to +71°C. INDUSTRIAL VOLTRIPS: DC: 0.5% of voltage programmed AC: 1.0% of voltage programmed from 0 to 40°C.

Repeatability: Approx. 1/4 of the specified error.

Construction: MIL-T-27 Size FA can.

Complete data will be sent on request.  
Write for Bulletin 34.

**VOLTRON** Products

1010 Mission St., South Pasadena, California

CIRCLE 457 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 10, 1959





Construction of the basic thermo-cell is shown in the top photo. Operation at  $-35^{\circ}\text{C}$  is shown below.

## Thermoelectric Unit Heats, Cools, Generates Power

DESIGNED for low level cooling, heating and power generation applications, the TA-11 Thermocell is made from high figure-of-merit, cast semiconductor thermoelectric materials.

The Thermo-cell—available in experimental quantities from Ohio Semiconductors, Inc., 1035 W. Third Ave., Columbus 8, Ohio—can be used with quartz crystal ovens, and to keep temperature-sensitive electronic circuits, such as oscillators, above or below the ambient temperature.

In normal room ambient temperatures, with an input power of 2 w, the device provides a temperature difference in excess of  $40^{\circ}\text{C}$ . With no external heat load, the cold junction temperature is  $-15^{\circ}\text{C}$ . With a temperature differential of  $150^{\circ}\text{C}$ , the unit's output power is about  $1/4$  w.

For greater capacities, units can be combined in series, parallel or cascade, and can be ordered that way. They are also available with different characteristics and temperature ranges.

Resistance of the unit is 0.0025 ohms and the maximum current for heating and cooling applications is 40 amp. Maximum hot junction temperature is  $150^{\circ}\text{C}$ ; minimum cold junction temperature is  $-75^{\circ}\text{C}$ .

For more information turn to the Reader-Service Card and circle number 102.

# Here's how General Electric solves typical DC power-supply problems

for computers and special applications

### PROBLEM

*"We need to devote our engineering time to designing our electronic circuitry . . . not the power components."*



### SOLUTION

This is a frequent problem facing computer manufacturers. General Electric's Rectifier Department has complete engineering and manufacturing capability not only to design and apply all types of power supplies, but also to incorporate power supplies into completely integrated systems.

These systems could include load distribution, supply sequencing, protection for power supply and load, and complete power distribution. Let General Electric tackle your DC power problems such as those associated with load IR drop, "cross talk," and other nuisance-type problems plaguing your engineers.

### PROBLEM

*"It's always a problem making sure transistorized equipment is safe from its power supply."*

### SOLUTION

To alleviate this problem, General Electric has developed several methods of making transistorized equipment safer in this respect. With G-E protective circuits, shorting a plus high-voltage bus to a plus or minus low-voltage bus would not cause the low-voltage bus to exceed a small percentage of nominal rated value.

General Electric power supplies protect completely transistorized pieces of equipment from large losses due to over-voltage failures.

### PROBLEM

*"My power supply requirements fluctuate so much . . . big jobs, little jobs, all in between."*

### SOLUTION

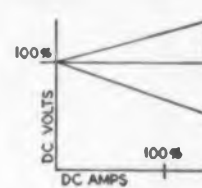
G.E. has built individual power supplies and complete systems ranging from less than one watt up to 35,000 kilowatts. These power supplies span the complete range of DC power—regulated and unregulated—applying all types of components. G-E experience includes completely transistorized supplies, and supplies with the new controlled rectifier, magnetic amplifiers, voltage stabilizing transformers, and motor-alternator "brute force" systems.

### PROBLEM

*"We have a real low-voltage power distribution problem with our computer."*

### SOLUTION

Low-voltage distribution problems can be handled easily through load compensation. Curve "A" is net desired no-load to full-load regulation at load point. "B" is regulation at load without remote sensing or load compensation. "C" represents IR compensation in power supply itself. "D" is amount of IR or load compensation.



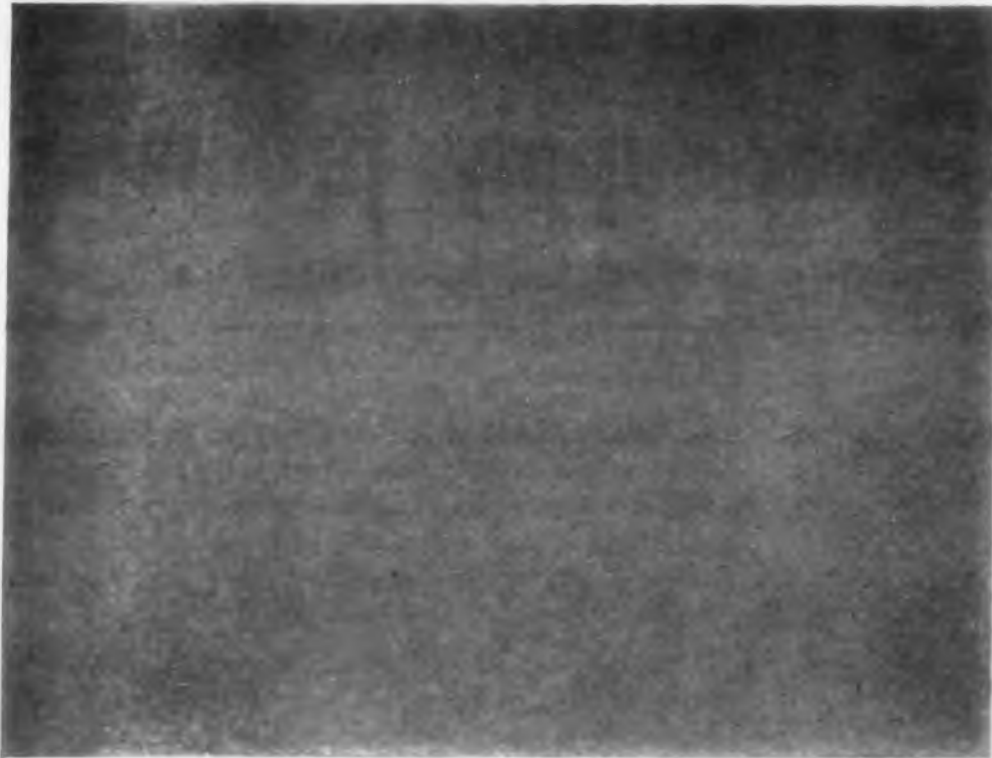
**NO MATTER WHAT** your computer and other special power-supply problems are, General Electric can help you economize—economize by helping you free your engineers of these problems. For more information on power-

supply products and services, contact your nearest General Electric Apparatus Sales Office or write to Section B 535-2, General Electric Company, Schenectady, New York.

*Progress Is Our Most Important Product*

**GENERAL ELECTRIC**

CIRCLE 458 ON READER-SERVICE CARD



## It's great to be proud of the place you work

To some engineers, a job is a job is a job. But it doesn't have to be. It *can* be a career to take pride in, the way the engineers and scientists at Autonetics do.

These young men have already made Autonetics a leader in electronics and electromechanics. For example, they designed the inertial navigation systems for the USS Nautilus and Skate and the monopulse radar system for the Air Force's F-105.

These same young men now are working on new developments—an even more advanced inertial navigation system for the first nuclear-powered Polaris-carrying submarines...the guidance and control systems for the Minuteman and GAM-77 missiles...and many more.

Today at Autonetics there is room for engineers and scientists who want to have a part in these history-making activities. Please send your resume to Mr. V. F. Benning, 9150 East Imperial Highway, Downey, California.

**Autonetics** 

A DIVISION OF NORTH AMERICAN AVIATION, INC.  
Downey, California

INERTIAL NAVIGATION / ARMAMENT CONTROL / FLIGHT CONTROL / DATA PROCESSING



Among the achievements of Autonetics' young men: the first successful airborne all-inertial navigation system...first navigation system accurate enough to guide the USS Nautilus and Skate on their historic voyages beneath Arctic ice...first successful automatic star tracking by an inertial navigation system during daylight flight...first completely maneuverable, inertially stabilized gyro platform...first successful completely automatic landing system for supersonic missiles and aircraft...first transistorized portable digital computer with "big computer" capabilities.

## NEW PRODUCTS

# Micro-Diode

## Designed For Computer Applications

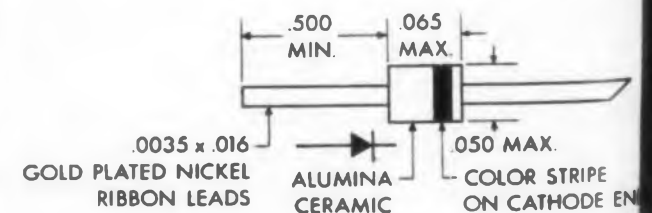
**P**ARTICULARLY suited for computer-type applications because their maximum power dissipation is 2 mw, the XD diodes are packaged for minimum volume and weight. If packed side by side with space allowance for leads equal to diode body volume, 5270 units can fit within a cubic inch.

Built to withstand the environmental testing specified by MIL-STD-202A, the diodes are made by Pacific Semiconductors, Inc., 10451 W. Jefferson Blvd., Culver City, Calif.

All of the diodes available—XD-1, XD-021, XD-031, XD-034, XD-041, XD-042—have a maximum storage and operating temperature range of from -55 to 125 C. At 25 C their maximum power dissipation is 50 mw, derated linearly to 125 C. They can stand a peak pulse current of 2 amp for 1  $\mu$ sec, 1% of the duty cycle.

The diodes are rugged, having no pressure contacts or vibration prone parts; they are encased in ceramic shells. The leads can be bent to meet 0.1 in. grid spacing on printed circuit boards and are gold plated for easy soldering or welding. All diodes are tested 100% to electrical specifications and materials and construction are good to temperatures in excess of 200 C. No soft solders or fluxes are used.

For more information turn to the Reader Service card and circle number 103.



Because these diodes dissipate a maximum of 50 mw, they are particularly suited for computer applications.



# 650 Micro-Module Diodes

Fit In 1 Cubic Inch

PAPER-THIN and wafer-shaped, 650 of these micromodule diodes fit into a cubic inch. And 350 of them weigh one ounce.

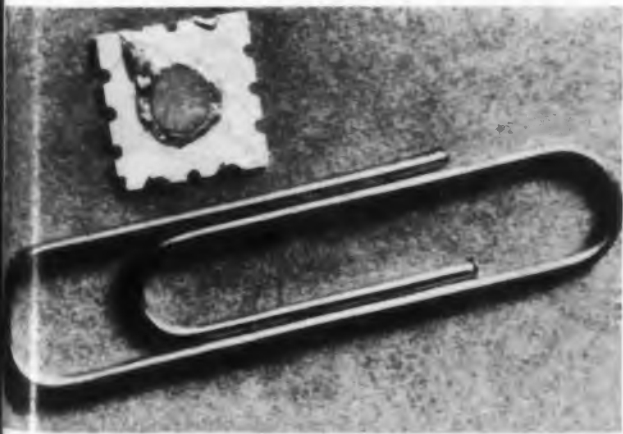
The diodes are designed for use in various types of ultra-miniature military, industrial and consumer products now in development, and are made by the General Instrument Corp., Semiconductor Div., 65 Gouverneur St., Newark, N. J.

Contained in a ceramic wafer 0.31 in. sq and 0.016 in. thick, the gold-bonded germanium units were developed for the Signal Corps.

Designated type F-1, the units have these characteristics: 125 piv; 75 ma dc output current; 100 ma forward current at 1 v max; 10 ma max reverse current at 10 v, and 50  $\mu$ a at 50 v; maximum reverse current at 75 C, 75  $\mu$ a at 10 v and 250  $\mu$ a at 50 v. Typical values are 100 ma at 0.7 v for the forward current and 60  $\mu$ a at 50 v at 75 C for the reverse leakage.

The diodes are produced in approximately 12 different terminations as required by the specific micro-module circuit applications.

For more information, turn to the Reader-Service card and circle number 104.



The diodes come in approximately 12 different terminations as required by circuit applications.



## How to keep your cut-off sharp!

Audio filter designers use molybdenum permalloy powder cores when they want razor sharp attenuation that will hold

Audio filter designers, faced with a crowded frequency spectrum, specify molybdenum permalloy powder cores to rigidly define channel cut-offs . . . with sharp, permanent attenuation at channel cross-overs.

Moly-permalloy, with virtually no resistive component, makes a core with almost no core loss. The resultant high Q means sharp attenuation of blocked frequencies in both the high and low band pass ranges. This is permanent—moly-permalloy cores were developed specifically to provide a very long term inductance stability.

Compare molybdenum permalloy to powdered iron. See the smaller size and the superior stability despite unusual fluctuations in current or temperature. Even unstabilized permalloy powder cores are more stable with temperature swings

than cores made of any other material. And . . . stabilized cores are at least four times more inductance-stable than unstabilized cores.

What's more, there's no longer any guesswork! We have published limits within which the designer can depend on core performance. These limits—and full information on our Performance-Guaranteed permalloy powder cores—await your inquiry. *Magnetics, Inc., Dept. ED 61, Butler, Pa.*

**MAGNETICS inc.**

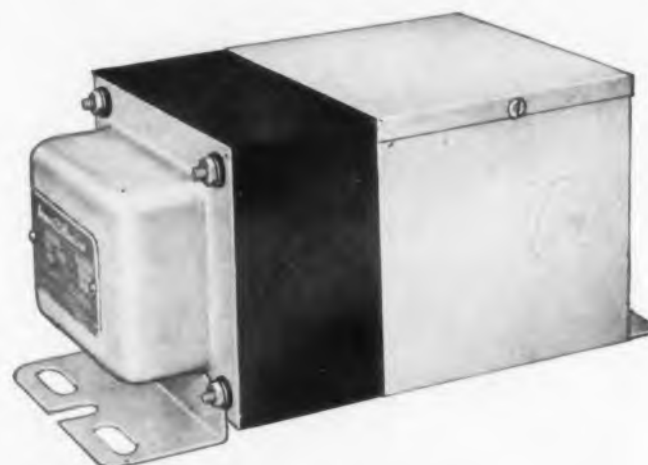
CIRCLE 459 ON READER-SERVICE CARD

Acme  Electric

## CONSTANT VOLTAGE STABILIZERS

Provide  $\pm 1\%$  Regulation,  
Overload Protection

This new series of Acme Electric constant voltage stabilizers include all the features engineers requested in custom made units. Designed to stabilize a voltage which may vary over a range as much as 30%. Stabilization response is practically instantaneous; inductive surges or other causes of fluctuation are corrected within 1/30 of a second. Under overload or short circuit condition, output voltage automatically drops to zero thus limiting the current and providing full protection.



SEND FOR NEW CATALOG

New Bulletin CV5-321 gives engineering data; performance curves and full specifications. Write for your copy.

ACME ELECTRIC CORPORATION

906 WATER STREET • CUBA, NEW YORK

Acme  Electric  
TRANSFORMERS

PO 3209

CIRCLE 460 ON READER-SERVICE CARD



### CERAMIC HIGH VACUUM DIODE HAS 16 KV PEAK INVERSE RATING

Only 2 1/4 inches long, Eimac's rugged new 2CL40A is a ceramic-metal high-vacuum diode for use in high-voltage rectifier or clipper-diode service. It weighs just 2 1/2 ounces.

When operated with convection liquid cooling the 2CL40A carries a maximum peak-inverse rating of 16,000 volts, a maximum peak plate-current rating of 10 amperes, and an average plate-current rating of 0.12 amperes. Under these conditions, allowable plate dissipation is 40 watts.

The 2CL40A also may be operated with convection air cooling at reduced ratings. Maximum allowable peak-inverse plate voltage is then 8000 volts and maximum plate dissipation 10 watts. Employing an oxide-coated, unipotential cathode, the 2CL40A requires a heater potential of 6 volts and a heater current of 2.1 amperes.

The Eimac 2CL40A is rated at a maximum anode and seal temperature of 250° C. for use under extreme environmental conditions. For further information, consult our Application Engineering Dept.



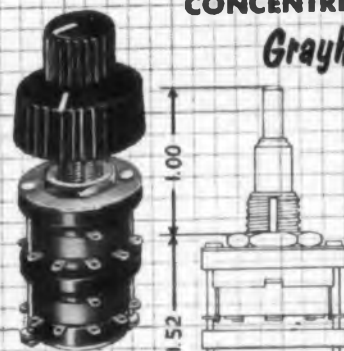
EITEL-McCULLOUGH, INC.  
SAN CARLOS • CALIFORNIA

CIRCLE 461 ON READER-SERVICE CARD

### NEW from the Grayhill Sketch Book

#### MINIATURE CONCENTRIC SHAFT SWITCH!

#### Grayhill Series 6



- New flexibility in a miniature rotary tap switch.
- Allows 2 switches to be mounted in the space normally occupied by one.
- Up to 3 decks controlled by each shaft.
- Two to 10 shorting or non-shorting positions per deck.
- Breaks 1 amp. 115 V. AC resistive, carries 5 amps.
- Available in over 6500 combinations of decks and positions.

Write for complete information

"Pioneers in  
Miniaturization"

Grayhill  
INC.

Phone: Fleetwood 4-1040

565 Hillgrove Ave., LaGrange, Illinois

CIRCLE 462 ON READER-SERVICE CARD

## NEW PRODUCTS

# Three Diode Testers Have Modular Construction Automatic Features

THE THREE diode testers described here combine both modular construction and automatic features to quickly evaluate all of today's (and probably most of tomorrow's) diodes. One of the testers is designed for production testing, another for incoming inspection, and the third is for diode reliability studies.

All three testers are made by the Cal-Tronics Corp., 11307 Hindry Ave., Los Angeles, Calif.

#### Production Testing

The model 3002 unit is designed for automatic production testing, and a line drawing of the tester is shown in Fig. 1. It has a hopper-fed, chain conveyor that carries the diodes sequentially to seven different test stations. Each station consists of a contact head assembly that makes contact with the individual diodes under test.

The output of the contact head assembly drives a parameter translator. The translator

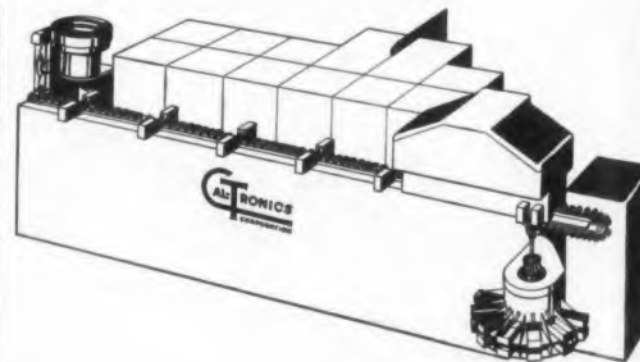


Fig. 1. Model 3002 automatic production diode tester features a hopper-fed, chain conveyor and modular construction.



diode testers

ular construction,

atic features

consists of equipment that generates a standard input signal to the diode, detects the resultant changes in its electrical output characteristics and converts the output to a standard form. When testing for forward current, for example, the translator places a constant forward voltage across the diode, measures the resultant current, and translates the current to a proportional voltage for evaluation in a voltage comparator. Similar translations are carried out for other characteristic tests.

The dc output voltage from the parameter

automatic  
of the  
oper-fed,  
sequen-  
each stably that  
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assembly  
translator

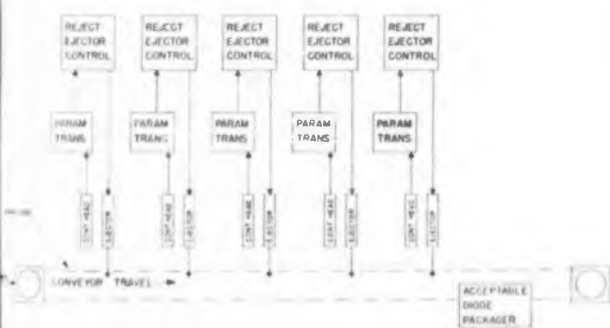


Fig. 2. Incoming inspection of diodes is performed with the model 3003 unit, shown in block form. The diodes are hand loaded on the conveyor.

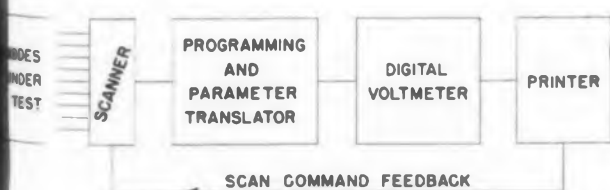


Fig. 3 The model 3000 unit, shown in block form, was designed for component reliability evaluation and body programs.

), 1959 ELECTRONIC DESIGN • June 10, 1959

new  
from SIE

output meter and  
calibrated attenuator  
on front panel

portable • tilttable • rackable

RANGE: 2 cps — 200 kcps

ACCURACY: 2%

OUTPUT: 1 volt

DISTORTION: less than 1%

N-1 signal generator

Another in the line of SIE Advanced Design Instruments, human engineered for operating efficiency. Easier to set up • Easier to read • Adjustable viewing angle • Parallax free vernier tuning • Large, easily set control knobs • Protected front panel • Convenient carrying handle.



SOUTHWESTERN INDUSTRIAL ELECTRONICS COMPANY  
10201 Westheimer • P. O. Box 13058 • Houston 19, Texas  
CIRCLE 463 ON READER-SERVICE CARD



BENCH OR RACK MODEL 310<sup>00</sup> f.o.b. Houston, Tex

marion  
advancement  
in instrument  
design



NEW  
LOW COST  
ELAPSED TIME INDICATOR

Unsealed, bakelite case design provides low cost. Self-starting synchronous motor drives 5-digit counter; records hours to 99999 or hours and tenths to 9999.9. Square Model 53 SET 3 1/2" also available. For 110 or 220 volt, 60 cycle AC. Standard ASA/MIL 3 1/2" mounting. Data on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Co., Manchester, New Hampshire, U.S.A.  
Copyright © 1959, Marion

marion  
"WHERE ELECTRONICS MEETS THE EYE"  
meters



CIRCLE 464 ON READER-SERVICE CARD

How KPR\* simplifies  
etched circuit  
production

\*Kodak Photo Resist

KPR helps you set up efficient coating and handling routines... because it is extremely stable (allows you to coat circuit boards months in advance, then store them to use as needed)... because it is durable... because your operators can learn to use it effectively with a minimum of training. All this helps reduce make-overs and rejects, too. The basic steps in producing circuits with this all-plastic, presensitized, liquid coating are outlined below:

- (1) Clean metal; use power brush for speed.
- (2) Quick acid rinse insures good adhesion of KPR.
- (3) Coat plates by spraying, whirling, dipping; then store till needed.
- (4) Expose briefly to high-intensity arcs; exposure time never varies because of heat, humidity, or long storage.
- (5) Develop; vapor-spray degreaser is fastest.
- (6) Etch circuits, using standard techniques. KPR protects circuit image during assembly of components, strips off clean when panel is "skated" on tin-lead solder.

There's full information in a new booklet called "Industrial Uses of Kodak Photo Resist"—yours for the asking.

No statement or suggestion in this advertisement is to be considered a recommendation or inducement of any use, manufacture, or sale that may infringe any patents now or hereafter in existence.

EASTMAN KODAK COMPANY  
Rochester 4, N. Y.

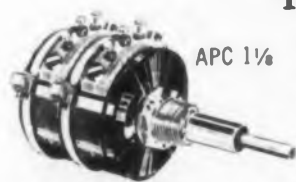
Kodak

CIRCLE 465 ON READER-SERVICE CARD



## CONTENTMENT IS FOR COWS

Recently our engineering department came up with an improvement in a miniature precision potentiometer which had been ordered consistently by one of our customers. Although the original design had more than met the customer's specifications, we filled his next order with the improved version — at no increase in cost! This is but one example of how Waters' alertness to the need of constant research and experimentation is advantageous to all concerned. We are never content with any potentiometer we make, regardless of how well it meets, or even exceeds, specifications. Ask for Waters Catalog PF1253 — we believe you will be favorably impressed.



APC 1 1/4

### Twice as many pots in the same panel space!

The APC 1 1/4 permits mounting two 1 1/4" diameter pots in tandem rather than side by side . . . saves panel space, simplifies design. Concentric shafts can be rotated independently by a dual knob, concentric gears, or other simple means. For single hole or servo mounting. With stops, or continuous rotation of either or both elements. Also available with 3/4" diameter (type APC 3/4). Either size can be supplied with the same specifications as Waters standard RT 3/4 and AP 1 1/4 potentiometers. Write for Bulletin PCA 459-2



POTENTIOMETERS • SLUG TUNED COIL FORMS • RF COILS • CHOKES • POT HOOK & PANEL MOUNTS • TORQUE WATCH® GAUGES • CONTROL METER/CONTROLLER • INSTRUMENTS  
CIRCLE 466 ON READER-SERVICE CARD

## NEW PRODUCTS

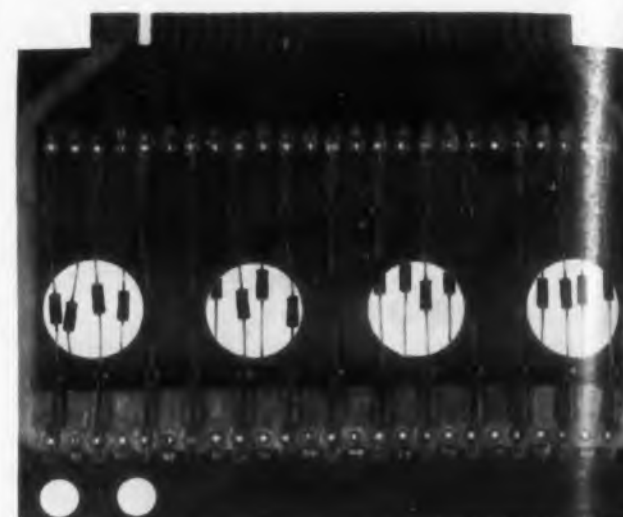


Fig. 4. Diodes through reliability studies on the model 3000 unit are mounted on printed circuit cards.

translator is fed to a comparator system where the voltage is compared to a suitable reference standard. The output of the comparator is one of three classification levels which is then punched on paper tape. The tape serves as a buffer memory to store evaluated output data until the diode reaches the sorting area on the conveyor. At this point, the tape is read, decoded, and the diode is classified and ejected into one of fifteen bins.

Modularization of the unit's construction permits quick changes in equipment configuration. It can thus perform many different functions—which is essential to manufacturers of a wide variety of diodes.

The limit-of-error of this tester is about  $\pm 1\%$  of the absolute magnitude of the parameter being measured. The limit-of-error for an automatic test system is defined as the degree of error contributed to the tested results by the test equipment. It includes factors such as accuracy, drift, resetability, repeatability and general stability. This is exclusive of changes in the diodes, such as diode drift, as contrasted to the requirements for test program reliability.

### Incoming Inspection

The model 3003 tester is designed for incoming inspection on a semi-automatic basis. A block diagram of the unit is shown in Fig. 2. The diodes are hand loaded on the conveyor which carries them to each test station. The contact head makes a connection between the diode under test and the parameter translator.

The translator output drives a reject-ejector control circuit. If a diode's characteristics do not meet the minimum limits set into the parameter translator it is dropped out at the individual test station. Non-acceptable diodes are classified



go, no-go basis as to the parameter that has

Acceptable units reach the final packaging system where they may be either bulk or tape packaged, depending on the particular requirements.

The test rate of this tester is not as great as the unit used in production testing because the user does not have the volume requirements, that approaches that of the manufacturer. Also, the slower rates allow effective use of hand loading of the conveyor.

To handle diodes made by many different companies, and diodes of dissimilar characteristics, the tester is built on a modular basis. This feature also permits the user to cope with new products.

The limit-of-error for this tester is somewhat broader than that for production testing. That is because inspection is more on a qualitative than a detailed quantitative basis and limit ranges of from  $\pm 2$  to  $\pm 5$  per cent are acceptable.

#### Reliability Studies

Intended primarily for component reliability evaluation and study programs, the model 3000 tester handles diodes in a semi-automatic fashion. A block diagram of the tester is shown in Fig. 3, and the method of mounting diodes under test on printed circuit cards is shown in Fig. 4.

The diode card is inserted in a scanner system which sequentially connects the diodes to the parameter translator unit. The converted test parameter is fed to an analog-to-digital converter (digital voltmeter), the output of which drives a printer, punched card, punched tape or other suitable data recording unit. When the test is completed, a feedback signal from the recorder automatically advances the scanner to the next diode and the test cycle is repeated.

This tester is normally operated in a laboratory type atmosphere for much shorter periods of time than the production or inspection units. Because of this requirement more delicate and considerable more precise instrumentation is used. It has a limit-of-error of about  $\pm 1$  per cent.

Having modular construction, the tester is flexible enough to allow new studies to be performed with a minimum of difficulty. Interconnections between the test system and the various environmental chambers are possible.

Other than mounting the diodes of the cards, no other mechanical handling is required. This permits the construction of precision equipment at a minimum of cost.

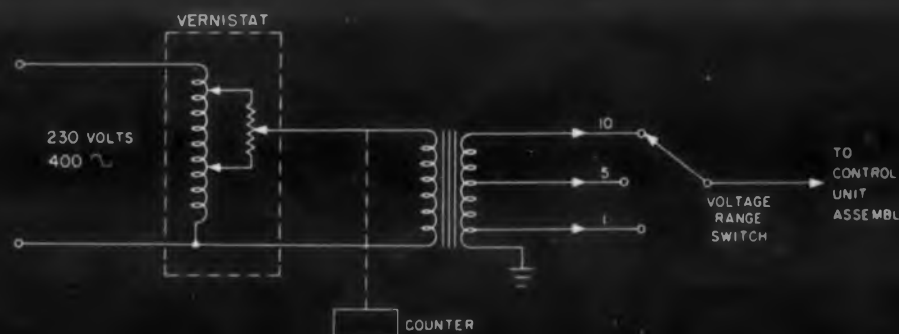
For more information on these diode testers, turn to the Reader Service Card and circle number 105.

## Eclipse-Pioneer designs test set for B-58 Hustler autopilot system...



An automatic flight control system that "thinks ahead" of the pilot is a "must" for the Air Force's Convair B-58 Hustler — world's fastest bomber. "Brain" of this system — developed by Eclipse-Pioneer Division of Bendix Aviation Corporation — is a compact control unit assembly in which all flight factors are continuously and instantly translated into commands to control surfaces. To check out this assembly quickly and conveniently, a mobile test set has also been designed — and Vernistat is there as an accurate source of test voltages in simulating a number of signals and commands.

...and Vernistat\* is there!



Vernistat a.c. potentiometers were selected for several of the test panels because of their unique combination — in one component — of reliability, low output impedance, low phase shift, and high linearity. In the typical application above, a Vernistat is mechanically geared to a counter to provide an output voltage that can be accurately set to the required value. Low phase shift from input to output is maintained by the Vernistat's inherent design. And need for an isolation amplifier — with its added cost and disadvantages — is eliminated.

## Doesn't Vernistat thinking belong in your system design too?

In this application, Vernistat thinking by Eclipse-Pioneer engineers helped solve a design problem with reduced equipment cost, system complexity, and design time. Cost was only a quarter of that of an alternative method utilizing conventional potentiometer, isolation amplifier, and d.c. power. Use of fewer components reduced system complexity, increased accuracy and reliability, and saved valuable

design engineering man-hours.

In servo systems, analog computers, and similar uses, you too can obtain such results with Vernistat a.c. potentiometers. With this new concept in relating shaft position to voltage, you get low output impedance (as low as 45 ohms) with high input impedance (as high as 200,000 ohms), plus high resolution (to 0.004%), low phase shift (as low as 0.2 minutes), and high

linearity (to 0.01%).

In addition to precision a.c. potentiometers, Vernistat products include function generators (adjustable non-linear potentiometers), and variable ratio transformers. Military specifications are met by the wide selection of models available.

Write today for complete details and specifications on Vernistat precision products.

\*vernistat® — a new design concept that unites in one compact device the best of both the precision autotransformer and the multiterm potentiometer.

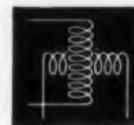
**Perkin-Elmer** Corporation

vernistat

765 Main Avenue, Norwalk, Conn.

CIRCLE 467 ON READER-SERVICE CARD

# KEARFOTT PRECISION RESOLVERS FOR EVERY SYSTEM APPLICATION



Kearfott has available a complete line of precision resolvers for every system application. Computing resolvers range in functional accuracy from 0.1% to .005%, in bridge accuracy from 5 minutes to 20 seconds of arc and in size from 11 to 25. Non-compensated resolvers range from 5 minutes to 20 seconds of arc in

accuracy, from 8 to 25 in size.

All Kearfott resolvers feature stainless housing, shafts and bearings and corrosion-resistant lamination materials for maximum environmental resistance. Optional designs available for operation at 200°C and in environment of 2000 cps vibration at 30 g's.

## Computing Resolvers

Available with integral compensating windings. Can be provided with trimming networks to match existing isolation amplifiers or Kearfott-designed transistorized amplifiers.

### Size 11

For applications where size and good functional accuracy are of paramount importance. Functional accuracy as good as 0.1% and bridge errors of 3 minutes of arc are in production.

### Size 15

A 2:1 improvement in functional accuracy obtained in this configuration. Unit tabulated is the direct equivalent of standard Navy BuOrd Mark 4 Mod 3 and contains necessary trimming network

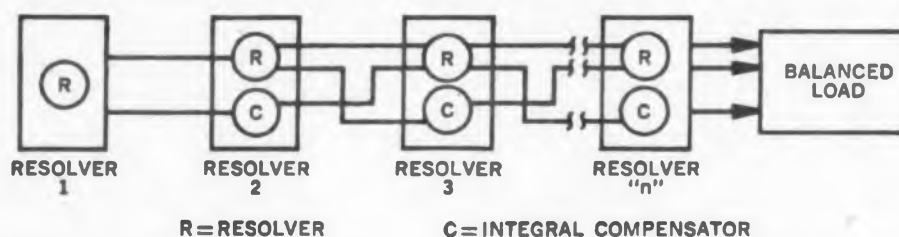
for standard buffer amplifiers. Transformation ratio is 1.000 ± .0001, phase shift 0° ± 1 minute. Functional accuracy of .05% and bridge error of 3 minutes of arc are standard.

### Size 25

For applications demanding the highest order of accuracy. Close attention has been paid to design parameters.

### Size 18

A special resolver which permits a unique cascading of these units without the necessity for buffer amplifiers. Typical application is illustrated in following cascade:



COMPENSATED RESOLVERS FOR PRECISE COMPUTER APPLICATIONS

SIZE	11	15	18	25	
PART NUMBER	R980-01	R980-41	T980-51	V980-004	425506-1
Excitation Volts—(Max.)	60	60	26	26	115
Excitation Volts (Test)	10	10	15	13	25
Frequency—(cps)	400	400	400	400	400
Primary Impedance	629 + j2510	450 + j2200	220 + j1000	3000 + j (0 ± 40)	1630 / 78.5°
Secondary Impedance	695 + j2750	500 + j2300	240 + j1100	3000 + j (0 ± 40)	1620 / 80°
Transformation Ratio (Primary to Secondary)	.980	.980	.980	.775	.980
Transformation Ratio (Compensator to Rotor)	.985	.985	.950	.775	.985
Phase Shift (Lead)	8.5°	7.5°	8.5°	0° ± 10'	2.1°
Fundamental Null (MV)	15	15	8	15	15
Bridge Error From E.Z. (Max.)	*7 mins.	*5 mins.	*5 mins.	3 mins.	0.7 mins.
Primary	Stator	Stator	Stator	Stator	Stator

\*Also available 3 mins. from E.Z.

## Non-Compensated Resolvers

Basically for application in precise data transmission systems. These synchro resolvers permit system designer to achieve system errors of better than 1 minute of arc without using 2-speed servos and elaborate electronics. By proper impedance matches up to 64 resolver control transformers can also operate from one resolver transmitter.

### Size 11

Where size is important. These units have a maximum unit error of 3 minutes of arc.

### Size 25

Where highest accuracy is required. These units have a maximum error as low as 20 seconds of arc.

NON-COMPENSATED RESOLVERS FOR PRECISE DATA TRANSMISSION

	SIZE 11			SIZE 25		
	Transmitter	Differential	Control Transformer	Transmitter	Differential	Control Transformer
Type Resolver	R982-004	R982-002	R982-012	Z5161-001	Z5191-001	Z5151-003
Part Number	R982-004	R982-002	R982-012	Z5161-001	Z5191-001	Z5151-003
Excitation Volts (Max.)	26	11.8	11.8	115	90	90
Frequency (cps)	400	400	400	400	400	400
Primary Impedance	170 / 77°	95 / 80.2°	2000 / 80°	400 / 82°	800 / 80°	8500 / 82°
Secondary Impedance	42 / 80.5°	110 / 75.7°	8000 / 76°	260 / 82°	900 / 80°	14000 / 82°
Transformation Ratio	.454	1.000	1.906	.7826	1.000	1.278
Max. Error from E.Z.	3 mins.	3 mins.	3 mins.	20 seconds	20 seconds	20 seconds
Primary	Rotor	Stator	Stator	Rotor	Stator	Stator

Write for complete data.

**KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.**

A subsidiary of General Precision Equipment Corporation  
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**GENERAL  
PRECISION  
COMPANY**

CIRCLE 468 ON READER-SERVICE CARD

## NEW PRODUCTS

# Battery Operated Lightweight All Transistorized Portable TV

A PORTABLE television set that operates without external power and can be lifted from a floor without powerful muscles is scheduled for production this month.

Weighing only 15 lbs, with battery and built-in telescopic antenna, the set provides 80 sq. in. of viewing area, equivalent to a 14-in. screen.

The Philco Corp. receiver employs 21 transistors plus 14 diodes and is only 8-3/8 in. wide by 16-5/8 in. high by 5-5/8 in. deep. Compact packaging is achieved in part by the use of a two-inch picture tube coupled with an optical arrangement that magnifies the image seven times.

### Battery Can Be Recharged

Looking somewhat like a jumbo reflex camera, the set is equipped with a visor that shields the image from glare or sunlight. The receiver is completely battery-powered by a rechargeable dry cell developed by the Eveready Co. After four hours of operation, recharging is recommended.

A built-in charger permits the battery to be recharged from 117 v ac in about 16 hours. Up to 25 battery charges are possible before battery re-





The receiver can be tilted on its rest for convenient viewing.

placement is necessary. The set may be operated from a standard 117 v, 60 cps power outlet for indoor use, if desired.

Three Philco MADT (Micro Alloy Diffused Transistor) transistors are used in the tuner to provide a matched power gain of 28 to 32 db on low channels and 18 db on high. Noise figures range from 6 to 8 db on low to 10 to 12 db on high stations.

#### Sensitivity Maintained

The overall sensitivity of the receiver is in the neighborhood of 10  $\mu$ v—in short, no compromise in sensitivity or noise figure is conceded to conventional tube receivers.

Tuner output is coupled to a 45 mc if strip containing four MADT transistors; the first three stages are AGC controlled. Stagger tuning is used to obtain an overall if band width of 3 mc at 70 db. Due to low transistor input impedance of approximately 100 ohms, a balanced-T trap is required for adjacent sound trapping and two series-tuned traps are needed for adjacent picture trapping. The video crystal detector output is fed to the

## Industrial Laminates

from General Electric—the company that stands for reliability in the electrical and electronics industry



Flame dies 2 seconds



after torch is removed

## SELF-EXTINGUISHING G-11 EPOXY-GLASS LAMINATE RETAINS HIGH FLEXURAL STRENGTH AT 150°C.

**New high-temperature transparent General Electric Textolite<sup>®</sup> 11559 has exceptional mechanical and electrical properties . . . developed especially for computer and military electronic printed circuits**

High insulation resistance and flexural strength *even at 150°C.*—that's what you get with new General Electric Textolite Grade 11559 epoxy-glass electrical laminate. Self-extinguishing 11559 exceeds NEMA G-11 requirements and Specification MIL-P-18177, Type GEB. Here's how Grade 11559 performs:

- **Insulation resistance:** 20,000,000 megohms at 50°C.; 500,000 megohms at 165°C.
- **Flexural strength:** retains 65% of room temperature strength at 150°C.
- **High peel strength:** 9 lbs./in. for 1 oz. copper-clad; no blistering after 30 seconds in molten solder at 500°F.

The base laminate withstands the effects of concentrated nitric acid and all conventional etching and plating solutions. In addition, 11559 is the only G-11 laminate that is *self-extinguishing*—has approximately

2-second flame-out time. Textolite Grade 11559 is available unclad or clad with 1 or 2 oz. copper.

Consult Sweet's Product Design File, Cat. 2b/Gen., for technical information on the complete line of Textolite laminates. Or for a brochure showing test data on Grade 11559—or engineering assistance for special problems—call or write: *Technical Service, Laminated Products Dept., General Electric Company, Coshocton, Ohio.*

# Textolite<sup>®</sup>

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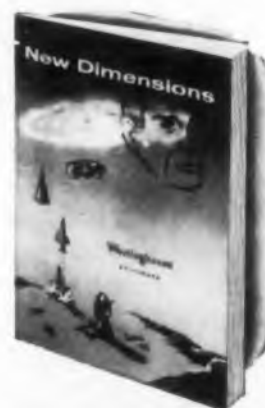
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# Westinghouse

## BALTIMORE

CIRCLE 915 ON CAREER INQUIRY FORM PAGE 79

## NEW PRODUCTS



Chassis can be easily removed from case for servicing. Note printed circuit board at right.

base of an emitter-follower stage, containing contrast control in the emitter leg.

Intercarrier sound output, at 4.5 mc, is coupled to a sound if amplifier, limiter and duo-diode discriminator. From this point the audio signal is amplified in a driver stage and fed to a class-B push-pull stage. Audio output up to 200 mw is then applied to the three-inch PM speaker. The collector of the emitter-follower stage is ac bypassed, and amplified AGC is taken off this point.

### 10 Kv on 2-in. Tube

The video amplifier stage is supplied from +12 v and -12 v supply developed in the horizontal output stage. Peak-to-peak video signals of 20 v are available for application to the kinescope. The two-inch picture tube is operated at 10 kv second-anode potential. With the high-efficiency phosphor screen, only 25  $\mu$ amp current is drawn at normal brightness levels. The tube deflection angle is 30 deg, and one-watt heater power is required.

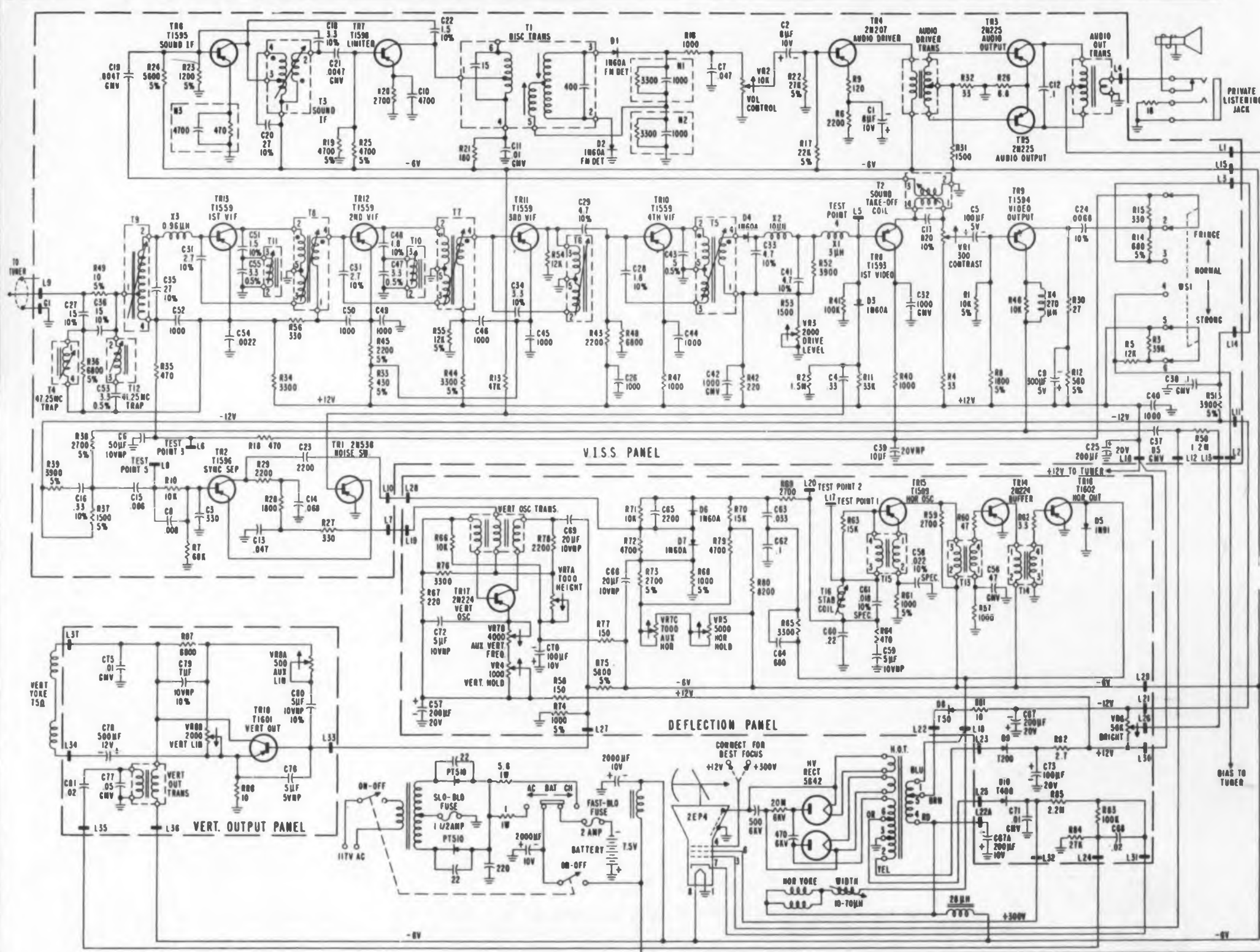


Sync stability is assured by the presence of a noise-switch transistor and diode coupled to the sync amplifier. The diode is normally cut off, allowing the noise switch to conduct and thus provide a low-impedance path for the emitter of the sync stage. Upon arrival of high-amplitude noise pulses, the diode conducts, cutting off the noise switch and opening the sync emitter return.

### Frequency Shift Balked

A buffer stage is employed between the horizontal oscillator and output stage to prevent frequency shift due to the varying load at the horizontal output. High voltage,  $\pm 12$  v supply sources, yoke energy and  $+300$  v for kinescope electrostatic focus are drawn from the horizontal output stage.

The input power for the set is 9 w during ac operation, 4 w when supplied by a 6 v battery. The cost of the set will be under \$300. Battery replacement will cost about \$5 for 100-hour service.



Schematic diagram of completely transistorized receiver.



Individual spring contacts are twisted to ensure positive contact.

## New Twist in Printed Circuit Connectors!

Only DOT printed circuit connectors by Ucinite give you the advantages of Torsion Contact (U. S. and Foreign patents pending). Contact points are precisely twisted so that they apply powerful, continuous and vibration-proof pressure against the printed circuit board. Wiping action during mating ensures a clean connection. Contact edges are rolled after stamping so that high contact pressures do not result in scoring (as is often the case with sheared-edge

contacts). Polarizing keys are available. Full engineering details on request.

With an experienced staff of design engineers, plus complete facilities for volume production, Ucinite is capable of supplying practically any need for metal or metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.



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### ADVERTISERS' INDEX

June 10, 1959

Advertiser	Page
AMP, Inc. ....	21
Ace Electronics Associates ....	114
Ace Plastic Co. ....	172
Acme Electric Corp. ....	182
Advance Relays ....	156
Aeronutronic Systems, Inc. ....	136
Aerovox Corp. ....	172
Alford Mfg., Co., Inc. ....	115
Allegheny Electronic Chemicals Co. ....	12
Allegheny Ludlum Steel Corp. ....	140
Allied Control Co. ....	127
Alpha Wire Corp. ....	118
Amperex Electronic Corp. ....	33
Amphenol Borg Electronics Corp. ....	178
Aanaconda Wire & Cable Company ..	84, 85
Applied Research, Inc. ....	168
Arnold Engineering Co. ....	71
Arnold Magnetics, Co. ....	174
Assembly Products, Inc. ....	98
Atlas E-E Corp. ....	96
Atlas Precision Products ....	164
Automatic Electric Co. ....	110
B & H Instrument Co., Inc. ....	99
Balco Research Laboratories ....	172
Barker & Williamson, Inc. ....	150
Belden Mfg. Company ....	92
Bendix Aviation Corp., Pacific Div. ....	151
Bendix Aviation Corp., York Div. ....	82
Birtcher Corporation ....	45
Blue M. Electric Company ....	176
Boehme, H.O., Inc. ....	99
Bowmar Instrument Corp. ....	170
Breeze Corporations, Inc. ....	175
Buckbee Mears Co. ....	87
Bulova Watch Co. ....	8
Burroughs Corp., Electronic Tube Div. ....	142, 143
CBS-Electronics ....	31
Cal-Tronics Corp. ....	166
Cambridge Thermionic Corp. ....	16
Cannon Electric Co. ....	117
Canoga Corp. ....	25
Carborundum Co., The ....	19
Chicago Standard Transformer Corp. ....	86
Christie Electric Corp. ....	102
Clevite Transistor Products ....	48
Clifton Precision Products Co. ....	Cover II
Communication Measurements Laboratory, Inc. ....	85
Computer-Measurements Corp. ....	83
Consolidated Electrodynamics Corp. ....	53
Continental Device Corp. ....	23
Corning Glass Works ....	22
Dale Products, Inc. ....	10
Daven Co., The ....	175
Daystrom Transicoil Corp. ....	128
Delco Radio, Div. of General Motors Corp. ....	95
Deluxe Coils, Inc. ....	132
Digitran Co. ....	14
Dow Chemical Company, The ....	74
Driver-Harris Company ....	124
Du Pont, E.I. de Nemours & Co., Freon Pds., Div. ....	101



Du Pont, E.I. de Nemours & Co.,  
Mylar Div. .... 171  
Dymec, Inc. .... 65

F H Research Laboratories ..... 118  
FSC Corporation ..... 123  
Eastman Kodak Company ..... 183  
Eitel-Mc Cullough, Inc. (Eimac) ..... 182  
Elastic Stop Nut Corp. .... 174  
Electric Regulator Corp. .... 97  
Electron Products, Inc. (Preco, Inc.) .... 116  
Elgin Metalformers Corp. .... 151  
Epoxy Products Inc. .... 144  
Epsco, Inc. .... 141

Fafnir Bearing Co. .... 113  
Fairchild Controls Corp. .... 100  
Fansteel Metallurgical Corp.  
..... 158, 159, 160, 161, 163  
Federal Tool & Engineering Co. .... 150  
Fischer Special Mfg., Co. .... 115  
Franklin Electronics, Inc. .... 108

Garrett Corp ..... 165  
Gee Lar Mfg. Co. .... 170  
General Electric Co., Apparatus Div. .... 179  
General Electric Co., Laminated Products  
Dept. .... 187  
General Electric Co., Lamp Division .... 85  
General Electric Co., Light Military  
Div. .... 77  
General Instrument Corp. .... 137  
General Mills, Inc. .... 81  
General Plate Div., Metals & Controls  
Corp. .... 72  
General Radio Co. .... 170  
General Transistor Corp. .... 37  
General Transistor Corp., Western Div. .... 87  
Gertsch Products, Inc. .... 162  
Globe Industries, Inc. .... 63  
Grainger, Inc., W.W. .... 174  
Crayhill, Inc. .... 182  
Gries Reproducer Corp. .... 173  
Guardian Electric Mfg., Co. .... 173  
Gudebrod Brothers Silk Co., Inc. .... 156

H & H Machine Company ..... 172  
Hart Manufacturing Company ..... 119  
Heinemann Electric Company ..... 69  
Heminway & Bartlett Mfg. Co. .... 176  
Hetherington, Inc. .... 125  
Hewlett-Packard Company .... 192 Cover III  
Hickok Electrical Instrument Co. .... 130  
Hi-G, Inc. .... 167  
Hoffman Semiconductor Div., Hoffman  
Electronics Corp. .... 40, 41  
Holt Instrument Laboratories ..... 142  
Hopkins Engineering Co. .... 138  
Howard Industries, Inc. .... 175  
Hughes Aircraft Co. .... 5, 7, 9, 11

Indiana Steel Products Co. .... 103  
Industrial Electronic Engineers ..... 66  
Industrial Test Equipment Co. .... 177  
International Business Machines Corp. .... 78  
International Rectifier Corp. .... 145

J F D Mfg. Co. .... 121  
Jarrod Electronics Corp. .... 101

Jable Engineering Co. .... 43  
Jay Electric Co. .... 130  
Jearfott Co., Inc., Little Falls Div. .... 186  
Keithley Instrument Co. .... 158

## IMPACT VS. PLASTIC LAMINATES

It's more than  
"How Much"  
and "How Often"



It is easier to picture impact than to describe the effects of it upon plastic laminates such as Synthane. For one thing, impact is measured in several ways. In the standard A.S.T.M. (Izod) test notched samples  $\frac{1}{2}$ " x  $\frac{1}{2}$ " x  $2\frac{1}{2}$ " are struck by a pendulum. This test is an accepted standard yet it seldom measures the impact behavior upon plastic laminates. Reason: certain grades of laminates are "notch sensitive", a condition which they may never meet in a practical application.

Nor does the Izod test indicate the ability of Synthane to resist repeated blows. Figure 1 shows how many times blows of a pre-determined intensity can be absorbed before the material breaks down.

### Temperature Affects Impact Strength

Even repetitive impact is not the whole of the story. Temperature has an in-

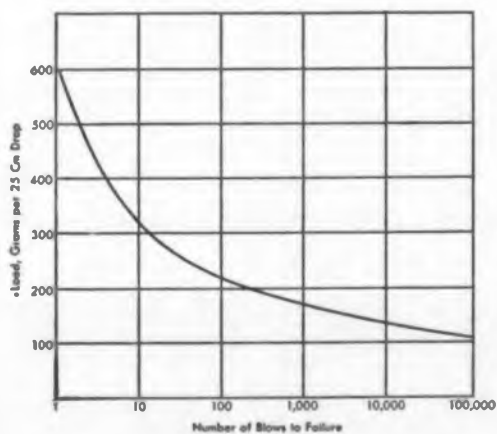


FIG. 1 Intensity of impact vs. cycles

teresting effect upon impact strength (Izod). The curves in Figure 2 show that at extremely low temperatures glass-base grades of Synthane actually improve in impact strength, while other grades improve as they are warmed. The impact strength of Glass Epoxy Grade G-10 improves sharply at temperatures above 75° F.

### Impact Rarely Travels Alone

Like so many other properties of laminates, impact strength can rarely be regarded alone; it must be related to other properties required for the application. A sheet of Synthane has less impact strength than an equal thickness of steel. But steel is over seven times heavier and is a conductor, not an insulator. It is the combination of other properties desired, including impact strength, that is decisive.

Typical applications for Synthane's combined properties under impact conditions are (a) Grade LE Synthane in the shock struts of Airplane Landing Gear (light weight, low coefficient of friction, compressive strength, wear and shock resistance); (b) Welding Tong Insulation, made from G-5 Synthane

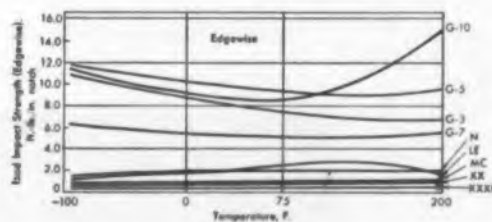


FIG. 2

Effect of temperature on impact strength  
CIRCLE 470 ON READER-SERVICE CARD

(high resistance to impact, excellent resistance to heat, and good dielectric strength); (c) Ignition Breaker Arms of Grade C molded-laminated Synthane (impact resistant, wear resistant, dielectrically strong).

If you have any question about the selection of the proper grade of Synthane for your impact application refer it to us directly or to a Synthane representative. Make sure you obtain the most of what you want for the money. For information write Synthane Corp., 42 River Road, Oaks, Pa.



Synthane laboratory machine for measuring impact fatigue.

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Laminated Plastics for Industry  
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Kellogg Switchboard & Supply Co. ....	1
Kelvin Electric Co. ....	164
Kennedy, D. S., & Co. ....	157
Key Register Corp. ....	100
Krengel Mfg. Co., Inc. ....	167

L & R Mfg. ....	177
Lavoie Laboratories ....	60
Lear, Inc. ....	122
Lepel High Frequency Laboratories, Inc. ....	107
Linde Co. ....	55
Lockheed Aircraft Corp. ....	103
Lord Mfg. Co. ....	109

M B Mfg. Co. ....	129
McLean Engineering Laboratories ....	166
Machlett Laboratories ....	88
Magnetic Amplifiers, Inc. ....	159
Magnetics Inc. ....	181
Magnavox Co. ....	81
Malco Tool & Mfg. Co. ....	105
Marconi Instrument Co. ....	166
Marion Instrument Div., Minneapolis- Honeywell ....	183
Markite Products Corp. ....	148
Melpar, Inc. ....	82
Merck & Co., Inc. ....	35
Micro Switch, Div. of Minneapolis Honeywell ....	93
Microwave Assocs., Inc. ....	133
Miniature Precision Bearings ....	147
Minneapolis-Honeywell Co., Transistor Div. ....	75
Minnesota Mining & Mfg. Co. ....	111
Minnesota Mining & Mfg. Co., Chemical Products Div. ....	154, 155
Monitor Products ....	89
Motorola, Inc. ....	76
Mycalex Corp. of America ....	64

Narda Ultrasonics Corp. ....	177
National Carbon Co. ....	91
National Co., Inc. ....	135
Networks Electronic Corp. ....	149
North American Aviation, Inc. ....	180
North American Electronics ....	90

Ohmite Mfg. Co. ....	17
----------------------	----

PSP Engineering Co. ....	157
Packard-Bell Electronics Corp. ....	67
Pacific Scientific Co. ....	138
Panoramic Radio Products, Inc. ....	106
Perkin Engineering Corp. ....	6
Plastic Products Div. of Raybestos Manhattan, Inc. ....	116
Plastoid Corp. ....	94
Polytechnic Research & Development Co. ....	160
Precision Inc. ....	96

Radio Corp. of America, Designers Industrial ....	139
--	-----

Radio Corp. of America, Semiconductor & Materials Div. ....	Cover IV
--	----------

Radio Corp. of America, Employment Div. ....	80
Radio Industries, Inc. ....	70
Raytheon Mfg. Co., Semiconductor Div. ....	2
Reeves-Hoffman Div., Dynamics Corp. of America ....	84
Relay Sales ....	176
Renbrandt, Inc. ....	176
Rust Industrial Co. ....	119

Delivering  
now!

# PRECISION



Ⓟ 372C/D Precision Attenuator



# ATTENUATORS

totally unaffected by aging or ambient conditions!

*Aging, humidity, temperature* or other ambi-  
ents — none has any effect on the precise calibra-  
tion of these ultra-dependable, wideband new Ⓟ  
attenuators.

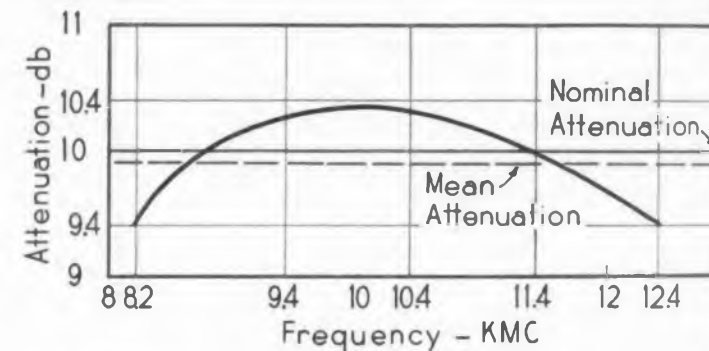
Attenuation is inherently invarient because it  
depends neither on the position of, nor power ab-  
sorbed by, resistive cards or vanes. Instead, atten-  
uation is a function of the coupling-hole array  
between two permanently-joined waveguide sec-  
tions — the same principle as employed in Ⓟ di-  
rectional couplers. Attenuation accuracy thus  
achieved averages better than  $\pm 0.4$  db from nom-  
inal, and variation full band is less than  $\pm 0.5$  db  
from mean.

### HEWLETT-PACKARD COMPANY

1003K PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.  
CABLE "HEWPACK" • DAVENPORT 5-4451  
Field representatives in all principal areas

Since there are no protrusions into the wave-  
guide, SWR's are permanent and extremely low  
— 1.05 to 1.

Ⓟ 372 series attenuators are offered in six  
waveguide sizes, with nominal attenuations of 10  
or 20 db.



Typical attenuation characteristics Ⓟ X372C, 10 db model.

### SPECIFICATIONS

Model	Freq. (KMC)	Nominal Attenuation	Fits Waveguide Size (in.)	Power (watts ave.)	Price	Model	Freq. (KMC)	Nominal Attenuation	Fits Waveguide Size (in.)	Power (watts ave.)	Price
S372C	2.6 - 3.95	10	3 x 1½	2	\$375.00	H372C	7.05 - 10.0	10	1¼ x ¾	1	120.00
S372D	2.6 - 3.95	20	3 x 1½	2	375.00	H372D	7.05 - 10.0	20	1¼ x ¾	1	120.00
G372C	3.95 - 5.85	10	2 x 1	2	250.00	X372C	8.2 - 12.4	10	1 x ½	1	100.00
G372D	3.95 - 5.85	20	2 x 1	2	250.00	X372D	8.2 - 12.4	20	1 x ½	1	100.00
J372C	5.85 - 8.2	10	1½ x ¾	1	140.00	P372C	12.4 - 18.0	10	0.702 x 0.391	1	115.00
J372D	5.85 - 8.2	20	1½ x ¾	1	140.00	P372D	12.4 - 18.0	20	0.702 x 0.391	1	115.00

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



pioneers again in better waveguide equipment



①

**LOOK!**  
one new instrument  
useful 2 ways

②

**Microvoltmeter-  
Micromicroammeter  
measures to  
1  $\mu$ v, 1  $\mu$ μa!**



New **425** Microvolt-Ammeter

**Sensitive  
high-impedance  
voltmeter  
input values to  
approximately  
400 megohms!**

This versatile new **425** instrument serves you in many ways. It is a high sensitivity microvoltmeter measuring to 1  $\mu$ v, and a micromicroammeter measuring to 1  $\mu$ μa with sensitivity 10 times that previously available. Drift is less than  $\pm 2 \mu$ v/hour and noise is less than 0.2 v RMS.

Or, with a simple factory modification offered at no extra cost, the input impedance can be increased to approximately 400 megohms. This insures accurate measurement without loading on most high impedance circuits. In many situations, the 425A thus performs measurements for which expensive electrometers were previously required.

Model 425A also serves as an ohmmeter, measuring resistances from milliohms to 10 megamegohms in conjunction with an external constant current.

Other unique features include a photoelectric chopper replacing the conventional multi-vibrator, heavy ac filtering, protection against momentary overloads up to 1,000 volts, and a new probe minimizing thermocouple or triboelectric effects.

### HEWLETT-PACKARD COMPANY

5499K PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.  
DAVENPORT 5-4451 • CABLE HEWPACK  
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

### SPECIFICATIONS

#### MICROVOLT-AMMETER

**Voltage Range:** Positive and negative voltages from 10  $\mu$ v end scale to 1 v end scale in an eleven step, 1-3-10 sequence.

**Current Range:** Positive and negative currents from 10  $\mu$ μa end scale to 3 ma end scale in an eighteen step, 1-3-10 sequence.

**Input Impedance:** Voltage Ranges: 1 megohm  $\pm 3\%$ .  
Current Ranges: 1 megohm to 0.33 ohm, depending on range. (With factory modification, over 200 megohms. Please specify Model H 01-425A in ordering; no extra cost).

**Accuracy:** Within  $\pm 3\%$  of end scale.

#### AMPLIFIER

**Ac Rejection:** At least 3 db at 0.2 cps, 50 db at 50 cps, approx. 60 db or more at 60 cps.

**Gain:** 100,000 maximum.

**Output:** 0 to 1 v for full scale reading, adjustable.

**Output Impedance:** 10 ohms, shunted by 5000 ohm potentiometer.

**Noise:** Less than 0.2  $\mu$ v rms referred to input.

**Drift:** After 15 minute warm-up, less than  $\pm 2 \mu$ v per hour referred to the input.

**Power:** 115/230 v  $\pm 10\%$ , 60 cps, 40 watts.

**Dimensions:** Cabinet Mount: 7 $\frac{1}{2}$ " wide, 11 $\frac{1}{4}$ " high, 14" deep.

**Weight:** Net 17 lbs.

**Price:** **425AR** (rack mount) \$505.00. **425A** (cabinet) \$500.00.

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

Advertiser	Page
Sage Electronics Corp.	98
Sangamo Electric Mfg. Co.	13
Sarkes Tarzian, Inc.	155
Servo Corp. of America	161
Shallcross Mfg. Co.	89
Shockley Transistor Corp., Div. of Beckman Instruments, Inc.	47
Silicon Transistors	15
Simpson Electric	169
Sola Electric Co.	112
Southwestern Industrial Electronics Co.	183
Spectrol Electronics	173
Speer Carbon Co., Jeffers Electronics Div.	97
Spencer Thermostat, Div. of Metals & Controls Corp.	107
Sperry Microwave Electronics Co., Div. of Sperry Rand Corp.	18
Sperry Semiconductor, Div. of Sperry Rand Corp.	54
Sprague Electric Co.	68
Stevens Mfg. Co.	134
Stoddart Aircraft Radio Co., Inc.	148
Struthers Dunn, Inc.	136
Superior Electronics	167
Sylvania Electric Products, Inc., Semiconductor Div.	162
Sylvania Electric Products, Inc. Mt. View Labs	80
Synthane Corp.	191
Taylor Fibre Co.	105
Technical Information Corp.	104
Technology Instrument Corp.	132
Telecomputing Corp.	24
Teletronics Labs.	20
Texas Instruments, Inc.	38
Tobe Deutschmann, Corp.	102
Torotel, Inc.	114
Transitron, Inc.	49
Tung-Sol Electric, Inc.	131
Twin-Lock Inc.	152
Ultronix Inc.	88
Unimax Switch Div., W.L. Maxon Co.	168
Union Switch & Signal Div., Westinghouse Air Brake Co.	117
United-Carr Fastener Corp.	190
U.S. Gasket Co.	84
U.S. Relay Company	4
U.S. Semi-Conductor Pdts.	26
Vernistat Div., Perkin-Elmer Corp.	185
Vickers, Inc.	146
Victoreen Instrument Co.	104
Victory Engineering Corp.	106
Voltron Products	178
Wallson Associates, Inc.	86
Waters Manufacturing Co.	184
Westinghouse Electric Corp.	188
Westinghouse Electric Corp., Semi-Conductors	153
Weston Instruments, Div. of Daystrom, Inc.	61
Wheelock Signals, Inc.	126
Wilkinson Co.	20
Wright Machinery Co.	73

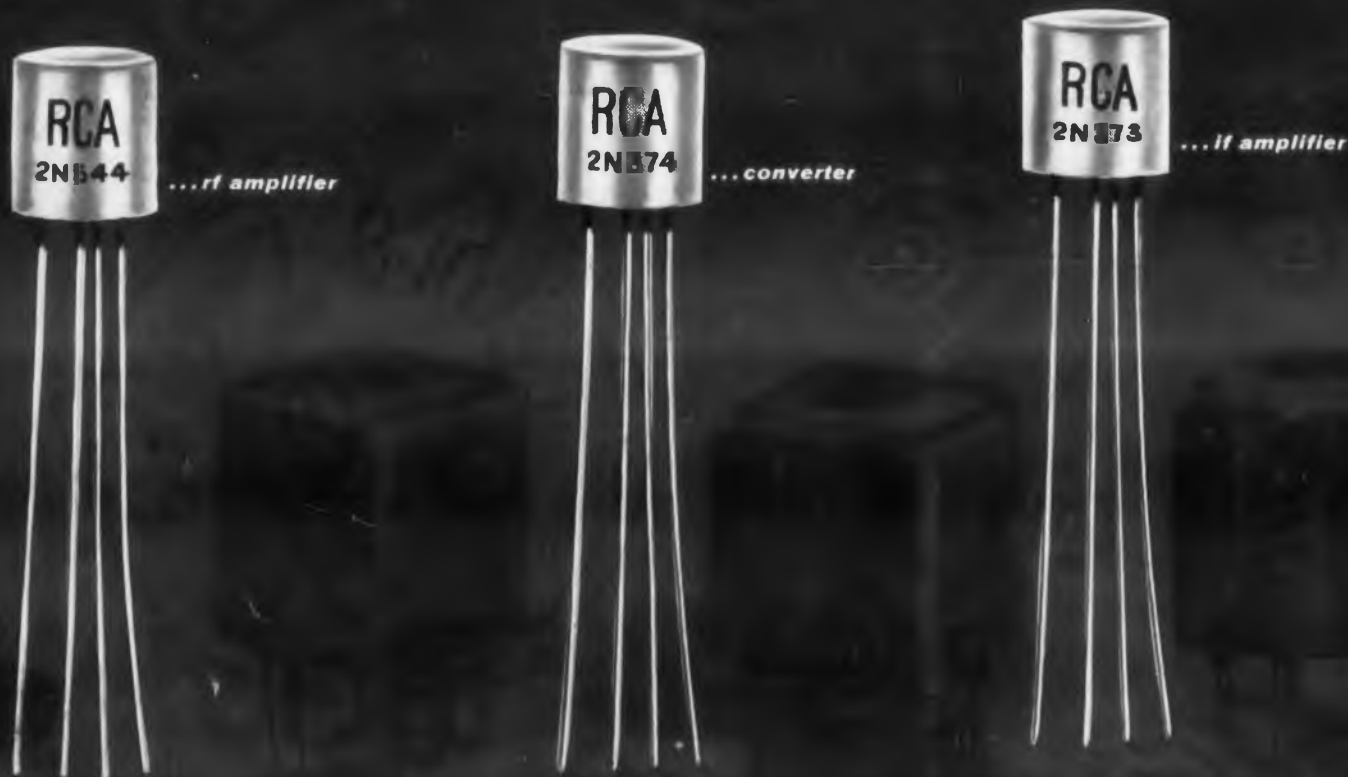


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performance-proved in top-rated portables

# RCA DRIFT TRANSISTORS

... specifically designed and priced  
for service in AM broadcast receivers!



RCA DRIFT types simplify circuits by minimizing need for neutralization; offer more gain per stage; and in many cases cut costs by eliminating an entire IF stage

RCA DRIFT Transistors offer low feedback capacitance and exceptional uniformity of characteristics, making feasible the design of circuits having:

- high input-circuit efficiency
- good signal-to-noise ratio
- good automatic-gain-control capabilities over a wide range of input-signal levels
- excellent high-frequency operating stability.

RCA DRIFT types—2N373, 2N374, 2N544, feature a fourth lead, connected to the case internally, to minimize interlead capacitance and reduce coupling to adjacent circuit components. For additional information, contact your RCA Field Representative. For a description of the DRIFT principle, and for technical data on other RCA Semiconductor Devices, write RCA Commercial Engineering, Section F-18-NN2, Somerville, N. J.



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