

# ELECTRONIC DESIGN

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High-Speed

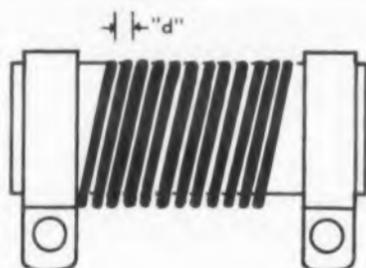
Sampling Switch ..... 32



# What everyone should know about Power Wire Wound Resistors

Since power wire wound resistors are essential elements of many circuits an explanation of their behavior and performance may be found helpful.

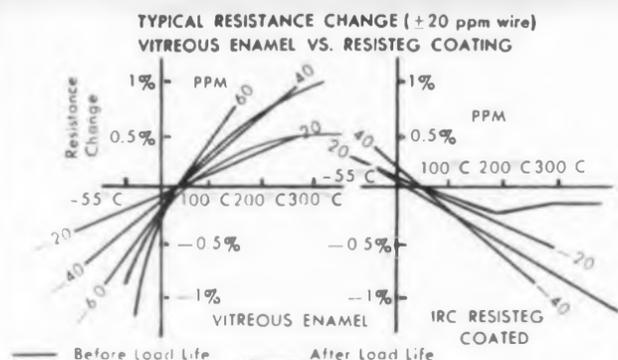
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1 For example, in the illustration above, MIL-R-26C permits a pitch "d" of as much as 5 x wire diameter. The maximum is desirable with a vitreous enamel coating because at the high (1200°F. or more) curing temperature the turns tend to loosen and move toward each other. The result may be either an actual short or an imminent one, prevented only by the oxide film on the wire. High voltages could easily pierce and short or arc-over the turns.

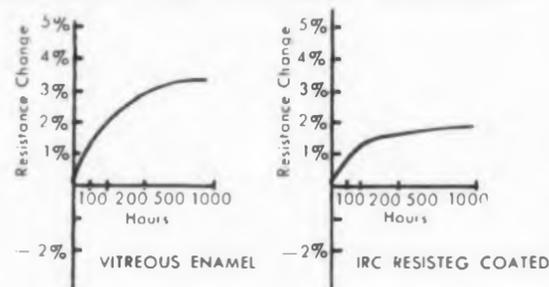
The low temperature (205°F. or less) at which the IRC Resisteg Coating is cured permits a minimum "d" in IRC Power Wire Wound Resistors of 1.8 x wire diameter and a maximum of 2.8 x wire diameter, assuring the use of the largest wire diameter and the maximum number of turns on any given size of core.

The use of fine wire, required with many vitreous enamel resistors—to allow sufficient spacing—does not provide a margin of safety for mechanical abuse, and taxes reliability. Fine wire cannot withstand surges such as are common in aircraft applications.



WRITE FOR THE NEW POWER WIRE WOUND RESISTOR BULLETIN C-1C

TYPICAL RESISTANCE CHANGE DURING LOAD LIFE AT RATED LOAD. VITREOUS ENAMEL COATED VS. IRC RESISTEG COATED RESISTOR



2 The high temperature vitreous enamel cure changes the temperature coefficient and the resistance of the wire. Actually, the temperature coefficient of resistance wire furnished by the wire manufacturer is only 20 ppm. By the time IRC Resisteg Coated Resistors are cured the average TC is about 25 ppm. By comparison, vitreous enamel units are not TC guaranteed for less than 80 ppm and then only on special order.

3 To prevent shifting of turns during curing of vitreous enamel coated power wire wound resistors, the turns must be wound at high tension. This, of course, work-hardens the wire which increases the temperature coefficient and lowers the resistance. These disadvantages are not completely offset by firing and cooling in vitreous enamel coated resistors.

4 Because of the low temperature at which IRC Resisteg Coated Power Wire Wound Resistors are cured, there is no tendency for turns to shift during cure, no necessity therefore for tight windings, no appreciable change in the TC or resistance.

5 The ability to use heavier wire in IRC Power Wire Wound Resistors increases the transfer of heat from the interior of the resistor to the terminals, minimizes the necessity for derating at high ambient temperatures.

6 Vitreous enamel coating being inherently brittle is subject to cracking and crazing from aging, thermal shock, or internal stress; the coefficients of expansion involved are critical and must be carefully matched.



INTERNATIONAL RESISTANCE COMPANY • Dept. 341 401 N. Broad Street, Philadelphia 8, Pa.

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## HIGHLIGHTS OF ISSUE



### High-Speed Sampling Switch (cover) ..... 32

Low level outputs from transducers may be fed directly into this all-transistor commutator without pre-amplification. Extreme flexibility of operation allows a choice of a wide range of sampling rates and channels. As many as 50 channels may be sampled at rates up to 24,000.

### Industrial Electronics following p 60

An ELECTRONIC DESIGN staff report showing the state of the art of industrial process control, and revealing the weak links and problems besetting the industrial electronic design engineer.

### Magnetic Amplifiers for Process Control ..... 20

Seven of the most important types of magnetic amplifiers for process control are tabulated with their most important properties. Also included are concise descriptions of the properties of four different core types.

### Designing for Industrial Electronic Equipment Reliability 24

With the proper division of responsibility, all parts of an organization can contribute to reliable equipment performance.

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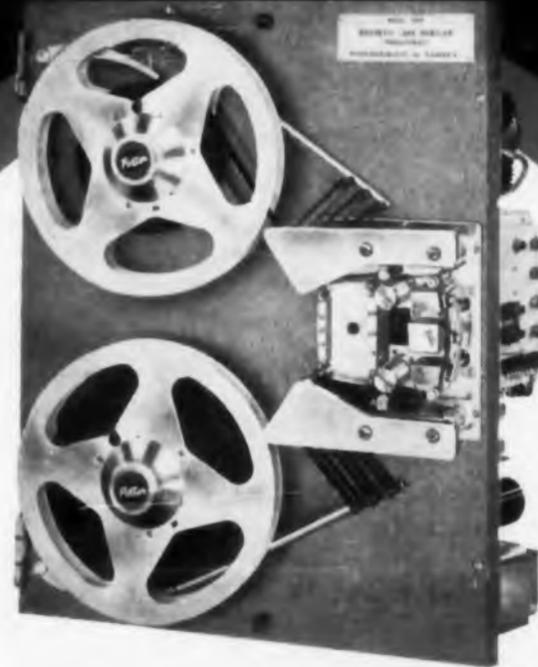
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New Speed...Versatility...Reliability...



## TRANSISTORIZED DIGITAL MAGNETIC TAPE HANDLER MODEL 906

### Optimum performance in virtually all tape handling applications

The advanced design of the completely transistorized Potter Model 906 Tape Handler provides improved performance in virtually any tape handling application.

Replaceable Capstan Panel permits use as Perforated Tape Reader with a remarkable new brake capable of stopping on the stop character at speeds up to 1000 characters per second. Using a small vacuum loop buffer, Model 906 features:

- Complete front accessibility—single panel construction
- Pinch rollers capable of 100 million start-stop operations
- In-line threading, end of tape sensing and tape break protection
- Speeds up to 150 ips
- As many as 4 speeds forward and reverse
- Capable of continuous cycling at any frequency from 0 to 200 cps without flutter
- Rewind or search at 300 ips
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Potter also manufactures a complete line of Magnetic Tape Handlers, Perforated Tape Readers, High Speed Printers, Record-Playback Amplifiers and Record-Playback Heads.

Contact your Potter representative or call or write direct for further information.



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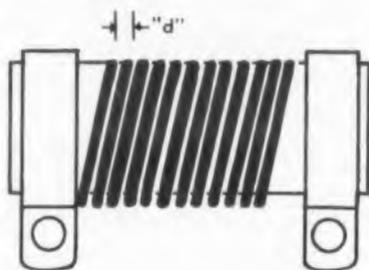
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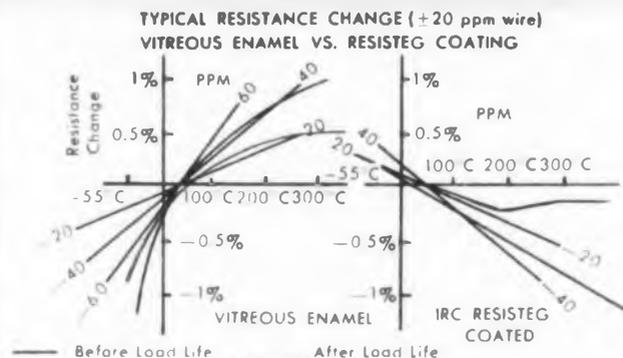
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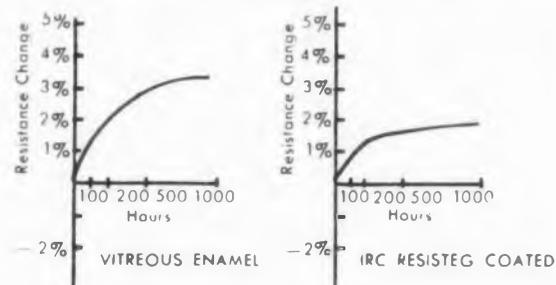
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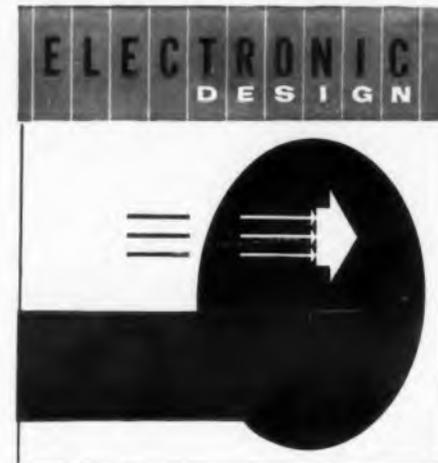
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Potter has career opportunities for qualified engineers who like a challenge, and the freedom to meet it.



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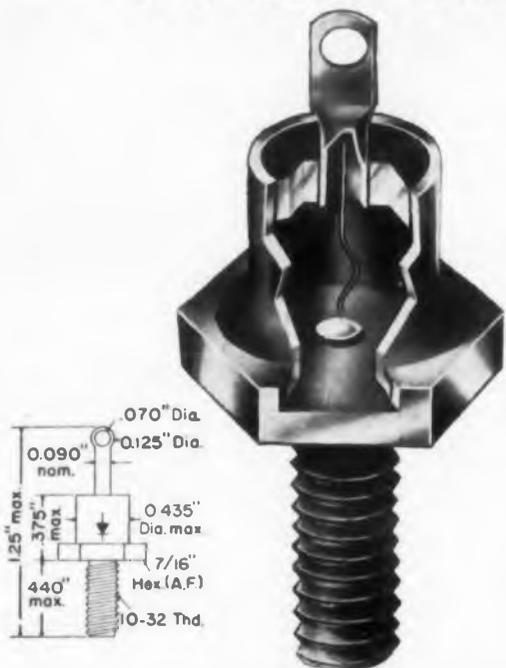
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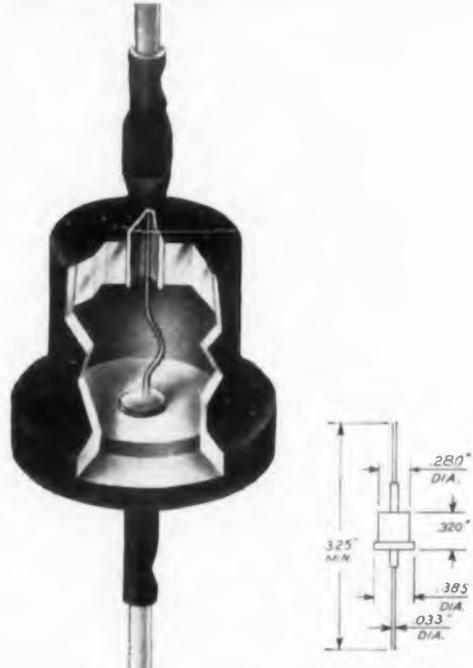
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- welded hermetic seal

## 7/16" STUD TYPE



## WIRE-IN-TYPE



TYPE	Peak Operating Voltage -65°C to +165°C		Ave. Rectified Current		Reverse Current (Max.) at Specified PIV, 25°C
	Volts	Amps.	25°C	150°C	
<b>1N253</b>	95*	3.0	1.0*	10	10
<b>1N254</b>	190*	1.5	0.4*	10	10
<b>1N255</b>	380*	1.5	0.4*	10	10
<b>1N256</b>	570*	0.95	0.2*	20	20
<b>CK846</b>	100	3.5	1.0	2	2
<b>CK847</b>	200	3.5	1.0	2	2
<b>CK848</b>	300	3.5	1.0	2	2
<b>CK849</b>	400	3.5	1.0	2	2
<b>CK850</b>	500	3.5	1.0	2	2
<b>CK851</b>	600	3.5	1.0	2	2

TYPE	Peak Operating Voltage -65°C to +165°C		Ave. Rectified Current		Reverse Current (Max.) at Specified PIV, 150°C
	Volts	mA	25°C	150°C	
<b>1N536</b>	50	750	250	0.40	0.40
<b>1N537</b>	100	750	250	0.40	0.40
<b>1N538</b>	200	750	250	0.30	0.30
<b>1N539</b>	300	750	250	0.30	0.30
<b>1N540</b>	400	750	250	0.30	0.30
<b>1N1095</b>	500	750	250	0.30	0.30
<b>1N547</b>	600	750	250	0.35	0.35

1N253 through 1N256 available to MIL specifications

\*to +135°C

1N538, 1N540, 1N547 available to MIL specifications

†Same as 1N1096

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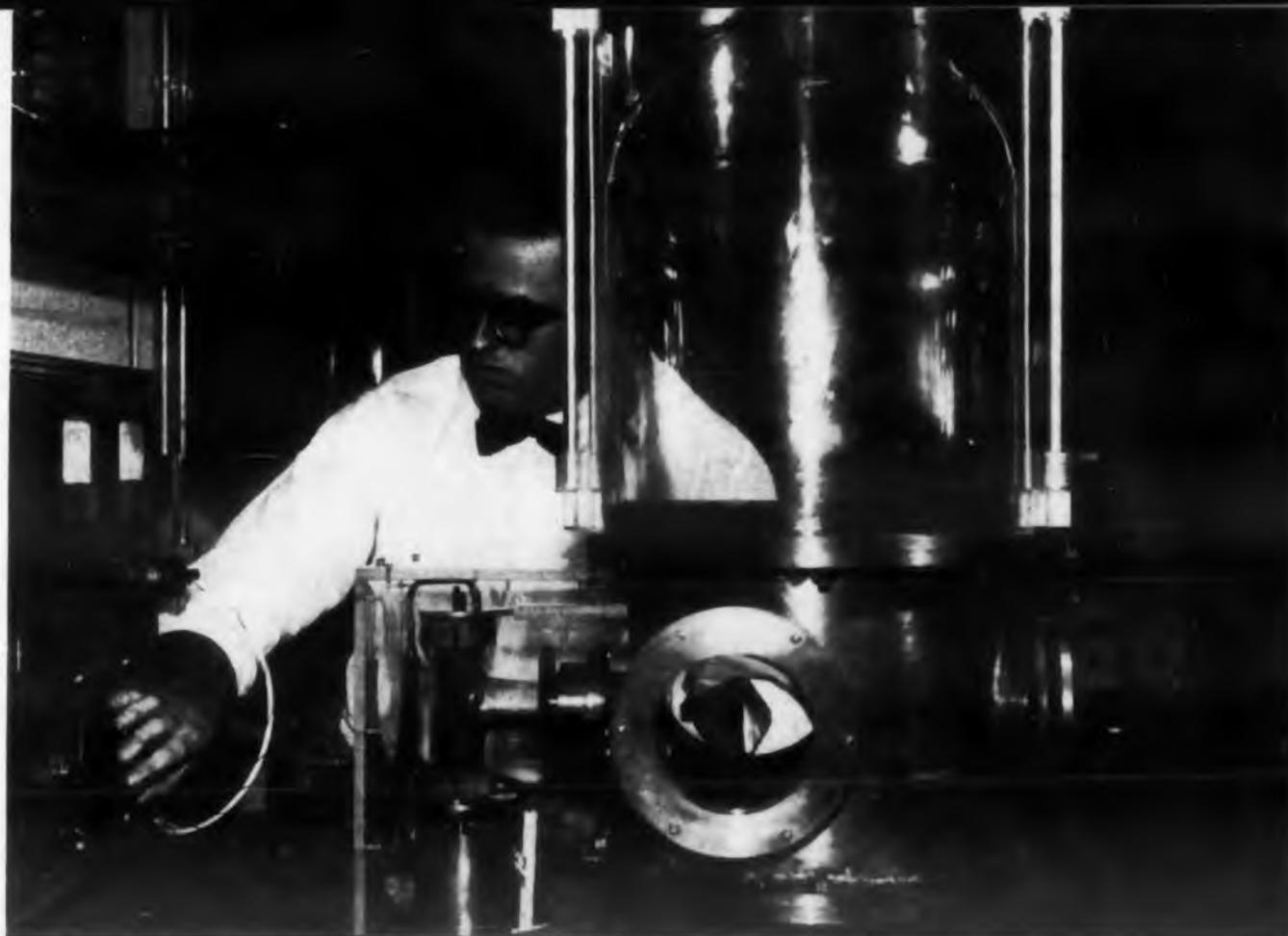
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# BEHIND THE NEWS



**Pulsed plasma** turns paddle-wheel visible through the porthole. Current is stored in two capacitors, then dumped through the spark gap inside the accelerator to create the plasma. Extending vertically across the arm of the "T" are the brass electrodes. The electric spark which breaks the air into ionized plasma is generated across the gap between them. Current is returned through the brass strap along the back of the tube, creating a magnetic field that propels the plasma.

## How to Steer a Space Ship

Magnetohydrodynamics (MHD) promises to yield the ultimate in space vehicle propulsion—at least until something better comes along. The technical problems MHD presents, however, are vast. But inroads are rapidly being made. GE recently developed a working model of a "pulsed plasma accelerator" which can change space vehicle direction in flight.

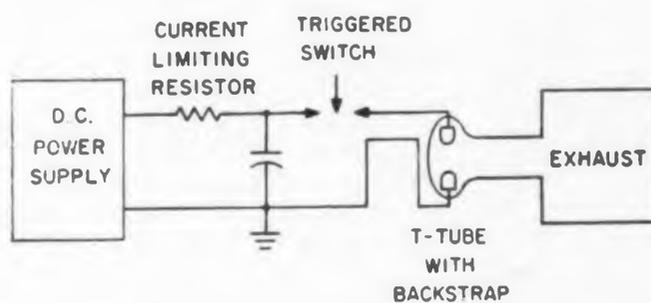
It was demonstrated at the Air Force Association meeting in Dallas last month. As the device is now set up, it requires a peak current of 5000 amps at 2500 volts to ionize the air in the tube and create the required magnetic field. The laboratory device requires a 100 kw power supply to generate this kind of power—10 kw at 10 amp. To drive a space ship would require much greater power.

### Needs Much Work Yet

The GE development is the forerunner of a system that would utilize a nuclear reactor as the prime power source. But GE's present de-

sign is very new and will require considerable refinement before it can be used.

MHD operation is, in essence, no different from that of a motor. Electric and magnetic fields assert a force upon an ionized fluid much like rotor reaction in a motor. Ultimate advantage of an MHD system is that it can propel a low density gas at such a high specific impulse as to exceed present exit velocities of chemical propulsion systems (approximately 4 km/sec) by 10 to 100 times.



Circuit of Pulsed Plasma Accelerator

GE's working model consists of a glass T-shaped tube with electrodes in two arms of the T, between which a spark is generated from a stored capacitor. The third arm is used for transit of the plasma. The plasma moves away from the electrodes partially by the action of a magnetic field set up by the discharge current. This is accomplished by a backstrap around the outer end of the electrode portion of the T-tube.

### Energy from Capacitors

Capacitor energy is delivered to the accelerator tube through a three-element switch, which consists of a series spark gap and trigger electrode. The latter is energized by a high voltage pulse from a pulse forming circuit. The switch and pulse forming network are modifications of the design of the Lovotron circuit of Dr. W. Chace of the Air Force Cambridge Research Center.

Essentially the accelerator relies on the rapid

# Creative Microwave Technology

Vol. 1

No. 1

Published by MICROWAVE and POWER TUBE DIVISION  
RAYTHEON MANUFACTURING COMPANY, WALTHAM 54, MASSACHUSETTS

## NEW DEVELOPMENTS IN ELECTRONIC TUBES AND CERAMICS

Where abnormal conditions of vibration (25 to 2000 cps at 10G) are encountered, such as in advanced airborne applications, this pulsed-type X-band (9245 ± 40 Mc) air-cooled RK6967A/QK366A magnetron oscillator maintains exceptional frequency stability and operational reliability. Optimum performance is assured by a double-end supported cathode and aluminum-clad integral magnets. Nominal peak



power output is 100 kw at typical pulse conditions of 0.5 μ sec. (.001 duty cycle). The tube operates at a peak anode voltage and current of 15 kv and 13.5 amp. respectively.

**CIRCLE 519**  
Reader Service Card

\* \* \*

Integrally insulated semi-conductors can now be produced by using high-alumina ceramic stem assemblies. Heat dissipating ceramic wafer (arrow) in the base insulates up to 2000 volts dc and withstands soldering temperatures as high as



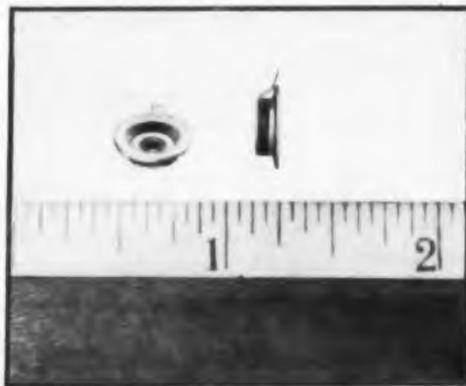
1100C. Bases can be directly mounted to chasses or cold plates. Stems are available to all semi-conductor manufacturers.

**CIRCLE 520**  
Reader Service Card

\* \* \*

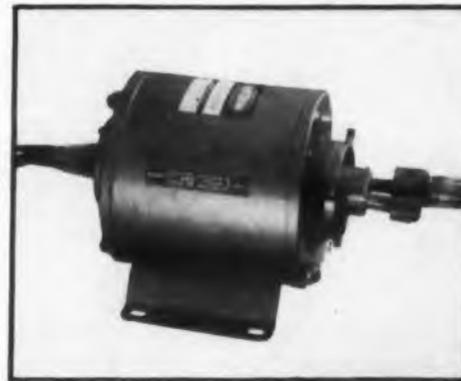
Miniature gyro feed-throughs provide take-off points from gas-filled gimbal housings. These high-alumina, vacuum-tight, R-95 ceramic assemblies can be soldered to housings at temperatures up to 1000C. They also assure positive electrical insulation with leakage less than one micro-ampere per 500 volts dc.

**CIRCLE 521**  
Reader Service Card



Designed for voltage tunable CW or pulsed operation over the Government X-band (8500 to 9600 Mc), the QK-684 integral magnet backward wave oscillator delivers 10 to 50 mW over delay-line voltages ranging from 215 to 325 vdc. Regulation of a special control grid facilitates pulsed or amplitude modulation to meet power and frequency requirements. Models available for coupling to standard, type "N" connectors.

**CIRCLE 522**  
Reader Service Card



\* \* \*

Compiled as a Raytheon service to the field, new Consolidated Data Booklet contains comprehensive information about principal unclassified magnetrons, klystrons, backward wave oscillators and special purpose tubes manufactured by Raytheon. Characteristics presented include maximum ratings, typical operating values, band or frequency ranges and other essential data for microwave engineers and purchasing departments.

**CIRCLE 523**  
Reader Service Card

## BEHIND THE NEWS

charging of a capacitor bank, the much more rapid discharge through the switch and T-tube when energized by the trigger pulse, and the subsequent push obtained on the plasma formed by the heating of the gas and the magnetic field produced. Gas is exhausted into a large bell jar. A pinwheel mechanism indicates thrust obtained from the plasma. A ballistic pendulum arrangement has been fashioned, which can be calibrated directly in ounces of thrust. The model produces a thrust of 0.303 oz.

As the accelerator is presently assembled, the thrust is directly proportional to the amount of current of each discharge. This current determines first the amount of ionization obtained, and secondly the magnitude of magnetic field at the discharge to be used for repulsion of the plasma. A high current is dependent on electrical circuit parameters and original capacitor charge for each burst.

Efficiency of this initial model is necessarily small because of losses in the switch and accelerating mechanism. Work is underway for increase of plasma production efficiency and magnetic energy coupling to the plasma.

### Fuel is Problem

Introduction of fuel to the accelerator is also a problem for designers as is the problem of plasma production and exhaust when ambient pressure conditions are those of upper atmosphere and outer space. Present plasma production is readily obtained at ambient pressures of roughly 0.001 atmosphere, as in the present model.

Adaptation of this principle to outer space control equipment presents a challenge to the spaceminded engineer. At present accelerator work is proceeding at GE's Missile and Space Vehicle Dept. under the \$158 million contract for Atlas and Thor nose cone development. Other accelerator guns are being designed, and larger power equipment for more realistic operating conditions will be used in the near future.

## 13 New Members Admitted to EIA

Thirteen additional manufacturing firms have been accepted for membership in the Electronic Industries Association: Aeronutronic Systems, Systems, Inc., Amco Engineering Co., Columbus Electronics Corp., The Martin Co., Master Mobile Mounts, Inc., Resistron Laboratories, Inc., The Siegler Corp., SNC Manufacturing Co., Inc., Syncro Corp., U. S. Semiconductor Products, Inc., United Transformer Corp., Wyco Metal Products.

A Leader in Creative Microwave Technology



## BaTiO<sub>3</sub> May Shed Light On Why It "Forgets"

Barium titanate is undergoing self-analysis at the National Bureau of Standards to determine why this ferroelectric material tends to "forget" when used as computer memory elements. The fact that different types of electrodes have a direct influence upon this characteristic—a dependence which implies a surface effect—has generated the study of surface layers.

Recently, NBS scientists observed electroluminescence from the surface layer of barium titanate. This effect is now providing information on the unusual surface layer which may contribute to the development of better ferro-devices.

To produce light emission from the surface of BaTiO<sub>3</sub>, the most satisfactory arrangement is a concentric configuration of the electrodes. This concentrates the rf field around the small center electrode and produces maximum light output. Light emission, however, is extremely low in both intensity and efficiency. Although various metals serve successfully as electrodes, best results are obtained from either indium-gallium rubbed directly on the crystal surface or evaporated silver, soldered with indium.

The studies conducted with this arrangement show that at the Curie point—the temperature above which ferroelectric materials lose their spontaneous polarization—of BaTiO<sub>3</sub> the light emission intensity jumps to about 1000 times its value at lower temperatures.



Electroluminescence may tell scientists why barium titanate "forgets" in computer memory work.

... six



... five



... four



... three



... two



... one



... fire



.....



SYVERSON

When the target is space and a million dollars' worth of missile rests idly on the ground—not even a long countdown helps. In a showdown situation, the successful shoot depends on the "go, no-go" type of test that pinpoints the trouble.

## NEXT TIME...LOOK TO INET FOR PRECISE GROUND POWER



This INET 400-cycle ground power unit was tailor-made for the Atlas. In meeting all of Convair's specifications for pre-flight calibration of electrical systems, the unit operates in parallel with the missile's power system and provides remote control regulation. Frequency regulation is  $\pm 0.2\%$ . With shock load equal to a third of rated output, frequency recovers to  $\pm 0.2\%$  in 0.15 seconds. Voltage regulation is  $\pm 0.5\%$  with recovery time at 0.30 seconds.



Missile men desiring a special reprint of the above cartoon should write to "Count-down", c/o Inet Division of Leach.

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with crimp-type,  
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Makes possible  
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holds 35 contacts.  
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*crimp-type*

## MODULAR ELECTRICAL CONNECTORS

IN 3 NEW BASIC TYPES

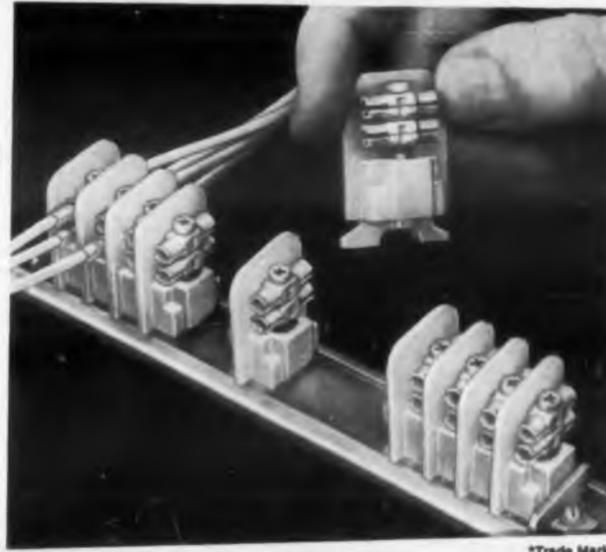
Modular units by Burndy provide versatile, rapid and reliable answers to the problem of connecting a multiplicity of wires in relatively limited spaces. Crimped contacts—installed with any of several hand, pneumatic, semi-automatic or automatic tools—can be removed, re-inserted or replaced, providing the most complete flexibility in the connector field. Computers, ground-based radar, missile ground controls, and instrumentation are typical applications for Burndy modular connectors.

quick-disconnect  
or permanently  
connected

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True versatility in a  
terminal block. 30  
modules (2 or 4 tier)  
per foot. Twist of a  
screwdriver transforms  
quick-disconnect con-  
tacts to permanent  
connections.

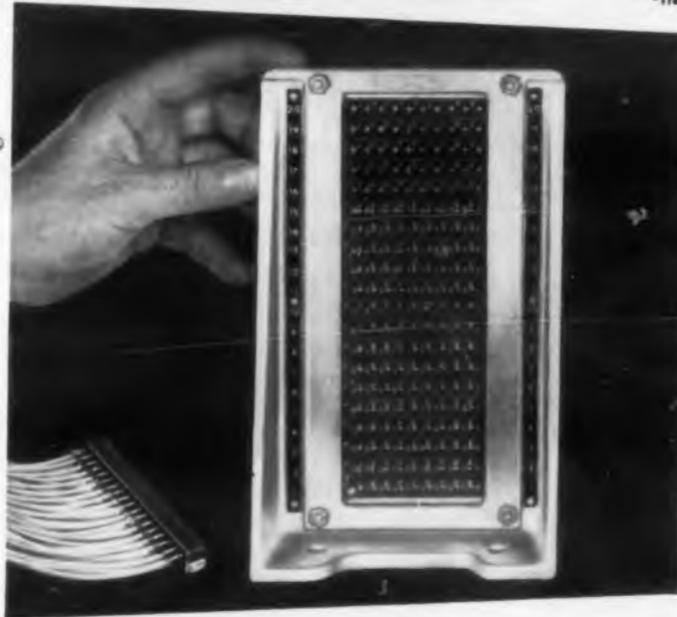


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CIRCLE 6 ON READER-SERVICE CARD

BEHIND THE NEWS

## SAC Orders Global

The global command system for the Strategic Air Command—involving display, computing, and communication switching equipment—is to be drastically improved under a contract awarded recently to International Telephone and Telegraph Co.

Ultimately, the multimillion dollar system (System 465L) will allow the Omaha-based SAC staff to plan, direct, and control global peacetime and wartime operations of the command faster and more directly. There is also a high probability that the system may cost as much as \$150 million before it is eventually linked to System 456L—a modernization program for the present SAC communications system.

ITT's role in the global command system will be that of systems manager. Initially, this means first deciding how best the system should be designed and then finding the equipment to go into it. Here, the electronics industry will be canvassed to determine what equipment is immediately available for the proposed system.

Recognizing that the success of the whole program depends on the development of the concept and the availability of equipment to bring it to life, the Air Force has released only \$3 million of a budgeted \$32.6 million to ITT. Once the concept and the availability of equipment have been set and determined, the remainder of the program allotment will be released.

### Can It Be Done?

One interpretation of this partial allocation may be the desire of the Air Force to find out if a reasonable system can be developed within the guidelines—technical and financial—set down by SAC. ITT—and many Air Force officers—express great confidence in the idea.

One of the program managers will be ITT's G. M. Mooney. He expects to spend the next few months canvassing the industry for equipment. He told ELECTRONIC DESIGN emphatically that time and money will not allow the development of new equipment, new techniques, or breakthroughs.

Biggest equipment problem, according to the ITT official, is display. A tremendous amount of information is expected to flow into the global command system. Unfortunately, there is no abundance of equipment currently available

## Command Network

that is designed to handle this magnitude of traffic. Moreover, whatever equipment is finally selected will have to be of reasonable size in spite of the desired capacity.

ITT plans on using computers not now in the company inventory. Mooney estimates the computers must have a capacity 10 times that of the IBM 704—but not great as LARK and STRETCH.

As for communications switching, ITT officials feel that available circuitry will do the job. The problem will be to convert existing techniques to new applications.

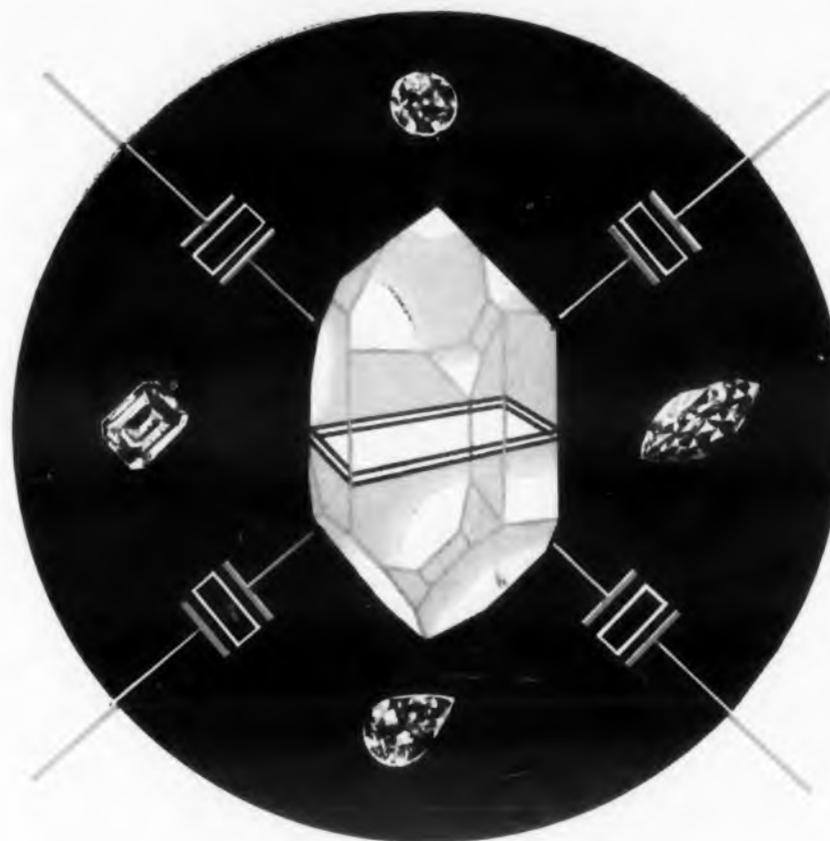
### Start with Wire Links

As a first step in the process, ITT plans to design the system for landline linkage. As this phase progresses, other engineers will begin studying how the system on this continent can be most efficiently linked to the whole global SAC network. It is expected that the Air Force's experience in tropo and ionosphere communications will receive high priority consideration.



### Just Plane Riveters

Four new numerically-controlled are riveters building wing panels for the B-52 Stratofortress at Boeing's Wichita plant. All four machines are controlled by signals on punched tapes. Each machine automatically drills and countersinks the hole, inserts a rivet slug, upsets both ends, shaves off the outer head, and then moves on to the next rivet. Eight to ten rivets per min are driven, fastening stiffeners to lower wing panels. The new riveters are about 12 feet high and 10 feet wide and roll back and forth over the work on floor rails. Wing panels as big as 75 feet in length and four feet in width can be riveted.



## HOW TO SIMPLIFY CIRCUIT DESIGN WITH BURNELL CRYSTAL FILTERS

Through advanced crystal filter production techniques and circuitry by Burnell & Co., it is now possible to overcome numerous design problems formerly believed insoluble with even the best individual toroidal components.

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Economy is achieved with standardized complex designs of lattice networks and their three terminal network derivatives. Packaging encompasses a wide range in standard, miniature and sub-miniature sizes with considerable latitude in permissive impedance range from transistor usage to pentode operation.

### STANDARD DESIGN OR CUSTOM ENGINEERED

Whether you need crystal filters of standard design or custom units engineered to specifications of center frequency, band width, selectivity and impedance level, the facilities of Burnell & Co. are at your disposal. Write for new Burnell Crystal Filter Bulletin XT-455.

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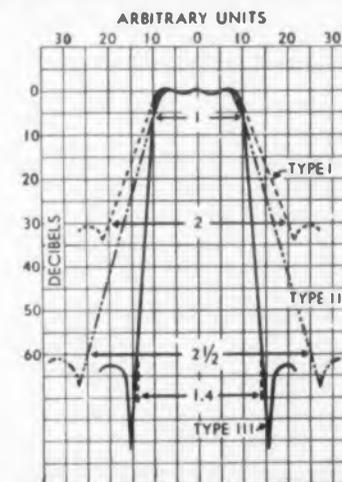
PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS



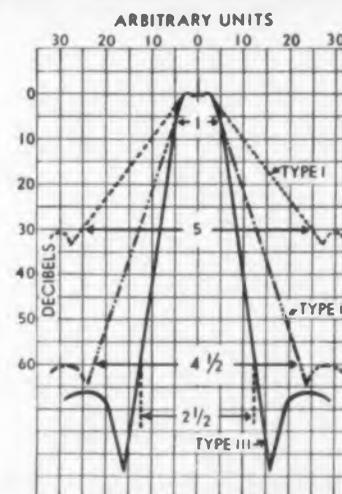
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NARROW BAND CRYSTAL FILTER

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# Fairchild silicon transistors

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3) **Silicon temperature performance** — Maximum junction temperature of 175° C. gives low leakage and more safety factor at any lower temperature.

These characteristics are the outcome of the solid-state diffusion technique used at Fairchild. Other important accomplishments of this process are excellent reliability and a high order of electrical uniformity throughout large production runs.

The accomplishment of a research-production team Singleness of purpose did it. Fairchild assembled a uniquely experienced team of research scientists and production engineers whose objective was to bring the advanced solid-state diffusion process under close control. They succeeded in putting laboratory-quality silicon transistors into quantity manufacture with firm product specifications exceeding anything previously offered.

### 2N696 and 2N697 SILICON TRANSISTORS

Symbol	Specification	Rating	Characteristics	Test Conditions
$V_{CE}$	Collector to Emitter voltage (25° C.)	40v		
$P_C$	Total dissipation Case temp. 25° C. Case temp. 100° C.	2 watts 1 watt		
$h_{FE}$	D.C. current gain		2N696 — 15 to 30 2N697 — 30 min.	$I_C = 150\text{ma}$ $V_C = 10\text{v}$
$R_{CS}$	Collector saturation resistance		6 n typical, 10 n max.	$I_C = 150\text{ma}$ $I_B = 15\text{ma}$

For full information and specifications,  
write Dept. B-10



844 CHARLESTON ROAD • PALO ALTO, CALIFORNIA

The unretouched scope face below shows the time comparison of input (positive) and output (negative) pulses in a non-saturating mode. Time base is 20m $\mu$ sec. per large division on the scope face. Maximum collector current is 50 ma.



## BEHIND THE NEWS

### Printed Circuits Made

Cathode metal sputtering may be useful in producing precision circuits. Research at Bell Telephone Laboratories indicates that entire circuits, including resistors, capacitors, and leads, may be laid down by this technique.

In cathode sputtering, an effect noted a century ago, a plate of the metal to be deposited is used as a cathode. The substrate on which the film is to be deposited is placed on a table close to the cathode. After evacuation, argon or other suitable gas is introduced and maintained at a pressure of approximately 20 to 40 microns.

When a voltage is applied, ionized atoms of the gas bombard the cathode, dislodging metal atoms or clusters of atoms, which then deposit on the substrate.

Bell has produced thin films of a number of high melting point metals. Tantalum and titanium, for example, melting at 3000 C and 1670 C respectively, can be laid down in films which show sufficiently high resistivity to be useful as resistors in printed circuits. With proper masking of the substrate, lines and patterns of practically any desired shape and size can be formed, ranging in widths down to a few mils. These sputtered films generally are between a few hundred and a few thousand angstroms thick.

Some alloys such as those of nickel-copper and nickel-chromium can also be sputtered without difficulty. They appear to retain their approximate original composition.

Printed capacitors have been produced by a combination of sputtering and chemical methods. A tantalum film of the proper shape and

## NEWS BRIEFS . . .

. . . **ROCKET TO THE SUN** with an assist from the moon suggested by GE satellite engineer. R. P. Haviland says that this "stepping-stone" trip would be made possible by the "crack-the-whip" effect of centrifugal force generated by the moon in its orbit around earth. Under the present state-of-the-art, according to Haviland, 50-lb probes could be sent as far as the planet Mercury using five-stage vehicles with 250,000-lb take-off weights.

## By Metal Sputtering



Experimental sputtering apparatus which laid down resistor film under inspection.

size is first sputtered onto the substrate and then anodically oxidized to form a tantalum oxide dielectric film. The counter electrode, a film of gold, can then be evaporated onto a dielectric to form the completed capacitor "sandwich."

Copper leads can be sputtered without difficulty to connect the various components. The technique is attractive since it eliminates the need of any organic adhesives.

In "reactive sputtering," films of inorganic compounds are formed by introducing a small controlled amount of a reactive gas such as oxygen, nitrogen or hydrogen sulfide into the apparatus. Compounds which can be formed in this way include the oxides, nitrides, and sulfides of a number of metals.

... **TWENTY MILLION DOLLARS** awarded to Northrop Aircraft by Air Force for construction of Snark, intercontinental guided missile. Total contract may total \$70,000,000. Nortronics, division of Northrop, also announced development of miniature electronic refrigerator capable of inducing 50 degree temperature drop in thermally sensitive electronic components. Device uses Peltier effect. Navy is presently evaluating it. Unit measures 1/4 in. square x 1 1/4 in. long.

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2. Model TSA Direct Reading Spectrum Analyzer
3. Model B Code Modulated Multiple Pulse Microwave Signal Generator
4. Model MSG-34 Ultra Broadband Microwave Signal Generator
5. Model ESG Microwave Sweep Generator

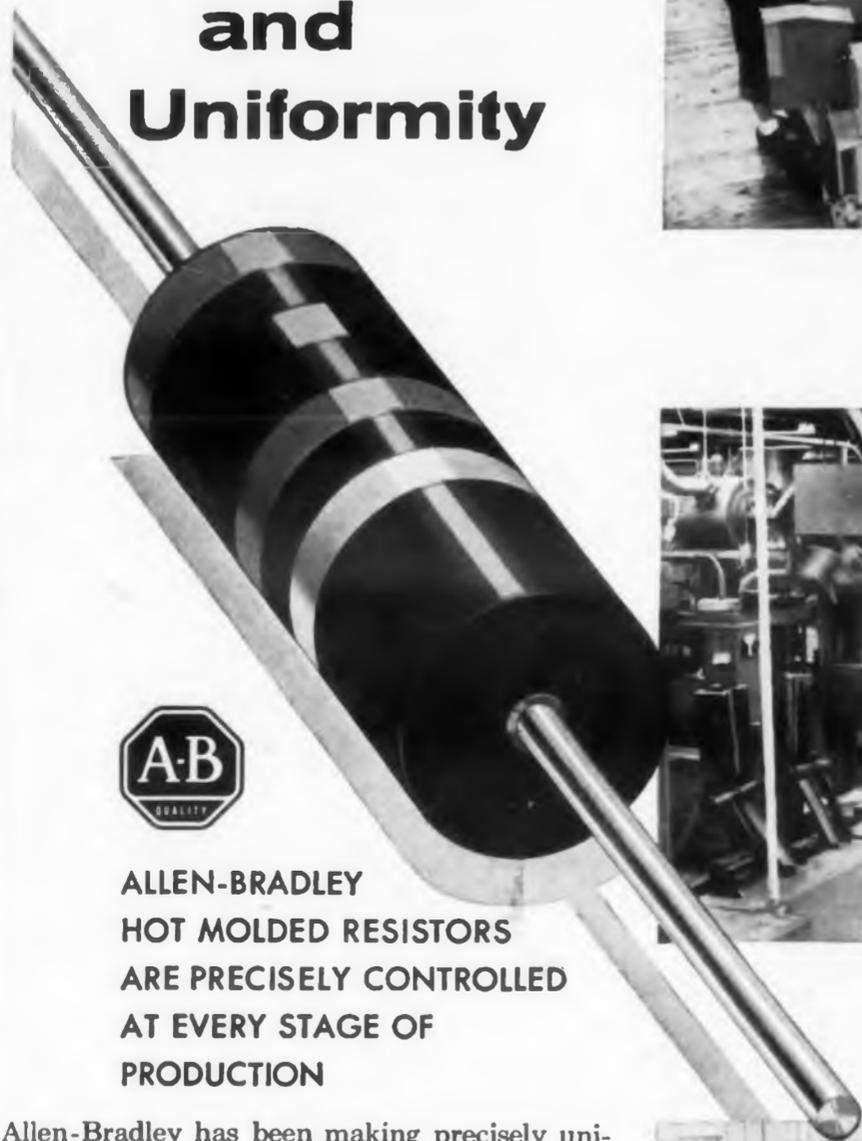
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ARE PRECISELY CONTROLLED  
AT EVERY STAGE OF  
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## WASHINGTON REPORT



Herbert H. Rosen

### Canada to Integrate Bomarc-SAGE System

Boeing Aircraft's Bomarc missile and Western Electric's SAGE are scheduled to assume a major role in Canadian defense as the Royal Canadian Air Force gradually phases out fighter interceptors. While this move brings more business to Boeing and the SAGE manufacturing team, it means RCA, Minneapolis-Honeywell, Canadian Westinghouse and others involved in the CF 105 ARROW fighter program must look elsewhere for business.

Canadian Prime Minister John D. Diefenbaker's announcement of the change in September caught many in Washington unawares. In his statement he cast doubt on the need for supersonic interceptor aircraft beyond the 1960's. Instead, Canada will introduce missiles into the air defense system.

Diefenbaker disclosed that "negotiations are underway with the United States to work out arrangements for obtaining BOMARC guided missiles and the necessary equipment for maintenance, testing, and launching them. Discussion will also be held on the best way for Canadian industry to work in the production programs related to such missiles and associated equipment."

(Canada has for several years been trying to build up its aircraft and electronics industries. However, the strong core of these industries is made up of subsidiaries of U. S. firms.)

### Want Radar Improved

Diefenbaker continued, "The government has also approved the extension and strengthening of the PINE TREE radar control system which was constructed and is being operated jointly by the United States and Canada. Several additional large radar stations will be constructed . . .

"In order that the PINE TREE radar system will be able to deal more effectively with the increased speed and number of aircraft to be controlled by the introduction of the BOMARC guided missiles, the Canadian government has decided to install SAGE electronic control and computer equipment in the Canadian Air Defense system. This will be integrated as part of

the North American Sage System under NORAD."

By this act, the speed at which SAGE systems can be installed is increased. Moreover, an IBM official told ELECTRONIC DESIGN that the Canadian Sage system will incorporate the very latest techniques. The two installations in the U. S., however, represent 1952 technology. Later sites, fortunately, will be updated.

Very likely the last Canadian fighter aircraft will be the CF 105 ARROW. It is an extremely long-range craft incorporating very special electronic equipment. The system, ASTRA, was developed and was to be manufactured by RCA. Douglas and Canadair were to supply Sparrow missiles for the fighter. All of these contracts have been cancelled—including those of the major subcontractors. In fact, only the engine and airframe development contracts for the CF 105 remain.

#### To Use Hughes System

In an effort to save money, negotiations are now underway with Hughes for its "stock" MB-1 control system. This electronic flight system is now part of the U. S. F-106. The Douglas Genie free flight rocket will replace the Sparrow missile.

The Genie costs about \$7000. When fitted with a nuclear war head, the price jumps up to \$250,000 per rocket.

Unfortunately, the range characteristics of the Hughes system coupled with Genie will force the RCAF to modify the long-range mission originally set for the CF 105 interceptor.

Canada appears to be risking little by adopting Bomarc-SAGE. Besides the insurance of our own Tactical Air Forces, recent tests have shown the 200 mile plus Bomarc to be a very effective weapon.

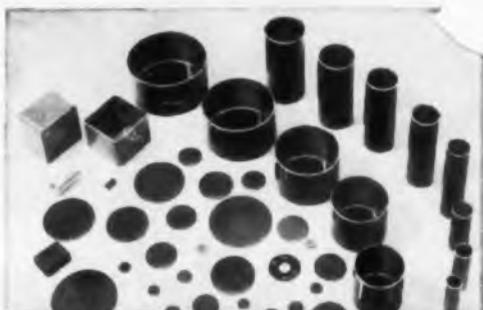
The latest Bomarc success featured guidance from the SAGE center in Kingston, N. Y. with launching from Cape Canaveral, Fla.

#### More Missile Successes

Meanwhile, other missiles are making the news. Firings of Polaris components are occurring more frequently, although a flight of the complete missile is some time off. Recently, the Interstate Electronics Corp. received nearly \$3 million in contracts for construction of "data gathering electronic instrumentation" for installation aboard the Polaris submarine.

Western Electric also was given a hefty \$135 million contract to continue work on the Nike Zeus system. About \$21 million is earmarked for the R & D, while the remainder is primarily for procurement of experimental supporting equipment and missiles.

## THESE



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**EPOXY SHEET**— Molded epoxy sheets in a variety of thicknesses. When heated to 125°F this material can be formed and cut. Ideal for prototype packaging and short runs.



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*will solve any component encapsulation problem!*

Shells, sheeting, powder, pellets, liquid—EPOXY PRODUCTS can provide the right form of epoxy to solve your component encapsulation problem. Using these 5 basic forms (the widest line available today) we custom-build an epoxy unit that is just the right size, shape and quality for your component.

Once the right encapsulating unit is developed, it can be produced in quantity immediately and placed on your production line. In short, no matter what type of component you are encapsulating, no matter what your facilities are now, there is an epoxy form and method just for you—from EPOXY PRODUCTS! Write today for complete technical data and literature.

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RELAYS  LONG BRANCH, N. J.

CIRCLE 12 ON READER-SERVICE CARD



## LETTERS

### Cut Life With Care

Dear Sir:

Mr. G. R. Carl and R. A. O'Connor's article on Airborne Electronic Transformers was enlightening. However, derating life expectancy in order to achieve small size has not, in our opinion, proven too rewarding.

If maximum temperature rise, regulation, and all other factors are specified, one thing we gain by cutting life expectancy is the utilization of lower temperature insulating materials. This can provide two savings. One, lower temperature materials are cheaper in cost, and second, some lower temperature materials are less bulky than the higher temperature ones. However, cost saving is negligible as long as we do not hit the Teflon category. The proper use of the polyester series of insulations produces a transformer which will last for 10,000 hours at 190°C, 2500 hours at 205°C, and 500 hours at 225°C. The savings in cost between these polyester materials and the paper and enamel series of compounds (105°C maximum temperature) is usually not worth the life expectancy derating. The saving in space due to the bulky materials is of course completely absent as the polyester family is extremely efficient size-wise.

The only other saving comes from allowable corona limits. Because of the paucity of accurate life vs. corona data on polyester materials, it is suggested that either the absence of corona or life under 500 hours be designated. We do not believe that a little bit of corona can be tolerated for long life expectancy. It, of course, should be realized that only a small percentage of transformers work at a high enough voltage to gain anything by purposeful inclusion of corona in order to cut down insulation.

To summarize, cutting life expectancy only pays if (a) the maximum life expectancy is 500 hours or less, (b) maximum hot spot temperature is over 200°C, (c) voltage stresses are over 2000 volts, (d) the unit is an appreciable size, 1 cubic inch or larger and probably using the higher power frequencies (400 cycles and higher so as to allow the inclusion of higher core losses).

Howard Buschman, Pres.  
Bush Transformer Corp.  
Endicott, N.Y.

## More on Short-Cut Drafting

Dear Sir:

This letter is in reply to a letter recently published in your magazine on the subject: "The False Economy of Short-Cut Drafting." I would like to take the opportunity at this time to add further discussion concerning my impression of the "false" in "The False Economy of Short-Cut Drafting."

Much has been written and said, pro and con, regarding short-cut drafting. Any one person's definition of it would be prompted by what he has been exposed to in the way of drafting systems. A definition which would suit all is this: "A means of communication wherein the information to be communicated should be as brief and clear as possible, but complete (only to the degree that completeness of assembled information is necessary to promote efficiency in all subsequent phases of use) and decipherable to anyone familiar with reading drawings."

There is hardly a company existing which does not design and make drawings for equipment which it will have outside vendors manufacture. Therefore, if a company adopts heterodox short-cut methods which cannot be easily deciphered and decoded by the average craftsman who must translate from drawing to physical reality, then much is lost in man hours. Time is lost first in the deciphering and decoding of the hieroglyphics on the drawing, and secondly in remaking pieces which are wrong because of ambiguity so often present in the simplified approach. . . .

How efficient short cut methods can transmit information depends upon how successfully standardization of simplified approaches can be imposed upon industry as a whole, and upon the judicious use of these methods to preclude ambiguity, but include clarity and brevity.

William R. Golz  
RS Electronics Corp.  
Palo Alto, Calif.

## Open Letter

To the Editor and Your Readers

You have attended many Conferences. You have listened to speeches at luncheons and dinners. You have been entertained by people who had something to sell you. You have listened or dozed while papers were read by men, inexperienced in public speaking.

You have been bored stiff. You have wondered what it was all about.

You have wondered if you could honestly justify the money your Company spent in sending you to the Conference.

# Miniature plug-in Relay for printed circuits

...millions  
of operations  
without attention!

Need a dependable relay for direct insertion into printed circuits? Automatic Electric's new Printed-Circuit Relays run up to 120 million operations without a single readjustment or relubrication!

Miniaturized without sacrifice of ruggedness, these SQPC Relays, with reinforced mounting, deliver reliable performance under extreme conditions—dependable contact operation at up to 10.5 G's, 25 G's shock, and temperatures from  $-55^{\circ}$  to  $+85^{\circ}$ C.

SQPC Miniature Printed-Circuit Relays are available with many different contact spring arrangements—can be permanently secured with any acceptable soldering technique.

Save parts, assembly and wiring time by using printed circuits—and Automatic Electric SQPC Relays. For full details, write or call: Automatic Electric Sales Corp., Northlake, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. Offices in principal cities.



RELAY SPRING TAKING ITS "PHYSICAL." A technician explores critical spring areas for tool marks and concealed defects—calibrating radii to .001 inch—checking for the strength and stamina which will assure long, uniform service life. Automatic Electric quality control is unmatched in the industry—a compelling reason why you should specify AE in your engineering.

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CIRCLE 13 ON READER-SERVICE CARD

# New

FROM **ITT Components Division**

## TANTALUM capacitors

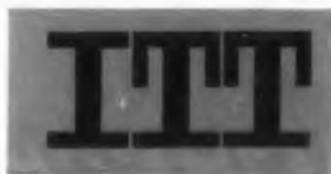
Complete line of miniature tantalum capacitors for industrial and military applications.

Only ITT offers you these outstanding advantages.

- **Superior Product — Competitively Priced**  
Backed by world-wide engineering, research and manufacturing experience.
- **Widest Ranges of Product Type**  
Wet Anode, Solid Anode, Foil Type Tantalum and Miniature Aluminum Dry Electrolytic Capacitors.
- **Long Shelf Life — High Operating Reliability**  
Protect your investment and reputation.
- **Availability**  
Network of warehouse and stocking distributors assure dependable delivery.
- **Design Features**
  - Hermetically Sealed • Small, lightweight
  - withstands high shock and vibration
  - electrical stability • complete uniformity •
- **Temperature Ranges**

wet anode:	-55° C to +125° C
solid anode:	-80° C to +85° C
foil type:	-40° C to +85° C
miniature aluminum:	-40° C to +85° C

Write today for complete technical information.

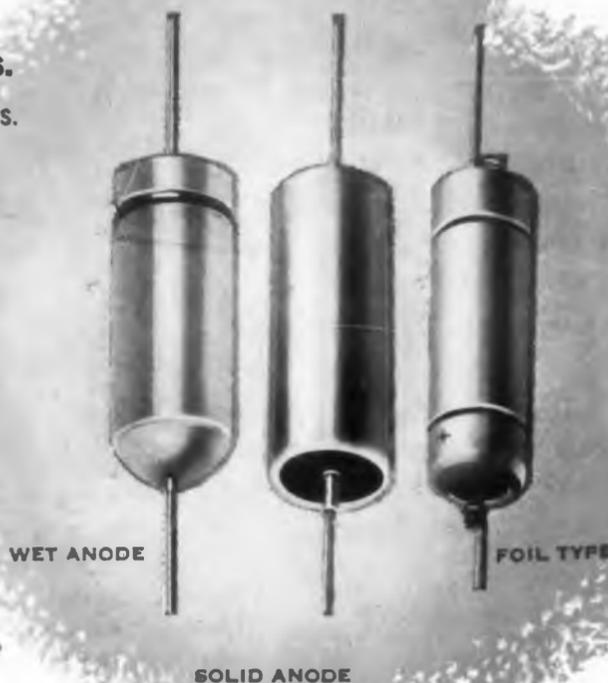


**Components Division**

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

P. O. BOX 412 CLIFTON, NEW JERSEY

CIRCLE 14 ON READER-SERVICE CARD



## LETTERS

When you got back home, you had to write a report to justify the time and money you spent. You had to scratch your head and maybe make believe, that you really brought something back of value to your Company.

The third E.I.A. Conference on Reliable Electrical Connections, Dec. 2, 3, and 4, 1958, Dallas, Texas is going to be conducted on a different basis.

The usual authors of papers will be there, but you will not have to listen to them read their papers. They will be published and offered for sale October 15.

You can read the papers before the conference takes place. You can prepare questions, which you can ask of the authors.

You may also ask questions of other men who are specialists in the field in which you are interested. You will be able to pursue a subject to its bitter end in order to get the facts.

You will not be distracted by exhibits. You will not be solicited by men who want to sell you something. You will not be entertained except as you entertain yourself. There will be no planned lunches or dinners.

You can devote your entire time to getting answers to your questions and to personally meet the men you want to meet.

You can contribute to their knowledge and they can contribute to yours.

Every known type of electrical connection, both internal and external, will be discussed. All the materials and all the processes which go to make up an electrical connection and protect it, will be discussed.

There will be no holds barred. You will have an opportunity to acquire the knowledge you honestly seek, provided you are willing to contribute something.

In this case, you can contribute by coming and by asking questions.

Will be looking forward to seeing you in Dallas.

R. George Roesch  
General Chairman  
1068 S. Clinton St.  
Syracuse 4, N.Y.

► We can't, as a rule, publish in toto publicity chairman's reasons for attending such and such a conference. But because we are extremely interested in Mr. Roesch's unusual efforts to improve communications between speaker and listeners and all conference attendees in general, we're printing this letter in full. Write Mr. Roesch to get advance conference papers.

# EDITORIAL

## We've A Long Way To Go

If there's one thing that stood out in ELECTRONIC DESIGN's recent survey among users of industrial control equipment, it is this:

**Three types of actuators led all the rest in popularity—solenoid valves, servomotors, and humans. Humans!**

Mind you, this is in the day and age when many of us believe that the completely automatic factory is just around the corner; when our technology has advanced to the point where we can toss balls around the world; when we even consider pitching a few around the moon.

Yet we still need a man to close a valve, open a switch, or shove a lever. Why? For one thing, we simply don't understand enough about some of our processes. Our chemists know what will happen if they mix some ingredients together and let them settle. They know sodium hydroxide and hydrochloric acid will yield salt and water. But they're not quite sure what happens while they're mixing.

Beyond that, the art of control still has a long way to go. There are still lots of things we don't know how to do economically—or how to do at all. For example, we'd like to

- measure moisture in granular materials—in sugar, flour, wheat;
- measure moisture in cloth;
- measure pH under high pressure, high temperature conditions;
- measure liquid level in a closed tank in a radiation environment.

Yes, we can make these measurements in the laboratory. But that's a far cry from measurements on the line—in flow processes.

More processes than not have a man someplace in the control loop. Often, it's because we know of no other way of doing things. Often, it's because we need a man's judgment. Often, it's because it's cheaper to use a man than it is to use a machine. And very often, it's because control equipment may not have the reliability we need.

If you ask control equipment users what they need in their equipment above all else, they'll cry out with one voice—"longer, trouble-free life."

So there's much to be done. We need much more understanding of our basic processes. We need many more sophisticated instruments of control. And we need hardware we can trust a lot more. We've a long way to go.

*George H. Rostky*

## UHF-MICROWAVE TELEMETERING EQUIPMENT

by **CANOGA**

Canoga Corporation has recently developed and is now manufacturing a complete line of transmitting and receiving antennas for communication and telemetering in the 2200 mc region.

The compact blade antenna has been designed for missiles and supersonic aircraft. It is less than 1 inch high, has very low drag, an all metal leading edge, and provides an omni-directional pattern.

The 8 foot diameter horn fed paraboloid weighs only 82 pounds and provides a 4 degree pencil beam for high gain requirements. Polarization is readily changed from horizontal to vertical. The pedestal includes angle scales, a dual speed drive in azimuth and a single speed drive in elevation.

The conical scanner shown below is installed in 6, 8 or 10 foot diameter paraboloids. Optimum reception of telemetering signals even at long range is obtained by automatic tracking with the narrow beam provided. Horizontal, vertical and circular polarization are available.



FOR ADDITIONAL INFORMATION COMPLETE THE COUPON BELOW AND RETURN TO CANOGA.

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Dr. Robert J. Jeffries, president of ISA speaking at Keynote Session.

## MEETING REPORT

# Reliability Accented At Instrument-Automation Conference

**W**HEN an electronic component fails it is the fault of the design engineer nine times out of ten." This observation was made by Kenneth Halvorsen speaking at one of the Data Handling Workshops of the 13th annual Instrument-Automation Conference and Exhibit. The Conference was held in Philadelphia from September 14th through the 19th. It was sponsored by the Instrument Society of America.

### Are Electronics Reliable?

Discussing the topic "Are Electronics Reliable in Control?" Mr. Halvorsen emphasized that reliability is a nebulous term. "Any control system," he said, "that failed every day but didn't blow up the process or plant it monitored could be considered relatively reliable. However, the control system that failed every three years and destroyed every thing it monitored at that time would have to be considered less reliable."

Summarizing, Laurence M. Silva, chairman of the Data Handling Workshop session on electronic reliability, confirmed the findings of ELECTRONIC DESIGN's staff report on Industrial Electronics in this issue. He said:

In considering reliability, the time it takes to

fix a failure must be evaluated along with the interval between failures.

Equipment should be designed for quick location of trouble, and test points should be liberally located in the equipment.

Mechanical failures are just as much a source of trouble as electronic failures in the breakdown of complicated control systems.

Tubes should not be checked regularly. Pulling tubes can lead to socket failure.

Basic, proven circuits should be used. A multiplicity of circuits only confuses troubleshooters.

### How Good Transducers?

At another workshop session it was generally agreed that transducers have come a long way in the past year in meeting the need for accuracy. Manufacturers, though, are still pressed to produce transducers to meet a wide variety of seemingly impossible conditions. In the past, units that operated within a two or three hundred degree range were considered satisfactory. But now there is need for transducers that will function properly from  $-300$  to  $+600$  C. And they have to stand rough and rugged handling too.

What would help the manufacturer a lot, stated one speaker, would be the user examining

his requirements carefully, and determining over just what range his transducer must be accurate. Transducers that are accurate over a wide range are costly and often unnecessary.

### Whither Computers?

Computers are playing an ever increasing role in controlling industrial processes. Not everyone is fully sold on computers, though. Most expenditures for computer control equipment fall in the \$25,000 bracket. Only a few companies want to take a \$250,000 plunge into a computer that will fully control a process.

One reason that everyone is interested in computers today is that computers are relatively new and still a novelty. This partially explains the widespread purchase of small units which are, in effect, data loggers rather than control computers.

There is one basic reason why more companies aren't buying the big, "closed-loop" control systems. It is often very difficult to economically justify controlling an industrial process by computers. Thomas Vickroy, an Instrument Consultant Group Supervisor at Du Pont admitted that computers are getting better every year. But the marginal increase in productivity, he said,

that computers can provide in some processes doesn't warrant their purchase. He illustrated his case by citing a chemical process that might be operating more efficiently if under the control of a computer. But, he explained, if someone came up with a better catalyst for the chemical process, the process might become efficient enough to operate without the aid of a computer.

It was generally agreed though, that if what has to be done in a given process can be rigidly defined, if an equation can be written for it, then a computer can outperform human operators and provide more safety and efficiency.

In the future, the big problem will lie in designing plants for control by computers. Present designs and plans are similar to those of the past. Plants are laid out for control by human beings. New philosophies and new techniques will have to be developed so plants can more easily be controlled by computers. Of course, the first question to be answered is whether computer control is desired or even necessary for a given process.

#### Instrumentation—Big Business

"Instruments are big business," said Thomas R. Jones, president of Daystrom, Inc. "A recent report," he continued, "states that the instrument industry is growing at a rate about five times greater than that of the entire economy." Since the sundial—probably man's first instrument, instruments have developed until they are now the five senses of our industrial giant.

About half a billion dollars worth of equipment was on display at over five hundred exhibits. Units ranged from a butterfly valve that was over a yard in diameter and could handle 42,000 gallons a minute to a transistor.

#### The Future

Kicking off the convention at the keynote session, Dr. Robert J. Jeffries, president of the Instrument Society of America took a look into the future and said that instrumentation would play a vital role in:

- Increasing economic prosperity through increased productivity.
- Developing new products and processes.
- Improving world health through reducing the cost of medical drugs.
- Providing more national security.
- Bettering industrial management through improved data gathering and analysis.

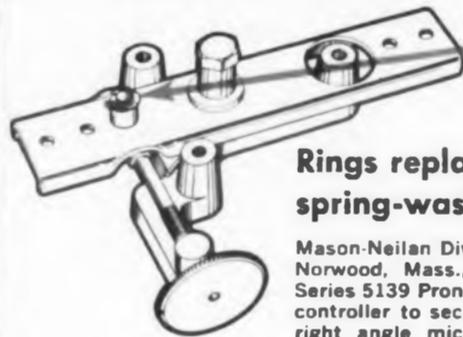
Dr. Gaylord P. Harnwell, president of the University of Pennsylvania and another keynote speaker, urged the instrumentation engineer to aim for simplicity in the design of new equipment.

## Waldes Truarc Prong-Lock Ring Eliminates Springs, Washers, Takes Up End-Play

### WALDES TRUARC SERIES 5139 RETAINING RING\*

application: external for shafts  
range: 3/32" through 7/16"

\*U. S. Pat. No. 2,755,698

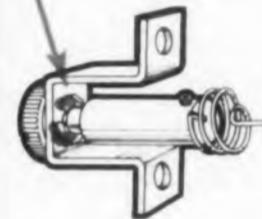


Rings replace cotter pins,  
spring-washers; save \$68<sup>00</sup>/<sub>M</sub>

Mason-Neilan Division of Worthington Corp., Norwood, Mass., uses two Waldes Truarc Series 5139 Prong-Lock rings on its pressure controller to secure pivots through which a right angle micrometer adjustment screw passes. Each ring replaces hairpin-type cotter pin and bowed washer. provides necessary tension to prevent adjustment screw from shifting. Manufacturing costs were reduced by \$68 per 1,000 units.

After radial application, the Waldes Truarc Prong-Lock retaining ring locks and holds securely in its groove by means of two prongs. Because of its resistance to radial displacement, the ring may be used as a shoulder for rotating parts. Thrust-load capacity ranges from 80 to 700 lbs. for sizes from 3/32" to 7/16". Bowed construction provides end-play take-up, often eliminating springs, washers and accessory devices.

### Ring replaces locknut, eases control calibration



On a differential pressure control mechanism, Taylor Instrument Companies, Rochester, N. Y., replaced a locknut and eliminated a costly threading operation with a series 5139 Prong-Lock ring. Also eliminated is the loosening and tightening of the locknut before and after each calibration setting. Spring action of the ring securely holds the calibration setting.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get:

**Statistically Controlled Quality** from engineering and raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

**Complete Selection:** 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available

quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

**Field Engineering Service:** More than 30 engineering-minded factory representatives and 700 field men are at your call.

**Design and Engineering Service** not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.



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**TRUARC**<sup>®</sup>  
**RETAINING RINGS**

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Consult the Yellow Pages of your Telephone Directory for name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

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Waldes Kohinoor, Inc., Long Island City 1, N. Y.

Please send me additional information and engineering data for the Truarc Prong-Lock Ring, Series 5139.

Name \_\_\_\_\_

Title \_\_\_\_\_

Company \_\_\_\_\_

Business Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

ED-100

©1958 Waldes Kohinoor, Inc.

## Magnetic Amplifiers for Process Control

**Horace E. Darling**  
Foxboro Company  
Foxboro, Mass.

Here is a guide to the most useful magnetic amplifiers for industrial electronic applications. Some of the circuits tabulated here, were revealed only recently for the first time.

On the following page there is a discussion of these amplifiers, and a presentation of the four basic cores in general use—their advantages, their disadvantages, and their problems.



Horace Darling has spent 14 years in research and development, mostly on solid state devices for industrial control. The last 5 years have seen an accent on magnetic amplifiers. During this time, he developed a variety of new types, particularly for operation from extremely small power input.

Amplifier Type	Schematic	Transfer Curve	Reliability
<b>Saturable Reactor</b>			Least complex of all magnetic amplifiers. Potentially most reliable.
<b>SR with Feedback</b>			Reliability of rectifiers in bridge must be considered.
<b>Self-Saturating Reactor</b>			Only slightly more complex than SR. Potentially very reliable. Reliability related to rectifiers used.
<b>Bistable SSR</b>			Basically simple. A very reliable relay; no moving contacts; hence, indefinite life. With proper design, bias system normally used to adjust latching point does not detract appreciably from reliability.
<b>Fast Response SSR</b>			Reliability and life (determined largely by rectifiers in control circuit), comparable to any SSR.
<b>Second Harmonic Magnetor</b>			Circuitry simple. Reliability very high.
<b>Balanced SSR</b>			No rectifiers in bias circuit. Reliability comparable to any SR but probably not as great as magnetor.

# ers for Industrial Electronics

	Power Output	Stage Gain	Response Time	Sensitivity	Notes
ag- all	Milliwatts to kilowatts.	Power gain to 40 db. Current gain 10 to 30.	4 cycles or more. Varies with current gain and supply frequency. Cannot reproduce a step input.	Not suitable below $10^{-6}$ watts.	Output is distorted alternating current. Four-unit bridge rectifier required for dc output, decreasing reliability. Output level varies directly with supply voltage. Does not recognize control signal polarity. Rarely used except where high current and power levels make rectifiers impractical, impossible, or undesirable.
in	Milliwatts to kilowatts.	With positive feedback, more current and power gain than SR. Less with negative feedback. Power gain to 50 db. Current gain 100-200.	Response time greater than SR. Increases directly with current gain. Decreases with negative feedback.	To $10^{-7}$ or $10^{-8}$ watts, but only with positive feedback, and at cost of long time constant.	Rectifier bridge required for feedback. Output can be ac or dc. Becomes more polarity sensitive as feedback is increased. Otherwise similar to SR.
plex reli- rec-	Limited only by current rating of available rectifiers—to kilowatts.	Power gain to 60 db at low power output; to 40 db at high power output. Current gain to 5000 at low power output; to 100 at high power output.	4 cycles or more. Increases with current gain.	To $10^{-8}$ amps and $10^{-12}$ watts. Low levels demand matched cores and rectifiers.	One of the most popular types. Good recognition of control current polarity. Easy to control reaction on control circuit or driving stage. If bias supply is derived from power mains, at least two additional rectifiers required.
y re- con- life. sys- adjust tract y.	To kilowatts.	Power gain to 40 db. Current gain 10-100. Depends on latching interval.	10 cycles or more.	High current sensitivity possible. Input power to $10^{-6}$ watts.	Limited to bistable use. Pulsating dc output often requires filter. Operation possible from many control signals.
eter- rs in le to	Fractions of a watt to kilowatts.	Power gain to 50 db. Voltage gain equals ratio of control to gate turns.	1 cycle.	Not suited for low voltage or low current control circuits because of interaction. Input power to $10^{-6}$ watts under favorable conditions.	Input can be dc or ac for either dc or ac output. Control can be ac or dc voltage, resistance, or reactance. Low impedance source required for ac or dc control. Control current is from power source, not control source, so interaction always is present. Matched cores recommended.
ability	Microwatts.	Voltage gain (frequency sensitive) 100 or more (with tuned circuit and high impedance load.) Power gain 20-30 db.	Usually much greater than 10 cycles.	To $10^{-9}$ amps, $10^{-14}$ watts or noise level of cores. Core design and matching critical for low level work.	Acts as static chopper and one stage amplifier. Adaptable to any audio supply frequency. With feedback, input impedance can be megohms. Most effective as voltage converter working into high impedance load. Works well with tubes or transistors. Difficult to drive other magnetic amplifiers. Output has double the supply frequency. Ideal for thermocouples or low impedance emf devices. Very low level work requires magnetic shielding against earth's field or stray fields. Altered physically, it can serve as flux detector or magnetometer.
circuit. any eat as	Microwatts to milliwatts.	Current gain to 2000. Power gain to 50 db.	4 cycles or more. Increases with current gain.	To $10^{-9}$ amps or less, $10^{-12}$ watts or noise level of cores. Core design and components critical for low levels.	Controlled by dc signal, or ac signal at supply or twice supply frequency. Rectifier pairs must be matched for forward conduction and temperature changes. (Only silicon junction rectifiers). Matched pairing required for load resistors and filter capacitors. Choke isolating impedance required for high current and power gain. Its time constant usually major factor in stage time constant. Low level work demands magnetic shielding against stray fields and electrostatic shielding against ac pickup.

## Magnetic Amplifiers for Process Control continued

OF ALL THE magnetic amplifier types, those described in the table on the previous page are the most useful building blocks for control systems. Each is treated as a single stage unit. As such, its properties are quite well understood, and performance can be predicted with good accuracy.

But when stages are cascaded, they interact, and predictions are no longer easy. One often has to rely on instinct and experiment to solve interaction problems. Nevertheless, cascading of as many as four stages is now a practical reality. Happily, this is adequate for all control problems encountered to date.

### Cascaded Magnetic Amplifiers

As the number of stages increases, expected reliability goes down rapidly. One has to build the maximum reliability into each component.

Years of work has shown that when the utmost in reliability is designed into each stage, a three or four stage amplifier can have virtually the same life expectancy as a single stage unit—ten years being very probable. Much of this performance and reliability can be attributed to the superior qualities of the silicon junction rectifier.

### Cores

The heart of the magnetic amplifier is its core. It should be carefully selected for each individual application. There are four core types in general use, each with its advantages and disadvantages.

#### E-I Cores

Unsuited for low input power levels. For levels above one watt, core assembly is rugged, moderately reliable, and inexpensive, but rather bulky, and sensitive to external fields.

Rarely used in instrumentation work, except for power transformers and chokes.

Core assemblies always have a temperature sensitive residual air gap. Poor square hysteresis loop results, along with low to moderate current gain per stage (10 to 30). Obtainable in many different alloys, but shape prevents effective use of grain orientation.

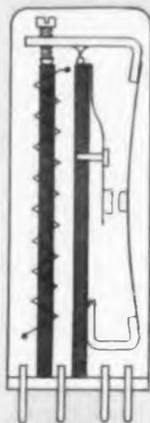
Production techniques assure uniformity of magnetic characteristics. Core matching is difficult. Mass production winding techniques are adaptable, and provide maximum potential reliability of windings.

Square loop properties are degraded by eddy current insulation, mechanical strains of assembly, impregnation, and mounting.

THOMAS A.

# EDISON'S

## model 250 miniature time delay relays are shock and vibration resistant



As heater causes the expansion member to stretch, lever pivots on its hinge, compressing the bow spring at a high rate in the direction of contact closure. Matching expansion member compensates for external changes in temperature between  $-65$  and  $+100^{\circ}\text{C}$ .

Designed to meet military requirements, Edison's line of miniature time delay relays are available for a wide range of electronic applications.

The 250 Series Time Delay Relays combine in one unit superior design, top workmanship and performance at lowest cost. Check these advantages:

- Designed to withstand vibration frequencies to 500 CPS.
- Exceptionally high rate of contact closure.
- Permanent calibration and hermetic seal.
- Extremely rigid mechanical structure using high-strength, high-expansion alloys.

For bulletin #3046 showing timing ranges and operating performance write to:

**Thomas A. Edison Industries**  
INSTRUMENT DIVISION

LAKESIDE AVENUE, WEST ORANGE, N. J.

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### DU Cores

Useful to microwatt input levels, with current gains of 100 per stage, and power gains of 40 db.

Core assemblies have much lower effective air gap than equivalent E-I cores, so they are less temperature sensitive, and have a more nearly square hysteresis loop. They make better use of grain orientation and they approximate toroid properties.

Production techniques assure uniformity of magnetic characteristics. Core matching is difficult. Mass production techniques apply.

As with E-I cores, insulation and mechanical strains of assembly, impregnation, and mounting detract from square loop properties. For best results, great care is needed during assembly. Core is rugged, reliable, and inexpensive, but bulky, and sensitive to external fields.

### Tape Wound Cores

Useful to input levels of  $10^{-8}$  watts or less (limited by noise level of cores). Current gains to 1000 per stage. Power gains to 50 db.

Core assemblies have the ultimate in grain orientation, squarest hysteresis loop, and a very small effective air gap.

Production techniques assure highest possible uniformity. Core matching to close tolerances is standard procedure.

Special winding required. Assembly is compact, and relatively immune to external fields.

Cores, if properly packaged in metal boxes, liquid or grease filled, hermetically sealed, and encapsulated, are insensitive to shock and acceleration, mounting strains, corrosion and temperature effects. Very rugged and reliable. No mounting problem.

### Stamped Ring Cores

Useful to  $10^{-14}$  watts. Noise level can be less, depending on material. Current gains to 5000 per stage. Power gains to 60 db.

Core assemblies have no air gap. They use grain orientation effectively, and have moderately square hysteresis loops.

Production techniques yield high uniformity. Balanced core pairs easily obtained. Differential temperature effects very small. Most stable cores known.

Special winding techniques required. Assembly is compact, and relatively immune to external fields.

Cores must be mounted in metal boxes, liquid filled or, with paper separators between lams, hermetically sealed, and encapsulated. Most nearly strain free assembly of any core. Immune to shock, acceleration, corrosion, and mounting strains. Very stable with temperature.

For reprint, circle 103 on Reader-Service card.

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To secure optimum performance and reliability in your duplexer system you now have a choice of five basic techniques.

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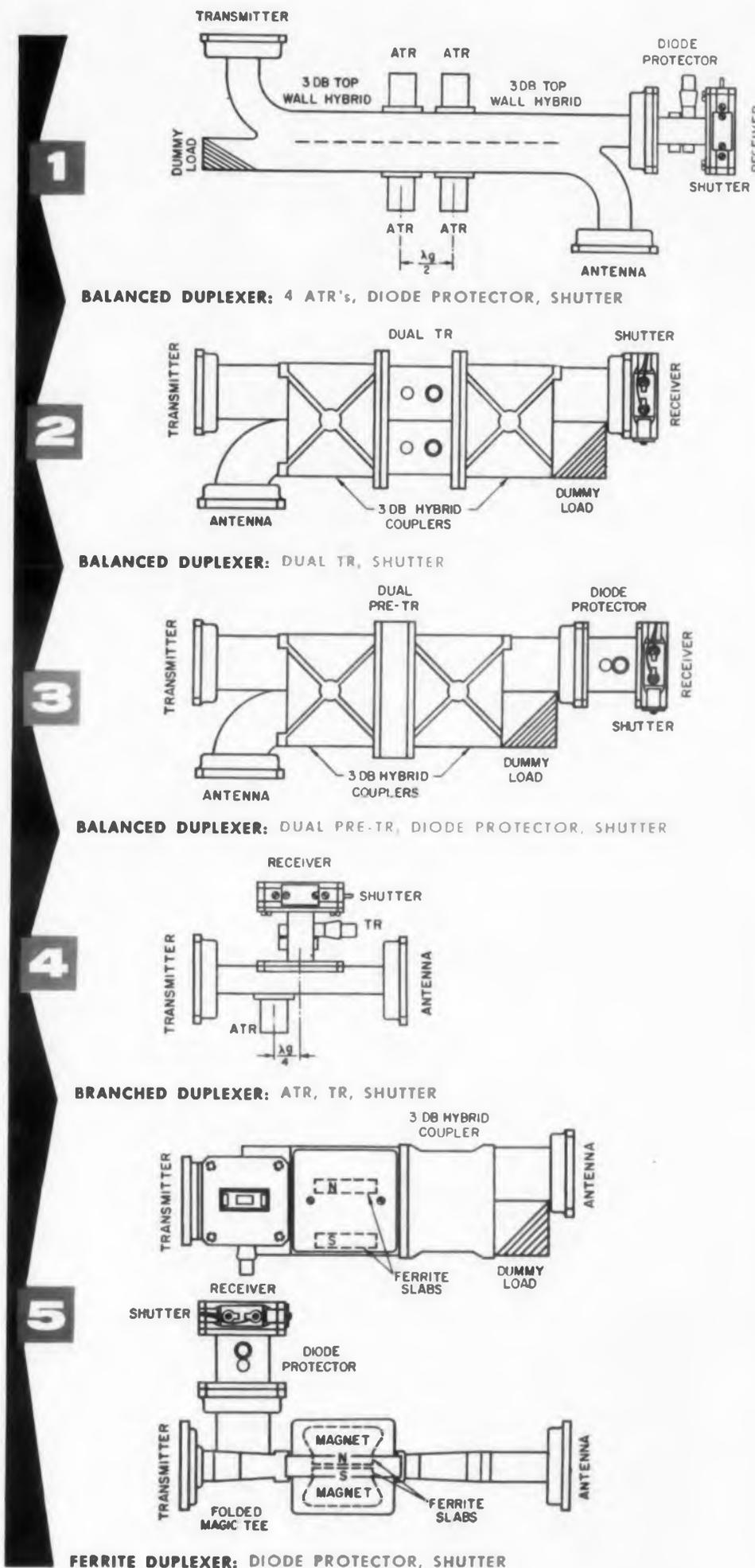
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do you need  
OUR NEW  
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DUPLER?**

*Write or call...*



**MICROWAVE ASSOCIATES, INC.**

BURLINGTON, MASSACHUSETTS TELEPHONE BROWNING 2-3000  
CIRCLE 18 ON READER-SERVICE CARD



**Fig. 1.** The price of small components is negligible in comparison with the cost of developing the controls for a giant miller like this one. This electronic tracer-controlled profile miller has all but eliminated hand finishing on B-52 wing spars. Total production time for wing ribs for a single B-52 part has been knocked down from 200 hours to 8.



## Designing for Industrial Electronic Equipment Reliability

**W. H. Lesser**

Specialty Control Department  
General Electric Co.  
Waynesboro, Va.



Bill Lesser has spent most of his ten years with the General Electric Company in the fields of quality control and reliability engineering.

"Reliability," he comments, "goes hand in hand with the design objectives of product leadership and customer acceptance at optimum cost. Dependable equipment performance has always been the ticket to long range customer acceptance."

In this article, Mr. Lesser shows how, with a division of responsibility, all parts of an organization can contribute to reliable equipment performance. This approach has been tested and found to work admirably.

**I**N CONTRAST with military reliability, determined by combat conditions, industrial equipment reliability is determined in the economic balance with performance and price. Only the proper relative weights of these ingredients can assure customer acceptance and adequate profit margin.

Planned reliability must include the following activities:

- Establishing overall reliability specifications early in product life in terms of per cent down time, expected product life, or average time between service calls. Equipment performance requirements must be anticipated, often before the customer knows his own requirements. A sound market analysis, followed by calculated business risks early in product life, often save valuable months of development. They can result in a valuable "market first."
- Allocating a proportionate share of overall reliability to each assembly, subassembly, and component. Thus one quickly discovers weak links in the reliability chain. This, in turn, directs development effort to the area most needing attention.
- Selecting component parts for adequate reliability. One must use performance tests, field results, and derating curves to appraise components.
- Monitoring decision making procedures that can change or degrade a reliable design.
- Assuring information from field service organization.

Table 1 shows some basic reliability functions of different departments in a typical organization. Notice that each department must contribute to product reliability. Feedback of information is essential for successful performance. Obviously such a decentralized program needs the full support of top management. Reliability objectives must be emphasized, together with the more talked about management objectives of cost reduction, inventory control, and profit margin.

### Design Engineering

Faced with the problem of obtaining high equipment reliability and limited by inadequate component performance data, the design engineer must resort to conservative design practice. He prefers component derating to the practice in home radio-TV design of working components at rated loads or higher.

He doesn't depend on random tube characteristics which are not a part of the general tube specification. For example, in a timing circuit which depends on abnormally low grid current for successful operation, reliability is impaired by grid current aging characteristics. Here, it is desirable to design for a charging current considerably larger than the grid current to minimize

the effect of grid current changes on timer performance.

In general, the wise engineer designs a circuit whose performance is not affected by component tolerance buildup or aging.

**Cost.** When conservative design calls for higher currents, the increased cost of components must be weighed against the improvement in reliability.

Often, component cost is negligible, as for example, in the expensive machine tool control shown in Fig. 1. Here, development expense is so high that small components can practically be given away to minimize customer complaints.

This type of industrial equipment is often over-designed at the start to protect against unknown duty cycles. Then, after operating conditions are better known, cost reductions can be made without degrading reliability.

**Standardization.** The value of standardization to reliability, both in components and circuits, must be emphasized. A recent survey by a large electronic equipment manufacturer revealed that 81 types of power supplies were provided on equipment shipped over a five year period. Preliminary review showed that 9 preferred types would have been completely satisfactory.

Duplicated engineering effort can often be

### Table 1. Basic Reliability Functions

#### Sales

1. Establish overall equipment reliability requirements.
2. Sell equipment within capability limits.
3. Constantly evaluate competition's equipment performance.

#### Engineering

1. Allocate required reliability to assemblies, sub-assemblies and components.
2. Evaluate component reliability data.
3. Derate components to assure overall reliability.
4. Integrate component reliability into optimum system reliability in terms of performance—reliability—cost ratios.

#### Quality Control

1. Assure product conformance to established specifications.
2. Control decision making which would degrade design reliability, such as: changing component vendors, changing tooling and manufacturing methods.
3. Report quality assurance test results in terms of corrective action.
4. Feedback recommended improvements to Engineering.

#### Field Service

1. Assure adequate installation of equipment.
2. Assure adequate operating instructions to customer personnel.
3. Adequately report customer complaints.
4. Feedback recommended improvements to Engineering.

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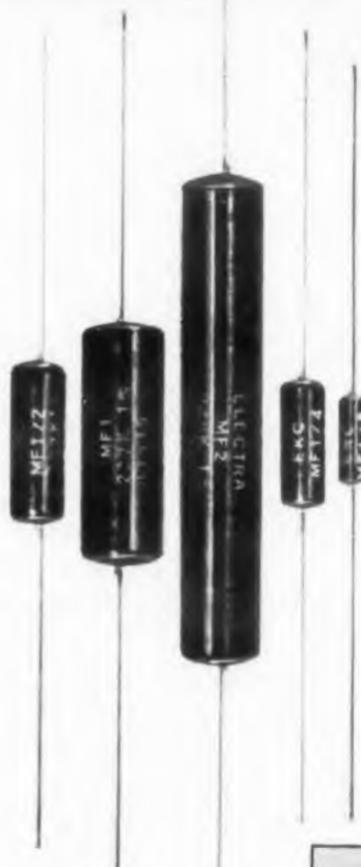
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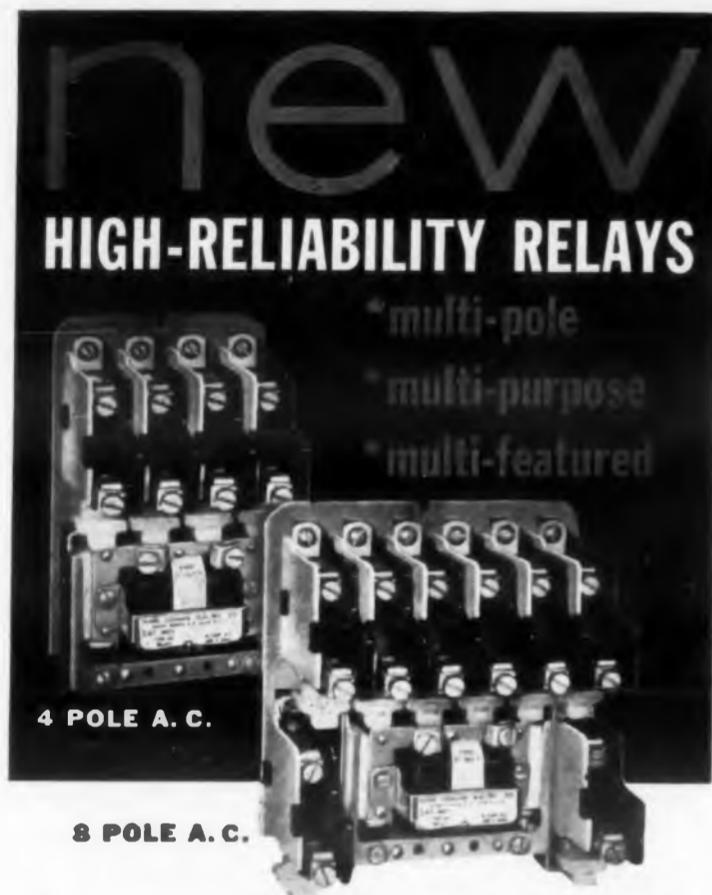
\*Parts Per Million Per Degree Centigrade (100 PPM equals 0.01%)

\*\*The T.C. code marking is combined with the code for the date of manufacture

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**COILS:** A.C. 110, 208-220, 440, or 550 V., 50-60 cps. D.C. for 115 or 230 V. Others on special order.

**POLES:** 2 to 8, in all combinations of N.O. and N.C. Contacts convertible from N.O. to N.C. and vice versa.

**DIMENSIONS:** Maximum, 4 pole—3<sup>3</sup>/<sub>8</sub>"W, 5<sup>3</sup>/<sub>4</sub>"H, 3<sup>3</sup>/<sub>32</sub>"D. 8 pole—5<sup>1</sup>/<sub>8</sub>"W, 5<sup>3</sup>/<sub>4</sub>"H, 3<sup>3</sup>/<sub>32</sub>"D. Mounting centers for all models identical.

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saved by an index and history of proven circuits. This can enable the designer to put more creative effort on new designs. Inexperienced people can be trained more quickly with less risk of design errors reaching the assembly floor.

Standardization, of course, imposes the responsibility of keeping circuits up to date. It also imposes the need to watch the break-even point, where the cost of maintaining standards exceeds the savings realized.

#### Reliability Engineering

This new title has recently found its way into many organization charts. Previously known as component or parts engineering, its function is to evaluate parts for reliable performance and general acceptability. Here also, conservative design by derating can improve reliability. For example:

- Expected operating life of dry electrolytic capacitors can often be doubled by reducing working voltage to 70 per cent of rated value.
- Expected life can double for each 10 deg C drop in ambient temperature within a nominal temperature range.

Such derating prolongs expected life and overcomes unavoidable drift.

One of the difficult problems is to specify the

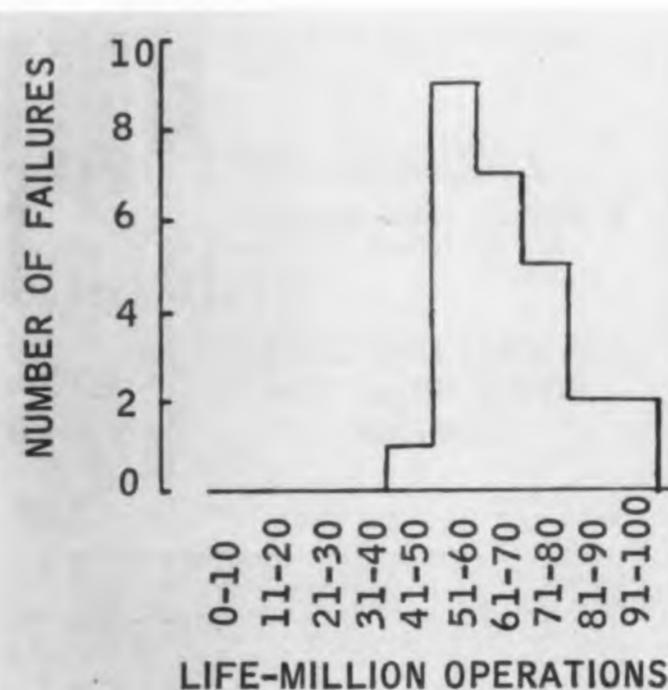


Fig. 2. Load life test results on an industrial type relay.

degree of reliability to expect for a given performance characteristic. This problem quickly becomes statistical. Answers are based on the number of performance tests, or on the amount of field data available.

Fig. 2 shows the results of many load life tests on a small industrial type relay. In this case, nominal life occurs at 50 to 60 million operations, but life can extend out to 100 million operations.

The corresponding reliability curve in Fig. 3 is sometimes called a "survivor curve." Here the reliability at any point in life is equal to the number of survivors at that point divided by the number of units originally placed on test. Such a curve can reveal the magnitude of failures expected over the range of relay operating life. Combined with reliability curves for other components, it can give a rough idea of overall equipment performance.

The reliability engineer can provide information valuable to purchasing agents in vendor selection. This can include:

- Original component qualification and subsequent comparative performance test results.
- Vendor performance rating based on tests to verify component specifications.
- Cost reduction as a result of working closely

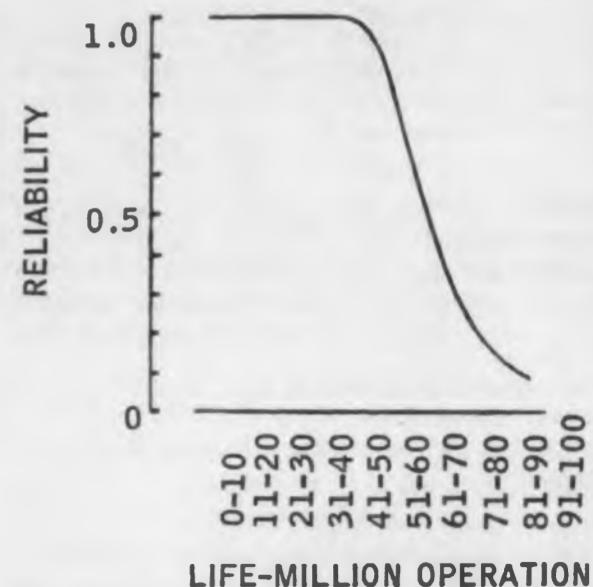


Fig. 3. Reliability curve for expected relay life.

with vendors on application and manufacturing problems.

#### Quality Control

Almost every design engineer has had the experience of striving for the last bit of performance from a design, only to see its reliability fall off due to subsequent degrading. This can be corrected by effective quality control. Established procedures, preferably documented, should control the decision making functions which can change the designed reliability. Look for those conditions where:

- Quick changes are made in component vendors without adequate evaluation of production samples and test results.
- Repairs or replacements are made in high production tools.
- Meters or calibration methods are changed.
- Disposition is made of obsolete and defective production materials.
- Selective assembly of component parts is the accepted practice to "make equipment work."
- Abnormal test conditions may occur, such as aging of test tubes, variations in line voltage, or mishandling of fragile equipment.

Poor control over any of these conditions guarantees reduced product reliability.

Expansion by traditional electronic equipment manufacturers into the computer and machine tool control business requires learning how to deal with new mechanical problems. Methods of precision gaging, hydraulic testing, and accurate assembly methods demand new skills and quality control methods.

#### Field Service

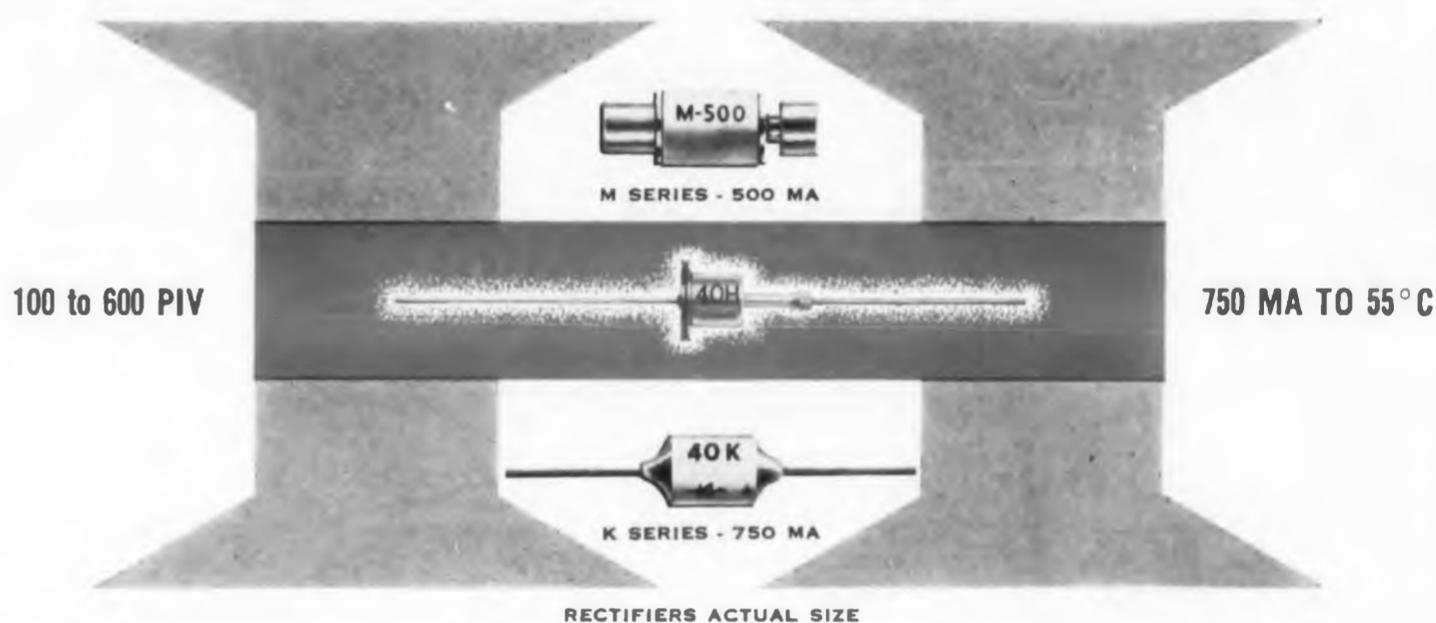
Reliable feedback of field information is vital, not only in making product improvements, but in evaluating the effectiveness of field service. An alert service organization can obtain corrective action to improve product reliability as follows:

- Instruction of customer's repairmen on how to adjust for component variations rather than replace expensive parts.
- Teaching customers how to lengthen tube life by operating filaments continuously.
- Instituting preventive maintenance with due care to avoid unnecessary tube testing.
- Reporting minor and nuisance errors such as faded wire color codes, labels upside down to customer but right side up to factory tester, sliding replacement part trays that fall out, absence of lock washers in vital locations, etc.
- Providing additional control cabinet ventilation.

A successful planned reliability program requires the coordinated effort of each function in an organization to obtain customer acceptance and maintain product reputation.

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30H	300	210	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	30	30	15
40H	400	280	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	30	30	15
50H	500	350	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	03	30	15
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CIRCLE 21 ON READER-SERVICE CARD



# 100 Design Suggestions

**T**HE PURPOSE of the NEL<sup>o</sup> *Reliability Design Handbook* is to increase the reliability of electronic equipment. As a handy check list, it points out the need for techniques having low-failure rates. Most of our readers are already familiar with the 1957 edition. Here are some of the additional design suggestions that has been included in the 1958-59 edition. Request for copies of this booklet should be directed to the Commanding Officer and Director (Code 3560) U. S. Navy Electronics Laboratory, San Diego 52, Calif.

## Cooling Factors

### ■ Natural Cooling Factors:

1. Specific heat-flow paths must be used.
2. Heat-flow paths should be as short as possible.
3. Provide metal heat-flow paths.
4. Arrange hot parts to form a bank of minimum height.
5. If vertical stacking is used, the parts should be staggered.
6. Use heavy metal chassis to conduct heat.

7. Make good heat conducting joints throughout.
8. Isolate temperature-sensitive parts from heat sources.
9. Use polished or unpainted radiation shields to protect sensitive parts less than 2 inches away from hot parts.
10. All parts dissipating more than 1/2 watt should be mounted on a metal chassis.
11. Plastic chassis must have metal heat conductors if its parts dissipate more than 1/2 watt.
12. Heat sources should have high emissivity.
13. Provide metal heat conductors for embedded heat sources.
14. Louvers should be provided.

### ■ Forced-Air Cooling Factors:

1. Direct cool air on hot spots.
2. Cool hot parts with parallel air flow.
3. Do not use "second-hand" air for cooling.
4. Maintain all air-flow paths free and unobstructed.
5. Isolate intake port from exhaust.
6. Provide air passage and ducts of proper size.
7. Blower capacity must be adequate.

<sup>o</sup>Navy Electronic Laboratory

8. Air flow in equipment should be measured and mapped with smoke.
9. Design to utilize induced draft.
10. Provide adequate air filters, accessible for easy cleaning and replacement.
11. Cool blower motors.
12. Protection should be provided if a blower fails.
13. Measure critical temperatures.
14. Minimize air-flow noise.
15. Provide critical power tubes with adequate air flow.
16. Protect fragile fins.
17. Pass air over seals of critical tubes first.

■ Liquid Cooling Factors:

1. Direct liquid cooling:

- a. The coolant must be nonflammable and nontoxic.
- b. The coolant must be chemically neutral to parts.
- c. Provide for coolant expansion.
- d. Design container to withstand expansion pressure.
- e. Hermetically seal the unit.
- f. Provide drain and filler plugs.
- g. Design so that the coolant will not boil under maximum conditions.
- h. Provide coolant maintenance placards.

2. Indirect liquid cooling:

- a. Provide drains at system low points.
- b. Provide bleed valve at the high point.
- c. Use a check valve on each disconnect.
- d. Provide for expansion of coolant.
- e. Design so that coolant will not boil or freeze.
- f. Provide adequate piping.
- g. Select exchangers specifically for the system design.
- h. Design to preclude condensation of moisture in the equipment.
- i. Provide temperature control, if necessary.
- j. Select design wherein air "locks" cannot form.
- k. Provide coolant maintenance placards.
- l. Coolant must be noncorrosive to exchangers and piping.

■ Vaporization Cooling Factors:

1. Check all liquid cooling factors, preceding.
2. Expendable evaporative cooling:
  - a. Provide adequate quantity of coolant.
  - b. Install make-up reservoir if required.
  - c. Vent vapor to the atmosphere.
  - d. Prevent toxic fumes from contacting personnel.
  - e. Provide pressure control valve.

(Continued on following page)

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CIRCLE 23 ON READER-SERVICE CARD

## 100 Design Suggestions

- f. Include a pressure relief valve.
3. Continuous vaporization cooling:
  - a. Test refrigeration system in its ultimate environment.

### Parts Considerations

#### ■ Electron Tubes:

1. Tubes and tube sockets should be free from discoloration.
2. No "glass-sucking" should occur.
3. The design must not allow the anodes to operate at red heat except for tantalum anode transmitting tubes.
4. Space unshielded tubes 1-1/2 diameters apart.
5. Prevent tubes from "seeing" each other.
6. Do not pot tubes in plastic.
7. Measure bulb temperatures.
8. Use thermatrons to investigate critical tube applications.

#### ■ Tube Shields:

1. Use the correct shield.
2. Shields must fit tightly.
3. Shields should provide adequate protection from mechanical damage.
4. Blacken inner surface of shields.
5. Conduct heat to the chassis.
6. Provide low resistance metal joints.
7. The chassis must be able to dissipate the heat.
8. Conduct heat to the chassis.

#### ■ Resistors (The following factors apply to resistors which dissipate more than 1/10 rated power.):

1. Clamp resistors to a heat sink.
2. Use short leads.
3. Mount resistors in free-flowing air.
4. Mount power resistors in groups vertically.
5. A single resistor over 5 inches long should be mounted vertically.
6. Prevent power resistors from radiating heat to sensitive parts.

#### ■ Capacitors (Capacitors are heat sensitive in the following order of decreasing sensitivity: (1) electrolytic; (2) paper-tubular (wax impregnated); (3) phenolic molded paper; (4) oil-filled, sealed, metal clad; (5) ceramic, barium titanate; (6) Teflon; and (7) glass and mica.):

- a. Do not mount heat sensitive capacitors near hot parts.

- b. Use radiation shields.
- c. Capacitors must be free from bulging and leaking.

#### ■ Transformers and Iron-core Inductors:

1. Provide clean, low-resistance thermal joints to heat-conducting chassis.
2. Design magnetic power devices so that the heat is conducted from the windings to the chassis.
3. Clean thermal joints of impregnant and paint.
4. Mount heat-sensitive inductors away from hot parts.
5. Protect i-f and r-f coils from radiated heat.

#### ■ Transistors and Semiconductors (These devices are temperature-sensitive, and thermal designs are critical.):

1. For power transistors, provide low thermal resistance path to heat-conducting chassis.
2. Liquid cool the chassis where feasible.
3. Provide constant temperature environment.
4. Transistors dissipating more than 100 mw should be clamped to a chassis.
5. Design circuitry to prevent performance deterioration with increasing temperature.

#### ■ Semiconductor Power Rectifiers (These devices must be well cooled.):

1. Provide low thermal resistance to cooled chassis.
2. Use rectifiers with large fins.
3. Select cool spot to mount rectifiers.
4. Mount fins vertically.

### Reliability

Failures in electronic equipment have been so numerous and so frequent that tactical operations have been impaired seriously. Failure data have indicated the following approximate mean-time-between-failure (MTBF) rates for existing electron-tube-type equipments. ( $M$  (hours) = mean-time-between-failures, and  $N$  = total number of electron tubes.):

$$\text{For shipboard electronic equipment: } M = \frac{1.4 \times 10^4}{N}$$

$$\text{For airborne electronic equipment: } M = \frac{2.5 \times 10^3}{N}$$

$$\text{For ground electronic equipment: } M = \frac{1.8 \times 10^4}{N}$$

Field studies have indicated that failures are distributed in time in a chance or random manner describable by a Poisson process. In this process, the time intervals between failures are exponentially distributed, and the probability,

$P_o$ , of failure-free operation during time  $t$  is given by the expression:

$$P_o = e^{-t/m} \quad (1)$$

where

$P_o$  = probability of nonfailure,  
 $t$  = time in hours,  
 $m$  = mean-time-between-failure, and  
 $e$  = 2.718 (natural base).

Designers must enhance reliability by every means available. Following are some suggestions: **Simplify circuitry.** Expressed in fashion similar to equation (1), above, the reliability of a multi-part equipment is:

$$P_o = e^{-nt/T} \quad (2)$$

where

$T$  = part mean-time-between-failures, and  
 $n$  = number of parts (a measure of complexity).

Thus, if part life is constant, the fewer the parts, the longer will be the mean-time-between-failure.

**Use safety factors.** Most electronic parts have longer life if the applied stress is reduced below their ratings. If this stress (dissipation in composition resistors is reduced to 60 per cent of rated, the mean-time-between-failures is increased two or three times. The excursions of primary and secondary stress factors must be minimized. These excursions are noted in powerline voltage and frequency, vibration resonance, high-impact shock, humidity, and temperature.

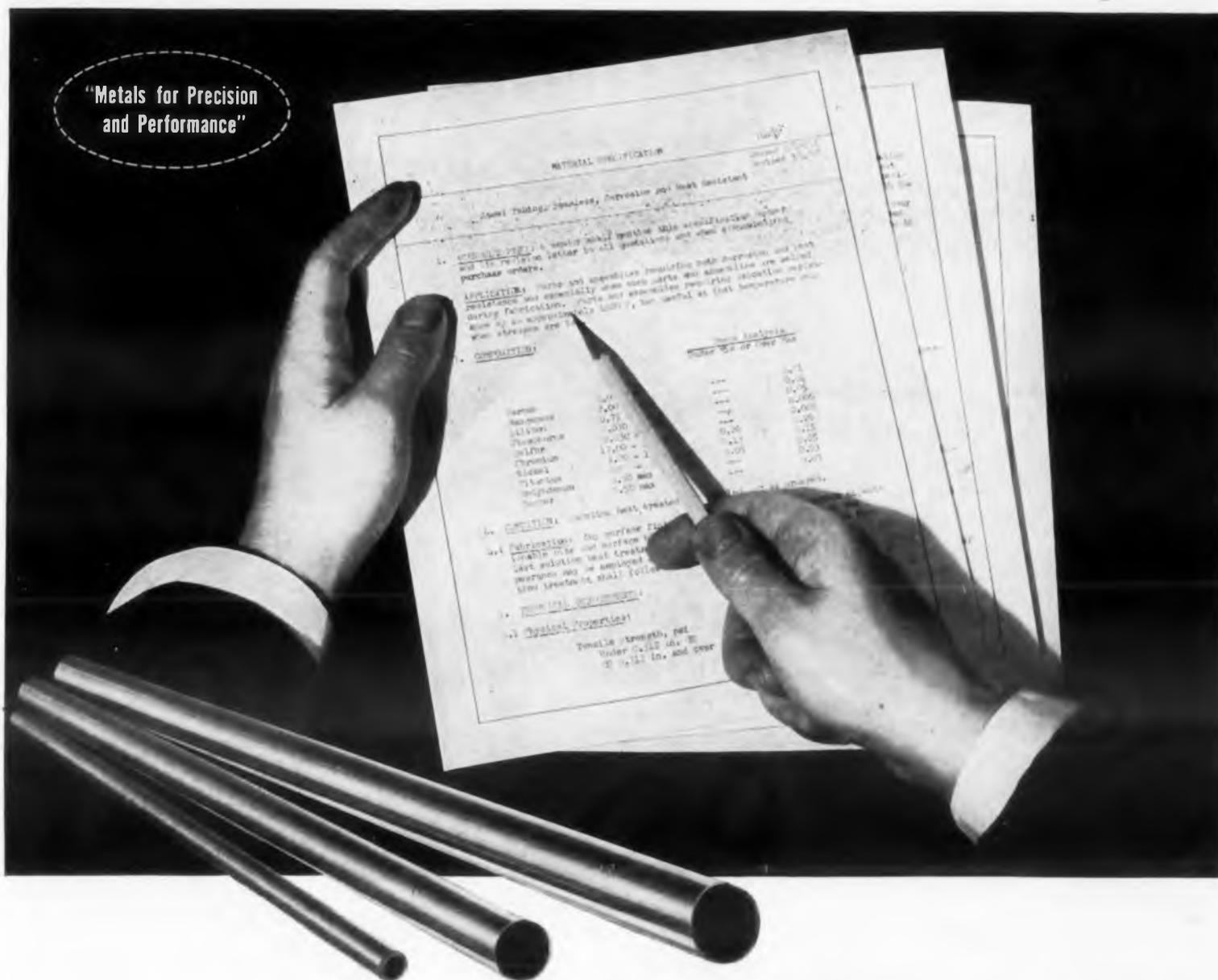
**Reduce operating temperature, and position parts in equipments to minimize the effect of connection and radiation heat.** The life of most parts can be improved by reducing the temperature of parts (such as by reducing the internal ambient temperature in equipments). For one type of equipment the MTBF was doubled when the internal ambient temperature was reduced 20 C.

**Use redundancy.** When state-of-the-art limitations preclude achieving the reliability objective, the use of redundant parts, circuits, and equipments must be utilized.

**Use techniques inherently reliable.** The use of solid-state devices—magnetic circuits, transistors, dielectric amplifiers—will enhance reliability in some applications. Thermionic devices have high failure rates—sometimes one order of magnitude greater than solid-state devices.

**Use conservative circuit design.** Check circuit function with transistors or tubes having life-test-end-point performance. Use prescribed derating factors and compensate in circuit design for known weaknesses of parts. Military preferred parts should be used in all applications possible.

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GLASS-TO-METAL SEALING ALLOYS	Low expansion alloys for glass sealing applications	
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Send in your individual specs for prompt handling, thorough analysis, prices, deliveries. Write, wire or phone Malvern 3100, or call your local steel service center.



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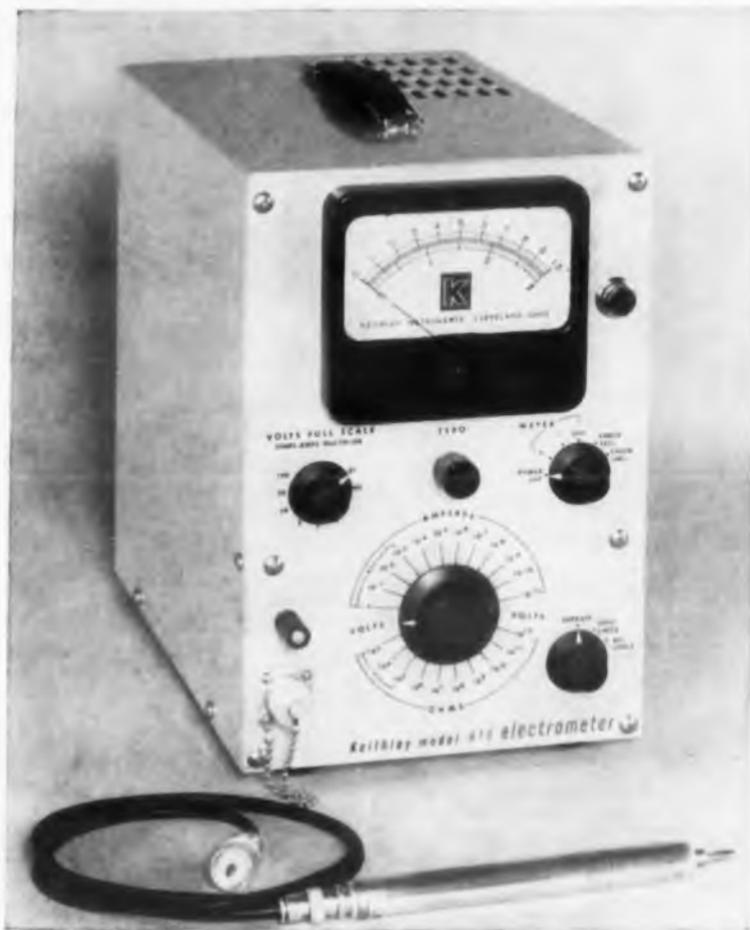
**J. BISHOP & CO.**

platinum works

MALVERN, PENNSYLVANIA

CIRCLE 24 ON READER-SERVICE CARD

# Keithley electrometers for every dc laboratory test



## Model 610, line-operated, 59 ranges

The Keithley 610 Electrometer is a laboratory workhorse, doing the work of several instruments. It covers the extreme spans of dc voltage, current, and resistance tabulated below, and is a useful preamplifier as well. It has precise gains to 1000, a dc to 500 cps bandwidth, and 10-volt and 1-ma outputs. Input resistance of the 610 is selectable from one ohm to over  $10^{14}$  ohms. It checks its own resistance and voltage supply standards. Zero drift is comfortably within 2 millivolts per hour after warmup.



## Model 600, battery-operated, 53 ranges

The Model 600 is a small, portable, battery-operated sister of the 610. Its many ranges also are tabulated below. Like the 610, its input resistance may be varied from one ohm to over  $10^{14}$  ohms, permitting an optimum balance of low circuit loading versus minimum pick-up. Output is sufficient to drive potentiometric recorders directly, with a dc to 100 cps bandwidth, and zero drift is within 2 millivolts per hour. The 600 will check its own batteries; minimum battery life is 500 hours.

### Need a few specials?

Recent Keithley developments include instruments for the Navy's Vanguard, for Army research balloons, and for Air Force research missiles. Your special problem will receive a prompt reply.

MODEL	FULL SCALE RANGES			PRICE
	VOLTAGE	CURRENT	RESISTANCE	
610	10 mv to 100 volts	$10^{-13}$ amp. to 3 amperes	10 ohms to $10^{14}$ ohms	\$465.00
600	10 mv to 10 volts	$10^{-13}$ amp. to 3 amperes	10,000 ohms to $10^{13}$ ohms	\$380.00

**THREE ACCESSORY** probes are available to facilitate measurements and extend the measuring range to 30 kv (Model 610) or 10 kv (Model 600). A convenient accessory test shield permits rapid checks of small components. Write today for more details.



**KEITHLEY INSTRUMENTS, INC.**

12415 EUCLID AVENUE • CLEVELAND 6, OHIO

CIRCLE 25 ON READER-SERVICE CARD

# High-Speed Sampling

**H**IGH-SPEED sampling of low-level signals is accomplished by a new all-transistor electronic commutator. Designed by Radiation Inc., P. O. Box 37, Melbourne, Fla., the device is capable of operating at rates up to 24,000 samples per second. It contains 50 diode gates which enable the commutator to sample up to 50 channels. Distortion and losses are negligible.

Called Radiplex, the unit may be controlled by synchronizing signals or commanded from an external source computer. An important feature is the ability of the commutator to mix signals of full scale amplitudes as high as  $\pm 10$  v with signals at levels as low as  $\pm 10$  mv. Output may be connected to analog-digital converters to obtain coded outputs for storage or computation. Input can be obtained from accelerometers, thermocouples, etc. without a preamplifier.

Reliable operation at the extreme sampling speeds has been made possible by new sample and hold circuitry. Sequential output of the diode bridge is sampled over a period of 4 microseconds. Then the output information is held,



# Switch . . .

*for low-level signals*

or remembered for 40 microseconds.

Flexibility is provided to enable the operator to program a variety of sampling rates. Often it is necessary to sample different channels at different rates. With Radiplex, the operator may preprogram the unit for almost any combination of channels (one to fifty), and sampling rates. For example, it is possible to program the unit to use two channels, sampling each at 12,000 per second. Or all 50 channels may be sampled at 480 per second.

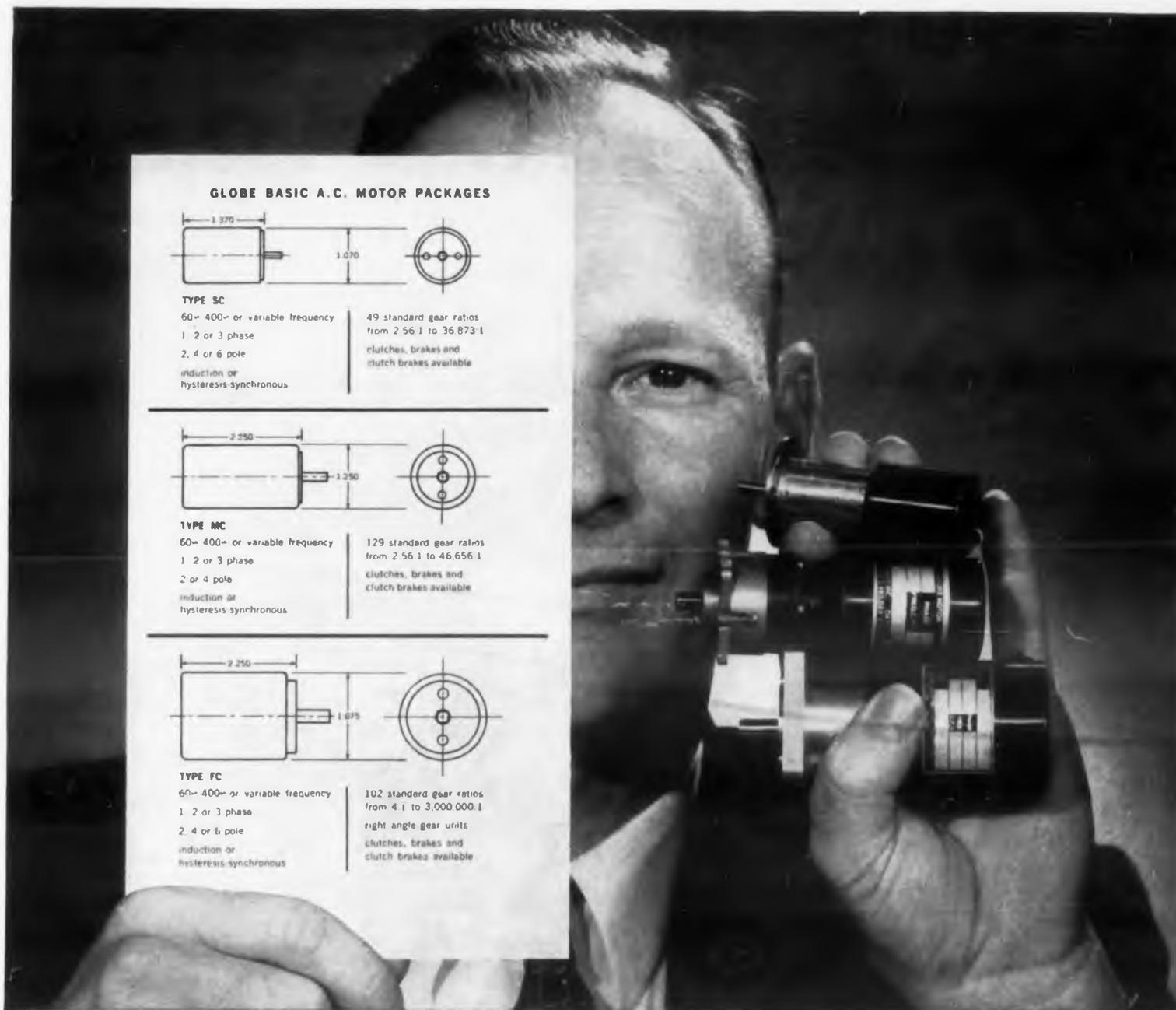
Fifty channels are available; sampling rate is from 0-24 kc. Input is  $\pm 10$  mv to  $\pm 10$  v full scale with an input impedance of 30,000 ohms. Recommended driving source impedance should be less than 1000 ohms.

Linearity is within 0.1 per cent with inter-channel modulation of  $10^{-4}$  for a source impedance less than 1000 ohms. Power supply is built in and will operate from 60-400 cps ac sources.

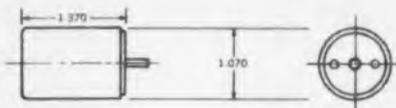
For more information about this high-speed electronic commutator, turn to Readers Service Card and circle 101.



**New high-speed** electronic commutator can be preprogrammed to permit sampling of any logical arrangement of channels and switching rates. Patch plugs are at the rear (bottom photo).



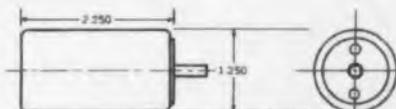
## GLOBE BASIC A.C. MOTOR PACKAGES



### TYPE SC

60- 400- or variable frequency  
1. 2 or 3 phase  
2. 4 or 6 pole  
induction or hysteresis synchronous

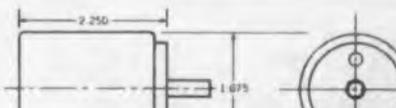
49 standard gear ratios from 2.56:1 to 36.873:1  
clutches, brakes and clutch brakes available



### TYPE MC

60- 400- or variable frequency  
1. 2 or 3 phase  
2. 4 or 6 pole  
induction or hysteresis synchronous

129 standard gear ratios from 2.56:1 to 46,656:1  
clutches, brakes and clutch brakes available



### TYPE FC

60- 400- or variable frequency  
1. 2 or 3 phase  
2. 4 or 6 pole  
induction or hysteresis synchronous

102 standard gear ratios from 4:1 to 3,000,000:1  
right angle gear units  
clutches, brakes and clutch brakes available

## GLOBE A.C. MOTORS / GEAR REDUCERS / PACKAGES

In precision miniature motors, gear reducers, and small-package devices using clutches, brakes, and other components, Globe Industries has the hardware to meet your requirement. From a single source you can get fast 2 to 4 week prototype delivery of standard units. Modular design, interchangeable precision parts, and an efficient special order department are specific, unique reasons why you get what you need before your design grows cold.

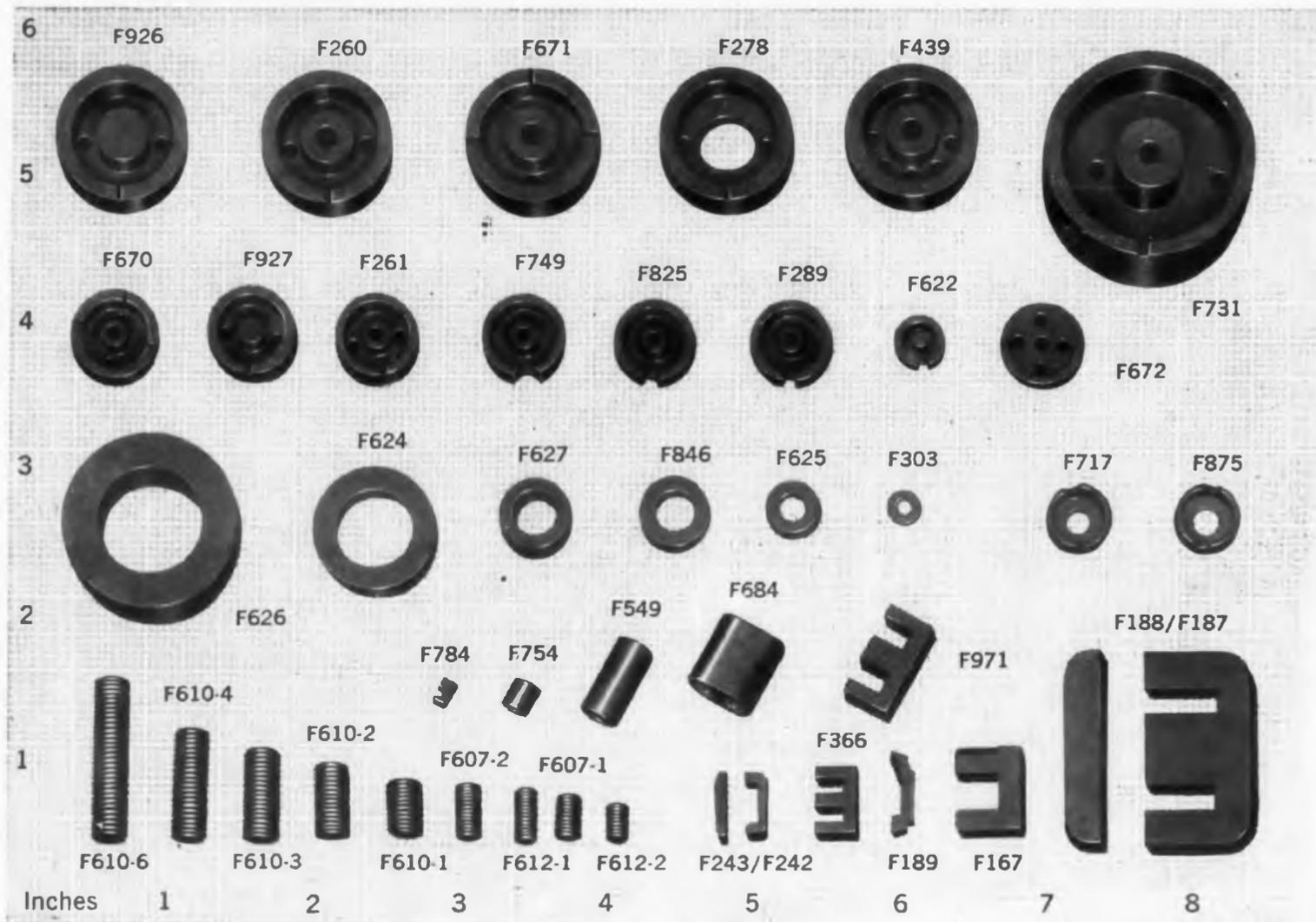
Three basic A.C. motors are shown above. With their integral gear reducers they reliably span the torque range to more than 2000 in. oz. Custom modifications are a specialty.

Globe motor packages were chosen for the Army's Jupiter C, and as you read this, at least one such package is circling the earth. Ask the largest precision miniature motor manufacturer first. Request the Globe A.C. Motor Catalog now. GLOBE INDUSTRIES, INC., 1784 Stanley Avenue, Dayton 4, Ohio. BAldwin 2-3741.



CIRCLE 26 ON READER-SERVICE CARD

# Now, Immediate Delivery from Stock on GENERAL CERAMICS SPECIAL PURPOSE FERRITE CORES



**Rush service for designers - use  
this handy materials selector chart**

Ferrite Cores available in various materials for development and design engineers to cover specific frequency bands of operation from 1 KC to 50 megacycles. General Ceramics provides extra-fast service on sample quantities for development and will make prompt delivery on production parts in reasonable quantities. Call, wire or write General Ceramics Corporation, Keasbey, New Jersey. Please direct inquiries to Dept. ED.

APPLICATION	DESIRED PROPERTIES	FREQUENCY	FERRIMIC BODY	SHAPES
Filter Inductors	High $\mu$ , magnetic stability, sometimes adjustable	up to 200 kcs 200 kcs-10 mcs 10 mcs-80 mcs	"O-3", "T-1" "Q-1" "Q-2"	Cup cores, toroids, C-cores, E-cores, slugs
IF Transformers	Moderate Q, high $\mu$ , magnetic stability, adjustable	465 mcs 40 mcs other	"Q-1" "Q-2" Materials for filter inductors apply	Cup cores, threaded cores, toroids
Antennae Cores	Moderate Q, high $\mu$ , magnetic stability	.5-10 mcs 10.50 mcs	"Q-1" "Q-2"	Rods, flat strips
Wide Band Transformers	High $\mu$ , moderately low loss	1 kc-400 kcs 1 kc-1 mc 200 kcs-30 mcs 10 mcs-100 mcs	"O-3", "T-1" "H" "Q-1" "Q-2"	Cup cores, toroids, C-cores, E-cores
Adjustable Inductors	High $\mu$ , moderately low loss	Same as Wide Band Transformers	Same as Wide Band Transformers	Rods, threaded cores, tunable cup cores
Tuners	High $\mu$ , moderate to high Q, magnetic stability, as much as 10 to 1 adjustability with mechanical or biasing methods	Up to 100 mcs	For high Q selective circuits, materials under filter inductors apply. For others, materials under wide band transformers apply	Threaded cores or rods for mechanical tuning, Toroids, C-cores, E-cores for biasing methods
Pulse Transformers	High $\mu$ , low loss, high saturation	Pulse	Materials under wide band transformers apply	Cup cores, toroids, C-cores, E-cores
Recording Heads	High $\mu$ , low loss, high saturation, resistance to wear	Audio, pulse	"H" "O-3", "T-1"	

## GENERAL CERAMICS

Industrial Ceramics for Industrial Progress... Since 1906

CIRCLE 27 ON READER-SERVICE CARD

## MEETING REPORT

# First Insulation Conference Probes Material Problems

L. N. Tolopko

Assistant Editor  
ELECTRONIC DESIGN

DEMANDS being made on insulation material today are similar to those being made on electronic components and equipment: it must be able to stand up to higher and higher temperatures, occupy less volume, and weigh less.

This trend was made clear at the first National Conference on the Application of Electrical Insulation. The conference, cosponsored by the American Institute of Electrical Engineers and the National Electrical Manufacturers Association, was held in Cleveland on September 3, 4 and 5. Over one hundred papers were delivered at the sessions which were divided into four groups: rotating equipment, transformers, controls and instrumentations, and electronics. In addition, an exhibition provided the opportunity for displaying the latest advances in insulation and a meeting ground where manufacturer and user could thrash out common problems.

Undoubtedly the greatest advances in recent years have been the development of the silicones and fluorocarbon materials. To meet today's ultrahigh temperature requirements these substances, along with the newer plastics, are being combined successfully with the traditional insulating materials.

Spurring today's demands are the requirements of military aircraft. As airplane speeds increase so do the ambient temperatures. If any useful load can be carried, permissible conductor temperatures must be raised to 1000 F. and higher.

#### The User's Gripe

Chief complaint from the users of insulation material, as sampled in the corridors and various forums, was that they were never quite sure of quality of the material they were receiving. As a result, virtually every user talked to admitted to testing the material they purchased before using it. One user complained that generally the manufacturer's data sheet is correct but suffers from incompleteness. He related how he had taken used wire which was supposed to maintain its insulation at 130 C. After using the material he discovered this to be true. What they had forgotten to tell him was that the insulation shrunk by three per cent. Another user supported this contention. He said the data sheets he received gave the characteristics of the materials, but that how the characteristics were obtained was never given. The data sheets were therefore meaningless to him.

#### The Manufacturer's Side . . .

The trouble, a representative of the manufacturer explained, is that there are no standards regarding the testing of material. Everyone seems to be testing dielectric strength, flexure strength and what have you their own way. The ground rules have not been laid down. He related how his company had been asked to develop a material that would remain noncombustible in the presence of a Bunsen flame. The material had been developed and tested satisfactorily in the manufacturer's laboratory. However, when submitted to the user, the material was turned down because it burned when touched with the flame of a Bunsen burner. After extensive studies it was discovered that the BTU value of the user's gas flame was much higher than that of the manufacturer's. The representative of the manufacturer said that the most useful outcome of the conference would be everyone agreeing to a set of common ground rules and definitions. This, he admitted, might take several years. But this first conference was a good start, he concluded.

#### The Work Ahead

Incoming chairman of the AIEE Committee on Electrical Insulation, K. N. Mathes of General Electric, and other members of the committee, hope to bring peace into the area of insulation. At a dinner meeting, ambitious plans to define basic insulation terms, and methods of testing to

the most  
reliable  
metallized  
capacitors  
made!



## DIFILM<sup>®</sup> METALLIZED CAPACITORS

Now improved and better than ever!!!

UNMATCHED for reliability in high temperature operation, Sprague's Type 118P DIFILM Metallized Capacitors have the highest insulation resistance of any metallized paper capacitors. Their unusual reliability is largely attributed to the dual dielectric, a unique combination of polyester film and metallized paper impregnated with a special high-temperature mineral wax. They're designed for operation at 125°C without voltage derating.

Life tests for Sprague's new Type 118P capacitors are the same as those for standard paper capacitors—140% of rated voltage for 250 hours at full rated temperature, 125°C. Dielectric tests, too, are the same as for comparable paper capacitors—twice the rated voltage.

Type 118P DIFILM capacitors may also be used at extremely low voltages. Capacitors in typical applications have been operated up to 5000 hours with only 2 volts applied without the non-clearable short circuits which have been typical of earlier metallized paper designs. The vibration and shock resistance of DIFILM

Metallized Capacitors make them well-suited to missile electronics and similar applications.

The improved quality of these capacitors is the result of advanced manufacturing techniques combined with the development of new and better materials . . . all under strict quality control. Sprague is the only commercial capacitor manufacturer to metallize its own condenser tissue . . . the only manufacturer to continuously inspect all plastic film used to see that it meets rigorous Sprague standards. No wonder Sprague is first in quality metallized paper capacitors!

Write for Engineering Bulletin 2211A to Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

For fast deliveries of popular ratings, call your local Sprague Industrial Distributor.

# SPRAGUE<sup>®</sup>

the mark of reliability

#### SPRAGUE COMPONENTS:

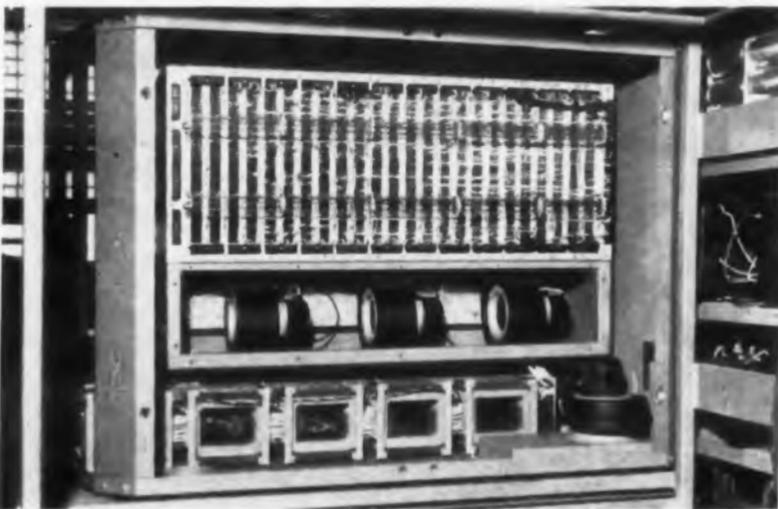
CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS  
CIRCLE 28 ON READER-SERVICE CARD

## THE NATIONAL SCENE

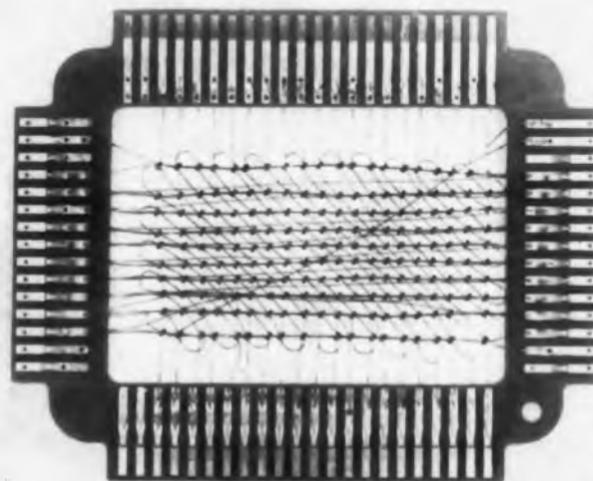


**KEEPING "ELECTRONIC BRAINS" FROM LOSS OF MEMORY.** One of science's greater marvels is IBM's 705 Electronic Data Processing Machine—which makes intricate calculations and logical decisions in millionths of a second. Heart of this electronic "wizard" is its main magnetic core memory. Designed for use with the machine's high-speed printer is the IBM 760 Control and

Storage Unit containing its own core memory of 1,000 positions which allows central processing to continue in the 705 while other data are being printed. Helping the 760 remember what information is to be printed is a job for PHENOLITE® Laminated Plastic. PHENOLITE's unique combination of properties makes it ideal for this application.



**MOST ADVANCED FORM OF ELECTRONIC STORAGE.** The 1,000-position core memory for the IBM 760 Control and Storage Unit—a portion of which is shown here—consists of pinhead size cores strung on copper-wired frames of PHENOLITE. Electrical impulses, passing through wires, alter the magnetic state of cores so that a group of them stands for a word or figure. Reversing the process recalls information from storage. PHENOLITE frames safeguard the circuit and permit stacking of core planes as shown.



**PHENOLITE MEETS CRITICAL STANDARDS.** Core frames like the one shown are punched out of laminated PHENOLITE by IBM. Each frame has printed circuit type terminal strips and soldered connections. PHENOLITE proves an ideal material for this application because it is mechanically strong and stiff, punches cleanly, etches well, remains flat, has high dielectric properties and withstands the heat of dip soldering.

**NATIONAL CAN HELP YOU** reduce unit product cost or improve product performance at no added cost. Here's why . . . You can select the "one best material" from over 100 grades of PHENOLITE, Vulcanized Fibre and National Nylon—without compromise in properties or cost. You can simplify production and purchasing with the timed delivery of 100% usable parts—from a single reliable source. You gain competitively with National's new materials and grades—the direct result of programmed materials-research.

You benefit by calling National first. Check Sweet's PD File 2b Na, the Telephone Directory Yellow Pages, or write Wilmington 99, Delaware, Dept. E-10,

CIRCLE 29 ON READER-SERVICE CARD

**NATIONAL**  
VULCANIZED FIBRE CO  
WILMINGTON 99, DELAWARE

In Canada:  
NATIONAL FIBRE CO. OF CANADA, LTD., Toronto 3, Ont.

determine insulation to everyone's satisfaction were laid out for the coming year.

### Roundup of Papers

Some of the papers delivered at the conference and of value to the electronic design engineer are abstracted in the following paragraphs.

In discussing "Dielectric Papers for Electronic Applications," S. W. Pease of the Crocker Burbank & Co. Assn., told how to select the best paper for a particular application.

"If a unit is in production using a particular grade of paper, but improvement is desired, the following factors should be considered:

"1. To improve dielectric strength: Use a greater number of thinner sheets or change to a higher density, better formed paper. In either case, the cost of the paper will be higher, but the cost of the unit may or may not be affected since production losses may be lowered.

"2. To lower the dissipation factor: Use a lower density paper. If a drop in the 30 to 60 C range is desired, use a modified kraft pulp paper.

"3. To lower cost: Since thicker papers usually cost less per pound, using a few thicker sheets will be cheaper than a greater number of thin sheets. If some latitude in properties is available, examine the cost figures of the different density sheets. The price per pound of the paper is not a good indication of the cost of using a particular grade in any specific application.

"If a paper grade is to be chosen for a new unit of a completely different design, it is necessary to analyze the properties desired and make a well-educated guess at the grade of paper to start with. Having established the properties of the units, one may proceed as above. In either case, the suggestions of the paper company will be helpful.

"A word of caution should be added to the engineer evaluating a new grade of paper. Various grades of paper need to be handled in different ways. The winding, drying, and impregnation processes suitable for one grade may prove entirely unsatisfactory for a grade with completely different properties."

Characteristics the design engineer should consider in selecting and insulating material was covered in "What Every Engineer Should Know About High Temperature Wire and Cable," a paper prepared by F. X. Buschman, Tensolite Insulated Wire Co., Inc.

"1. Temperature Rating. That is, the maximum temperature at which the material may be used in operation continuously without loss of its basic properties.

"2. Dielectric Constant which is a measurement of its insulating efficiency. Dielectric constant is in itself a comparison of the insulating effectiveness of a material as compared to a vacuum

which is arbitrarily assigned a constant of unity.

"3. Chemical Resistance. If the finished wire will operate in or around presence of materials which can corrode or otherwise deteriorate a conductor, or if penetrable to the conductor can cause dielectric loss, an insulating medium must be chosen to present these actions.

"4. Flexibility. Particularly in electronics and aircraft or missile installation where assemblies of flexibility must be maintained.

"5. Moisture Absorption. Where conditions of high humidity or the presence of water are anticipated, a resistance to the absorption of moisture becomes critical in the selection of insulating materials.

"6. Effects of Soldering. Since many wire terminations in electronics and aircraft assemblies are accomplished by soldering the conductor to a termination point, and this is frequently done in confined spaces, an insulating material which is not affected by the heat present in the soldering operation is very frequently a must."

"Analysis of Soldering and Conductor Breakage in High Temperature Hook-Up Wire" was the title of a paper prepared by Messrs. W. Nold and C. Brown of the Laboratory For Electronics, Boston, Mass. The following points were made:

"Good flexibility of the conductor is necessary to reduce breakage due to repeated bending, and individual strands of high-temperature wire can not be tin-coated as in the usual hook-up wire, because tin-coated strands would fuse together at the temperatures used in curing the high-temperature insulations on the wire.

"The composition of the solder and the temperature at which it is used greatly affects the amount of bending that the soldered connection will stand. In general, the higher the tin content of the solder and the higher the temperature at which the soldering is done, the poorer the bend endurance of the soldered connection. The best results were had from a solder which was composed of equal parts of tin and lead with 1-1/2 per cent copper; this solder melts and flows as freely as ordinary 50/50 tin-lead solder.

"Soldering which is done at temperatures below 550 F usually produce lumpy-looking connections and the long time required to heat up the wire and the termination may actually result in heating up adjacent areas to an undesirable degree, even to the extent of melting previously soldered connections."

After testing wire for bend endurance it was found that: "As might be expected, very large angles of bend caused greatly reduced bend-endurance. All breaks occurred within the soldered area of the wire, sometimes between the end of the insulation and the connector pin, sometimes within the insulation."



Truly sub-miniature, these capacitors were devised especially for printed circuits and automatic assembly. Since they retain all the properties of larger, pig-tail capacitors, they are well suited to general circuitry as well.

## Now—Corning Fixed Glass Capacitors in new sub-miniature size

**Packing up to 1,000 uuf at 300 V. and 125°C. into 0.010 cubic inches, these new capacitors are designed for use on printed circuit boards and all applications requiring high-quality components. Advantages include fixed temperature coefficient, high insulation resistance, low dielectric absorption, the ability to operate under high humidity and high temperature conditions, plus the added advantage of increased miniaturization.**

You can now up-grade your specs for miniature capacitors used on printed circuits.

These new capacitors measure only  $\frac{3}{32} \times \frac{1}{16} \times .115$ , yet have capacitances up to 1000 uuf at a full 300 V. rating at 125°C. Such exceptional thinness makes these capacitors particularly well suited for vertical mounting in small, high-rated units.

The capacitors have high temperature soldered leads which allow direct connection to circuit boards. The leads are .100 inches long, fitting most circuit board thicknesses and eliminating any trimming.

**Reliable** • Since the new construction is extremely simple, reliability is correspondingly high.

**Rugged** • These capacitors, when mounted, successfully withstand a standard five-hour vibration cycling test at 10 to 55 cycles, 15G Max.

Known as WL-4 capacitors, these units are in mass production. Your inquiries concerning data and prices are welcome.

### FEATURES

1. to MIL C-11272A except smaller
2. 1 to 1,000 uuf
3. 300 volts
4. 125°C. full rating
5. .010 cubic inches

*Corning means research in Glass*



**CORNING GLASS WORKS, Bradford, Pennsylvania**

Electronic Components Department

CIRCLE 30 ON READER-SERVICE CARD



## regaTRAN

### Transistorized Power Supplies Turn Claims Into Specs!

- **super regulated . . .**  
No derating ever! Specified regulation is valid over the entire range of input and load . . . 0.1% or 0.01 V.
- **short circuit proof . . .**  
An exclusive electronic (no moving parts) circuit breaker fully protects transistors against burnout.
- **remote sensing . . .**  
Brings voltage regulation to the load where it's needed. Eliminates the effect of voltage drops in power leads.
- **all popular ranges . . .**  
Available in narrow or wide range models. Narrow range models cover all standard battery voltages. Wide range models start at 0 to 7 volts and are available up to 0 to 60 volts. Various current ratings up to 15 amperes.

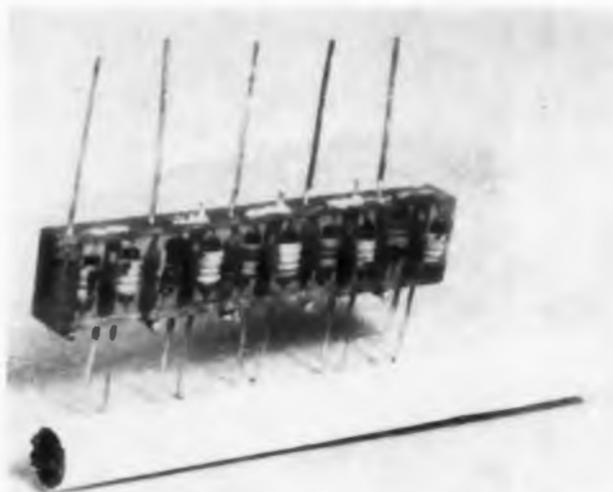
. . . plus all the other features you'd expect in an E/M Power Supply: low output impedance (approx. 0.001 ohm at 1 kc); ripple free (less than .001 volt); negative, positive or ungrounded output; front panel calibration and null balance controls . . . and the extras too, like printed circuitry; removable subassemblies . . . but why not get all the facts. Write for Preliminary Bulletin T.

**ELECTRONIC MEASUREMENTS CO., Inc.**  
EATONTOWN • NEW JERSEY



CIRCLE 31 ON READER-SERVICE CARD

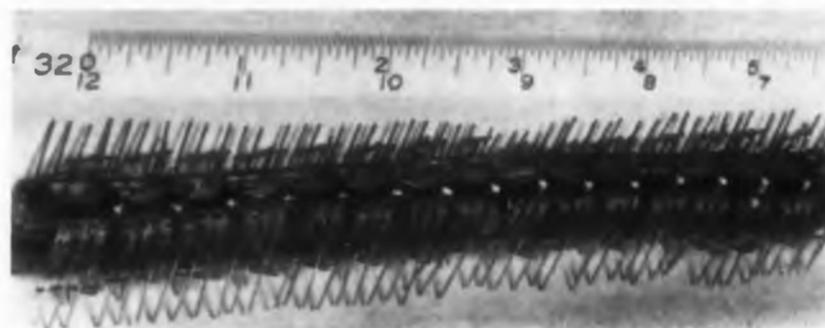
## Instrument Sticks For Tomorrow's



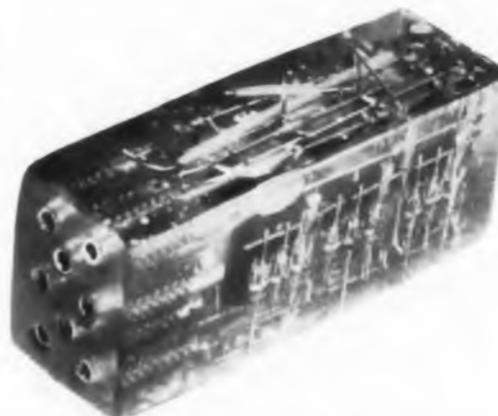
Instrument stick (above) with soldered connections by Lind Corp.



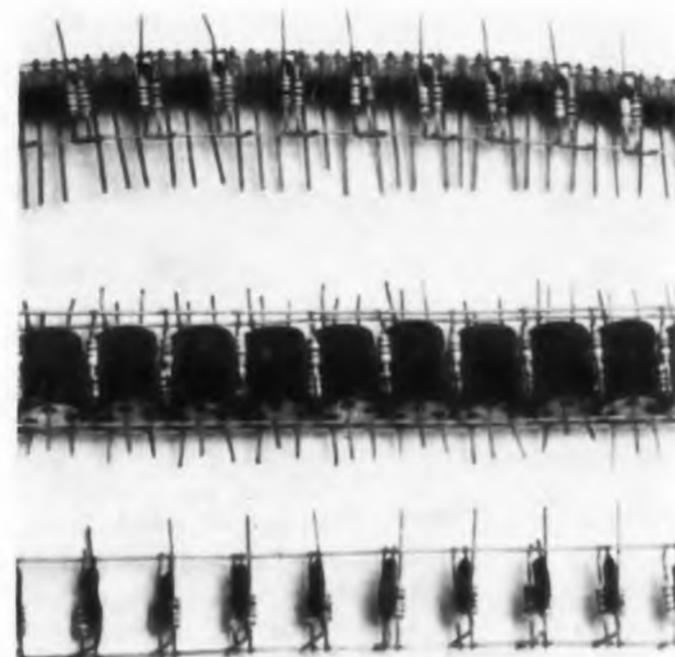
Rigid plastic foam (right) cushions against shock in this Lind assembly.



Back-to-back power transistors are flanked by diodes, resistors, and capacitors to form a fragment of computer logic. In this Sippican unit, all interconnections are resistance spot welded.



Circuit assembly (above) with end connectors—ready for use. (Sippican)



Three sticks (right) ready for assembly. (Sippican)

ELECTRONIC DESIGN • October 29, 1958

## Packages

**E**XTREMELY high component densities, to 74 per cent, are featured in "instrument sticks," a new packaging concept. Almost at the same time, two companies, working independently, announced this new packaging service. Unbeknownst to each other, both companies coined the same term for their packages—"instrument sticks."

Available from Sippican Corp., Marion, Mass. (an affiliate and licensee of Francis Associates), and from Lind Corp., Research Park, Princeton, N.J., the sticks are similar in appearance and basic concept, yet they have important differences.

### Units Are The Same . . .

In both cases, each component is in close physical contact with its neighbors and no supporting structure is normally required. Sticks of components are normally encapsulated in a suitable potting resin, and individual modules may be strapped together and stacked. The potting protects against humidity, fungus, and salt spray.

Packages are very strong and rigid. Lind lists typical specifications for vibration of 25 to 2500 cycles at 25 g; 150 g for 11 msec, for shock; and 150 g of continuous acceleration.

Since leads are very short and well insulated cross-talk and interference are very low.

Thin sheets of metal can be interleaved in parallel planes among the sticks assembled in a cube for high thermal conductivity, or thermal problems can be eliminated with an aluminum "sandwich."

Surgery can be performed on either unit to replace defective components—but the operation is a ticklish one.

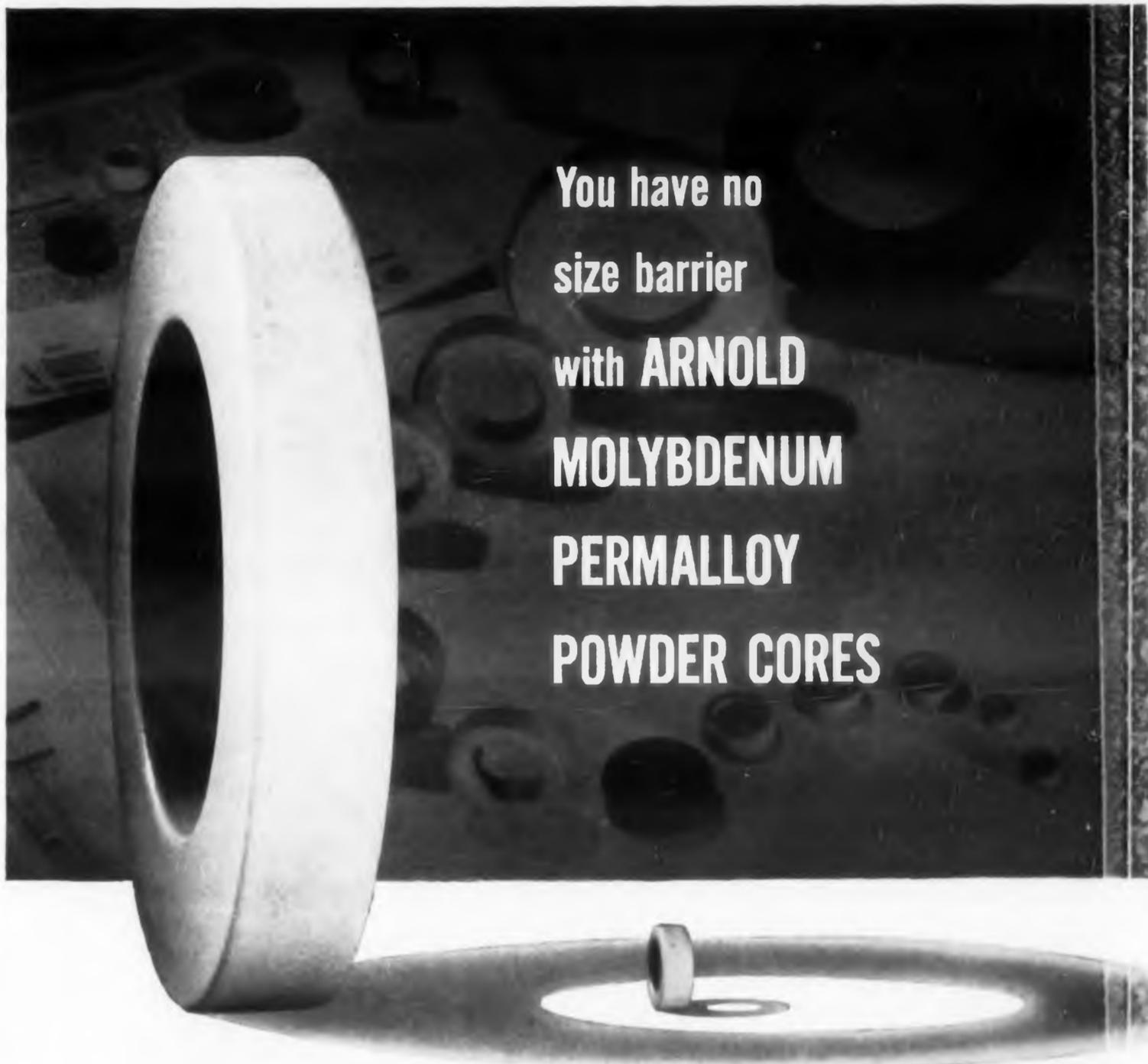
### . . . Yet Different

The outstanding difference between the packages is that interconnections are made by resistance spot welding in the Sippican models, and by soldering or electroplating in the Lind units.

Sippican uses structural engineering principles—depending on the natural compressive strength of the components packed so densely, and the tensile strength of the interconnecting wiring. If the assembly is potted in a suitable casting resin—its strength is roughly analogous to a steel reinforced concrete beam.

Lind casts the individual modules in an epoxy stick, straps them together, then uses a rigid plastic foam to hold the members together.

For further information on both techniques, turn to the Reader-Service Card and Circle 102.



You have no  
size barrier  
with **ARNOLD**  
**MOLYBDENUM**  
**PERMALLOY**  
**POWDER CORES**

Starting with the smallest up to the largest, Arnold leads the way in offering you a full range of Molybdenum Permalloy Powder cores for greater design flexibility . . . from 0.500" O.D. to 5.218" O.D.

As long ago as 1953 Arnold pioneered and developed for production use the small "Cheerio" core illustrated above. Today, hundreds of thousands of Arnold "Cheerio" cores are filling the requirement for miniaturization in circuit design in industrial and military applications. And even smaller sizes have been developed by the Arnold Engineering Company and are available.

Arnold also is the exclusive producer of the largest 125 Mu core commercially available. A huge 2,000 ton press

is required for its manufacture and insures its uniform physical and magnetic properties. This big core is also offered in the other three standard permeabilities of 60, 26 and 14 Mu.

Most core sizes can be furnished with a controlled temperature coefficient of inductance in the range of 30° F to 130° F. Many can be supplied temperature stabilized over the wide range covered by the MIL-T-27 specification of -55° C to +85° C . . . another of the special features only Arnold provides. • Let us handle all your magnetic materials requirements from the most extensive line in the industry: Powder cores, tape cores, cast or sintered Alnico permanent magnets, and special magnetic materials.

For more information write for  
Bulletin PC-104B

Lists complete line of Mo-Permalloy Powder cores . . . available in 23 sizes from 0.500" O.D. to 5.218" O.D. Furnished also with various types of temperature stability from Type "A" unstabilized to Type "W" stabilized over the temperature range of -65° F to +185° F.

ADDRESS DEPT. ED-810.

**THE ARNOLD ENGINEERING COMPANY**



**Main Office & Plant: Marengo, Illinois**

**Repath Pacific Division Plant: 641 East 61st Street, Los Angeles, Calif.**

**District Sales Offices:**

**Boston: 49 Waltham St., Lexington Los Angeles: 3450 Wilshire Blvd.**

**New York: 350 Fifth Ave. Washington, D.C.: 1001-15th St., N.W.**

CIRCLE 32 ON READER-SERVICE CARD



## regaTRAN

### Transistorized Power Supplies Turn Claims Into Specs!

- **super regulated . . .**  
No derating ever! Specified regulation is valid over the entire range of input and load . . . 0.1% or 0.01 V.
- **short circuit proof . . .**  
An exclusive electronic (no moving parts) circuit breaker fully protects transistors against burnout.
- **remote sensing . . .**  
Brings voltage regulation to the load where it's needed. Eliminates the effect of voltage drops in power leads.
- **all popular ranges . . .**  
Available in narrow or wide range models. Narrow range models cover all standard battery voltages. Wide range models start at 0 to 7 volts and are available up to 0 to 60 volts. Various current ratings up to 15 amperes.

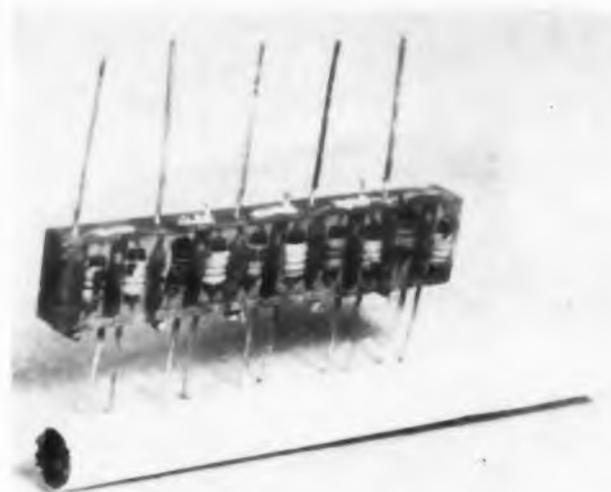
. . . plus all the other features you'd expect in an E/M Power Supply: low output impedance (approx. 0.001 ohm at 1 kc); ripple free (less than .001 volt); negative, positive or ungrounded output; front panel calibration and null balance controls . . . and the extras too, like printed circuitry; removable subassemblies . . . but why not get all the facts. Write for Preliminary Bulletin T.

**ELECTRONIC MEASUREMENTS CO., Inc.**  
EATONTOWN • NEW JERSEY



CIRCLE 31 ON READER-SERVICE CARD

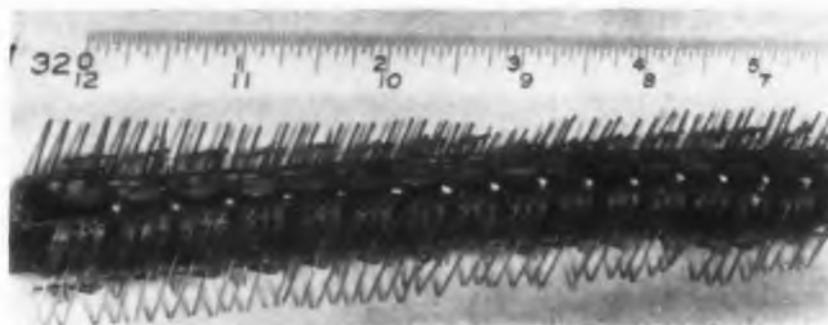
## Instrument Sticks For Tomorrow's



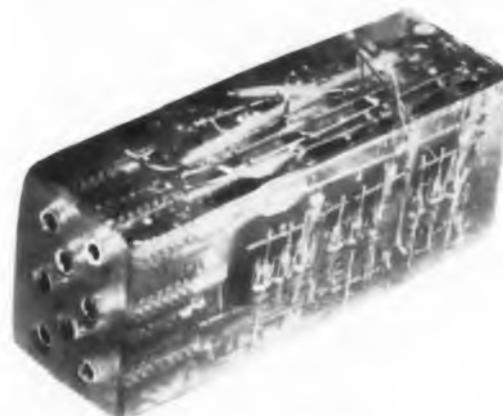
Instrument stick (above) with soldered connections by Lind Corp.



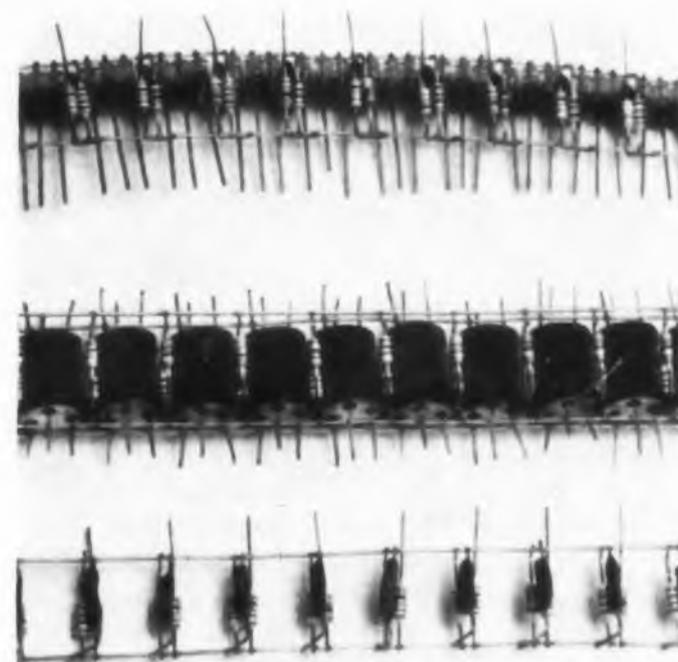
Rigid plastic foam (right) cushions against shock in this Lind assembly.



Back-to-back power transistors are flanked by diodes, resistors, and capacitors to form a fragment of computer logic. In this Sippican unit, all interconnections are resistance spot welded.



Circuit assembly (above) with end connectors—ready for use. (Sippican)



Three sticks (right) ready for assembly. (Sippican)

## Packages

**E**XTREMELY high component densities, to 74 per cent, are featured in "instrument sticks," a new packaging concept. Almost at the same time, two companies, working independently, announced this new packaging service. Unbeknownst to each other, both companies coined the same term for their packages—"instrument sticks."

Available from Sippican Corp., Marion, Mass. (an affiliate and licensee of Francis Associates), and from Lind Corp., Research Park, Princeton, N.J., the sticks are similar in appearance and basic concept, yet they have important differences.

### Units Are The Same . . .

In both cases, each component is in close physical contact with its neighbors and no supporting structure is normally required. Sticks of components are normally encapsulated in a suitable potting resin, and individual modules may be strapped together and stacked. The potting protects against humidity, fungus, and salt spray.

Packages are very strong and rigid. Lind lists typical specifications for vibration of 25 to 2500 cycles at 25 g; 150 g for 11 msec, for shock; and 150 g of continuous acceleration.

Since leads are very short and well insulated cross-talk and interference are very low.

Thin sheets of metal can be interleaved in parallel planes among the sticks assembled in a cube for high thermal conductivity, or thermal problems can be eliminated with an aluminum "sandwich."

Surgery can be performed on either unit to replace defective components—but the operation is a ticklish one.

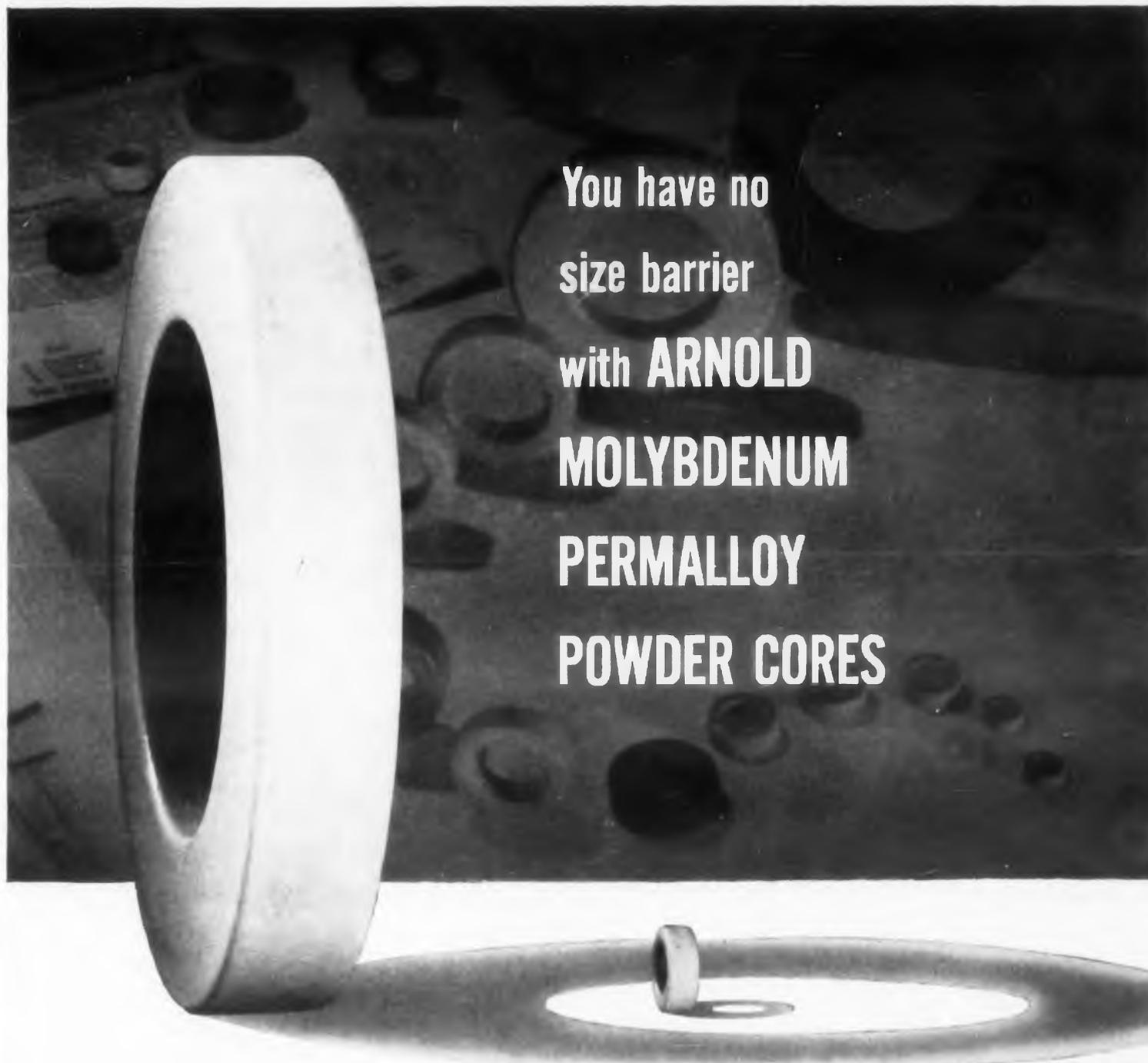
### . . . Yet Different

The outstanding difference between the packages is that interconnections are made by resistance spot welding in the Sippican models, and by soldering or electroplating in the Lind units.

Sippican uses structural engineering principles—depending on the natural compressive strength of the components packed so densely, and the tensile strength of the interconnecting wiring. If the assembly is potted in a suitable casting resin—its strength is roughly analogous to a steel reinforced concrete beam.

Lind casts the individual modules in an epoxy stick, straps them together, then uses a rigid plastic foam to hold the members together.

For further information on both techniques, turn to the Reader-Service Card and Circle 102.



You have no  
size barrier  
with **ARNOLD**  
**MOLYBDENUM**  
**PERMALLOY**  
**POWDER CORES**

Starting with the smallest up to the largest, Arnold leads the way in offering you a full range of Molybdenum Permalloy Powder cores for greater design flexibility . . . from 0.500" O.D. to 5.218" O.D.

As long ago as 1953 Arnold pioneered and developed for production use the small "Cheerio" core illustrated above. Today, hundreds of thousands of Arnold "Cheerio" cores are filling the requirement for miniaturization in circuit design in industrial and military applications. And even smaller sizes have been developed by the Arnold Engineering Company and are available.

Arnold also is the exclusive producer of the largest 125 Mu core commercially available. A huge 2,000 ton press

is required for its manufacture and insures its uniform physical and magnetic properties. This big core is also offered in the other three standard permeabilities of 60, 26 and 14 Mu.

Most core sizes can be furnished with a controlled temperature coefficient of inductance in the range of 30° F to 130° F. Many can be supplied temperature stabilized over the wide range covered by the MIL-T-27 specification of -55° C to +85° C . . . another of the special features only Arnold provides. ● Let us handle all your magnetic materials requirements from the most extensive line in the industry: Powder cores, tape cores, cast or sintered Alnico permanent magnets, and special magnetic materials.

For more information write for  
Bulletin PC-104B

Lists complete line of Mo-Permalloy Powder cores . . . available in 23 sizes from 0.500" O.D. to 5.218" O.D. Furnished also with various types of temperature stability from Type "A" unstabilized to Type "W" stabilized over the temperature range of -65° F to +185° F.

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CIRCLE 32 ON READER-SERVICE CARD

# NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.

## TRANSDUCERS

Transducers do one thing: change energy of one form into another form. Shown on this page are three of the newest transducers available. All are designed for use in converting pressure variations into frequency variations. The next issue of *ELECTRONIC DESIGN* will describe several transducers which were unearthed at the recent National Symposium on Telemetry.



Input pressures of 0 to 1000 psi are converted into a direct electrical output in terms of frequency by this transducer. Output of the unit is in the form of an audio (fm) signal, with a frequency inversely proportional to applied pressure. In the model 8815 the frequency output is achieved by means of a vibrating wire which is stretched between an anchor point and a pressure-sensitive metal diaphragm. The stretched wire is set into motion in a permanent magnetic field by an alternating current through the wire. Current is supplied by an associated amplifier connected in an oscillator circuit. Frequency of oscillation is controlled by the vibrating frequency of the stretched wire. Featuring accuracy, linearity, and ruggedness, the unit can be used in military or industrial airborne or ground equipment.

BJ Electronics, Borg-Warner Corp., Dept. ED, 3300 Newport Blvd., Santa Ana, Calif.

CIRCLE 33 ON READER-SERVICE CARD



Pressure-to-frequency converter OS-1000 can be used in missile, aircraft, and industrial telemetry. The unit combines a variable inductance diaphragm type transducer and a temperature stabilized transistor oscillator. It needs three connections: 28 v dc at 2 ma, ground, and output. For all IRIG channels, units are diaphragm and flush-type with ranges from 5 to 5000 psi differential, absolute, or gage.

Solid State Electronics Co., Dept. ED, 8158 Orion Ave., Van Nuys, Calif.

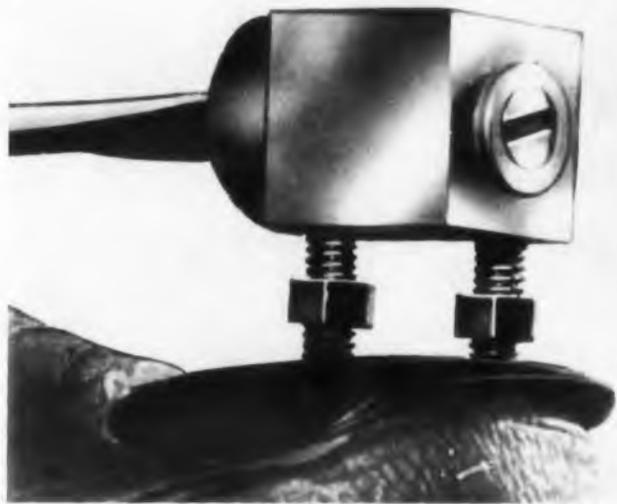
CIRCLE 35 ON READER-SERVICE CARD



Model S-60 is a single coil, variable reluctance, diaphragm type transducer. It is designed for use as the variable inductor in commercially available inductance and reactance controlled fm fm subcarrier oscillator systems. Differential, gage, and absolute models are offered with a selection of pressure ranges between 0 to 10 and 0 to 5000 psi. Its sensitivity to shock, vibration, and acceleration is 0.001 to 0.01 per cent per g, or less, depending on pressure range. Rise time is 75 to 150  $\mu$ sec. Basic size is 7/8 in. diam and 7/8 in. long. Operating temperature range is from -85 to +240 F. Units are suited for a wide variety of telemetry applications.

Ultradyn, Inc., Dept. ED, P.O. Box 3308, Albuquerque, N. Mex.

CIRCLE 34 ON READER-SERVICE CARD



#### TRIMMER POTENTIOMETERS

Measuring 1/4 in. sq by 3/8 in. long, these trimmer potentiometers are designed for horizontal mounting applications. Model MS-4 can be stud mounted and MS-5 is lead-mounted on printed wiring boards. Units are rated at 1/4 w and are available in standard resistance values from 100 to 10,000 ohms. Weight of unit is 0.05 oz and wiper is made of palladium alloy.

Miniature Electronic Components Corp., Dept. ED, Holbrook, Mass.

CIRCLE 36 ON READER-SERVICE CARD



#### RHEOSTAT

Capable of 12.5 w dissipation at 40 C, the model E rheostat is 7/8 in. in diam and extends 11/16 in. behind the mounting panel. Unit has a ceramic hub, independent contact arm pressure, and a vitreous enamel coating. Rheostat is available in 23 different resistance values with linear winding. Nonlinear taper, tandem or other types can be provided.

Ohmite Mfg. Co., Dept. ED, 3698 Howard St., Skokie, Ill.

CIRCLE 37 ON READER-SERVICE CARD



MODEL DL1010P  
(ACTUAL SIZE)

NEW FROM



## DELAY LINES

An outstanding new component series in the JFD tradition of uncompromising quality.



MODEL DL1010  
(ACTUAL SIZE)

Now . . . after extensive laboratory research — JFD distributed constant Delay Lines to meet today's challenging reliability demands!

Designed for applications calling for short delay intervals, the new lines offer a high ratio of delay to pulse rise time, in minimum space. Available for printed circuit assembly or for conventional mounting, JFD Delay Lines meet all military requirements. They can also be modified or custom-designed to meet your most rigid specifications.

Call or write today for Bulletin 213 providing complete electrical and mechanical data. Better yet, tell us *your* delay network problem — distributed or lumped constant. Our engineering staff will promptly recommend the solution with detailed specifications for your particular application.

#### Characteristics:

- Precise pulse fidelity
- Operating temperature range of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- Excellent temperature stability
- Rugged encapsulated construction resists environmental moisture, humidity, shock and vibration
- Linear phase shift
- 0.1 inch grid spacing for printed board types
- Attenuation of approximately 1 db per  $\mu$  sec.



JFD Canada Ltd.  
51 McCormack St.  
Toronto, Ontario, Canada

Pioneers in electronics since 1929

**ELECTRONICS CORPORATION**

1462 62nd Street, Brooklyn, New York

PHONE DEWEY 1-1000

JFD International  
15 Moore Street  
New York, New York

CIRCLE 38 ON READER-SERVICE CARD

# ATHENA

## UNIVAC® COMPUTER GUIDES TITAN MISSILE

The Air Force ICBM TITAN Missile, traveling at speeds up to 15,000 miles per hour, is controlled by a ground-based guidance system.

The Missile takes directions from ATHENA, the ultra-reliable Univac computer. Operating in milliseconds, ATHENA performs the prodigiously complex computations involved in controlling and correcting the flight of the missile during its initial powered phase. The computer determines where the warhead ultimately will fall.

The ATHENA is the latest achievement of the scientists and engineers of Remington Rand's Univac Division, a worthy member of the distinguished line of electronic computers which includes the UNIVAC I, UNIVAC II, the UNIVAC SCIENTIFIC and the UNIVAC FILE COMPUTER. Remington Rand is proud of the work its Univac staff has done in both the commercial and military fields and offers them, and other engineers and scientists, full recognition and an unlimited future in the field of automatic data processing.

*Replies will be held in strict confidence.*

*Address complete resume to the location you prefer.*

Mr. James Drumm, REMINGTON RAND UNIVAC  
1900 West Allegheny Avenue, Philadelphia, Pennsylvania

Mr. R. K. Patterson, REMINGTON RAND UNIVAC  
Univac Park, St. Paul 16, Minnesota

Mr. Robert Martin, REMINGTON RAND UNIVAC  
Wilson Avenue, South Norwalk, Connecticut

**Remington Rand Univac**

DIVISION OF SPERRY RAND CORPORATION



## CAREER OPPORTUNITIES AT ALL LEVELS

**Electronic Engineers**—With BS, MS and PhD degrees for Development Engineering. Experience in radar, servo-mechanisms, communications data processing desirable but not necessary.

**Electrical, Mathematicians and Physicists**—With BS, MS and PhD degrees for Systems Engineering. Two or more years' experience on electronic data processing systems.

**Mechanical Engineers**—With BS or MS degree for electro-mechanical development associated with data processing equipment. (South Norwalk only.)

**Specification and Standards Engineers**—For top positions in electronic component and systems standards and evaluation programs. Electrical Engineers or Physicists with heavy experience in applications development or standards.

**Quality Control Engineers**—With EE degree and two or more years' experience in quality control of electronic equipment.

**Human Engineer**—With degree in Industrial Psychology and experience in man-machine relationships.

## NEW PRODUCTS

### Silicon Rectifier

Can stand short circuits



Short circuits can be withstood by these rectifiers while protected by commercially available fuses. Recommended fuse rating is approximately 160 per cent of rms current. The rectifier stacks are available in half-wave or full-wave configurations from one to several hundred amperes, with peak inverse ratings in 50 volt multiples to thousands of volts. They are hermetically sealed cells for magnetic amplifier and power supply applications. Providing a regulation characteristic of less than one volt per cell forward drop, they can be used without derating from  $-65$  to  $+150$  C. Up to 99 per cent efficiency is possible with these units.

Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N.J.

CIRCLE 39 ON READER-SERVICE CARD

### Constant Current Source

1 to 100 ma range



Model 5900 constant current source can be used to test semi-conductors, thermistors, clutches, magnetic cores, and other current sensitive devices. Output is 0 to 100 v, 1 to 100 ma. Line regulation is 0.5 per cent and load regulation is 0.25 per cent.

Measurements Research Co., Dept. ED, 3801 Castor Ave., Philadelphia 24, Pa.

CIRCLE 40 ON READER-SERVICE CARD

← CIRCLE 550 ON READER-SERVICE CARD

## Signal Sources

Provide 10 w output



Covering 1 to 11 kmc, these 10 w signal sources have internal modulation facilities for pulse, square-wave, and fm operation. For 1 to 2 and 2 to 4 kmc, models 231T and 231T2 provide: 40 to 4000 pps sweep; 0.5 to 10  $\mu$ sec pulse widths; and 0 to  $\pm 2.5$  mc fm deviations adjustable from center frequency. For 4 to 8 and 8 to 11 kmc, models 231T3 and 231T4 offer: 10 to 10,000 pps sweep; 0.2 to 10  $\mu$ sec pulse widths; and 5 mc min deviations. Accuracy for all units is  $\pm 1$  per cent; output vswr, 2 to 1.

Levinthal Electronic Products, Inc., Dept. ED, Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 41 ON READER-SERVICE CARD

## Stepping Motors

Rotate control mechanisms



Translating pulses into incremental shaft positions, series 2 and 3 motors rotate control mechanisms, potentiometers, counters, and switches. A 36 degree angular increment per pulse gives 10 indexing positions with  $\pm 0.5$  degree detent accuracy at a maximum stepping rate of 15 per sec. The units meet MIL-E-5272A tests and operate from  $-55$  to  $+80$  C up to 90,000 ft. Load capacity for series 2 units is 13 oz-in. For series 3 units, it is 2 lb-in.

G. H. Leland, Inc., Dept. ED, 123 Webster St., Dayton 2, Ohio.

CIRCLE 42 ON READER-SERVICE CARD

CIRCLE 43 ON READER-SERVICE CARD

THIS

TELEMETER

MAGNETICS

MEMORY CORE

SUPPORTS

THE WEIGHT

OF ONE

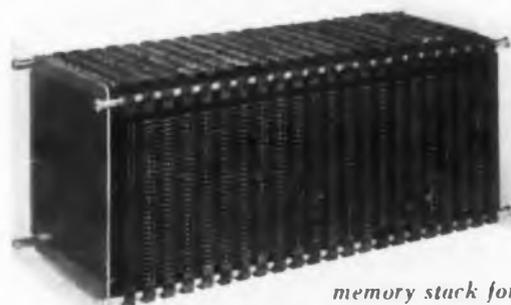
YOUNG

ELEPHANT

*has a faster, more reliable memory, too!*

SILLY TEST

*but we hope it attracts your attention to the thorough three-stage inspection and testing given every TELEMETER MAGNETICS memory product — from core to array to buffers and memory systems.*



*memory stack for a 20-microsecond system  
2048 words of 22 bits each*

### IMPORTANT JOB OPPORTUNITIES

Expansion to handle our increasing business activity plus research and development in new areas have created openings for qualified computer engineers. Investigate the wonderful opportunities offered by TMI in Southern California.

economical • reliable • fast • Telemeter Magnetics Modular Memory Systems are designed and manufactured for absolute dependability

Because **TELEMETER MAGNETICS** manufactures the memory system complete from core production through array wiring to finished units... and because **TELEMETER MAGNETICS** tests each phase of production thoroughly... you can be that much surer when you specify memory systems designed and engineered by **TMI**.

Modular design permits production of custom memory systems to satisfy practically any desired configuration. Units of from 100 to 1,000,000 bits are common... memories can be supplied incorporating several million bits. In addition, **TMI** offers you a selection of memory units with cycle times of 24 microseconds, 6 to 8 microseconds, and 3 microseconds.

Electronic circuits in **TELEMETER MAGNETICS** memory systems employ solid state elements throughout... transistors, diodes and ferrite cores. Amplifiers, registers, drivers, and logic are on plug-in cards for compactness and maintenance ease.

*write for specifications and complete information.*

*Manufacturers of ferrite cores • core arrays • buffers • memories*

**TELEMETER MAGNETICS Inc.**

2245 pontius avenue, los angeles 64, california • 306 "h" st., n.w. washington 13, d.c.

# RELIABILITY

# is the word



# El-Menco

## Dur-Micas

are  
the

# CAPACITORS

with

## BUILT-IN RELIABILITY.

TWO WAYS...

- Highest-Grade INDIA RUBY Mica Films . . .
  - TOTAL DEBUGGING . . .
- Guarantee Super Dependability

47±5%



DM15

Avoid Costly Breakdowns . . .  
with  
Two-Way Built  
In Rugged Reliability.

390±10%



DM20

63400±1%

El-Menco



DM42

ACTUAL  
SIZE

## the finest of materials...

superior engineering know-how . . .  
combine to build in El-Menco  
Dur-Mica Capacitors the highest  
reliability . . . to give long, ever-ready,  
powerful service in electronic equipment  
— from lightning-fast giant brains to  
tiny transistor receivers.

\* unique features in

## El-Menco Dur-Micas

● Specially-selected, highest-grade  
India Ruby mica films . . . pre-tested to  
have highest insulation resistance . . .  
greatest dielectric strength . . . lowest  
dissipation factor. Specially developed  
dipped coating retains the superior  
properties of India Ruby mica.

● Debugging — the removal of early  
failures by subjecting mica capacitors to  
short life tests at elevated voltages and  
temperatures . . . THE SCORE . . .  
DM30, 10,000 MMF, "Debugged"  
El-Menco Dur-Mica Capacitors . . .  
subjected to 257,000 hours of life at  
85°C with 100% of the rated DC  
voltage applied . . . turned in a record  
computed reliability performance —  
APPROX. 0.6% CUMULATIVE FAILURES  
OR ONLY 1 FAILURE PER 43 MILLION  
UNIT-HOURS.

### El Menco "Dur-Micas"

have proved their tremendous power  
and ability under accelerated conditions  
of 1 1/2 times rated voltage at ambient  
temperatures of 125°C and 150°C,  
winning out over all others in longest  
life, most powerful performance,  
smallest size, greatest stability.

DM15, DM16, DM19, DM20,  
DM30, DM40, DM42, DM43 . . .  
perfect for extreme miniaturization;  
ideal for new miniaturized designs and  
printed wiring circuits. New "hairpin"  
parallel leads insure easy applications  
in radio, television, guided missiles.  
El-Menco Dur-Micas meet all humidity,  
temperature and electronic  
requirements, including military specs.



# El-Menco

Capacitors

## THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

WILLIMANTIC CONNECTICUT

- molded mica
- mica trimmer
- dipped paper
- tubular paper
- ceramic feed-thrus
- silvered mica films
- ceramic discs

Arco Electronics, Inc., 64 White St., New York 13, N. Y.  
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

CIRCLE 44 ON READER-SERVICE CARD

## NEW PRODUCTS

### Pulse Generator

Offers multiple pulse code trains



Modules of the B3-2A pulse generator are connected through a patch panel so that multiple pulse code trains can be set up. The generator provides repetition rates from 10 cps to 1 mc. Four variable delay circuits have delays from 0 to 10,000  $\mu$ sec for controlling pulse position or width. The two pulse forming units produce positive or negative pulses with 0.02  $\mu$ sec rise and fall times and 25 v amplitude. Output impedance is 50 ohms, and the duty factor of the output pulse is 25 per cent. Rise time can be degraded to 1  $\mu$ sec.

Rutherford Electronics Co., Dept. ED, 8944  
Lindblade St., Culver City, Calif.

CIRCLE 45 ON READER-SERVICE CARD

### Temperature Recorder-Controllers

Ranges between -100 and +100 F



These temperature recorder-controllers cover the full range of filled systems. Model 7815 is a single pen recorder; models 7816 and 7817 are two pen, two control and one control units. Charts are 12 in., and ranges are between -100 and +100 F. A universal controller can be used for proportional, on-off, or differential gap control.

Daystrom, Inc., Daystrom-Weston Industrial  
Div., Dept. ED, Newark 12, N.J.

CIRCLE 46 ON READER-SERVICE CARD

TUBE PRODUCTION IS A SCIENCE AT VARIAN

## Resistance Bridge

Range of 1 K to 110 million meg



For calibrating high megohm resistors, this standard bridge covers the range from 1 K to  $1.1 \times 10^{11}$  ohms. Accuracy is 0.2 per cent up to  $10^{13}$  ohms. The test potential is continuously variable up to 1 kv, permitting accurate voltage coefficient analysis of components.

Mid-Eastern Electronics, Inc.,  
Dept. ED, 32B Commerce St.,  
Springfield, N.J.

CIRCLE 47 ON READER-SERVICE CARD

## Voltage Regulators

In sizes to 7.5 kw



With these primary voltage regulators, 10 to 20 per cent regulation in existing systems can be improved to 1 per cent for all conditions of line and load variation. In sizes to 7.5 kw, and 3 and 1 phase at 50 and 60 cps.

Gemco Electric Co., Dept. ED,  
25685 W. Eight Mile Rd., Detroit  
40, Mich.

CIRCLE 48 ON READER-SERVICE CARD

## Digital Voltmeter

Modular construction

Composed of a universal power module and a four-digit switch module, the DVA-400 transistorized digital voltmeter measures dc voltages from 0.0001 to 1100 v. The unit is accurate to  $\pm 0.01$  per cent and 1 digit.

Electro Instruments, Inc., Dept.  
ED, 3540 Aero Court, San Diego  
11, Calif.

CIRCLE 49 ON READER-SERVICE CARD

CIRCLE 50 ON READER-SERVICE CARD ➤

## Full dress inspection

This Optical Comparator with magnifications up to 50 times provides an extremely accurate check on component parts dimensions — particularly those of complex hole relationships. And only those that meet the most rigid tolerances find their way into **Varian Klystrons and Wave Tubes**.

This is typical of the care involved in the manufacture of **Varian Tubes**... and one of the reasons why they consistently give the finest performance. Over 100 of these tubes are described and illustrated in our latest catalog. Write for your copy today.



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MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

## NEW PRODUCTS

### Null-Balance Indicator

Utilizes accumulative reading



To obtain high readability and accuracy, this miniature null-balance potentiometer indicator utilizes an accumulative reading. Supplied with a remotely mounted servo amplifier, the unit has 0.25 per cent accuracy and 0.1 per cent sensitivity.

Westronics, Inc., Dept. ED, 3605 McCart St., Fort Worth, Tex.

CIRCLE 51 ON READER-SERVICE CARD

### Memory Processor

Has two recording modes



An 8-in. diameter hermetically sealed disc, this memory processor has two recording modes. One uses fixed channels for digital computation and control; the other uses a scanning head channel for data processing and correlative control.

Genesys Corp., Dept. ED, 10131 National Blvd., Los Angeles, Calif.

CIRCLE 52 ON READER-SERVICE CARD

### Not So Fast

Consolidated Electrodynamics' type 5-680 recorder/reproducer starts and stops in under 3 msec—not 3 usec, as reported in the Sept. 3 ELECTRONIC DESIGN.

## A PARTIAL LISTING OF INTERNATIONAL ...THE MOST EXTENSIVE

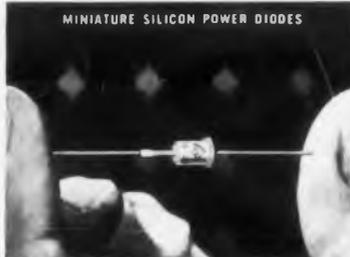
## ELECTRONIC TYPES FOR INDUSTRIAL AND MILITARY APPLICATIONS

### SILICON AND SELENIUM

### LOW CURRENT TYPES TO 1 AMP.

#### SPECIAL MILITARY TYPES

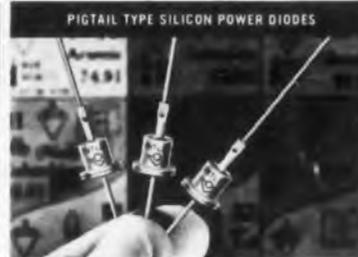
Special configurations and high reliability rectifiers for military applications may be obtained under our "Prescribed Reliability" Program. Address your inquiry to: Military Products Dept.



MINIATURE SILICON POWER DIODES

Ratings: 100 to 600 PIV, Up to 500 ma.

Specifically designed for missile and airborne equipment applications where miniaturization and reliability are prime factors. Hermetically sealed, all-welded, pigtail lead construction. Manufactured to meet the most rigid military requirements. Request Bulletin SR-203



PIGTAIL TYPE SILICON POWER DIODES

Ratings: 50 to 600 volts PIV • 250 to 750 ma.

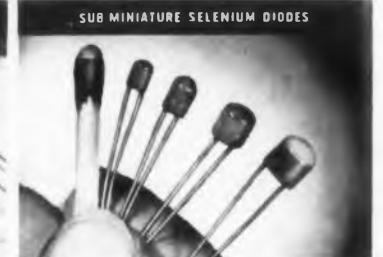
An extensive line of silicon power diodes for military and industrial applications featuring all-welded, hermetically sealed construction. All designed and manufactured to meet the most rigid military requirements. For information on types for your application Contact Factory



STUD MOUNTED SILICON POWER DIODES

Ratings: 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-135C



SUB MINIATURE SELENIUM DIODES

Ratings: 20 to 160 volts • 100µa 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.



SELENIUM RECTIFIER STACKS

Ratings: From 100 ma. to 50 Amps.

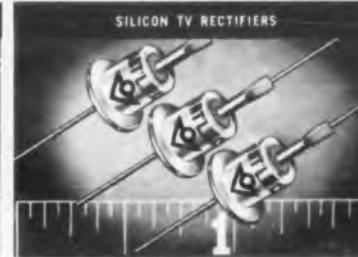
Low forward voltage drop and low leakage characteristics make this series ideal for a wide variety of power applications. For details request Bulletin C-439, (28 volt cells); Bulletin SR-160, (45 to 52 volts per cell) and Bulletin SR-152, on high current density cells.



SELENIUM TV AND RADIO RECTIFIERS

Ratings: 25 to 156 volts AC, 50 to 1,200 ma. DC

The widest range in the industry! Designed for Radio, Television, TV booster, UHF converter and experimental applications. Input ratings from 25 to 156 volts AC and up. DC output current 50 to 1,200 MA. Write for application information. Bulletin ER-176-A



SILICON TV RECTIFIERS

Ratings: 400 PIV, up to 750 ma.

SD-500. A hermetically sealed, all-welded silicon junction rectifier offering maximum reliability in the high temperatures encountered in TV applications. Pigtail leads eliminate the need for brackets, blocks, etc., simplify installation. For complete data: Contact Factory.



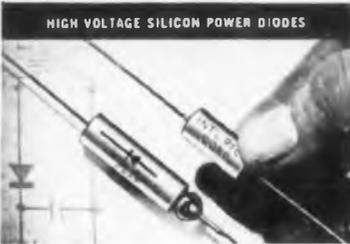
HIGH Q VOLTAGE VARIABLE CAPACITOR

Ratings: Q of 1000, 200 PIV DC

Semicap's small size, light weight, high reliability and low power requirements make it ideal for automatic frequency control, frequency modulation oscillators and filter networks. All-welded hermetically sealed, shock-proof housing. Request Bulletin SR-205.

### SILICON AND SELENIUM

### HIGH VOLTAGE TYPES



HIGH VOLTAGE SILICON POWER DIODES

Rating: 600 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-157.



HIGH VOLTAGE SILICON CARTRIDGE RECTIFIERS

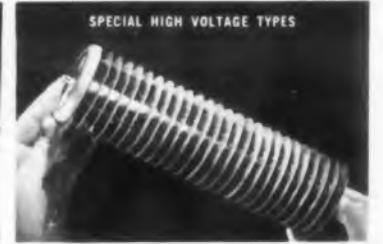
Ratings: 1500 to 16,000 volts PIV @ 45 to 440 ma. Especially suited for miniaturized military equipment where optimum reliability is a prime factor. Standard types for normal convection cooling and high current types for forced air or oil cooling. Hermetically sealed, metallized ceramic housing. Request Bulletin SR-223



SELENIUM HIGH VOLTAGE CARTRIDGE RECTIFIERS

Ratings: 20 to 20,000 volts • 0.2 to 195 ma.

Designed for long life and reliability in half-wave, voltage doubler, bridge, center-tap circuits, and 3-phase circuit types. Phenolic cartridges and hermetically sealed types available. Operating temperature range: -65°C to +100°C. For details specify Bulletin M-2.



SPECIAL HIGH VOLTAGE TYPES

Rating: 12,500 volts PIV at 5 Amps.

Illustrated above is a typical rectifier of advanced design produced by International Rectifier Corporation for military application. Data on ruggedized silicon substitutes for many standard vacuum tubes may be obtained from our Military Products Department.

# International

EXECUTIVE OFFICES: EL SEGUNDO, CALIF.

The World's Largest Supplier of Industrial Metallic Rectifiers • Selenium • Germanium • Silicon

RECTIFIERS FOR ALL DC REQUIREMENTS...FROM MICROWATTS TO MEGAWATTS!

## RECTIFIER CORPORATION PRODUCTS

LINE OF QUALITY RECTIFIERS ON EARTH!

*All designed and manufactured to meet the most rigid military requirements!*

### POWER TYPES FOR INDUSTRIAL AND MILITARY APPLICATIONS

**SILICON AND SELENIUM MEDIUM CURRENT TYPES TO 150 AMPS.**



**SILICON RECTIFIER STACKS**  
Utilizing junctions rated to 1.25 amps DC output. These stacks consist of hermetically sealed junction diodes mounted on copper cooling fins. Stacked to include the interconnections required for specific circuits. Junction ratings: 1.25 amps. DC output: 70 to 350 AC input volts rms. Request **Bulletin SR-137A**



**12 AMP. SILICON POWER DIODES**  
Conservatively rated to provide a substantial safety factor in industrial applications. Hermetically sealed, all-welded case construction provides reliability over a long life. Types available in a wide voltage range. For details **Contact Factory.**



**25 AMP SILICON POWER DIODES**  
Rating: 50 to 500 volts PIV • 25 to 45 Amps. Advanced ceramic techniques assuring excellent thermal characteristics and mechanical stability are used in the production of these highly reliable, hermetically sealed rectifiers for military or industrial applications. For complete technical data, request **Bulletin SR-304**



**150 AMP. SILICON POWER DIODES**  
Ratings: 50 to 600 volts PIV • 45 to 150 Amps. An extensive series of standard and reverse polarity types. Optional mounting bases including machine thread and pipe thread types. Machine thread base types: **Bulletin SR-300**, Pipe thread base types: **Bulletin SR-301**, Complete stack assemblies: **Bulletin SR-302**

**SILICON, SELENIUM AND GERMANIUM HIGH CURRENT TYPES TO 670 AMPS. PER JUNCTION**



**SILICON RECTIFIER STACKS**  
Ratings: 45 to 150 Amperes per Junction. Consisting of hermetically sealed junction diodes mounted on aluminum or copper cooling fins, stacked to include the interconnections required for specific circuits. Junction ratings: 45 to 150 amps average DC. Write for application data.



**250 AMP. SILICON POWER DIODES**  
Standard and reverse polarity types offered in a series of machine thread and pipe thread mounting styles. Complete assemblies in all circuit configurations also available. Rugged construction and hermetic sealing assure long life and reliability. Ask for **Bulletin SR-305**



**SELENIUM HEAVY POWER RECTIFIERS**  
Ratings: 6 to 30,000 volts • 50 to 2,300 Amps. Specifically designed for industrial DC power needs. Patented construction features assure long life. Descriptive bulletins available are: **Bulletin C-349**, (26 volt cells), **Bulletin SR-160**, (45 to 52 volts per cell) and **Bulletin SR-152**, on high current density cells.



**GERMANIUM POWER RECTIFIER JUNCTIONS**  
Ratings: 500 amperes • 26 to 68 volts rms. High capacity junctions especially designed for high-current, low-voltage electrochemical installations. Air cooled, these hermetically sealed junctions provide efficiency to 98.5%. Cast aluminum airfoil housing effects maximum heat transfer. For details **Contact Factory.**

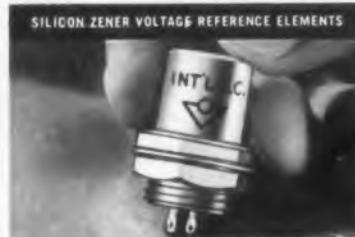
**SPECIAL SEMI-CONDUCTOR DEVICES**



**SELENIUM CONTACT PROTECTORS**  
Complete series of AC and DC types. Designed to eliminate arcing and erosion across the contacts of relays, switches, etc. A complete series in each of three basic types: diode type, cartridge type and hermetically sealed types for industrial application. For complete data, **Bulletin SR-150-A**



**SILICON VOLTAGE REGULATOR ZENER DIODES**  
Ratings: From 600 milliwatts to 10 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 type: **SR-254**



**SILICON ZENER VOLTAGE REFERENCE ELEMENTS**  
Temperature compensated for stability to  $\pm .001\% ^\circ\text{C}$ . Extremely precise units for power supplies and voltage sources. Temperature compensated for excellent stability over a temperature range of from  $-55^\circ\text{C}$  to  $+160^\circ\text{C}$ . Manufactured to meet the most rigid military requirements. Types **1N430**, **1N430A**, **1N430B**. **Bulletin SR-255**



**PHOTOELECTRIC CELLS AND SUN BATTERIES**  
(Wide range of silicon and selenium types.) Self-generating cells available in standard and custom sizes, mounted or unmounted. For details on wide selection of selenium types, request **Bulletin PC-649**. Silicon solar cells in mounted and unmounted types are described in technical detail—specify **Bulletin SR-154**.

For Complete Engineering Data on International Rectifier Corporation Products Described in the Advertisement USE THESE READER-SERVICE CARD NUMBERS

#### ELECTRONIC TYPES

Silicon and Selenium Low Current Types to 1 amp.

	Circle Numbers Indicated Below on Reader-Service Card
Miniature Silicon Power Diodes	(301)
Pigtail Type Silicon Power Diodes	(302)
Stud Mounted Silicon Power Diodes	(303)
Sub Miniature Selenium Diodes	(304)
Selenium Rectifier Stacks	(305)
Selenium TV and Radio Rectifiers	(306)
Silicon TV Rectifiers	(307)
High Q Voltage Variable Capacitor	(308)

Silicon and Selenium High Voltage Types

High Voltage Silicon Power Diodes	(309)
High Voltage Silicon Cartridge Rectifiers	(310)
Selenium High Voltage Cartridge Rectifiers	(311)
Special High Voltage Types	(312)

#### POWER TYPES

Silicon and Selenium Medium Current Types to 150 amps.

Silicon Rectifier Stacks	(313)
12 Amp. Silicon Power Diodes	(314)
25 Amp. Silicon Power Diodes	(315)
150 Amp. Silicon Power Diodes	(316)

Silicon, Selenium and Germanium High Current Types to 670 Amps. per Junction

Silicon Rectifier Stacks	(317)
250 Amp. Silicon Power Diodes	(318)
Selenium Heavy Power Rectifiers	(319)
Germanium Power Rectifier Junctions	(320)

Special Semi-Conductor Devices

Selenium Contact Protectors	(321)
Silicon Voltage Regulator Zener Diodes	(322)
Silicon Zener Voltage Reference Elements	(323)
Photoelectric Cells and Sun Batteries	(324)
Please have representative call	(325)

# Rectifier Corp.

• OREGON 8-6281 • CABLE ADDRESS: RECTUSA

NEW YORK AREA OFFICE: 132 E. 70th St., TRafalgar 9-3330  
CHICAGO AREA OFFICE: 205 W. Wacker Dr., FRanklin 2-3888  
NEW ENGLAND AREA OFFICE: 17 Dunster St., Cambridge, Mass., UNiversity 4-6520  
PENNSYLVANIA AREA OFFICE: Suburban Square Building, Ardmore, Penn., Midway 9-1428



REPRESENTATIVES THROUGHOUT THE WORLD



#### MODEL 296C MICROWAVE RECEIVER

IF frequency 30 mc

Bandwidth (overall) 1.3 mc at 3 db points

Gain IF amplifier 65 db min.  
Pre-amplifier 30 db min.

Attenuation range, calibrated 0-80 db  $\pm$  0.2 db above 5 db at 30 mc

Self-contained local osc. power supply 600-800v at 50 ma., beam supply

Self-contained AFC System. Constant IF type with a time constant of about 0.2 sec.

For highly accurate measurements

at all microwave and UHF frequencies...

## SPERRY'S MODEL 296C MICROWAVE RECEIVER

This Sperry Microline® Receiver is a precision instrument of great accuracy enabling measurements at all microwave and UHF frequencies.

Model 296C can be used for measuring coupling and directivity of directional couplers, relative field strength, very high and very low VSWR, antenna patterns and as a general-purpose microwave laboratory receiver. In addition, this receiver was designed for use as a good secondary standard of attenuation.

A completely self-contained unit, it includes a 30-mc pre-amplifier, 30-mc IF amplifier, 30-mc calibrated attenuator, local oscillator power supply and AFC circuits. The 296C

requires only the use of a local oscillator and an appropriate mixer for operation at any microwave or UHF frequency.

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

**SPERRY** MICROWAVE ELECTRONICS  
COMPANY

CLEARWATER, FLORIDA

Division of Sperry Rand Corporation

ADDRESS ALL INQUIRIES to Clearwater, Florida or Sperry Gyroscope offices in New York, Cleveland, New Orleans, Los Angeles, San Francisco, Seattle.

CIRCLE 53 ON READER-SERVICE CARD

## NEW PRODUCTS

### Transistor Circuit Tester

Checks designs without soldered wires



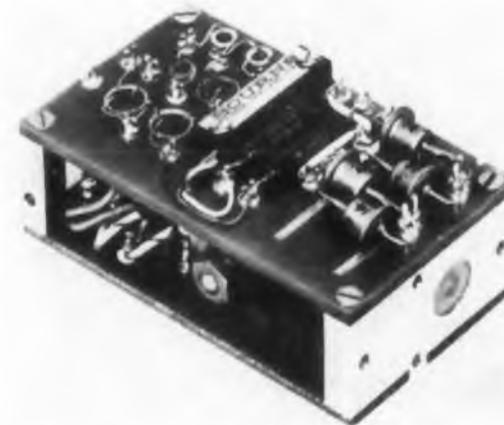
With this synthesizer, designers can check transistor circuit performance without a bread-board of soldered wires. Common base, common emitter, and common collector circuits may be assembled. The tester has a master meter panel and four independent, transistor stage panels. These may be combined for amplifier, flip-flop, oscillator, gate, and other circuit assemblies. Either pnp or npn transistors may be used. The metering panel has a curve tracer which, with an external oscilloscope, allows a display of the collector voltage versus collector current plot.

National Electronics Labs., Inc., Dept. ED, 1713 Kalorama Rd., N.W., Washington, D.C.

CIRCLE 54 ON READER-SERVICE CARD

### Power Supply

Series regulated



Regulation is better than 0.1 per cent in two models of series regulated ac to dc power supplies. Model PS 8001 has a current rating of 0 to 1.5 amp, and the PS 8002 is rated at 0 to 0.15 amp. Both models can be factory preset to any specified output voltage between 100 and 200 v. Output is adjustable by potentiometer to  $\pm 5$  per cent. Weight is 7 oz and it measures 1.875 x 1.5 x 3.0 inches. Operates from  $-50$  to  $+125$  C.

Power Sources, Inc., Dept. ED, Burlington, Mass.

CIRCLE 55 ON READER-SERVICE CARD

*not for nearsighted design engineers*

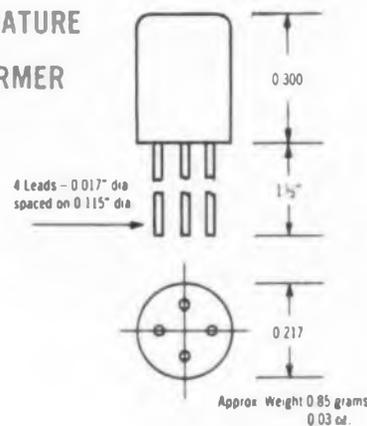


## NEW **ESC** MICRO-MINIATURE PULSE TRANSFORMER

*Fractional Micro-Second Pulse Width*

Where space and weight limitations are precious, ESC's new Micro-Miniature Pulse Transformer fills a vital need in missiles, computers and other electronic equipment. ESC Micro-Miniature Pulse Transformers can be custom built to your specifications for both military and commercial applications. Write for complete technical data today!

### **ESC** MICRO-MINIATURE PULSE TRANSFORMER



*electronic components division*

# **ESC**

CORPORATION • 534 BERGEN BOULEVARD • PALISADES PARK, NEW JERSEY

*exceptional employment opportunities for engineers experienced in pulse techniques*

Pulse transformers • Medium and low power transformers • Filters of all types • Pulse forming networks • Miniature plug in encapsulated circuit assemblies • Distributed constant delay lines • Lumped constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines

CIRCLE 56 ON READER-SERVICE CARD

# **ESC**

**WILL  
SHARE ITS  
PROFITS**  
*with*

**ENGINEERS...**  
*Experienced  
Computer  
Components*

ESC Corporation, one of America's fastest growing engineer-managed electronics manufacturers, offers both a challenging position in design and development and a chance to share in its growing profit-sharing plan. You can work under supervision or assume responsibility for these vital ESC projects:

**Audio and Video Filters  
Delay Lines  
Core Matrices  
Magnetic Shift Registers**

A minimum of 3 years general experience is required with 1 year of pulse techniques preferred. In addition to an excellent salary commensurate with ability, you'll receive all company-paid benefits. Write or telephone in confidence to—

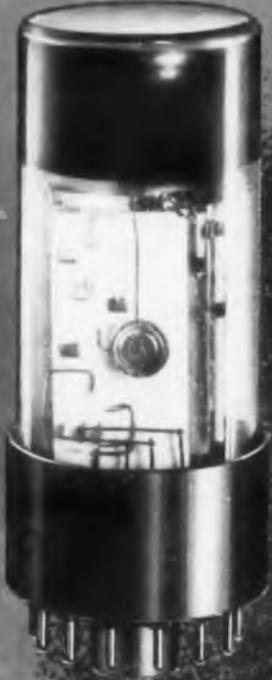
MR. RAY GRASSI



# **ESC** CORPORATION

534 BERGEN BOULEVARD  
PALISADES PARK, N. J.  
Windsor 7-0400

CIRCLE 551 ON READER-SERVICE CARD



**25% Better!**

**DU MONT 50  $\mu$ a/L**

STANDARD OF THE INDUSTRY 40  $\mu$ a/L

**NOW STANDARD\* DU MONT  
MULTIPLIER PHOTOTUBES GUARANTEE  
50  $\mu$ a/LUMEN MINIMUM CATHODE  
LUMINOUS SENSITIVITY  
AT NO EXTRA COST...**

30  $\mu$ a/L

20  $\mu$ a/L

10  $\mu$ a/L

Again, it's Du Mont with the biggest news first... Through advanced production techniques, plus new quality control concepts, Du Mont now guarantees a minimum of 50  $\mu$ a/lumen cathode luminous sensitivity in these standard multiplier phototubes at no extra cost. This 25% increase in sensitivity results in a higher signal-to-noise ratio in the overall system. Design with the best—design with Du Mont Multiplier Phototubes—they give you more to start with...

*Write for complete technical details.*

\*Types 6467, 6291, 6292, 6363, 6364

**DU MONT** Precise **PHOTOELECTRONICS**  
INDUSTRIAL TUBES SALES • ALLEN B. DU MONT LABORATORIES, INC. • 750 Bloomfield Ave., Clifton, N. J., U.S.A.

CIRCLE 57 ON READER-SERVICE CARD

## NEW PRODUCTS

### Oscillograph Recorder

Mobile 12 channel unit



This 12-channel mobile oscillograph recorder has interchangeable plug-in preamplifiers, separately mounted driver amplifiers and a multi-channel recorder. Write-out is by ink, electric or heated stylus. The direct-writing galvanometers are protected from signal overload damage and are mounted in a compact array for minimum recording table width.

Edin Co., Div. of Epsco, Inc., Dept. ED, 207 Main Street, Worcester 8, Mass.

CIRCLE 58 ON READER-SERVICE CARD

### Stepper Motor

Offers reliability



This stepper motor has a life that exceeds 24,000,000 steps. It will meet MIL specifications on vibration, temperature, shock and acceleration. The unit steps 9 times per revolution and weighs 4.5 oz. At 17.5 w input it will produce 2.5 oz in. of torque and follow a 25 cps pulse with a low torque, low inertia load. Higher pulse rates are possible if torque requirements are reduced.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

CIRCLE 59 ON READER-SERVICE CARD

## Sinusoidal Oscillator

25 cps to 100 kc range



Epoxy encapsulated, the S-100 silicon transistor oscillator creates a sine wave signal source. It stands 500 g shock for 11 msec, 30 g vibration to 2500 cps, and 700 g acceleration. Frequency range is 25 cps to 100 kc.

Solid State Electronics Co., Dept. ED, 8158 Orion Ave., Van Nuys, Calif.

CIRCLE 60 ON READER-SERVICE CARD

## Silicon Rectifiers

Low current units



Hermetically sealed series H silicon rectifiers have a welded case and heavy duty junction. Ratings are 100 to 600 piv and 750 ma to 55 C.

Sarkes Tarzian, Inc., Dept. ED, 415 N. College Ave., Bloomington, Ind.

CIRCLE 61 ON READER-SERVICE CARD

## Miniature Blower

Delivers 165 cfm



At 20,000 rpm the Aximax-3 fan delivers 165 cfm. For cooling electronic gear in missiles, it is 2.8 in. in diameter, 2.3 in. deep.

Rotron Mfg. Co., Inc., Dept. ED, Woodstock, N.Y.

CIRCLE 62 ON READER-SERVICE CARD

CIRCLE 63 ON READER-SERVICE CARD ➤



## Successful Vanguard equipped with Union miniature relays

**March 17, 1958**—Union Switch & Signal 6 PDT miniature relays functioned perfectly in the separation controls between the first and second and second and third stages . . . in the first stage propulsion unit . . . and in the third stage spin control assembly of the satellite-bearing Vanguard.

The Martin Company, builders of the Vanguard, chose these outstanding relays for their reliability . . . for their simple, rotary design . . . and for the expert quality control associated with the established leader in electrical relay design—Union Switch & Signal.

The 6 PDT relay used in the Vanguard is just one of a complete line of *dependable* relays designed by Union Switch & Signal—"Pioneers in Push-Button Science." Send the coupon for complete technical information.

### COMPLETE FACTS

Union Switch & Signal, Adv. Dept.  
Pittsburgh 18, Pennsylvania

Please send information on the following:

- New 4PDT relay which meets every requirement of MIL-R-25018.
- Catalog of other miniature dc and ac relays.
- Digital and Alpha-Numerical Indicators for data display.

Name \_\_\_\_\_ Position \_\_\_\_\_

Firm \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

*"Pioneers in Push-Button Science"*



# UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

## NEW PRODUCTS

### Time Delay Relay

Instant recycling



Using any standard ac or dc operating voltage, the MTRH-8 time delay relay offers instant recycling and accurate timing, independent of voltage variation, for 15 to 180 sec fixed delays. The spst unit weighs 3 oz.

Branson Corp., Dept. ED, 41 S. Jefferson Rd., Whippany, N.J.

CIRCLE 64 ON READER-SERVICE CARD

### Spectrum Analyzer

10 mc to 44 kmc range



With one tuning head, the SPA-4 spectrum analyzer covers frequencies from 10 mc to 44 kmc. Amplitude scales are calibrated for voltage and power as well as log.

Panoramic Radio Products, Inc., Dept. ED, 514 S. Fulton Ave., Mount Vernon, N.Y.

CIRCLE 65 ON READER-SERVICE CARD

### Power Resistors

5 to 50 w units



Powerpack silicone sealed miniature power resistors have anodized radiator finned aluminum housing and come in 5 to 50 w sizes. Tolerances are from 0.05 to 5 per cent; resistances, from 0.1 ohms to 100 K.

Tech-Ohm Resistor Corp., Dept. ED, 36-11 33rd St., Long Island City, N.Y.

CIRCLE 66 ON READER-SERVICE CARD

# ANACONDA ANATHERM



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# First polyester high-temperature magnet wire in full range of sizes

— — ROUND



— — SQUARE



— — RECTANGULAR



Anatherm, Anaconda's Class 155°C polyester film-coated magnet wire is now available in single, heavy, triple and quadruple grades of round wires (sizes 8 through 46) and in a full range of sizes of squares and rectangles. This is the first time a complete range of sizes and shapes has been offered in this type wire.

Fully tested for use at temperatures up to 155°C, Anatherm was also the first film-coated wire to meet the newly adopted AIEE 155°C (Class F) rating.

Anatherm gives you greater thermal stability—plus excellent abrasion-resistance, chemical stability and dielectric strength. Thus Anatherm is ideally suited for manufacturers seeking maximum per-

formance and reliability from smaller and smaller equipment operating at higher and higher temperatures.

As a polyester magnet wire, Anatherm can be used equally successfully at any "hottest-spot" temperatures over the range of 105°C to 155°C. If you're on the spot about high-temperature magnet wire, ask the Man from Anaconda about Anatherm.



Write for free Anatherm technical bulletin: Anaconda Wire & Cable Co., 25 Broadway, New York 4, New York.

58364



SEE THE MAN FROM **ANACONDA**<sup>®</sup>

FOR ANATHERM MAGNET WIRE

FROM ANACONDA... THIS WIDE VARIETY OF TOP-QUALITY MAGNET WIRES—

**ANALAC** (Class A-105°C)  
solderable magnet wire



**VITROTEX** (Class B-130°C)  
glass-insulated, high heat resistance



**PLAIN ENAMEL** (Class A-105°C)  
low-cost enameled magnet wire



**NYFORM** (Class A-105°C)  
high resistance to winding hazards



**EPOXY** (Class B-130°C)  
all-round compatibility



## Ohmmeter

Measures 1 microhm

This portable low resistance test set combines model 151-S microhm meter and model SM rectifier for supplying both a 10 and 100 amp dc current source. It measures resistances down to 1 microhm with 2 per cent accuracy.

J. W. Dice Co., Dept. ED, Englewood, N.J.

CIRCLE 67 ON READER-SERVICE CARD

## Vibrating Capacitor

±0.2 mv drift in 24 hours



Filled with inert gas, these vibrating capacitors drift less than ±0.2 mv in 24 hours at constant temperatures. Capacitance is 20 µfd, and excitation voltage is 4 v rms, 50 to 200 cps.

Tracerlab, Inc., Dept. ED, 1601 Trapelo Rd., Waltham 54, Mass.

CIRCLE 68 ON READER-SERVICE CARD

## Microwave Attenuators

Direct reading



Frequency ranges of these direct reading microwave attenuators are from 2.6 to 3.95 kmc to 12.4 to 18 kmc. Units in each range have 20 or 40 db maximum attenuation. They have a maximum vswr of 1.15 and feature accurate attenuation settings.

Polytechnic Research & Development Co., Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N.Y.

CIRCLE 69 ON READER-SERVICE CARD

CIRCLE 70 ON READER-SERVICE CARD

# WHY?



**Y**ESTERDAY it wasn't there. Today, he picks it up and wonders: *why did it grow like that?* The miracle of growth! Whether it's a "toadstool" that springs up overnight or a cancer cell that suddenly comes into being, we've a lot to learn about the whole beautiful process of orderly growth . . . and the dreadful, senseless growth that is cancer.

**The cancer puzzle** is tied up in growth—growth of body cells smaller than the periods on this page.

Scientists, working under grants from the American Cancer Society, are ceaselessly studying cells—normal and cancer cells. And they too are asking: *Why?*

*Why* do cells suddenly change from normal growth to uncontrolled, disorderly growth? This question can be answered only by the most probing, painstaking and costly research.

**Your contributions** to the American Cancer Society will support hundreds of scientific studies necessary to save lives today and tomorrow.

Remember: Cancer can strike anyone. But you can strike back *hard* with your dollars. Send your gift to **CANCER** in care of your local post office.

# AMERICAN CANCER SOCIETY



## NEW PRODUCTS

### Breadboard Kit

For transistors



Model BP-31TR transistor mounting kit contains twenty push-in type lugs for component wiring, four no. 3304 round sockets and rings for mounting, four no. 799BC rectangular sockets and four clamps for mounting in flat position.

Specific Products, Dept. ED, 21051 Costanso St., Woodland Hills, Calif.

CIRCLE 72 ON READER-SERVICE CARD

### Waveguide Components

For Q and Ka bands



These Hilger & Watts waveguide components are for use in Q and Ka bands. The Q band equipment includes mechanically tuned reflex klystrons, swr indicators, wavemeters, thermistors with mounts, and precision attenuators.

British Industries Corp., Dept. ED, Port Washington, N.Y.

CIRCLE 73 ON READER-SERVICE CARD

### Inverter

All transistorized

Transistorized model 4309 is a 9.5 lb, 250 va static inverter that produces both 1 and 3 phase 400 cps power from 28 v dc input. Single phase power is 170 to 200 va; 3 phase, about 50 w.

Varo Mfg. Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

CIRCLE 74 ON READER-SERVICE CARD

## Combination Potentiometer and Milliammeter

Two voltage ranges



The MV-1 potentiometer section has two voltage ranges: 0 to 60 mv and also 95 to 105 mv. Its ammeters are scaled from 0 up to 5.0 ma dc.

Technique Associates Inc., Dept. ED, P.O. Box 91, Indianapolis 6, Ind.

CIRCLE 75 ON READER-SERVICE CARD

## Pressure Transducer

For airborne telemetering use



For airborne telemetering and control, the P21 pressure transducer comes in ranges from 1 to 1000 psi gage, differential, and absolute. Accuracy is  $\pm 0.5$  per cent full scale.

Pace Engineering Co., Dept. ED, 6914 Beck Ave., North Hollywood, Calif.

CIRCLE 76 ON READER-SERVICE CARD

## Microwave Filter

0.5 db insertion loss

With a power rating of 300 w cw, model 210 tunable uhf cavity filter covers the 200 to 420 mc range. Insertion loss is about 0.5 db; Q factor, about 150; and vswr, 1.3.

Adams-Russell Co., Inc., Dept. ED, 292 Main St., Cambridge 42, Mass.

CIRCLE 77 ON READER-SERVICE CARD

CIRCLE 78 ON READER-SERVICE CARD ➤

# PERFECT SURFACE...EXTREME HARDNESS...LOW COST

## —all this and more, with LINDE Sapphire!

To assure dependability under the most severe conditions, tiny valve poppets and seats of pilot relief valves for space vehicle tanks built by Whittaker Controls are made from LINDE Sapphire. LINDE Sapphire was selected over other materials for this critical use because of its perfectly smooth surface, extreme hardness, and relatively low cost. Other advantages are resistance to corrosion and fast deliveries from LINDE.

Among other properties of LINDE Sapphire are zero porosity, great strength at elevated temperatures, and a high melting point of 2040° C. LINDE Sapphire is transparent, may be clear or red. It is easily sealed to metals or ceramics and has excellent IR transmission characteristics.

LINDE Sapphire is supplied in the form of balls, rods, tubes, domes, and special shapes to order. For more information, write Crystals Department, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Pilot section of this pressure relief valve has poppet ball (red) and seat of LINDE Sapphire. Valve was designed and manufactured by Whittaker Controls Division of Telecomputing Corporation.

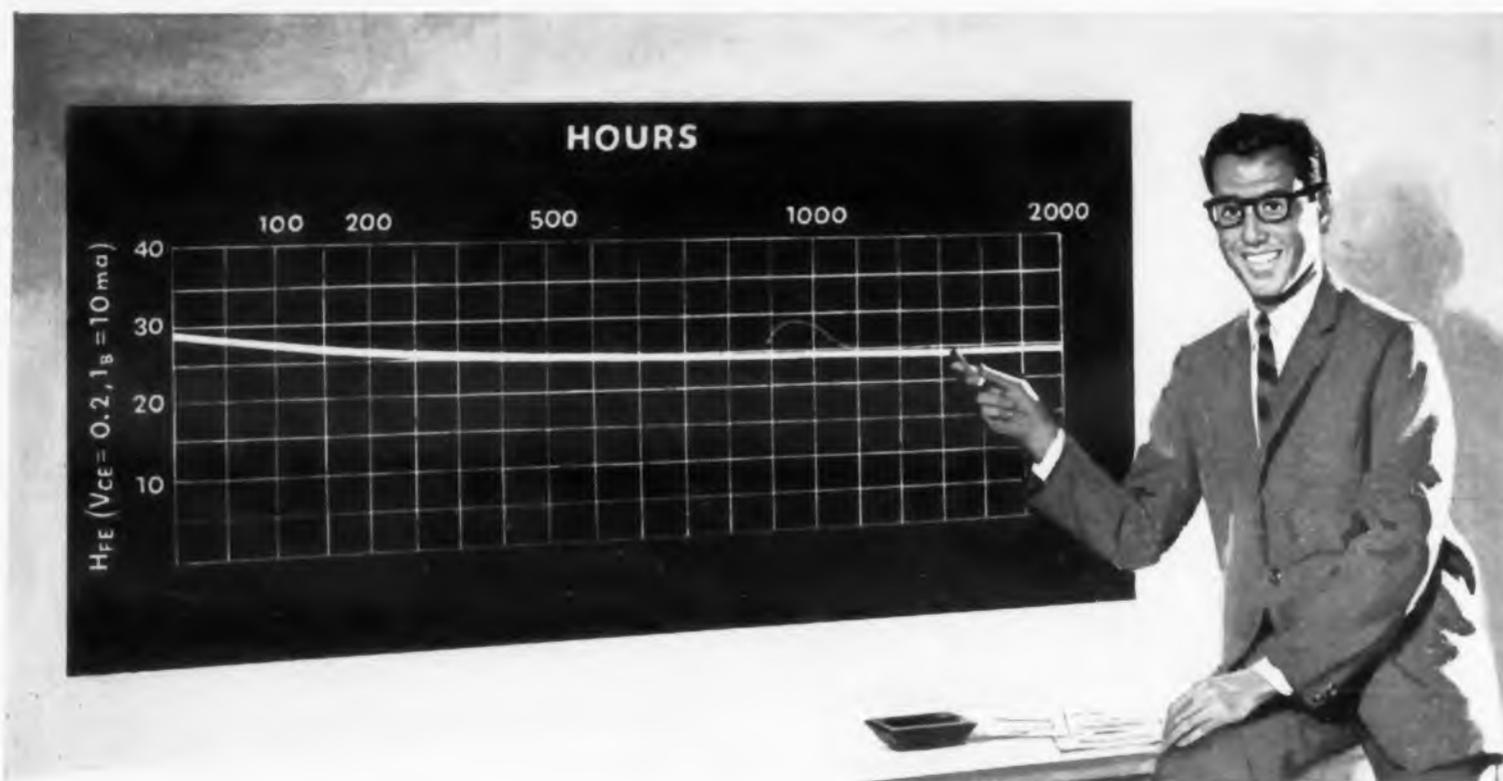
"Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation.

*Linde*  
TRADE MARK

UNION  
CARBIDE



# SYLVANIA-NPN SWITCHING TRANSISTORS

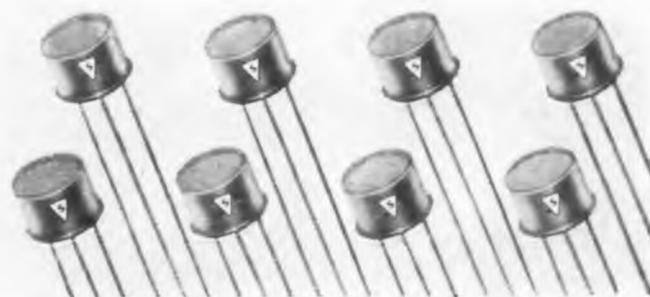


## ...still holding the line at 2000 hours

Eight new high stability NPN switching transistors designed for wide application in low and medium power switching circuits, are now available from Sylvania. They increase to 15, the total number of NPN switching types in the Sylvania line. Most of the units now have passed 2,000-hour evaluations and are continuing to maintain the high Beta stability and fast rise time so important in switching applications.

The fifteen NPN germanium transistors include both base-on-the-can types with 150 mw and 200 mw dissipation and base-off-the-can types with 100 mw dissipation.

Each of the types features the Sylvania welded hermetic seal for full protection against humidity and other environmental conditions and meets JETEC TO-5 and TO-9 dimensions. For further particulars on the entire line, contact your Sylvania representative or write Sylvania direct.



Type	Max. Dissipation at 25° Ambient	Max. Junction Temp. (°C)	Max. $I_c$ (ma)	Current Gain $h_{FE}$	Max. Rise Time, $t_r$
2N439	100 Mw	85	100	40	2.5 $\mu$ sec
2N556	100 Mw	85	200	30	3.5
2N557	100 Mw	85	200	30	6.5
2N558	100 Mw	75	200	35	3.5
2N376*	200 Mw	100	400	40	2.0
2N576A*	200 Mw	100	400	60	2.0
2N587*	150 Mw	85	200	30	2.0
2N679*	150 Mw	85	100	20	3.0
2N312	100 Mw	85	200	20	1.5
2N356	100 Mw	85	500	30	2.0
2N357	100 Mw	85	500	30	1.2
2N358	100 Mw	85	500	30	0.8
2N377*	150 Mw	100	200	40	2.5
2N385*	150 Mw	100	200	70	-
2N388*	150 Mw	100	200	110	1.0

\*Base internally connected to the case



# SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.  
1740 Broadway, New York 19, N. Y.  
In Canada: Sylvania Electric (Canada) Ltd.,  
P. O. Box 1190, Station "O," Montreal 9

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

CIRCLE 79 ON READER-SERVICE CARD

## NEW PRODUCTS

### Q Meter

Range of 100 kc to 100 mc



For use at frequencies between 100 kc and 100 mc. Oscillator is modulated at 60 cps 50 per cent, so that dc amplifiers need not be used in the voltmeter.

North Hills Electric Co., Inc., Dept. ED, 402 Sagamore Ave., Mineola, N.Y.

CIRCLE 80 ON READER-SERVICE CARD

### Telemetry Transmitter

Highly stable



Crystal stabilized, the TR-12 telemetry transmitter offers a 225 to 260 mc tuning range and up to 4 w output with a plate supply of 250 v. Its true fm design permits a 125 kc deviation over a 300 cps to 80 kc modulation range with 1 per cent distortion.

Dorsett Labs, Inc., Dept. ED, 401 E. Boyd St., Norman, Okla.

CIRCLE 81 ON READER-SERVICE CARD

### Miniature Connectors

Have removable contacts



Snap-in DS connectors have removable contacts, silicone inserts, and crimp-type solderless terminations. Wire depth can be checked after crimping through an inspection hole. The units withstand temperatures from -100 to +300 F.

The Deutsch Co., Dept. ED, 7000 Avalon Blvd., Los Angeles 3, Calif.

CIRCLE 82 ON READER-SERVICE CARD

## Flexible Coupling

Weight 1.5 g

Gear Grip 5-G is a flexible coupling 0.74 in. long with a 0.4 in. OD. It weighs 1.5 g. End fittings are available with or without 4-40 set screws. Standard shafts are 1/8, 3/16, and 1/4 in.

Guardian Products Corp., Dept. ED, 1215 E. Second St., Michigan City, Ind.

CIRCLE 83 ON READER-SERVICE CARD

## Multipoint Control

Nonindicating

Adjustable for one through six-point operation, model 6134 is a continuous control for use where no chart record is needed. The device needs no batteries, standard cell and standardizing mechanisms, or periodic standardization. Scanning cycle is adjustable to 2, 5, or 10 sec per point.

Daystrom, Inc., Daystrom-Weston Industrial Div., Dept. ED, Newark 12, N.J.

CIRCLE 84 ON READER-SERVICE CARD

## Silicon Transistor

For switching and transmission



A vacuum-sealed npn unit, the 2N560 double diffused silicon transistor is for low power, high gain switching and transmission applications. Maximum collector voltage is 60 v; maximum collector saturation current, 0.1  $\mu$ a at 20 v; and maximum collector capacitance 12  $\mu$ pf at 5 v.

Western Electric Co., Inc., Dept. ED, 120 Broadway, New York 5, N.Y.

CIRCLE 85 ON READER-SERVICE CARD

CIRCLE 86 ON READER-SERVICE CARD

BURTON BROWNE New York

# NEW

FILTORS NEW MICRO-MINIATURE...THE MOST ADVANCED DESIGN



Filtors, the leading specialists in the development and manufacture of sub-miniature relays is proud to announce the addition of the new Powrmite micro-miniature relay to its existing line of traditionally outstanding relays.

In every field of achievement there is always one leader. In

Leading manufacturers of hermetically sealed micro and sub-miniature relays.

relays with highest available reliability the leader is Filtors, Incorporated. All of the experience and know how gained in attaining its position of leadership have gone into making Filtors new Powrmite micro-miniature relay *truly reliable* — again the leader in a field of many.

**FILTORS, INC.**

Main office and plant: Port Washington, N. Y., POrt Washington 7-8220  
West coast office: 13273 Ventura Blvd., Studio City, Cal., STanley 3-2770

VIBRATION UP TO 30 G's AT 2000 CPS.  
70 G's SHOCK - 2 AMP OR DRY CIRCUIT  
-65°C. TO +125°C.



## NEW PRODUCTS

### Time Delay Relay

60 msec to 600 sec



This time delay relay is a 6pdt, 5 amp type with delays from 60 msec to 600 sec. Either delay-on-make or delay-on-break configurations are available. Accuracy from  $-62$  to  $+72$  C at constant 28 v dc is  $\pm 4$  per cent. Shock, acceleration, and vibration meet MIL-E-4970.

Voi-Shan Mfg. Co., Dept. ED, 8463 Higuera St., Culver City, Calif.

CIRCLE 87 ON READER-SERVICE CARD

### Audio Oscillator

$\pm 0.002$  per cent frequency stability



Frequency stability of the TCO 300-OC transistorized crystal oscillator is  $\pm 0.002$  per cent from  $-55$  to  $+85$  C. The unit has oven control and square-wave type output. It stands 100 g shock and 10 g vibration to 2000 cps.

Dynamics Corp. of America, Reeves-Hoffman Div., Dept. ED, Carlisle, Pa.

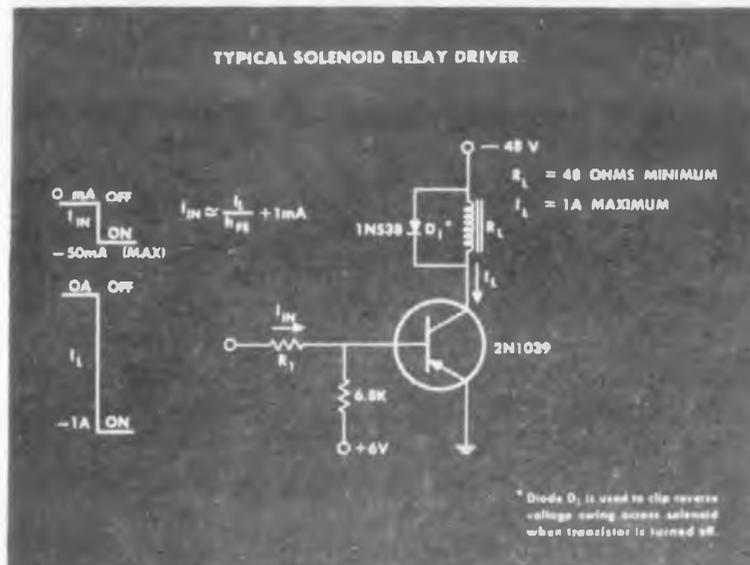
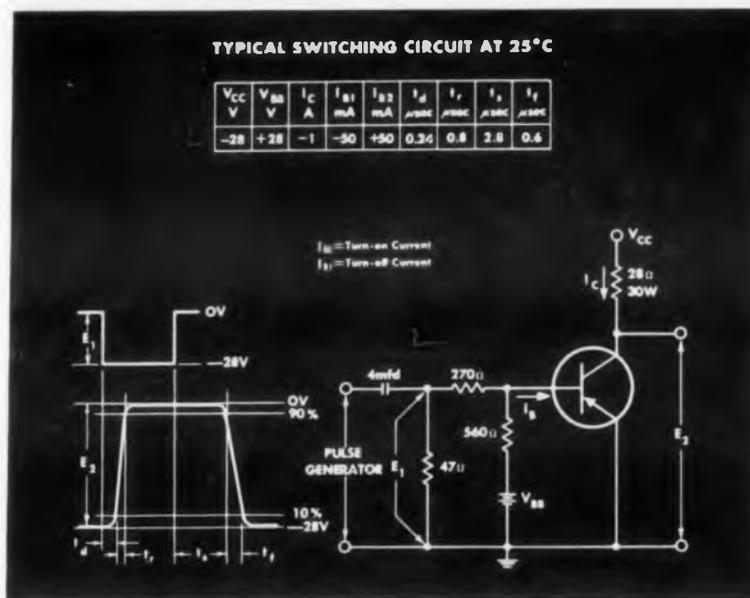
CIRCLE 88 ON READER-SERVICE CARD

### Miniature Motor

Weights 3 oz

Producing 0.2 oz-in. torque at 10,200 rpm, the 65JG1 blower motor is 1.07 in. in diameter, 1.32 in. long, and weighs 3 oz. The 27 v ac,

# INDUSTRY'S BROADEST LINE OF



## NEW POWER SWITCHING TRANSISTORS



(ACTUAL SIZE)

NEW P-N-P germanium power switching transistors *guarantee* 5.5 W dissipation at 25°C with voltage ratings of 40, 60, 80, and 100 volts for optimum design flexibility. The functional design of the heat sink assures rapid installation requiring only one mounting hole through the chassis.

You get *guaranteed* 20-to-60 beta spread and a low 0.16 ohm saturation resistance at the 3A maximum collector rating. In addition, a maximum 125  $\mu$ A collector reverse current is *guaranteed* at one-half rated breakdown voltage with TI 2N1042, 2N1043, 2N1044, and 2N1045 alloy junction transistors.

These new devices are well suited for your switching circuits... relay drivers... audio and pulse amplifiers.

## NEW MEDIUM POWER SWITCHING TRANSISTORS



(ACTUAL SIZE)

NEW P-N-P germanium medium power transistors give you switching times as low as 1.1  $\mu$ sec. TI 2N1038, 2N1039, 2N1040, and 2N1041 alloy junction transistors provide 800 mW dissipation in free air at 25°C, 450 mW at 55°C... with voltage ratings of 40, 60, 80, and 100 volts.

In addition, *guaranteed* 20-to-60 beta spread and low 0.2 ohm saturation resistance assure reliable performance for your high speed switching circuits... relay drivers... low power audio and pulse amplifiers.

	Type	Dissipation at 25°C	Collector Voltage-V max	Collector Current A max	Beta		Collector Reverse Current		Saturation Resistance Ohm
					min	max	$\mu$ A	V	
computer power	pnp	15W	-80	-3	40	70 (Avg)	-1mA	-40	0.75
medium power	pnp	800mW	-40	-1	20	60	-125	-20	0.2
		800mW	-60	-1	20	60	-125	-30	0.2
		800mW	-80	-1	20	60	-125	-40	0.2
		800mW	-100	-1	20	60	-125	-50	0.2
power	pnp	50W	-40	-5	30 @ 5A avg.		-2mA	-40	0.048
		50W	-60	-5	30 @ 5A avg.		-2mA	-60	0.048
		50W	-80	-5	30 @ 5A avg.		-2mA	-80	0.048
		50W	-100	-5	23 @ 5A avg.		-2mA	-100	0.08
		50W	-120	-5	23 @ 5A avg.		-2mA	-120	0.08
		5.5W	-40	-3	20	60	-125	-20	0.16
		5.5W	-60	-3	20	60	-125	-30	0.16
		5.5W	-80	-3	20	60	-125	-40	0.16
		5.5W	-100	-3	20	60	-125	-50	0.16

IMMEDIATELY AVAILABLE IN PRODUCTION QUANTITIES OR...

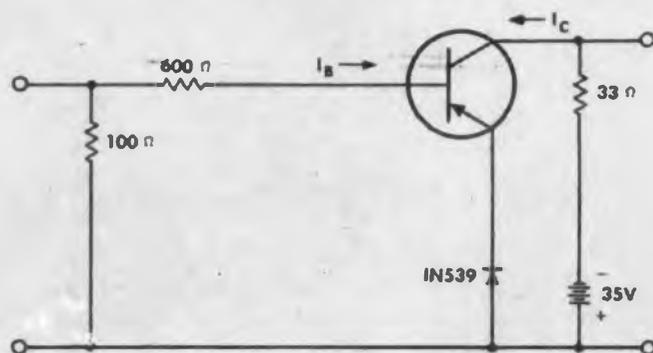
# TEXAS



WORLD'S LARGEST SEMICONDUCTOR PLANT

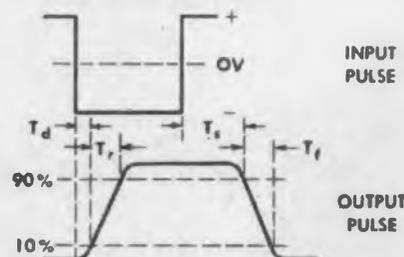
# GERMANIUM POWER TRANSISTORS!

## TYPICAL SWITCHING CHARACTERISTICS



### TYPICAL SWITCHING TIMES

$T_d$	Delay Time	0.3 $\mu$ sec
$T_r$	Rise Time	0.7 $\mu$ sec
$T_s$	Storage Time	1.2 $\mu$ sec
$T_f$	Fall Time	0.5 $\mu$ sec



### TEST CURRENTS

$I_{B1}$	(Turn-on Current)	= -30mA
$I_{B2}$	(Turn-off Current)	= +30mA
$I_C$	(Collector Current)	= -1A

## NEW HIGHEST FREQUENCY COMPUTER POWER TRANSISTOR



(ACTUAL SIZE)

NEW TI 2N1046 combines *high power, high frequency* and *high voltage* performance in a single transistor package! This P-N-P diffused base germanium transistor has *guaranteed* dissipation to 15 watts and collector breakdown voltage to 80 volts with 12 mc typical alpha cutoff. Extremely low collector reverse current averaging 0.2 ma at 40 volts and a low 0.75 ohm saturation resistance assure reliable operating characteristics.

Designed for your deflection circuits and computer core driving applications, the 2N1046 has a typical 10mc internal cutoff frequency,  $f_T$  (point at which forward current transfer ratio equals unity).

## NEW HIGHEST VOLTAGE TRANSISTORS



(ACTUAL SIZE)

NEW TI 2N1021 and 2N1022 germanium transistors, with *maximum operating voltages of 100 V and 120 V respectively*, provide typical betas of 70 at 1A... 23 at 5A!

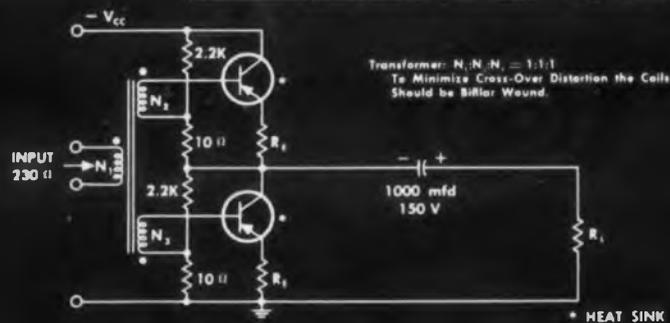
You get *guaranteed* 700  $\mu$ A maximum collector reverse current at one-half rated voltage and 2mA maximum at full rated voltage in addition to extremely low saturation resistance... 0.08 ohm  $R_{CS}$ .

For your audio, servo and power applications, consider these outstanding performance characteristics and specify TI germanium transistors.

## TYPICAL 20 WATT AMPLIFIER

POWER GAIN = 23 db

TRANSISTOR	$V_{CC}$ V	$R_L$ $\Omega$	EFFICIENCY	DISTORTION 20 WATTS	$R_f$ $\Omega$
2N1021	-80	30	66%	2%	3
2N1022	-100	50	66%	2%	5



OFF THE SHELF IN 1-99 QUANTITIES FROM YOUR NEARBY TI DISTRIBUTOR

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3 phase, 400 cps unit meets MIL-M-13787 specifications.

Western Gear Corp., Dept. ED,  
P. O. Box 182, Lynwood, Calif.

CIRCLE 89 ON READER-SERVICE CARD

## Quarter Square Multiplier

For analog computers



For use with analog computers, model 7007 multiplier utilizes a variation of the quarter square multiplication technique and avoids the need for internal amplifiers. Besides improving the frequency response of any analog computing facility, the unit offers low noise and infinite resolution.

Electronic Associates, Inc., Dept. ED, Long Branch, N.J.

CIRCLE 90 ON READER-SERVICE CARD

## DC Differential Amplifiers

Transistorized



Series 130 amplifiers are high gain dc differential units with two inputs and two outputs. They offer a wide variety of performance characteristics which can be obtained by selection of feedback elements. Open loop gains from 60 to 85 db are available.

Burr-Brown Research Corp.,  
Dept. ED, Box 6444, Tucson, Ariz.

CIRCLE 91 ON READER-SERVICE CARD

CIRCLE 92 ON READER-SERVICE CARD

# First from PHILCO



## A Complete Line of COMPUTER TRANSISTORS

Only Philco offers a complete line of specially designed computer transistors. Here are the best transistors for all phases of logic circuitry, read-in and read-out equipment, core-drivers, storage and switching devices.

Philco transistors are being used by all leading computer manufacturers, especially where millimicrosecond speeds are needed. A leading University has proven Philco transistor reliability in actual computer circuits

over tens of millions of transistor service hours.

All Philco transistors are hermetically sealed to insure maximum service life. Available in production quantities from the factory. Also available "off the shelf" in quantities 1 to 99 from your local Philco transistor distributor. When you think of TRANSISTORS . . . think of PHILCO FIRST.

### MEDIUM FREQUENCY, MEDIUM POWER ALLOY JUNCTION TRANSISTORS (250 mw) (in TO-9 package)

- 2N597 . . . . . for use in 200-300 kc computers,  $f_{\alpha_b}$  over 3 mc
- 2N598 . . . . . for use in 300-400 kc computers,  $f_{\alpha_b}$  over 5 mc
- 2N599 . . . . . for use in switching circuits faster than 400 kc,  $f_{\alpha_b}$  over 12 mc

### MICRO-MINIATURE TRANSISTOR

- 2N536 . . . . . high gain switching transistor, 20v maximum  $V_{CE}$ , DC beta typically 150

### HIGH FREQUENCY, HIGH GAIN (MICRO ALLOY) TRANSISTOR (MAT)

- 2N393 . . . . . combines high frequency response with high gain for general purpose, high frequency applications and switching circuits, typical  $f_{max}$  60 mc

### HIGH FREQUENCY SILICON TRANSISTOR (SAT)

- 2N496 . . . . . high speed silicon switch for speeds up to 5 mc characterized by extremely low saturation resistance.

### HIGH FREQUENCY SURFACE BARRIER TRANSISTOR (SBT)

- 2N240 . . . . . switching transistor, typical  $f = 60$  mc

### MICRO ALLOY DIFFUSED-BASE TRANSISTOR (MADT)

- 2N501 . . . . . extremely high speed switch; typical rise time 12 m $\mu$  sec, fall time 4 m $\mu$  sec

### BILATERAL ALLOY JUNCTION TRANSISTOR

- 2N462 . . . . . high gain ( $h_{FE} = 45$  in both directions), high voltage (40v) unit for applications where current reversal is desired

### POWER TRANSISTORS

- 2N353 . . . . . 40 volt, 30 watt power transistor
- 2N386 . . . . . 60 volt, 37.5 watt power transistor
- 2N387 . . . . . 80 volt, 37.5 watt power transistor
- 2N589 . . . . . 100 volt, 37.5 watt power transistor

### PHILCO'S NEWEST FAMILY OF MEDIUM- AND HIGH-POWER SWITCHING TRANSISTORS

- 2N670 . . . . . 300 mw, 2 amp pulse amplifier, in TO-9 type package
- 2N671 . . . . . 40 volt, 1 watt pulse amplifier in case with mounting stud and JEDEC E3-51 base
- 2N672 . . . . . 40 volt, 0.75 microsecond high frequency switching transistor
- 2N673 . . . . . 40 volt, 1 watt, stud mounted switching transistor
- 2N600 . . . . . stud mounted 3/4 watt high speed power switch ( $f_{\alpha_c}$  and 5 MC)
- 2N601 . . . . . stud mounted 3/4 watt high speed power switch ( $f_{\alpha_c}$  and 12 MC)

Make Philco Your Prime Source For All Transistor Information And Prices. Write Dept. ED-1058

**PHILCO CORPORATION**  
**LANSDALE TUBE COMPANY DIVISION**  
**LANSDALE, PENNSYLVANIA**



## NEW PRODUCTS

### Power Transistors

Maximum ratings of 65 w and 13 amp

Germanium pnp types, power transistors CTP 1511 through 1514 are capable of a current gain of 60 to 120 at 5 amp and 50 at 10 amp. Collector to base breakdown voltage ranges from 40 in the CTP 1514 to 100 in the CTP 1511. Absolute maximum ratings are 13 amp of collector current, 90 C junction temperature, and 65 w collector dissipation. Total power dissipation at 70 deg and mounting base temperature is 20 w.

Clevite Transistor Products, Div. of Clevite Corp., Dept. ED, Waltham 54, Mass.

CIRCLE 93 ON READER-SERVICE CARD

### Panel Meter

Has many faces



A variety of panel meters in one, the Unimeter has a basic movement section to which any number of dial components can be fitted in seconds. Dustproof and accurate, it has self-shielded bar-ring movements and ac and dc linear scales.

The Triplett Electrical Instrument Co., Dept. ED, Bluffton, Ohio.

CIRCLE 94 ON READER-SERVICE CARD

### Waveguide Tube

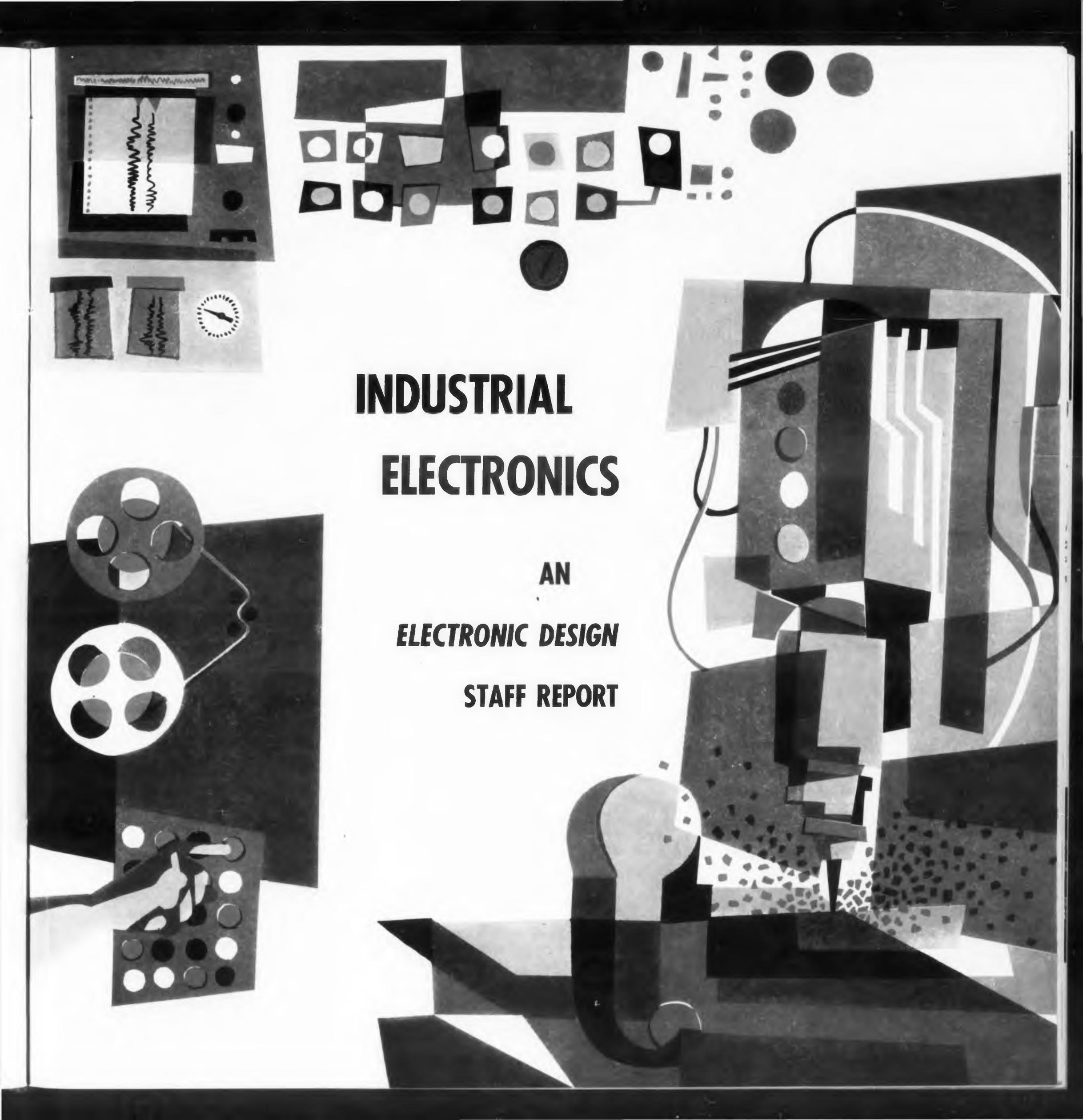
Has sharp corners

Sharp radii permit critical waveguide dimensions to be held into the corners of this stainless steel rectangular tubing. Standard tubes are 5 ft long with inside dimensions from 0.311 x 0.622  $\pm 0.002$  in. to 0.0 x 0.9  $\pm 0.003$  in.

Superior Tube Co., Dept. ED, 1521 Germantown Ave., Norristown, Pa.

CIRCLE 95 ON READER-SERVICE CARD

← CIRCLE 96 ON READER-SERVICE CARD

The background of the cover is a complex, abstract collage of black, white, and gray geometric shapes, including squares, circles, and rectangles, some with internal patterns or cutouts. On the left side, there are several rectangular panels: one with a wavy line graph, another with a circular gauge, and a larger one with a grid of circles and a hand-like shape. On the right side, there are more complex shapes, including a large vertical rectangle with a grid of circles and a large, curved shape that resembles a stylized letter 'C' or a similar symbol. The overall composition is dense and layered, suggesting a technical or industrial theme.

# **INDUSTRIAL ELECTRONICS**

**AN  
ELECTRONIC DESIGN  
STAFF REPORT**

# Industrial Electronics

An ELECTRONIC DESIGN staff report

George H. Rostky  
Associate Editor

Process and Machine Control in Action pg ii  
Designing for Industry pg vi

## Process and Machine Control in Action



Lithium Corp.'s processing plant uses both pneumatic and electrical instrumentation, provided by The Bristol Company.

"**A**NYTHING you want done, we can do with electronics." This old saw has worked out so well in military applications that we lose sight of the fact that there are other ways of doing things. The electronics engineer, on his first tour through a chemical processing plant, or an oil refinery might be quite surprised to see how much control is in the hands of pneumatics, or hydraulics, or mechanical gear.

He may well wonder: "Can't we do these things with electronics? Why don't we?" And therein lies a tale.

### Decisions, Decisions, Decisions

From the very start, an engineer on a plant automation project must make far-reaching decisions—many of them by no means clear cut. He'll have to decide:

- Is automation worthwhile? Will production economies, increased production, a superior product, or tougher competition justify the expense of automatic control?
- How extensive should the system be? Should we control one machine, one line or process, or an entire plant? Shall control be open-loop or closed-loop?
- How reliable will it be? How much will reliability cost? What will down-time cost?
- How many measurements are necessary and how important are they?
- How accurate and how must the system be? be?
- Shall instrumentation be electronic, pneumatic, hydraulic, mechanical—or a combination?



**Fingertip control** for Northrop Aircraft's giant Kearney and Trecker profile and contour milling machine.



**The business end** of a giant tracer-controlled profile milling machine. Electronic controls are by GE's Specialty Control Dept.



**Chips fly** as a deep cut is made in stainless steel by a numerically-controlled machine system with controls by Northrop.

- If electronic—shall it be vacuum tubes, transistors, or magnetic amplifiers.
- Shall information be analog or digital?

## Some Typical Installations

Our engineer might want to look into some installations to see just how things have worked out. He'd want to know what headaches others have had as well as the successes they've had. Here's what he'd probably note.

**Oil Refining.** Tidewater's Delaware Refinery is the largest ever planned and constructed as one overall effort. C. F. Braun & Co. designed and constructed the refinery, but many other companies provided systems, instruments, and hardware. Panellit, Inc. designed thirteen data handling systems to process information from 4700 points throughout the refinery.

Most of the instrumentation is pneumatic. This was motivated by several factors:

- Since control houses are centrally located, the average distance of signal transmission is no more than about 250 feet.
- Response speed is not particularly critical for controlling most of the processes.
- Many employees were already familiar with pneumatic instruments.
- There was no electronic signal standard among manufacturers, while there is a pneumatic signal standard (3 to 15 psi to represent zero to full range).

Tidewater insisted on a high degree of equipment standardization to cut inventories and ease

maintenance. Redundancy was one of the keys to reliability. Almost every motor, for example, can be powered via two distinct paths.

■ At the de-waxing plant of Esso Standard Oil Co.'s Bayonne, N. J. Refinery, our engineer would find a sticky problem automatically controlled. An electro-pneumatic system controls filter washing. Before its installation, filters were cleaned by manually operating a sequence of valves. Now, a battery of electrical timers is energized when the system detects too low a filter feed rate, indicating a dirty filter cloth.

Relays connect time-controlled contacts to electro-pneumatic actuators for the filter control valves. Then feed, vacuum, and cold solvent valves are closed. The valve for hot solvent filter wash is opened and the filter is cleaned. Hot solvent is then closed off automatically, and feed and cold solvent returned to service.

In addition to automatic and semi-automatic control, the system provides visual indication of the cycle progress on a panel and warns of abnormal conditions.

■ An installation where computers are especially helpful is at the Baton Rouge Refinery of Esso Standard Oil Company. Here, a field trial system installed by Leeds & Northrup has been operating round-the-clock since July 1, 1958.

One hundred sixty process variables are scanned at about a point a second. A Speedomax Type "H" indicator, equipped with a Giannini shaft position encoder, digitizes the millivolt-level analog signals. On command from the computer, the digital information is se-

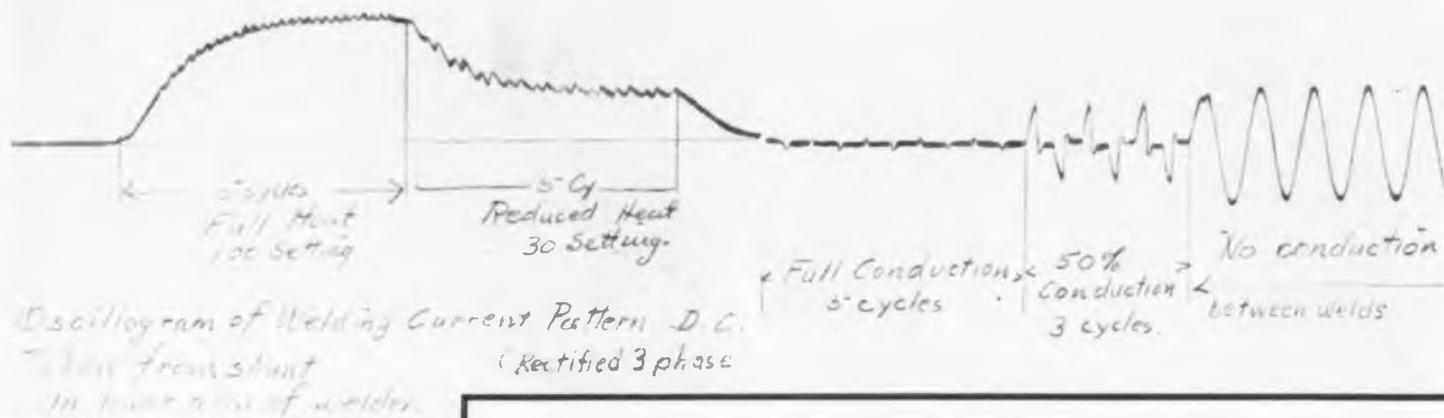
quenced into a Royal Precision LGP-30, general purpose, small-sized digital computer.

Operations including averaging readings on an hourly and daily basis, checking for "off-normal" points, preparing information for print-out, scaling, and linearizing are performed by the computer. In addition, the computer solves complex equations and prepares 27 operating guides including catalyst circulation rate, carbon burning rate, and material balance.

Though the computer doesn't automatically control the system, it guides the operator in changing control loop set points. Closed-loop control may follow when the operator's knowledge and experience can be reduced to equations which can be programmed into the computer, and when equipment is added which can adjust control set points based on information from the computer.

**Chemical Processing.** Pneumatic controls are far in the lead over other types in the chemical industry. Only now, with newer requirements for faster and more complex control, and with the need for rapid computer processing of information, are the chemical industries beginning to turn to electronic control. But they have many qualms which must be overcome.

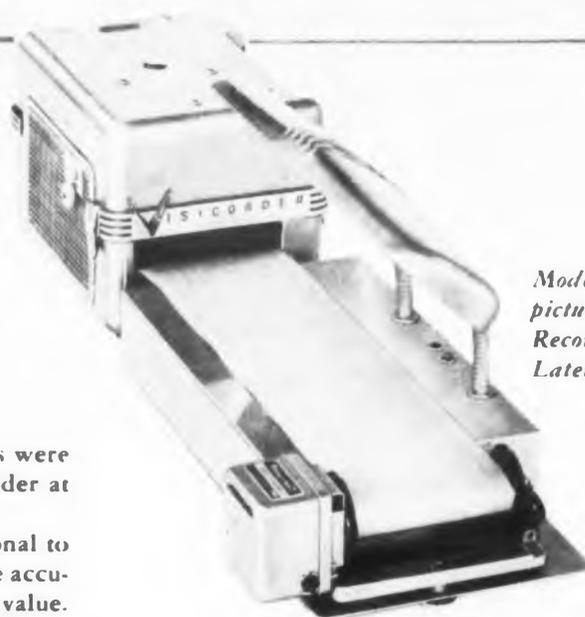
At the Bessemer City, N. C. plant of the Lithium Corp. of America, the production of vital lithium compounds is controlled over every step from the first kiln heating to the final continuous crystallizer. Normally in operation 168 hours a week, the instrumentation provided by The Bristol Company had to withstand corrosive



**this is a record of phase shift**

Oscilloscope trace showing welding current patterns. The trace is divided into three sections: "50% Full Heat 100 Setting", "50% Reduced Heat 30 Setting", and "50% Full Conduction 5 cycles". The first section shows a smooth, rounded peak. The second section shows a similar peak but with a different phase shift. The third section shows a series of sharp, periodic pulses. Handwritten notes indicate "No conduction between welds" and "50% Conduction 3 cycles".

Oscilloscope trace showing welding current patterns. The trace is divided into three sections: "50% Full Heat 100 Setting", "50% Reduced Heat 30 Setting", and "50% Full Conduction 5 cycles". The first section shows a smooth, rounded peak. The second section shows a similar peak but with a different phase shift. The third section shows a series of sharp, periodic pulses. Handwritten notes indicate "No conduction between welds" and "50% Conduction 3 cycles".



Model 906A Visicorder pictured with Record Takeup and Latensifier Unit.

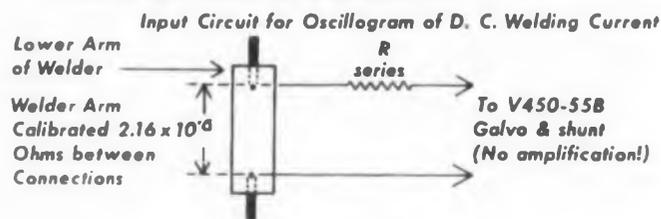
Visicorder Record — 3/4 actual size

These welder phase-shift heat-control patterns were directly recorded with a Honeywell 906 Visicorder at Bristol Aircraft (Western) Limited in Winnipeg.

Since the welding heat generated is proportional to the square of the current value, phase shift must be accurately controlled in order to determine the heat value. If the phase shift dial is not accurately calibrated, the result is too much or too little heat, and a poor weld.

In this application, the Visicorder is an essential guide to accurate calibration, since ink-type recorders do not cover the sensitivities and frequencies needed and an oscilloscope would present a continually changing pattern since most recording periods are less than 10 cycles. The directly-recorded Visicorder patterns allow a convenient study of the exact time when the current wave form was being cut off.

Here is the circuit used in this test.



The Honeywell Visicorder is the first high-frequency, high-sensitivity direct recording oscillograph. In laboratories and in the field everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics... in any field where high speed variables are under study.

The new Model 906A Visicorder, now available in 8- and 14-channel models, produces longitudinal grid lines simultaneously with the dynamic traces, time lines, and trace identification by means of new Accessory units.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

## INDUSTRIAL ELECTRONICS



Input control console of Daystrom Systems' solid state computer, controlling 350 point alarm-scanning system at the new steam electric station of the Louisiana Power and Light Co., Monroe, La.

attacks of excessive moisture, abrasive effects of dust, and interference from vibration.

Though temperature, pH, pressure, and flow are measured and controlled with pneumatics and electronics, all the instrument-directed automatic controls are pneumatic.

**Steel Processing.** Steel mills throughout the country have been using electronics extensively for measurement and control, and electrical, mechanical, and hydraulic devices for actuation. X-ray thickness gages detect steel thickness and relay information to remote indicators and recorders. Infra-red width gages, in closed loop systems, help keep strip width within tolerances. Industrial television allows a close view of difficult-to-get-near processes.

**Metal Working.** Here, electronic sensing, and control by magnetic or punched tape are married to electro-mechanical or hydraulic-mechanical actuation. Companies like General Electric's Specialty Control Dept., Bendix Aviation Corp.'s Industrial Controls Section, Magnasyn Mfg. Co., Electronic Control Systems, Northrop Aircraft, and many others have developed controls for milling machines, drill presses, jig borers, stampers, welders, and a host of other machine tools. These controls insure greater precision and speed as well as dollar economies.

**Lamp Making.** Here is an industry where a very large variety of measurements must be made; where many types of action must be controlled; where high speed and accuracy are the rule rather than the exception. At Westinghouse Electric Corp.'s Lamp Division in Bloomfield, N. J., one might see measurements with photocells, ultrasonics, geiger counters, optical systems, and microphones.

# Honeywell



Industrial Products Group

Reference Data: Write for Visicorder Bulletin

Minneapolis Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Avenue, Denver 22, Colorado

CIRCLE 106 ON READER-SERVICE CARD

Resistance of photoflash lamps (less than 1/2 ohm) must be measured to within one per cent at speeds faster than 3000 per hour. Thermocouples measure oven temperatures; waxes, stains, and radiation devices measure temperatures of moving parts. Temperatures to be measured vary from minus 40 C to 2400 C.

Measuring rates vary over the wide range from one per minute to 1000 per second. Required actuator response varies from a millisecond to five minutes. Instruments often have to tolerate tough environments—humidity, heat, and corrosion.

**Electric Power Generation.** Here is an area where electronic control is a natural. At the Sterlington Station of the Louisiana Power and Light Company, Daystrom Systems has installed a solid state, general purpose digital computer for alarm scanning and print-out. This versatile equipment replaces conventional historical recorders, scan recorders, bearing monitors, integrators, and hand logging.

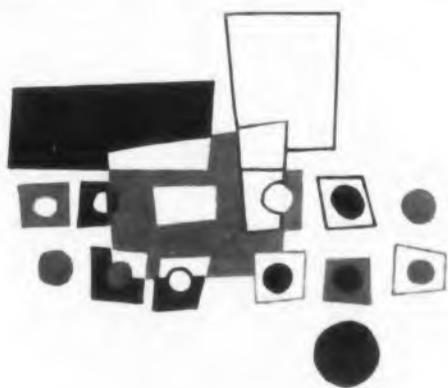
**Automobile Assembly.** Assembly line speed control is very important in any mass production industry. Ford Motor Company's assembly plant in Mahwah, N. J. uses an adjustable speed motor control to regulate assembly line speed. An eddy-current coupling transmits power to the line from a constant speed synchronous motor through a magnetic coupling.

A small tachometer on the output shaft generates a voltage proportional to shaft speed. It is fed back to the magnetic coupler to keep slip speed constant.

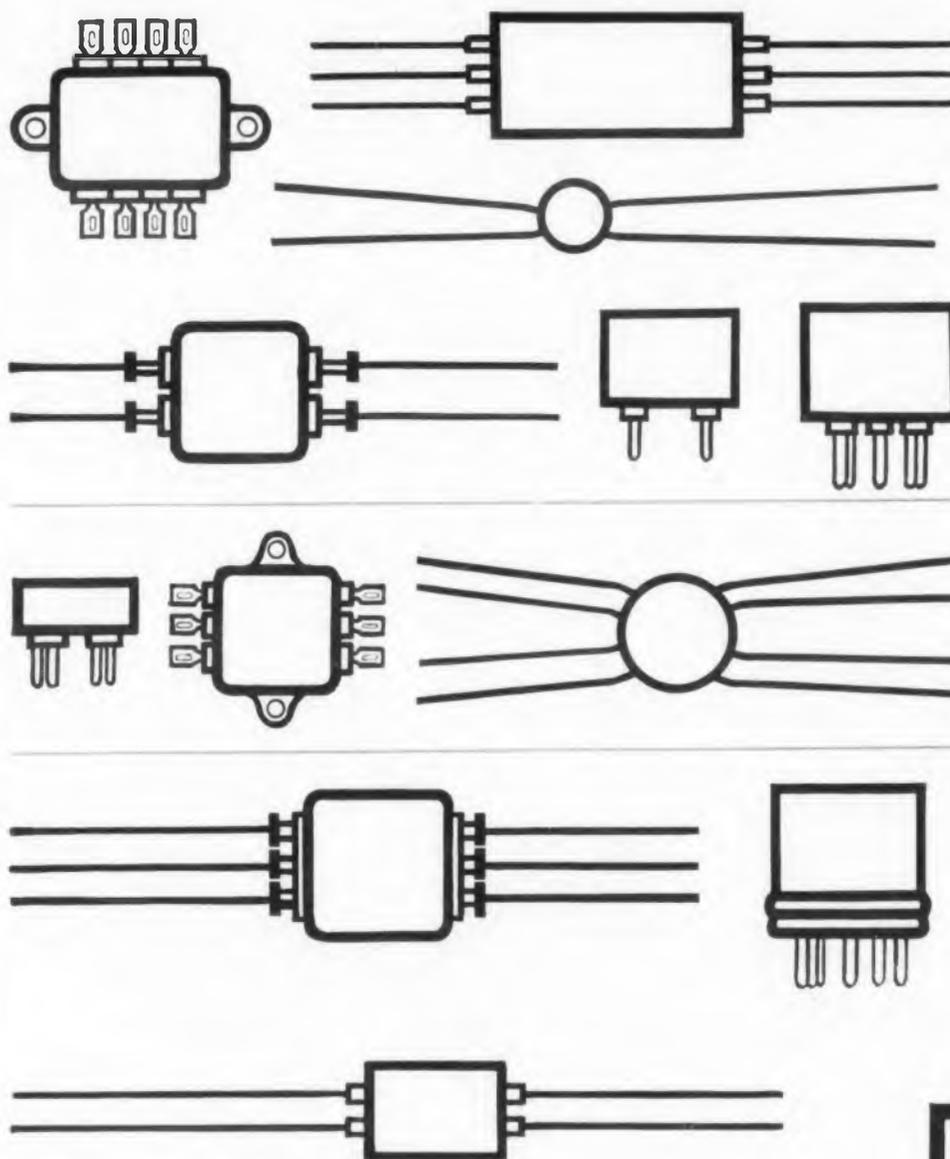
## All That Glitters . . .

Armed with just a glimpse of a few installations, and knowing the monumental effort and planning behind them, our engineer may want to probe more deeply. He may want to see just why one installation used electronic control rather than pneumatic; why one company preferred transistors, another vacuum tubes, and another magnetic amplifiers.

What he would learn appears on the following pages of this report, a free reprint of which is available if you turn to the Reader-Service card and circle 100.



# MIL PULSE TRANSFORMERS



**THE RELIABILITY** of Sprague Pulse Transformers is no "extra". Designed to meet military specifications, such as MIL-T-27, these hermetically sealed transformers serve the demands of high-speed computer circuits, pulse inversion circuits, impedance matching circuits, blocking oscillator circuits, memory core current drivers, current transformers, and many others.

Special designs for high acceleration, high ambient temperatures (above 85° C), or minified circuits can be furnished to suit specific requirements. For typical commercial applications, units are available in lower cost housings. Special kits to aid prototype work and selection are also available.

*For complete engineering data and application information on pulse transformers, switching transformers, and magnetic shift registers, write the Technical Literature Section, Sprague Electric Company, 317 Marshall St., North Adams, Massachusetts.*

**SPRAGUE®**  
the mark of reliability

#### SPRAGUE COMPONENTS:

MAGNETIC COMPONENTS • TRANSISTORS • RESISTORS • CAPACITORS • INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS  
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Instrument panel section for controlling drying kiln for Lithium Corp. of America.

## INDUSTRIAL ELECTRONICS

# Designing For Industry

**I**NDUSTRY measures almost everything. An ELECTRONIC DESIGN survey among users of industrial control equipment revealed a wide variety of measurement requirements in addition to the usual flow, pressure, temperature, liquid level, and displacement.

Even within individual companies, types of measurements might include diameters, speed, pH, viscosity, humidity, presence of parts, position, and weight. Transducers run the gamut from bourdon tubes, strain gages and thermocouples to photocells, pyrometers, microphones, Rayotubes,\* differential transformers, and a variety of resistive, capacitive, and magnetic devices.

The range of measurements is very wide indeed. Pressures vary from 1 to 20,000 psi, temperatures from minus 65 to 2400 C, weight from less than a milligram to more than 500 lb.

\* Leeds & Northrup trademark.

Accuracy requirements fall between 0.1 and 10 per cent with the dominant requirement for 1.0 per cent accuracy (or repeatability).

Preference for amplifying devices was split almost evenly among electron tubes, magnetic amplifiers, and transistors, with tubes leading by a small margin. Most users preferred line operation to batteries; and most didn't rate equipment size an important consideration.

Results of our survey and of many personal interviews revealed many of the motivations underlying the decisions designers have to make. They show clearly why designers grey too soon.

## Electronics? Pneumatics? Hydraulics?

No doubt the first decision the systems manager faces is what type of energy he wants to handle,

what type of signal he wants to transmit. Each has merits. Each has drawbacks.

**Pneumatics.** In the chemical and petroleum industries (largest users of process control instrumentation), pneumatic signal transmission is far and away the most popular form—for many reasons. For one thing, pneumatics came first. By now pneumatic signal levels and impedance levels are well standardized. All manufacturers use signal levels of 3 to 15 psi to represent zero to full range for transducers, actuators, and recording instruments. This makes it easy to build integrated systems with equipment supplied by different manufacturers. (Electronic equipment manufacturers, on the other hand, are too shy to publicly disclose what signal levels they're using.)

For simple process controls, pneumatic hardware is fine. Pneumatic circuits are fast enough for short transmission distances, yet they can provide long time constants. Simple logical circuitry (AND, OR, etc.) can be designed. And

with minimum maintenance, pneumatic equipment can work for years.

But for control over long distances, pneumatic systems are sluggish. Response is slow for transmission distances much in excess of 200 feet. For complex controls, pneumatics becomes cumbersome, if not impossible.

Pneumatic power supplies require very careful design. The equipment just can't work on dirty oily air.

**Hydraulics.** For servo control of machine slides, probably nothing is more popular than the hydraulic piston. It provides high dynamic response and stiffness; accurate, rapid, position control; and very smooth, short, straight-line strokes. And it's fine for heavy duty cycles with lots of start-stop action.

Offering repeatability to better than 0.001 in., hydraulic actuators are smaller than electrical ones, and they have less inertia.

Faster even than pistons, are the rotary hydraulic motors which, with preloaded ball-bearing leadscrews, provide fast, rigid, straight-line drives. And happily, high gain, highly stable systems are easy to design.

On the other side of the ledger—hydraulics is almost never justified for fractional horsepower applications, and the compressibility of oil limits frequency response. Hydraulic power supplies are large, and almost always dirty and greasy. And though some units boast very low leakage, they are rare. Leakage is a constant problem.

**Mechanics.** Particularly in machine control, it's almost always necessary to convert the rotary motion of a prime mover to a linear machine motion. This mechanical link is usually a leadscrew.

The conventional leadscrew has a high mechanical advantage. That's good. It's rigid. That's good too. But to minimize backlash and elasticity, friction and stiction, a leadscrew requires very exacting design. And for motion beyond about eight to ten feet, the leadscrew must be displaced by a rack and pinion, which suffer from backlash even more. The machine designer has to fight with deflection, weight, and inertia, backlash and elasticity, friction and stiction. And he has to keep the price down too.

**Electronics.** For very complex control, where there are many interdependent variables; for the most rapid control over long distances; for accuracy, flexibility, and versatility; for handling lots of data; and for the fastest computation—nothing beats electronics. Even the chemical companies, traditional users of pneumatic equipment, even they are "looking electronic."

The costs for pneumatic and electronic equipment are comparable. Though first costs of electronic equipment are somewhat higher, installation costs are somewhat lower. Electronics can

## VICTOR DIGIT-MATIC PRINTERS

# Proved by over 16,000,000 printings without repairing, adjusting or cleaning!

The adding machine in the Digit-Matic has been tested with over 16,000,000 continuous printings, with no failure, no service other than periodic oiling. Forty years of experience in producing 1,500,000 adding machines—as well as precision instruments such as the Norden Bombsight—has given Victor Adding Machine Co. outstanding qualifications for producing rugged and reliable digital printers.

### CHECK THESE 4 VICTOR ADVANTAGES

**Reliability:** Examine the rugged construction of a Victor machine. Each part is conservatively designed to provide extended life and reliability. Wearing surfaces heat treated, cyanide hardened to stand up under constant use. All steel parts cadmium plated to prevent rusting.

**Immediate Service:** Factory-trained servicemen (and parts) are on call in more than 725 cities coast to coast.

**Flexibility:** At least 500,000 different combinations available, with speeds up to 33 characters per second. With Victor Digit-Matics you have your choice of listers, accumulators, or calculators *plus* an almost infinite number of other variations ranging from electrical noise filters to upside-down printing.

**Fast Delivery, Low Price:** Because of Victor's continuous high volume of adding machine production, we can ship almost any quantity of Digit-Matics—built specifically to your order—within 30 days. Victor Digit-Matics, from only \$425.00, are the value buy in the digital printer field.



### VICTOR SERIAL ENTRY DIGIT-MATIC PRINTER

10 Digit solenoids. Digits are entered in sequence with most significant digit first. Accepts digits at a rate up to 20 per second. Print cycle: listers 0.27 seconds; accumulators 0.35 seconds. Available in up to 11 column entry capacity.

#### COIL DATA

Voltage	21-28VDC	42-54VDC	125-160VDC
Resistance, ohms			
Digit solenoid	25.5	75.0	490.
+ or - Print solenoid	25.5	75.0	450.
Minimum on time, seconds	.02	.02	.02
Maximum on time, seconds (continuous printing)	.05	.05	.05

Minimum off time between digits—all serial entry machines—.025 seconds.



COVER REMOVED

### VICTOR PARALLEL ENTRY DIGIT-MATIC PRINTER

All digits 1 through 9 of each column equipped with solenoids. Digit and print command solenoids may be simultaneously energized. Print cycle:—listers 0.30 seconds; accumulators 0.35 seconds. Available in up to 10 columns entry capacity.

#### COIL DATA

Voltage	21-28VDC	35-56VDC	125-160VDC	105-125VAC
Resistance, ohms				
Digit solenoid	17.6	53.0	700.	125.
+ Print solenoid	17.6	89.0	375.	125.
- Print solenoid	17.6	53.0	375.	125.
Minimum on time, seconds	.020	.020	.015	.025
Maximum on time, seconds (continuous printing)	.050	.050	.035	.050

A few popular model variations:—columnar spacing; right side of machine accumulating and left side listing data identification; Non-Add printing; Non-printing adding; MIL-I-17623 Electrical Motor Noise elimination; Induction Motors; Manual Keys over the solenoids; "digit key depressed" switch (serial entry Digit-Matics); tag and label printing; and all kinds of alphabetic and special types.



Write today! Victor's electronics-trained staff will gladly help you solve any digital printing or calculating problem.

Write for technical manual No. D 10-71.

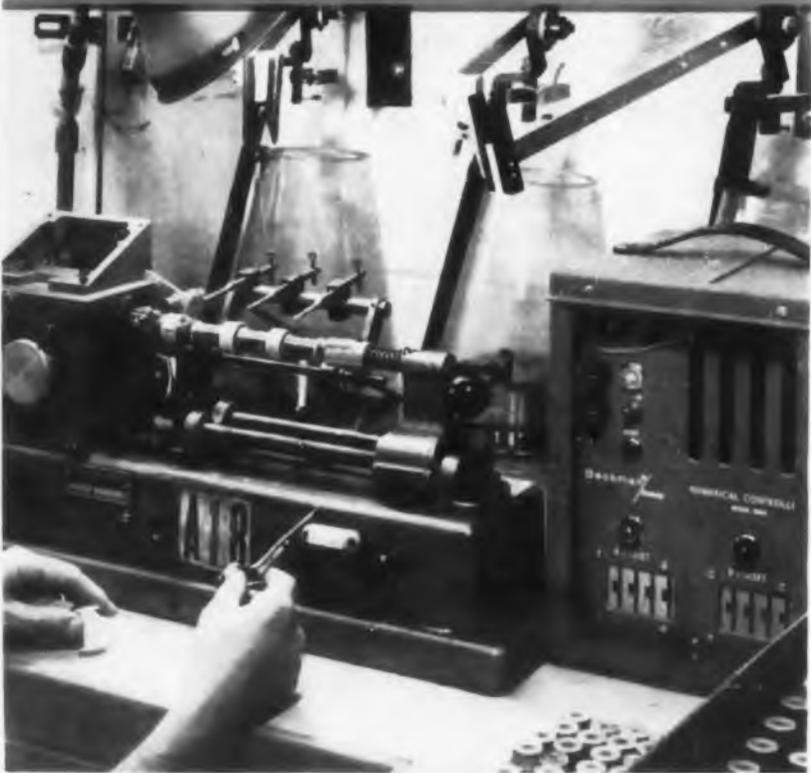
**Electronics Division**  
**VICTOR ADDING MACHINE CO.**  
3900 N. Rockwell Street, Chicago 18, Ill.

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Hydraulic servo on Bendix punched tape controlled milling machine.

Mechanical rotation is converted to digital electronic form by magnetic proximity pickup in Beckman's automatic coil winder.



## INDUSTRIAL ELECTRONICS

now match pneumatic performance. Until recently, electronic equipment couldn't provide the long time constants (minutes or even hours) required in some applications. But now it can. Improved materials (like Mylar), have enabled the design of capacitors with very low leakage, and with reasonable size and cost.

Electronics has a long way to go to win the field. Its complexity can frighten a man who works with pipes and tubes that carry stuff you can touch. Electronics must overcome his prejudices. This man's attitude on the reliability of electronic equipment may have been formed when his television receiver at home conked out in the middle of a World Series game.

Electronic equipment manufacturers have not standardized their signal levels, as have pneumatics companies. And they have not yet fully convinced the rest of the industry that electronic equipment can be as safe (explosion-proof, for example), and as reliable as any other.

### Tubes? Transistors? Magnetic Amplifiers?

**Electron Tubes.** Tubes are good. They're good for high impedance circuits, for high frequencies, and for high voltages. They can control power levels up to about 40 watts with no strain. And by now, tube makers know how to turn out really good tubes that can last for years—if you don't push them too hard, and if you don't keep pulling them for testing.

Even the old, full-sized, low cost radio receiver tubes are good. Many plant service and maintenance people distrust them. They don't realize that many of their premature failures were caused by misuse and misapplication. According to Harry Palmer, Manager of Engineering at GE's Specialty Control Department, these tubes are remarkably reliable considering their price. He points to considerable evidence to indicate that if a tube of this type has operated in given application for 15 or 30 days, it has exceedingly high probability of lasting 3 to 5 years—if undisturbed and not subjected to abnormal operating conditions.

Disturbing a tube for testing serves no purpose. Conventional tube testers have little value in testing for deterioration. They just fail to consider how a tube is used in a circuit.

But tubes do fail. And it's hard to predict when they'll fail.

**Transistors.** These ten-year-olds have a promising future. Newer production methods promise even better transistors and diodes. Silicon units

especially, with their tolerance to high temperatures, will establish a firmer foothold in industry—when their price comes down more.

In contrast to tubes, marginal operations of transistors and semiconductor rectifiers can be checked. End of life can be predicted, so unscheduled down-time can be avoided.

Perhaps the most exciting development in the semiconductor field is GE's new silicon controlled rectifiers. These "semiconductor thyatrons" can be controlled with very small power levels. They can deliver heavy currents to a load. And they should last many times longer than the relays and gas-tube thyatrons they can replace. Unfortunately, they usually require special drive circuitry. Most bitter complaint about them: "Can't buy enough of them for adequate tests."

To industry, the most attractive aspect of transistors is their potentially indefinite life. The most troublesome aspects are their sensitivity to temperature variation, their low voltage ratings, and their low power dissipation. Their gain drift with temperature can be tolerated in operational amplifiers and a few other circuits, but in most applications it must be compensated for at the cost of added circuit complexity.

Their small size, a boon to the military, is no powerful consideration for industry. Battery operation is something industrial users are a bit chilly about. Keeping a stock room supplied with a large assortment of batteries (with limited shelf life) is nothing to look forward to.

**Magnetic Amplifiers.** Magnetic amplifiers are moving into industry—and at an ever increasing pace. Some magnetic amplifier types can operate from infinitesimal signal levels. Others can control power levels unthinkable with most tubes. They can be designed for very long life (10 to 20 years). And they can do many jobs that relays can do—without moving parts.

But they are expensive. Each one must be designed for a specific job. Companies like Westinghouse and Control, Div. of Magnetics, Inc., have made a valuable contribution by introducing lines of standard control reactors as stock items.

Their usual time constant of 8 to 10 cycles makes them too slow for most plants which are limited to 60 cps current. They're fine for controlling temperatures—a slow process anyway. Their principal weakness is that a magnetic amplifier is no better than the diodes it uses. Improved techniques of diode manufacture, and very conservative design can correct this.

### Analog? Digital?

**Analog.** Almost every process or machine control system starts with analog information. A trans-

# JOURNAL OF APPLIED CONTROL DEVICES THAT NEVER WEAR OUT

For Control Engineers Who Are Wearing Out Before Their Time

ducer measures some process variable, and provides a signal proportional to the variable. In many cases, the signal is quite feeble, so amplifiers are needed. The more amplification required, the more likely it is that the system will suffer from jitter, instability, or drift. These amplifiers demand excellently regulated power supplies.

Usually less expensive, less rapid, and less accurate than digital computers, analog computers serve admirably in simulating complex processes, and thus lay the groundwork for optimum control.

**Digital.** For fastest computations, or computations where large volumes of data must be handled, digital computers are the answer. They're highly flexible, and most accurate.

However, since transducer signals are analog, these signals must be digitized for computer use. And if the results of computation are to be used directly to control actuators, the computer's output must be converted back to analog form.

Analog to digital, and digital to analog converters are weak links. They lose accuracy in the system, and they're less reliable than other parts. The solution is obvious: Somebody must invent transducers with digital output and actuators for digital input.

## Proportional? Discontinuous?

There are always processes that almost cry aloud for one specific type of control action. But more often, it's necessary to weigh relative advantages.

Discontinuous action is usually less expensive and potentially much faster. Actuators work at top speed, with full power applied, for a larger portion of their duty cycle. But discontinuous action usually demands very exacting start-stop control and complex computing circuitry. That's why proportional servos are the usual choice for rapid response. Furthermore, proportional circuitry can often be used to correct for certain errors in the controlled machine.

## Problems With Recorders

Written records of process variables will be required at almost any installation. Control centers for any sizeable process are always marked by vast panel areas covered with indicating devices and a multitude of recorders. This has gone about as far as it can go.

The trend today is away from walls full of recorders. Replacing them are smaller, less expensive indicators, and a handful of portable plug-in recorders. Even these are being replaced by data loggers.

(Continued on following page)

## HIGH SPEED STATIC SWITCHING (at half the price)!

Sylvania Electric Products Co. engineers have just replaced an electronic relay, two small mechanical relays, a limit switch, and a separate power supply with a single CONTROL switching reactor which costs only half as much! They did it by taking advantage of the multiple windings on a CONTROL switching reactor—equipment which, because of its static operation, never wears out. Seems a high speed assembly operation on one of Sylvania's complex, highly automated vacuum tube production machines calls for a magnetic clutch to drive an index table. The clutch orients the work part by rotating it until current flows through two properly located contacts. Our CONTROL switching reactors not only cut costs in half, but do a job that the relays couldn't do: provide the ultra high speed signal necessary for proper switching in the automated assembly. *It worked so well Sylvania said, "I'll be switched!" We said, "With a 10,000 to one switching ratio, and ratings of 15, 75, 150 and 300 VA, most anything for control can be!"*

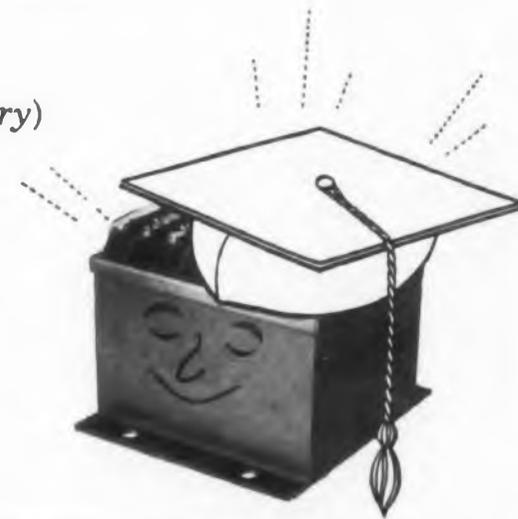


## ONCE UPON A TIME . . . (time delay, that is)

Versatile, we are too! The same type of CONTROL switching reactors that work so well for this high speed switching also are used by Sylvania engineers to eliminate production breakdowns caused by relay failures in time delay circuits. Many pneumatic time delay relays on their production machines were dying young (three months of age or less). CONTROL switching reactors (which, naturally, never wear out) not only have no moving parts, but do a dandy job with time delay relaying, easily handling 6,000 closures per hour. Sylvania happily expects its CONTROL reactors to last twenty years. *"Right now," Sylvania says, "we're not too worried about what will happen after that." Need you be any more worried than they?*

## LOGIC, MY DEAR WATSON (. . . is elementary)

Our educated switching reactors are masters at logic—the kind that gets built into automatic control operations. AND, OR, NOT, MEMORY and TIME DELAY—all are built into these high IQ reactors. By employing several isolated control windings, one reactor can translate many inputs (from push buttons, limit switches or other reactors, for instance) to any logic needed to switch very appreciable loads. And are they easy to use! Order standard units right from the catalog. You need no high falutin' systems engineering or auxiliary hardware (single purpose logic units, preamplifiers or transformers). *No wonder logical people order our logic-providing switching reactors. Can we send complete details to you?*



Reliability begins with **CONTROL**

A DIVISION OF MAGNETICS, INC.

Dept. ED-54, BUTLER, PENNSYLVANIA

CIRCLE 109 ON READER-SERVICE CARD



or plug-in subassemblies.

**The Servicing Dilemma.** Everybody wants reliability. But it's not an unmixed blessing—especially with complex equipment. How do we acquire servicing experience with equipment that rarely gives trouble? What happens if, after two or three years of uninterrupted service, the equipment fails? Who knows how to fix it?

One chemical company spokesman told ELECTRONIC DESIGN of a recently installed piece of electronic control equipment that performed superbly. Nobody at the chemical plant knew how to service this complex apparatus. It never needed service.

If it ever broke down, the manufacturer would send the original design engineer to repair it. He, and only he, understood the equipment thoroughly. "If he should leave that company—or die," commented the chemical man, "... we shudder to think."

**The Cost Dilemma.** Reliability is expensive. It often involves overdesigned components and redundant circuitry. But the cost of one unscheduled shutdown can by far exceed the additional expense of reliable equipment. In one case, sixteen hours of down time for a data logger cost a company a month's savings that the logger had accrued.

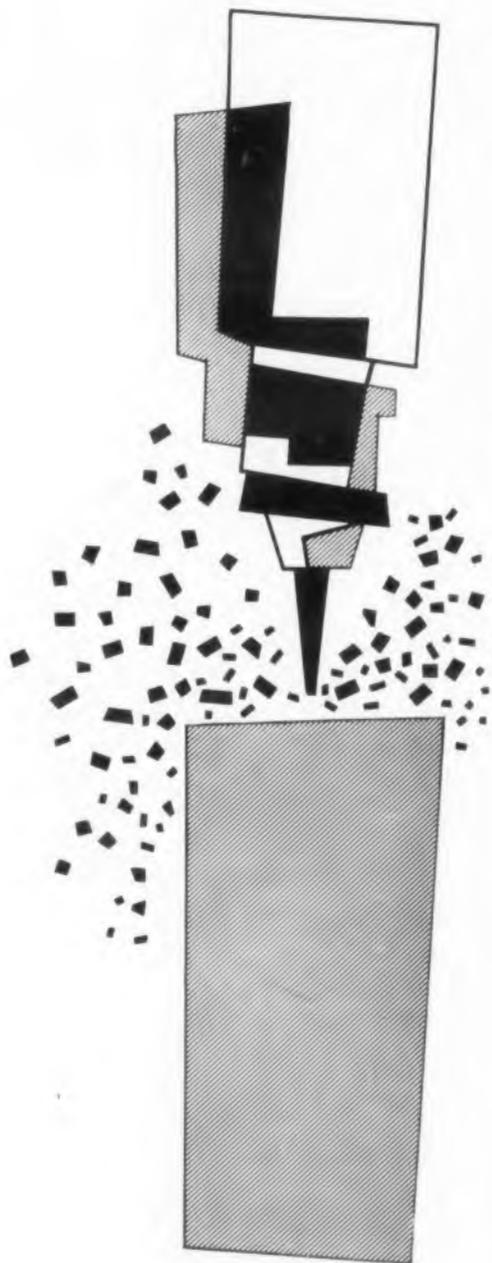
Costs can often be cut without sacrificing reliability. Where components will live in a protected environment (inside a cabinet), protective component housings can often be eliminated. Costs go down when open transformers, inductors, and relays are used instead of sealed and potted units.

But extra design care is required with exposed components. Moisture, dust, and other contaminants can impair their reliability). (Purified cooling air may often be required.) Even nonconducting particles can spoil bearings, pivots of contactors and relays, and create severe leakage problems in high impedance circuits.

## Where Do We Go From Here?

There's plenty of room for progress in controlling processes and machine tools. We still need transducers with huskier output signals, and more accurate position transducers for machine control. We still would like to improve machine accuracy without sacrificing speed or stability. We still would like to get around the limitations imposed by moving parts. The speed of many control systems is limited by the time it takes to move a piston, close a relay, open a solenoid or stop a motor.

The host of problems besetting the control engineer testify to the fact that the ideal control system is not yet with us.



# Good-All

## CAPACITORS

### Two thoroughbreds and a workhorse!

**SPACE  
SAVER**

**Good-All Type 663UW SPACE-SAVING  
Sub-Miniature with a SKIN-TIGHT Case**

Type 663UW is an ideal choice for miniaturized and transistorized products. The space-saving possibilities are amazing.

SPECIFICATIONS	Dielectric	Case	End Fill	Mylar Film Plastic Wrap Thermally Setting Plastic	Voltage Range	Temp. Range	IR at 25°C	Humidity Resistance
					100-600 VDC	-55° to +125°C	100,000 Meg. x Mfd	Superior

**HIGH  
TEMP.**

**GOOD-ALL Types 616 G and 617 G  
Sub-Miniature Metal Enclosed Mylar Designs**

Designed to provide EXTENDED LIFE at high temperatures. Rugged, military construction throughout. These lines include a 50-volt series for transistor applications.

SPECIFICATIONS	Dielectric	Case	Winding	Mylar Film Hermetically Sealed Extended Foil	Temp. Range	D.C. Voltage Rating
					Full rating to 125°C 50% derating at 150°C	50, 150, 400 and 600

**BROAD  
USAGE**

**METAL ENCLOSED Tubulars per MIL-C-25A**

The "workhorse" of military electronics. Good-All specializes in Types CP04, CP05, CP08, CP09, CP10 and CP11. Approvals are listed by ASESA in the current issue of the QPL.

\* DuPont's trademark for polyester film.

**A LEADING MANUFACTURER OF TUBULAR,  
CERAMIC DISC AND  
ELECTROLYTIC CAPACITORS**

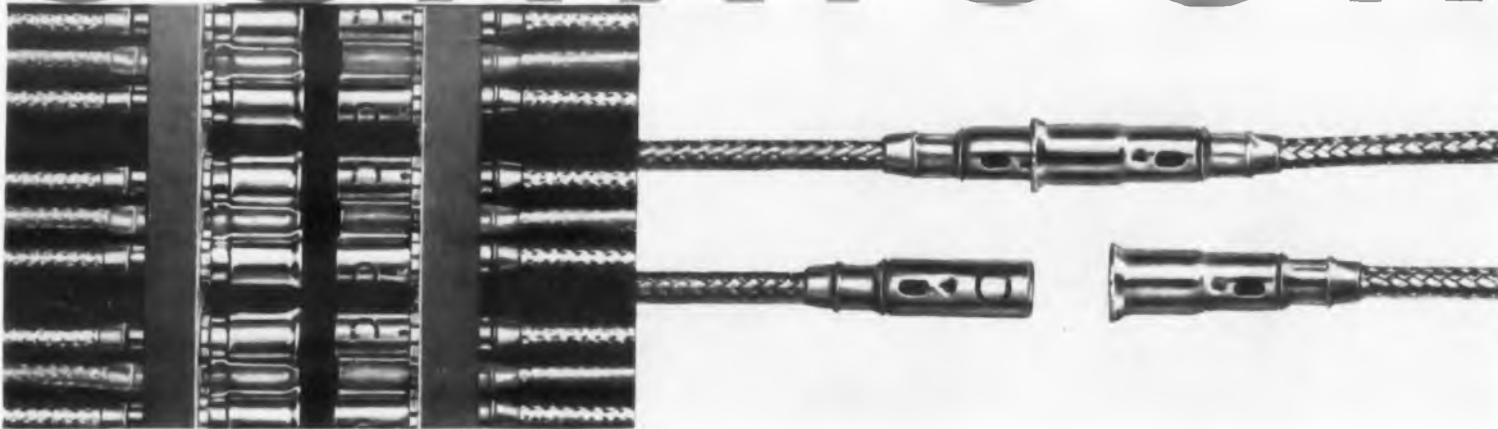


**GOOD-ALL ELECTRIC MFG. CO.**  
OGALLALA, NEBRASKA

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# THE NEW CONCEPT IN COAXIAL DISCONNECT SPlicing...

## COAXICON



Here is a totally new method for attaching disconnect splices to coaxial cables that will create new standards of performance . . . on chassis connections, computers, test equipment—in fact, anywhere that two coaxial cables need fast and reliable disconnect splicing.

Easily attached to coaxial cables by AMP's modern compression method, the all new A-MP COAXICON assures you of uniformity, absolute reliability and new low cost—in either free-hanging or through-panel units. In addition, the COAXICON supports cable shielding against vibration while offering fully insulated positive electrical performance.

Production rates easily exceed any method you're now using. With a simplified wire stripping method, it takes just one stroke of the matching A-MP tool to permanently crimp COAXICON to your coaxial cable.

Think of it—no more burned or melted insulation, no doubtful, sloppy connections, no time consuming, high-cost assembly methods. Once you've seen the all new COAXICON, you won't settle for less.

*Send for a sample and complete product information today.*

# AMP INCORPORATED

**GENERAL OFFICES: HARRISBURG, PENNSYLVANIA**

A-MP products and engineering assistance are available through subsidiary companies in: Canada • England • France • Holland • Japan

CIRCLE 112 ON READER-SERVICE CARD

## INDUSTRIAL ELECTRONICS

### CREDITS

Our many thanks to the following companies and their engineers who supplied information for this report.

American Cyanamid Co.  
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Ford Motor Co.  
Assembly Plant  
Mahwah, N.J.

Ford Motor Co.  
Automatic Transmission Div.  
36200 Plymouth Rd.  
Livonia, Mich.

The Foxboro Co.  
Foxboro, Mass.

General Electric Co.  
Specialty Control Dept.  
Waynesboro, Va.

Globe-Union, Inc.  
Centralab Div.  
900 E. Keefe Ave.  
Milwaukee 1, Wis.

Industrial Electronic Engineers  
3973 Lankershim Blvd.  
N. Hollywood, Calif.

Ketay Dept.  
Norden  
Div. of United Aircraft Corp.  
Commack, N.Y.

Arthur D. Little, Inc.  
Acorn Park  
Cambridge, Mass.

Magnasync Mfg. Co., Ltd.  
5546 Satsuma Ave.  
N. Hollywood, Calif.

Minneapolis-Honeywell Regulator Co.  
Brown Instrument Div.  
Wayne & Windrim Aves.  
Philadelphia 44, Pa.

Northrop Aircraft, Inc.  
Hawthorne, Calif.

The Swartwout Co.  
18511 Euclid Ave.  
Cleveland 12, Ohio

Tidewater Oil Co.  
Wilmington, Del.

Westinghouse Electric Corp.  
Lamp Div.  
Bloomfield, N.J.

## Precision Comparator

For go, no-go measurements



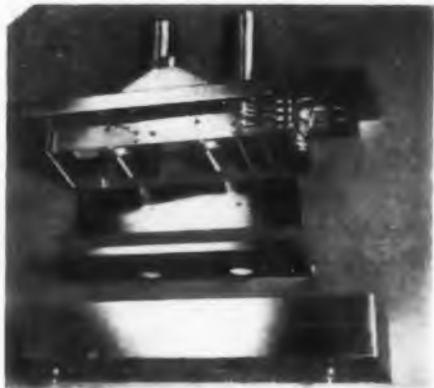
Measurement regions may be set up accurate to 0.01 per cent with these dc comparators. The units permit go, no-go regions to be established for any measurement which may be expressed in dc voltage terms. Detectable differences are 1 mv, and drift is less than 1  $\mu$ v per day. All models are fail-safe.

Optimized Devices, Inc., Dept. ED, P.O. Box 35, Gedney Station, White Plains, N.Y.

CIRCLE 113 ON READER-SERVICE CARD

## UHF Amplifiers

3 to 7 db noise figure



LNA series two-stage grounded-grid amplifiers have a 250 to 1000 mc frequency range and a 3 to 7 db noise figure. They are available with cavity or line type interstage and output coupling. Gain is 25 to 38 db for the line type; 33 to 38 db for the cavity type.

Ewen Knight Corp., Dept. ED, Needham Heights 94, Mass.

CIRCLE 114 ON READER-SERVICE CARD

## RF Transmission Cables

Foamed and solid dielectric

For TV systems, this line of eight rf transmission and distribution coaxial cables includes single and double shield types in both foamed and solid dielectric.

Entron, Inc., Dept. ED, P.O. Box 287, Bladensburg, Md.

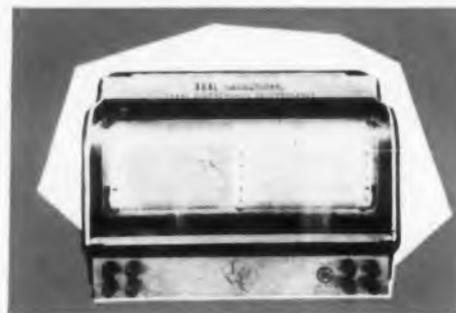
CIRCLE 115 ON READER-SERVICE CARD

## What's your application for versatile *recti/riter*<sup>®</sup> recorders?

TI's Applications Engineering Department invites your requests for technical assistance in OEM or end uses. Here are a few of the present applications.

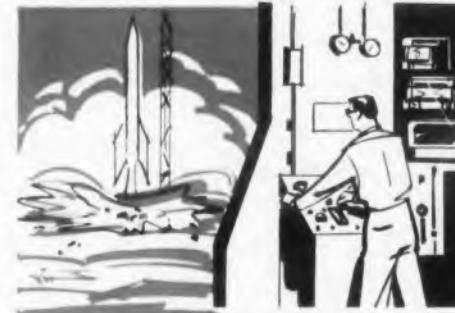


SINGLE



DUAL

Rectilinear Galvanometric Recorders, with a wide choice of sensitivities and "recti/riter" accessories, offer the most complete ranges available for recording electrical parameters from many types of transducers.



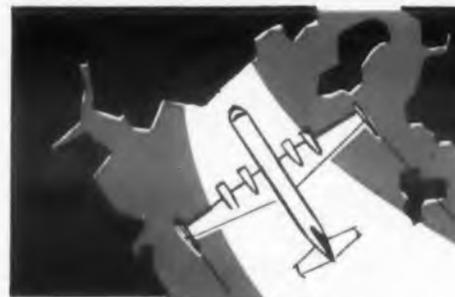
MISSILE TESTING

—a bank of "recti/riter" units record voltage frequencies and currents.



MEDICAL RESEARCH

—used with rate meters and nuclear scanners . . . also used to monitor rate of impurities in vaccines.



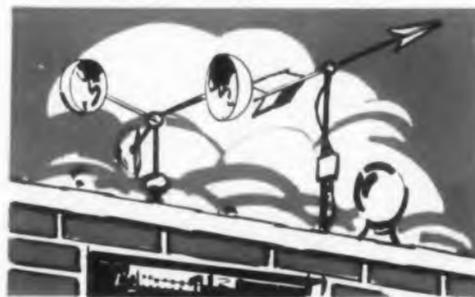
AIR NAVIGATION

—used to monitor ILS beams . . . also used to monitor LORAN signals.



QUALITY CONTROL

—used on numerous production lines to check sizes and contours of parts, as well as assembly rates.



METEOROLOGICAL

—records wind directions and velocities . . . also used in studies of Aurora and air glow through scintillometer counters.



AUTOMATIC COMPUTERS

—for studying stability of electrical parameters that affect accuracy.



OIL EXPLORATION

—used in well logging as well as airborne magnetometers and scintillometers.



RADAR SPEED METERS

—used in police vehicles to visually record speed of passing motorists.



OCEANOGRAPHY

—records wave frequency and magnitude . . . also monitors underwater pressures.



ATOMIC TESTING

—used to measure radiation fall-out at test centers and nuclear installations.

TI will custom manufacture "recti/riter" recorders to your specifications for OEM use. Write for complete information.



TEXAS INSTRUMENTS  
INCORPORATED

INDUSTRIAL INSTRUMENTATION DIVISION

3608 BUFFALO SPEEDWAY • HOUSTON, TEXAS • CABLE: HOULAB

CIRCLE 116 ON READER-SERVICE CARD

## NEW PRODUCTS

### Hall Generator

Flat frequency response to 1 mc

Useful in instruments and as an analog computer element, the Hall generator can multiply two electrical quantities if they are expressed as current and magnetic field. This is because its voltage output is proportional to the product of the control current passing through it and the magnetic field perpendicular to its major face. Owing to its fast response, this semiconductor device can also be used to measure the power content of transients. Maximum value of control current is 500 ma; internal resistance for control current, 1 ohm; and flux density range, to 10 kilogauss. Frequency response is flat up to 1 mc.

Westinghouse Electric Corp., Dept. ED, P.O. Box 2099, Pittsburgh, Pa.

CIRCLE 117 ON READER-SERVICE CARD

### RF Coaxial Connectors

Have aluminum shells

With aluminum shells, ALN and LSC connectors are 35 to 40 per cent lighter than comparable standard rf coaxials. The plugs have a thick anodic coating for corrosion resistance.

Cannon Electric Co., Dept. ED, 208 Humboldt St., Los Angeles 31, Calif.

CIRCLE 118 ON READER-SERVICE CARD

### Oscillator-Mixer

For fm data systems

For fm data systems, oscillator-mixer GRO-2 generates a reference frequency and mixes it with an n/fm telemetering multiplex. It so de-emphasizes the multiplex spectrum for recording and matches reference and signal amplitudes. A plug-in frequency unit adapts it to any reference frequency to 100 kc to tape speed.

Data-Control Systems, Inc., Dept. D, Danbury, Conn.

CIRCLE 119 ON READER-SERVICE CARD

*A Statement By*  
**I. D. DANIELS, GENERAL MANAGER**  
**RECEIVING TUBE DEPARTMENT**  
**GENERAL ELECTRIC COMPANY**

# TODAY'S TV-



For further information, phone nearest office of the G-E Receiving Tube Department below:

#### EASTERN REGION

200 Main Avenue, Clifton, New Jersey  
Phones: (Clifton) GREGORY 3-6387  
(N.Y.C.) WISCONSIN 7-4065, 6, 7, 8

#### CENTRAL REGION

3800 North Milwaukee Avenue  
Chicago 41, Illinois  
Phone: SPRING 7-1600

#### WESTERN REGION

11840 West Olympic Boulevard  
Los Angeles 64, California  
Phones: GRANITE 9-7765; BRADSHAW 2-8566

# MARKET DEMAND: *Reliability!*

- Consumers now want reliability in addition to good reception, quality pictures, and advanced styling.
- General Electric meets this need with new, complete line of Service Designed reliable tubes for TV—dependable, backed by experience in military tube design and manufacture.
- Production and field failures reduced, costs cut for set manufacturers.

Today's market for television sets calls for high standards of receiver performance. Having experienced, over the years, the benefits of a constantly improving product, buyers are accustomed to the best in picture reception. Now they are adding reliability to their demands.

As a leading supplier of receiving tubes, we at General Electric have been aware of the television buying public's increasing insistence on quality performance *all* the time. Moreover, there is a growing awareness on the part of TV manufacturers that tube reliability is fundamental to good set performance—that, as sometimes is said, "a receiver is as good as the tubes that are in it."

Charged with helping manufacturers supply superior sets to an exacting market, General Electric now has applied its resources, skills, and equipment to building greater reliability into 70 G-E Service-Designed Tubes for television. The range of these 70 types encompasses virtually every socket requirement.

#### 5-STAR HIGH-RELIABILITY EXPERIENCE APPLIED

Flying safety, fire-control accuracy, missile dependability: these and other critical needs for military tube reliability have given General Electric wide experience in high-reliability manufacturing techniques.

The methods found essential for reducing military tube inoperatives and stabilizing tube performance have been heavily drawn on to increase the reliability of General Electric tubes for television.

An example of such methods is "Snow White" manufacture. G-E workers who assemble tubes for TV now wear lint-free dacron and nylon garments. Air is filtered and conditioned to keep out dust and lint, the most frequent causes of short-circuits throughout tube life.

#### NINE ACROSS-THE-BOARD RELIABILITY ADVANCES

Besides lint-free, dust-free manufacture, eight important across-the-board steps are being taken to promote increased reliability in G-E tubes for television. Many more improvements are being made to individual types.

New tests are more exacting than any before applied to tubes for TV. An accelerated heater-cycling test assures that tubes will perform properly under wide variations in household line voltage. A new G-E-developed direct-current testing method for shorts and opens has 500% greater sensitivity and eliminates human-operator error.

Glass-strain specification tests have been tightened to a point where they match strict military-tube requirements. G-E life tests now are twice as rigid as the JAN specifications for tubes in the entertainment class.

Other important across-the-board advancements are being made in materials and manufacturing processes. On individual tubes, as many as 20 specific improvements bring higher dependability than ever before.

#### SAVINGS TO TV MANUFACTURERS

In addition to entrenching set manufacturers in a TV market that demands quality performance at all times, General Electric's new Service-Designed tube program offers cost savings that are direct and apparent.

First: fewer production-line slowdowns from tube failures. Second: less "dead inventory" of receivers in the factory that won't pass final inspection and must be reworked. Third: lower warranty costs, once sets have been shipped and delivered.

#### GET THE FULL RELIABILITY STORY!

The complete account of what G.E. has done to increase tube reliability is far too comprehensive to appear here. Among the many improvements, however, are specific steps that will interest every member of your designing staff.

I recommend, therefore, that you contact your nearest G-E Receiving Tube Department office at left, and ask for a G-E tube engineer to call at your convenience.

Besides posting you fully on the over-all General Electric reliability program, he will be glad to review with you the details of this program, tube by tube, as they affect TV circuits now in production, in the breadboard stage, or on your designers' drawing-boards.

*J. D. Daniels*

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

12-11-103

## Power Supplies

Low voltage



Transistorized ac to dc power supplies, types 550 and 551 are rated at 0 to 1.1 and 0 to 2.5 amp, respectively. Designed for energizing resistance type transducers and for transistor circuitry, they provide 1 to 40 v dc, continuously variable, with 0.005 per cent regulation.

Owen Labs, Inc., Dept. ED, 55 Beacon Place, Pasadena, Calif.

CIRCLE 120 ON READER-SERVICE CARD

## Accelerometer

Self amplifying



Effects of humidity and rf radiation are eliminated in these self amplifying accelerometer systems Designated 2806-2807 and 2808-2809, the systems combine two units, one for vertical, one for horizontal vibration measurement. Sensitivity up to 300 mv per g is preset to user specifications. First accelerometer resonances are above 35 kc with frequency range  $\pm 5$  per cent from 10 cps to 2 kc.

Endevco Corp., Dept. ED, 161 E. California St., Pasadena, Calif.

CIRCLE 121 ON READER-SERVICE CARD

## Phototube

### For scintillation counters

Designed for scintillation counters, the 7264 is a 14-stage, head-or-multiplier phototube. Its spectra response is 3000 to 6500 angstroms

Radio Corporation of America Electron Tube Div., Dept. ED Harrison, N. J.

CIRCLE 122 ON READER-SERVICE CARD

CIRCLE 123 ON READER-SERVICE CARD

## NEW PRODUCTS

### Recorder

Displays two thirds of data



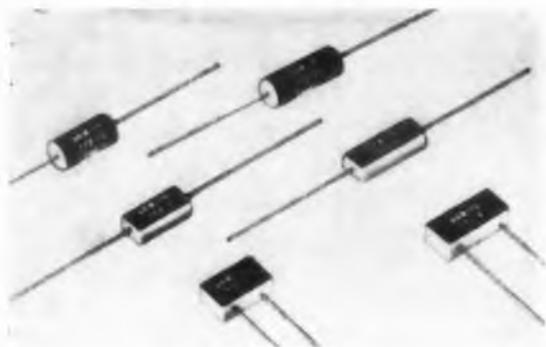
Rack mounted Model 2484 recorder can handle up to three channels. The chart, two-thirds of which is continually visible, can record data from 8 to 72 hours. Heated styli produce helical impressions on heat sensitive paper. Linearity is  $\pm 2$  per cent up to 3 in. deflection. Sensitivity is 15 ma (52 v) per in., peak to peak.

The Geotechnical Corp., Dept. ED, 3712 Haggard Drive, Dallas 9, Tex.

CIRCLE 124 ON READER-SERVICE CARD

### Metal Film Resistors

Tolerance of  $\pm 1$  per cent



Standard tolerances of series 77 low cost metal film precision resistors are  $\pm 1$  per cent, but tolerances of  $\pm 0.1$  per cent can be furnished. Resistance range of the line is 25 ohms to 400 K.

Ohmite Mfg. Co., Dept. ED, 3695 Howard St., Skokie, Ill.

CIRCLE 125 ON READER-SERVICE CARD

### Coaxial Terminations

dc to 10 kmc frequency range

Series SC 50-ohm coaxial connectors have a maximum vswr of 1.1 to 1.3 with 2 to 5 per cent accuracy from dc to 10 kmc. Input is 1 w average, 1 kw peak.

Weinschel Engineering, Dept. ED, 10503 Metropolitan Ave., Kensington, Md.

CIRCLE 126 ON READER-SERVICE CARD

## NEW CLASSIFICATION SYSTEM

ROOM CURING SYSTEMS					APPLICATION
TEMP. CLASS	MIXING RATIO A/B	POT LIFE (Room Temp.)	CURE CYCLE RANGE	CHARACTERISTICS	
B	2 to 1	45 minutes to 2 hours	24 hours at room temperature or two hours at 140° F.	Features low exotherm. Good electrical and physical properties. Easy mixing and handling.	<input type="checkbox"/> <input type="checkbox"/>
B	2 to 1	45 minutes to 2 hours	24 hours at room temperature or two hours at 140° F.	Features low exotherm. Good electrical and physical properties. Easy mixing and handling.	<input type="checkbox"/> <input type="checkbox"/>
B	5 to 1	45 minutes to 2 hours	24 hours at room temperature or two hours at 150° F.	Combines excellent shock resistance with good electrical properties. Easy mixing and handling.	<input type="checkbox"/>
B	5 to 1	45 minutes to 2 hours	24 hours at room temperature or two hours at 150° F.	Combines excellent shock resistance with good electrical properties. Easy mixing and handling.	<input type="checkbox"/>

HEAT CURING SYSTEMS					CHARACTERISTICS
TEMP. CLASS	MIXING RATIO A/B	POT LIFE (Room Temp.)	CURE CYCLE RANGE	CHARACTERISTICS	
F	1 to 1	three to four days	2 hours at 250° F. 12 to 18 hours at 200° F. Post curing improves high temperature properties.	High heat distortion resin. Unusually low viscosity. Low weight loss on heat curing. Excellent electrical and physical properties.	
F	1 to 1	three to four days	2 hours at 250° F. 12 to 18 hours at 200° F. Post curing improves high temperature properties.	High heat distortion resin. Unusually low viscosity. Low weight loss on heat curing. Excellent electrical and physical properties.	
F	1 to 1	three to four days	2 hours at 250° F. 12 to 18 hours at 200° F. Post curing improves high temperature properties.	High heat distortion resin. Unusually low viscosity. Low weight loss on heat curing. Excellent electrical and physical properties.	

PHYSICAL PROPERTIES					
Test	Resin	5	212	250	235
Specific Gravity (cured resin)		1.28	1.15	1.18	1.1
Viscosity (room temp. cps)		2200	1200	2000	1500
Coefficient of thermal expansion (ppm/deg. cent. 25° C. to 55° C.)		84	100	7	25
Impact Strength (ft. lbs./in. 1200)		35	80	Share D	Share D
Hardness		55° C	125° C	125° C	125° C
Heat Distortion Point					

ELECTRICAL PROPERTIES					
Test	Resin	5	212	250	235
Dielectric Strength (volts/mil 1/8" thickness)		470	450	460	2
Dielectric Constant (60 cycles—25° C.)		3.3	3.3	3.3	3.3
Volume Resistivity (ohm/cm)		10 <sup>18</sup>	10 <sup>18</sup>	10 <sup>18</sup>	10 <sup>18</sup>
Dispersion Factor (60 cycles—25° C.)		.03	.03	.03	.03

Values shown are averages for the best quality group and are based on test performance with ASTM or SAE Test Methods.

# makes it easy to select the right "SCOTCHCAST" BRAND RESIN!

A helpful data folder now lets you choose  
from 12 resin formulas for most applications

Which resin is right for your need? Room-curing or heat curing? Rigid or flexible? Filled or unfilled?

You'll find the answers to these questions—and many more—in our convenient new 6-page data folder. Its simplified classification system makes selection of the right "Scotchcast" Resin a fast, easy job.

"Scotchcast" Brand electrical insulating epoxy resins are pre-formulated, pre-measured, resin-hardener systems—complete, ready to mix and use right on the job. They have excellent electrical properties, minimum shrinkage during cure, high adhesion to most materials and remarkable resistance to oils, acids and alkali-

es. There is a "Scotchcast" Brand Resin that's right for every need.

"Scotchcast" Resins are production-designed and extensively tested and proved in actual applications. Formulated in one-part systems, and two-part systems using simple mixing ratios such as 2-to-1 or 1-to-1, they reduce the need for extensive mixing and dispensing equipment and highly-trained personnel.

#### FOR COMPLETE INFORMATION

on "Scotchcast" Resins, and how to choose the right resin for your need, write on your letterhead to 3M, Dept. ON-108, St. Paul 6, Minnesota.



REG. U.S. PAT. OFF.  
**SCOTCHCAST**  
BRAND  
RESINS

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**MINNESOTA MINING AND MANUFACTURING COMPANY**

... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 127 ON READER-SERVICE CARD



**Optical  
Transducer**  
Works in broad daylight

Model 701 vibration, motion, and displacement transducer is a noncontacting optical unit that operates in broad daylight. It measures from 100 micro-inch resolution to 1 inch full scale with different lenses. Frequency response is 0 to 5 kc.

Optron Corp., Dept. ED, 3526 State St., Santa Barbara, Calif.

CIRCLE 128 ON READER-SERVICE CARD

#### Latching Relay

Stands 30 g shock



A 1.5 w pulse for 10 msec transfers the contacts in the KE series miniature relay. The 6pdt dc unit operates under 30 g shocks and 10 g vibration at 55 cps. Contact rating is 2 amp, 115 v, 60 cps for resistive loads.

Potter & Brumfield, Inc., Dept. ED, Princeton, Ind.

CIRCLE 129 ON READER-SERVICE CARD

#### Microwave Absorber

Absorbs up to 400 w



A broadband, power absorbing waveguide waterload, the BL-570 can absorb up to 400 w of cw power over the 4.95 to 10.5 kmc range. Vswr is under 1.2 over the same range.

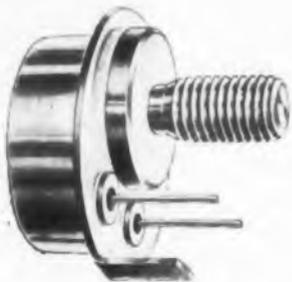
Bomac Labs, Inc., Dept. ED, 1 Salem Rd., Beverly, Mass.

CIRCLE 130 ON READER-SERVICE CARD



# WESTINGHOUSE TAKES A GIANT STEP IN SILICON POWER TRANSISTORS

Through major improvements in silicon purification and transistor fabrication, Westinghouse has broken down the previous limitations of Silicon Power Transistors. The result is a new series of Westinghouse Power Transistors which can operate at high efficiencies in the "true power range."



**LIFE-SIZE DRAWING** shows how Westinghouse Silicon Power Transistor is designed for attachment to heat sink with a screw stud. All leads are in the base.

	CURRENT RATING	V <sub>CB0</sub>	V <sub>CE</sub> (V <sub>EB</sub> =0)	R <sub>s</sub>
WX1015	2 AMPERES	30-300V	30-300V	0.5 OHMS TYPICAL
WX1016	5 AMPERES	30-300V	30-300V	0.4 OHMS TYPICAL

Thermal resistance—Junction to case, 0.7°C/watt typical. Current ratings based on the current at which current gain is equal to or greater than 10. It is possible to switch higher collector currents with some sacrifice in gain.

These are the first members of an entirely new family of Westinghouse Silicon Power Transistors, which have the advantages associated with silicon (high voltages and high operating temperature) without the disadvantages (high losses). As you can see from the chart below, these units possess exceptionally low saturation resistance—less than one half ohm. This low saturation resistance results in low internal dissipation. Coupled with high power handling capacity, it makes possible silicon transistors which can efficiently handle 1000 or 1500 watts. For example, as a DC switch, handling 1.5 kw (300 volts at 5 amperes) the internal dissipation of the units is about 12.5 watts with a resulting efficiency of better than 99%.

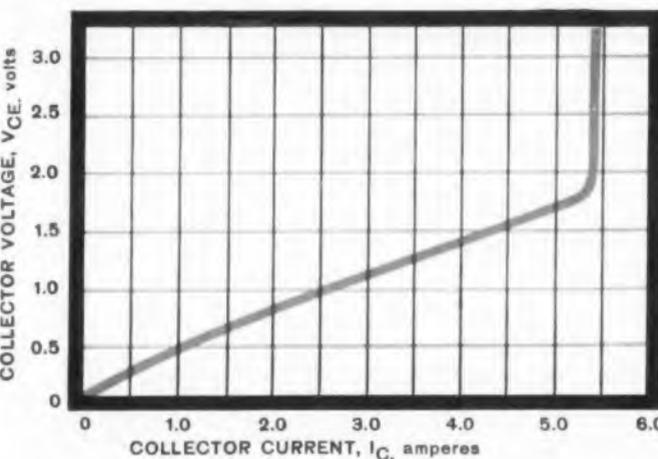
Like other silicon devices, these transistors can operate in ambient temperatures up to and exceeding 150°C while germanium units are limited to 85°C. Thus, where the higher power rating is not required these units may be used for their high temperature capabilities. It also follows that wherever germanium power units are presently employed, a switch to silicon transistors will result in higher reliability of operation, because of the greater margin of safety with respect to operating temperature.

There are a great many circuits for which this new type of silicon power transistor is made to order. It will

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

## Westinghouse

CIRCLE 131 ON READER-SERVICE CARD



**LOW SATURATION RESISTANCE** is exhibited in this graph showing values for a typical Westinghouse Silicon Power Transistor driven to 5 amperes. The values are fractions of those observed in other silicon transistors.

CIRCLE 131 ON READER-SERVICE CARD

## NEW PRODUCTS

### Relay Control

Requires 1/4 μw to switch



A self-contained unit with power relay, thyatron amplifier, and power supply, this sensitive miniature relay control requires 1/4 μw for switching. The unit contains printed circuitry and has an edge-type plug-in arrangement. It mounts vertically or horizontally. Output, one to three poles, is 5 amp each at 250 v ac.

Victory Engineering Corp., Dept. ED, 523C Springfield Rd., Union, N.J.

CIRCLE 132 ON READER-SERVICE CARD

### Magnetic Amplifier Relays

40 to 150 μw sensitivities



For missile and other military and industrial uses, this magnetic amplifier relay series includes three types: 15 amp RL-101 with 0.5 sec response time and 140 μw sensitivity; 2 amp RL-102 with 0.4 sec response and 40 μw sensitivity; and 2 amp RL-103 with 0.6 sec response and 80 μw sensitivity. All units are dpdt.

Ad-Yu Electronics Lab, Inc., Dept. ED, 249 Terhune Ave., Passaic, N.J.

CIRCLE 133 ON READER-SERVICE CARD

### Hydraulic Servovalve

1 per cent hysteresis

Miniature model 410 hydraulic servovalve has 1 per cent hysteresis and 0.1 per cent resolution. Its first and second stages can pass 200 micron particles without malfunctioning. Maximum flow ranges from 0.5 to 5 gpm with 1000 psi drop.

Raymond Atchley, Inc., Dept. ED, 2340 Sawtelle Blvd., Los Angeles 64, Calif.

CIRCLE 134 ON READER-SERVICE CARD

## Rotary Switch

Has plastic rotor



Miniaturization of this rotary switch was accomplished through the use of a plastic rotor. Used for multiple circuit selection, the switch has a 1-3/32 in. diam and a switch section 1/16 in. thick. The rotor is chemically inert, resists thermal shock and has high impact strength.

Oak Manufacturing Co., Dept. ED, Chicago, Ill.

CIRCLE 135 ON READER-SERVICE CARD

## Metallized-Paper Capacitors

Rated at 50 v dc



Type P1232NNG metallized-paper capacitors are rated at 50 v dc and were designed for transistor applications. The units, sealed in a metal tubular case, operate from -65 to +85 C at full voltage rating.

Aerovox Corp., Dept. ED, New Bedford, Mass.

CIRCLE 136 ON READER-SERVICE CARD

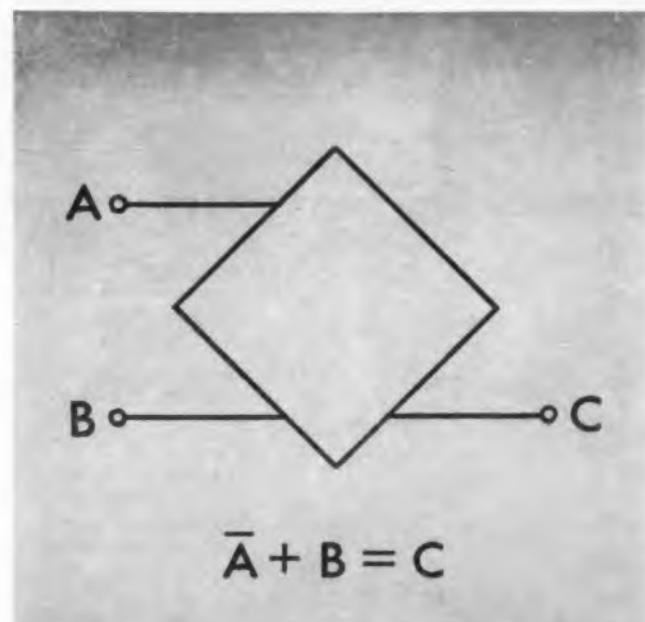
## Recorders

Circular chart type

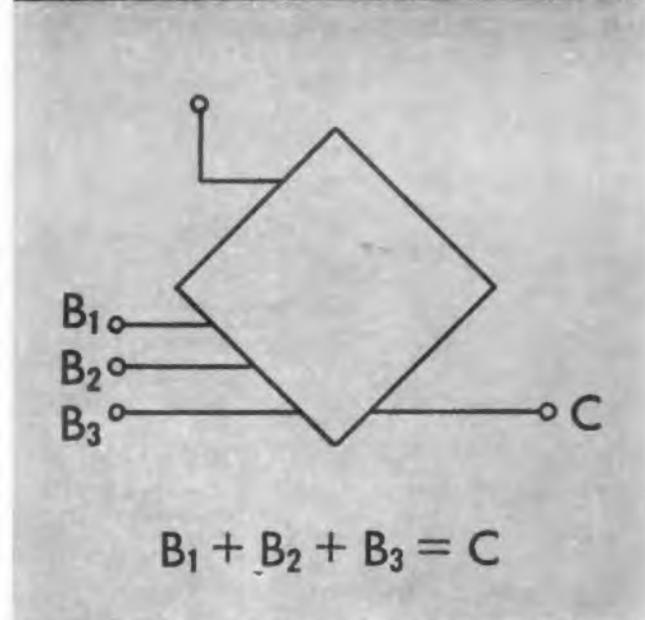
Recorders and recorder-controllers with pneumatic or electric control, these units come in two types: The 6836 are potentiometer devices and the 6856 are Wheatstone bridge instruments. All have a 12-in circular chart mounted on a rotating plate that prevents slippage. Pneumatic control is proportional, on-off, or differential gap; electric control is on-off and proportioning, with and without relays.

Daystrom, Inc., Daystrom-Weston Industrial Div., Dept. ED, Newark 12, N.J.

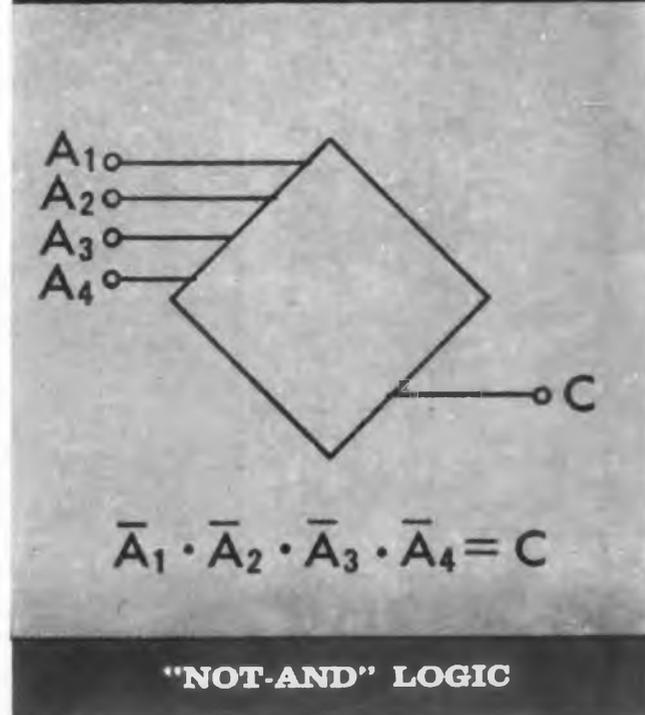
CIRCLE 137 ON READER-SERVICE CARD



"BASIC MODULE" LOGIC



"OR" LOGIC



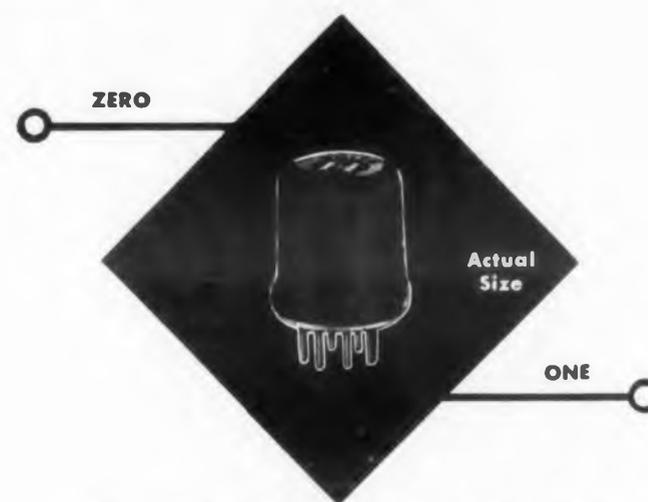
"NOT-AND" LOGIC

CIRCLE 138 ON READER-SERVICE CARD

# NEW for Logic Design Hoffman Magnalog System

featuring

**ZENER MAGNETIC LOGIC MODULE**



\* Designed for miniaturization and simplicity of circuitry.

Typical applications include: bistable; binary half and full adder; shift register; binary counters; decimal counters; "one" generator; "AND", "OR", "NOT" functions.

### FEATURES:

- 100 KC information rate
- High Temperature Operation
- Silicon Zener Diodes
- Miniature Size
- 7 pin, miniature plug-in cases
- Synchronous Operation
- All Static Components
- Low Cost
- Flexibility of Use
- Versatility of Application

**Hoffman  
Electronics**



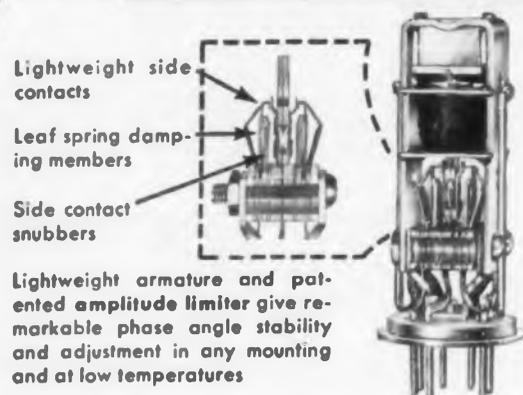
CORPORATION

SEMICONDUCTOR DIVISION

930 Pitner Avenue • Evanston, Ill. • UNIVERSITY 9-9850  
Regional Offices: WASHINGTON, D.C. . . . CHICAGO . . . LOS ANGELES

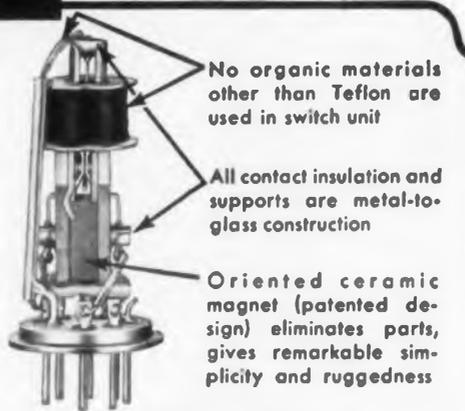
LEADING THE FIELD IN SILICON ZENER SEMICONDUCTOR DEVICES

# Save this Guide to Oak Choppers



**MINIATURE SERIES 600—MOST STABLE IN ITS CLASS**

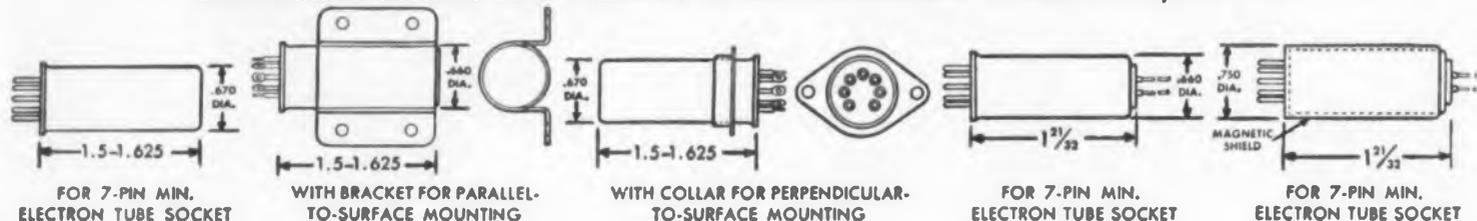
METICULOUS ENGINEERING combined with exhaustive testing provides a line of SPDT choppers which exhibit unusual stability and low noise. While the specifications shown here are necessarily abbreviated, they will help you make a preliminary appraisal. For complete details on any unit, send us the type number and a description of your application with its circuitry.



**MINIATURE SERIES M—SMALLEST, MOST RUGGED IN ITS CLASS**

**SERIES 600—MIL C4856, Class B, Type 1.** Capacity between switch terminals and ground, 15 uuf average. Contact symmetry, within 10°. Weight, less than 1 oz.  
**SERIES M—MIL C4856, Class B, Type 1, Grade 2.** Capacity between switch terminals and ground, 3-5 uuf. Contact symmetry: 0-500 cps, within 10°; at 1000 cps, within 20°. Weight, less than 3/4 oz.

## STANDARD MOUNTING AND TERMINAL STYLES—Modifications Available on Special Order



	SERIES 600						SERIES M For Shock and Vibration Conditions
	Types { 607 NC-600 602 603	Type 610	Type 604	Type 612	Type 605	Types { 608 609 NC-600A	Types { M5-1 M5-2 M5-3
Nominal Drive Freq. and Voltage	400 ± 20 cps at 6.3 v	400 ± 20 cps at 6.3 v	380-500 cps at 6.3 v	400 ± 20 cps at 6.3 v	400 ± 20 cps at 6.3 v	60 ± 5 cps at 6.3 v Aperiodic from 10-100 cps	4-8 Volts, 10-1000 cps. Aperiodic. Coil Current 60 ma at 400 cps Coil Res. 85 Ohms
Phase Lag at Nominal Drive Freq. and Voltage	65° ± 5° at 400 cps (25° C)	65° ± 5° at 400 cps (25° C)	75° ± 10° at 400 cps (25° C)	90° ± 10° at 400 cps (25° C)	180° +10° -0° at 400 cps (25° C)	20° ± 5° at 60 cps (25° C)	10 cps: 10° ± 5° 60 cps: 15° ± 5° 400 cps: 55° ± 10° 1000 cps: 110° - 0° (25° C)
Contact Dwell Time at Nominal Drive Freq. and Voltage	150° min (25° C)	140° max (25° C)	150° min (25° C)	150° min (25° C)	160° ± 10° (25° C)	165° to 170° at 60 cps	160° to 170° (25° C)
Contact Rating Into Resistive Load (Maximum)	CONTINUOUS: 10 v at 2 ma INTERMITTENT: 15 v at 2 ma	CONTINUOUS: 50 v at 2 ma INTERMITTENT: 100 v at 2 ma	CONTINUOUS: 10 v at 2 ma INTERMITTENT: 15 v at 2 ma	CONTINUOUS: 10 v at 2 ma INTERMITTENT: 15 v at 2 ma	CONTINUOUS: 50 v at 2 ma INTERMITTENT: 100 v at 2 ma	CONTINUOUS: 15 v at 2 ma INTERMITTENT: 50 v at 2 ma	CONTINUOUS: 10 v at 1 ma INTERMITTENT: 12 v at 2 ma
Life Expectancy (Optimum Conditions)	Up to 5000 hours	Up to 1000 hours	Up to 5000 hours	Up to 5000 hours	Up to 5000 hours	Up to 10,000 hours	Up to 10,000 hours
Switching Speed With DC in Coil	Less than 1 Millisecond	Less than 1 Millisecond	Less than 1 Millisecond	Less than 1 Millisecond	Less than 1 Millisecond	Less than 800 Microseconds	Less than 200 Microseconds

**OAK MFG. CO.**

1260 Clybourn Ave., Dept. D, Chicago 10, Illinois  
Phone: MOhawk 4-2222

CIRCLE 139 ON READER-SERVICE CARD

SWITCHES CHOPPERS VIBRATORS  
ROTARY SOLENOIDS TUNERS  
PACKAGED CIRCUITRY

## NEW PRODUCTS

### Counting Dial Sealed unit construction



Used with ten turn potentiometers, these Migit-Mite counting dials have sealed unit construction. Numerals are held in place until completion of the next full rotation of the dial. The dials provide continuous operation in either direction, and come in sizes up to 2 in. OD.

S. A. Asquith Co., Dept. ED, 427 W. Chevy Chase Drive, Glendale, Calif.

CIRCLE 140 ON READER-SERVICE CARD

### Silicon Voltage Reference High accuracy to 200 C



A temperature coefficient of 0.0005 per cent per deg C over a temperature range of -65 to +200 C is featured in this diffused silicon voltage reference. A silicon wafer construction makes possible the small size. Available in both axial lead and lug terminal styles for use in computers, measuring instruments and controls.

U.S. Semiconductor Products, Inc., Dept. ED, Phoenix, Ariz.

CIRCLE 141 ON READER-SERVICE CARD

### Magnetic Frequency Detector 0 to 500 µa output

Using only static components, the 510 magnetic frequency detector measures audio frequencies directly. It delivers 0 to 500 µa of dc output for 0 to 500 cps input and needs no external power sources. Accuracy is 1 per cent.

Acromag, Inc., Dept. ED, 22519 Telegraph Rd., Detroit 41, Mich.

CIRCLE 142 ON READER-SERVICE CARD

## Phase-Lock Receivers

215 to 260 mc range



Series 1400 phase-lock receivers cover a frequency range of 215 to 260 mc. In the case of IRIG fm/fm telemetry using standard receivers of 500 kc bandwidth, noise bandwidth can be reduced by a factor of approximately 2.5 when all subcarriers are used, resulting in a theoretical improvement of nearly 7.96 db both in reduction of receiver threshold and in improved signal-to-noise ratio above threshold.

Nems-Clarke Co., Div. of Vitro Corp. of America, Dept. ED, 919 Jesup-Blair Drive, Silver Spring, Md.

CIRCLE 143 ON READER-SERVICE CARD

## Capacitors

Variety of terminals



These bathtub-style capacitors come in a variety of terminals and have optional mountings. The terminals may be on any side of the unit and may be plug-in or solder-lug type. Produced in a wide range of capacities, the line offers a choice of dielectric materials.

Condenser Research Corp., Dept. ED, P.O. Box 161, Seymour, Ind.

CIRCLE 144 ON READER-SERVICE CARD

## Pressure Switch

For aircraft hydraulic systems

The 6512 is a snap action, spdt switch for aircraft and other hydraulic systems that need a pressure sensor to actuate electrical apparatus. Operating point is adjustable from 500 to 2000 psi and 2000 to 3500 psi.

Consolidated Controls Corp., Dept. ED, Bethel, Conn.

CIRCLE 145 ON READER-SERVICE CARD

MEMO TO THE ENGINEER/DESIGNER:

# Ask the people at Electrical Industries!



— BECAUSE

**E-I** knows glass-to-metal seals\*

AS ONLY A SPECIALIST CAN! E-I has sealing experience you can use! Almost two decades devoted exclusively to the design, development and manufacture of glass-to-metal seals means you can depend on E-I for a practical solution to your hermetic sealing problems. Available are a complete line of standard seals, facilities for the design and production of special types, and custom service for sealing components of your manufacture. Call or write for catalog or quotations, today.

Plug-in Type  
Multiple Headers

Compression  
Multiple Headers

End Seals Including  
Threaded Types

Transistor Closures  
and Diode Bases

Single Lead  
Terminals

A Division of  
Philips  
Electronics, Inc.



**ELECTRICAL  
INDUSTRIES**

MURRAY HILL, NEW JERSEY

\* Patented in Canada, No. 523,390; in United Kingdom, No. 734,583; licensed in U.S. under Patent No. 2561520

CIRCLE 146 ON READER-SERVICE CARD

**RATES HIGH\*  
IN CURRENT EVENTS!**

### ERA's TRANSISTORIZED HIGH CURRENT REGULATED POWER SUPPLIES

#### FEATURES:

- Continuously Variable Output
- Vernier Voltage Control
- Fast Transient Response
- Low output Ripple
- Positive, Negative, Zero % Regulation Control
- Line Frequency Insensitive
- Remote Sensing
- Constant Current Overload Limit Control
- Positive or Negative Outputs, Ungrounded
- Terminals On Front and Rear
- Hinged Panel For Full Accessibility
- High Efficiency
- Low Heat Dissipation
- Compact, Light Weight
- Instant Warm-up Time

Write For ERA's  
New Solid State  
Power Supply Catalogue

Additional stock models, special designs made to customers specifications also available.

#### Pioneers in Semi-Conductor and Transistorized Products.

First Miniaturized Power Packs.  
First Transistorized Power Supplies.  
First Automatic Transistor Test Equipment.  
First Dual Output Tubeless Supplies.  
First Packaged Transistor Circuits.

Models listed are designed for 105-125 VAC input, 60 cycles. Continuously adjustable output. Line and load regulation is within  $\pm 0.5\%$  full range (or less for any given output). Front panel regulation control. Frequency response of regulator extends into high audio frequencies. Ripple less than 0.05% or 5 mv. Current limiter control on front panel for full overload and circuit protection. Vernier voltage control. Units are for bench or standard 19" rack mounting.

#### TYPICAL STOCK MODELS

Model No.	Voltage VDC	Current Amps.	Output DC R(Ohms)	Price*
TR32-4	4-32	0-4	0.01	\$455.00
TR32-8	4-32	0-8	0.005	495.00
TR32-12	4-32	0-12	0.002	575.00
TR150-1	20-150	0-1	0.5	455.00
TR300-1	170-300	0-1	0.5	605.00

\*F.O.B. Cedar Grove, N. J. or Santa Monica, Cal.  
Prices subject to change without notice.

First Transistor Application Power Supplies.  
First Constant Current Generators.  
First High Current Semi-Conductor Regulated Supplies.  
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## ELECTRONIC RESEARCH ASSOCIATES

67 Factory Place, Cedar Grove, N. J.

Center 9-3000

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ERA ELECTRIC CORPORATION • NUTLEY, NEW JERSEY

CIRCLE 147 ON READER-SERVICE CARD

## NEW PRODUCTS

### Silicon Rectifier

Low reverse leakage



Type T encapsulated silicon rectifier is a diffused junction unit designed for 85 C ambient. The design allows low reverse leakage current and low forward voltage drop. Maximum piv is 400 v. Maximum dc load current is 500 ma. Forward voltage drop at max dc load is 0.5 v. Maximum reverse leakage current is 0.2 ma.

P. R. Mallory & Co., Inc., Dept. ED, Indianapolis, Ind.

CIRCLE 148 ON READER-SERVICE CARD

### Power Supply

Airborne strain gage type



Two versions of the 2 to 300 power supply provide 1 or 3 amp at 5, 10, or 15 v. Output voltage varies less than  $\pm 0.1$  per cent for line variations of  $\pm 0.1$  per cent from  $-55$  to  $+85$  C. The unit will operate to these specifications under 20 g vibration and 50 g shock up to 70,000 ft.

Neff Instrument Corp., Dept. ED, 2211 East Foothill Blvd., Pasadena, Calif.

CIRCLE 149 ON READER-SERVICE CARD

### Coil Assemblies

1-1/4 in. long

Ceramic coil forms 2480 through 2485 are 1-1/4 in. long and come with adjustable ring terminals or silicon Fiberglass terminal collars.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

CIRCLE 150 ON READER-SERVICE CARD

## Why do it Yourself?



It Pays to Standardize on

# Jeffers R.F.

### Choke Coils

You can save time, labor, and money by stocking the wide range of Jeffers R.F. choke coils just as you do resistors, capacitors, and other similar components. You can forget tedious, expensive hand assembly from miscellaneous forms, wires, and coatings by using standardized Jeffers coils, completely assembled for use.

Jeffers coils are well made, using insulated copper wire windings... husky molded jackets. All windings are soldered to leads... shorted end turns are completely eliminated.

Put these advantages to work in your circuits! Jeffers Electronics offers you... ready for delivery... a complete line of R.F. choke coils with a complete range of inductance values. Write today for our specification sheets.

Other Jeffers Products  
fixed composition capacitors

Other Speer Products  
for the Electronics Industry  
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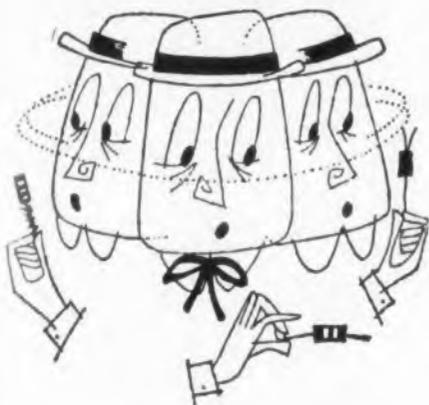


JEFFERS ELECTRONICS  
DIVISION  
SPEER CARBON COMPANY  
Du Bois, Pennsylvania

Other Speer Divisions:  
Speer Resistor, Speer Carbon Products,  
International Graphite & Electrode

CIRCLE 151 ON READER-SERVICE CARD

## Looking for the right resistor?



Call Speer for a complete line of fixed composition resistors, phenolic coil forms



For detailed information on specifications, characteristics and applications ask for this catalog of Speer Electronic Components!

Automation Soldering your concern? Be sure to send for Speer's Bulletin on this subject.

### Other Speer Products for the Electronics Industry

R. F. coils • chokes • fixed composition capacitors • Speer PAC made by Jeffers Electronics. Also electronic tube anodes • contacts • rocket and missile parts • brushes • battery carbons • graphite plates and rods and graphite products for the steel and chemical industries.



**SPEER RESISTOR DIVISION**  
**SPEER CARBON COMPANY**  
Bradford, Pennsylvania

- Send the Speer Resistor Catalog.  
 Send Automation Soldering Bulletin.

Name \_\_\_\_\_  
Title \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 152 ON READER-SERVICE CARD



**Silicon Rectifier**  
1500 v at 150 C

Designated TM155, this silicon rectifier offers 1500 v, 400 ma ratings at 150 C. It may be used in high voltage power supplies requiring 600 v output or higher. Hermetically sealed, it comes in the standard 7/16 in. hex package.

Transitron Electronic Corp., Dept. ED, Wakefield, Mass.

CIRCLE 153 ON READER-SERVICE CARD



**Spectrum Analyzer**  
0.5 cps to 300 kc range

The S-2 series makes possible spectrum and power density analysis of both discrete and random data from 0.5 cps to 300 kc. The system consists of a Panoramic spectral power density analyzer model PDA-1 plus a spectrum analyzer and chart recorder. Four different modes of analysis are selectable through front panel switching.

Panoramic Radio Products, Inc., Dept. ED, 520 South Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 154 ON READER-SERVICE CARD

## Terminal Blocks

Eliminate external wiring



In 1, 2, and 3, row units, these solderless terminal blocks accept standard AMP 53 taper pins. With internal buss connections to eliminate external wiring, units come in any combination of feed-through individual or shorting terminals.

DeJur-Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N.Y.

CIRCLE 155 ON READER-SERVICE CARD



## — and now for the heat test!

So you *did* build your own pot! Now — will it function at 150°C? It *might*, if you made sure to use some real cool winding wire (say, with no more than 20 parts per million temperature coefficient)! A specially-designed heat-resistant element card would also be handy to keep things cool! But you don't *have* to build-'em-yourself and then go through all this barbecue-broil testing, to be assured of pots with good high-temperature characteristics!

Why take "pot luck", when Ace has all these special high-temperature design features — neatly packaged in the Acepot X-500! Our exclusive design dissipates internal heat to the mounts, allowing greater dissipation at high temperature. So put away your chef's hat — and rely on Ace's four years of testing. For high temperature performance — the X-500's your answer. See your ACErep!



The X-500 Acepot. From -55°, up to 150°C, with special heat-resistant elements. Excellent resolution, ±0.3% linearity. 1/2" size, 1/4-ounce. Prompt delivery.

**ACE** ELECTRONICS ASSOCIATES, INC.  
99 Dover Street, Somerville 44, Mass.  
SOMerset 6-5130 TMX SMVL 181 West. Union WUX

Acepot® Acetrim® Acoset® Aceohm® \*Reg. Appl. for  
CIRCLE 156 ON READER-SERVICE CARD

new missile test panels  
feature

**EMCOR**<sup>®</sup>  
PACKAGING  
FLEXIBILITY



Test panels designed and instrumented by test equipment engineers and builders of Lear, Inc., Grand Rapids, Michigan, assure reliability standards of the Lear Stable Platform being used in the initial guidance system of Boeing's long-range IM-99 Bomarc missile. The test panels feature the flexibility of EMCOR's most modern concept in metal cabinetry... THE EMCOR MODULAR ENCLOSURE SYSTEM. Of uniform size, the test panel frames can easily be bolted, unbolted and rearranged to quickly meet changing production demands. EMCOR's engineering mastery of the design in metal cabinetry makes possible the arrangement of groups of intricately wired instruments, indicators, dials and electronic scopes for easy visual and manual operation while reducing environmental fatigue and strain.

<sup>®</sup>Registered Trademark of Elgin  
Metalformers Corporation

Your copy of Catalog 105  
is available upon request.

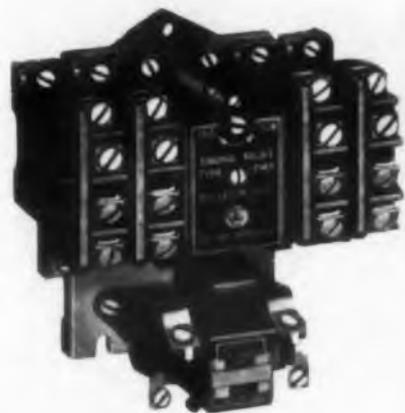


**ELGIN METALFORMERS  
CORPORATION**

630 CONGDON, DEPT. 1221  
ELGIN, ILLINOIS

CIRCLE 157 ON READER-SERVICE CARD

## NEW PRODUCTS



**Time Delay  
Relay**  
Saves panel  
space

Available in 32 variations of five basic models, the type PMT time delay relay needs no extra vertical space for latch and timing mechanisms. Time delays up to 3 min are offered in some of these pneumatic, 10 amp units. Using modular construction, the relays have universal poles with isolated contacts so that two circuits per pole may be used, even at opposite polarity.

Clark Controller Co., Dept. ED, Cleveland 10, Ohio.

CIRCLE 158 ON READER-SERVICE CARD



**DC Electrometer**  
Has 53 ranges

Model 600 dc electrometer has 53 ranges. It measures voltage from 10 mv to 10 v full scale; current from  $10^{-14}$  to 3 amp full scale; and resistance from 200 to  $10^{13}$  ohms full scale. It also serves as a dc preamplifier with precise gains from 0.1 to 100.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

CIRCLE 159 ON READER-SERVICE CARD

## Rotary Solenoid

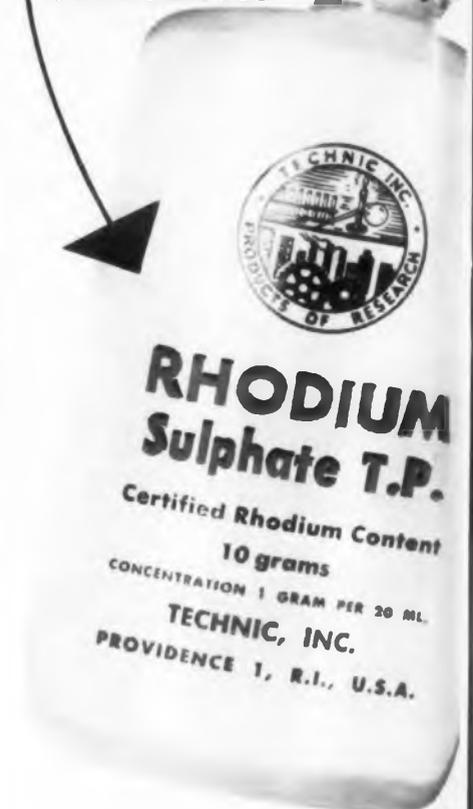
Has ratchet drive

Motoroid ratchet drive solenoids provide rotary output without the use of linkages. Output torques can be selected from any part of their torque curve, and their rotation angle can be varied by stop adjustment.

Leetronics, Inc., Dept. ED, 30 Main St., Brooklyn 1, N.Y.

CIRCLE 160 ON READER-SERVICE CARD

Test this  
**NEW Rhodium  
Concentrate**



an improvement  
by **TECHNIC**

Technic developed this superior Rhodium concentrate to meet today's electroplating specifications with —

- \* Lower Stress
- \* Higher Purity
- \* Finer Grain

Testing is easy because of high compatibility with existing Rhodium baths. Ask for complete data on characteristics and applications. When you adopt Technic solutions or methods, our technical staff is yours until optimum performance is assured. Write or phone today.

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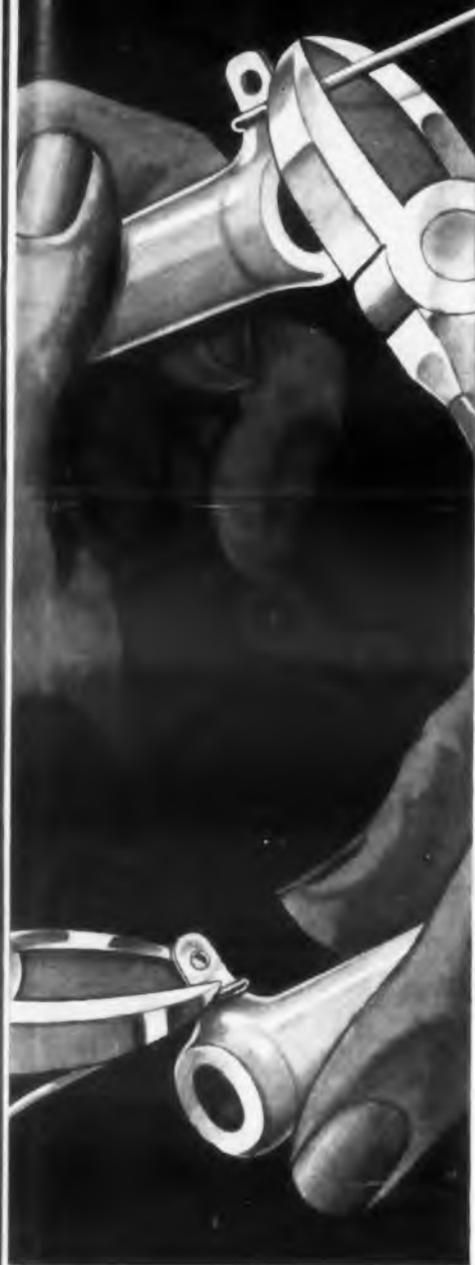
THE LARGEST ENTERPRISE OF ITS KIND IN THE WORLD



CIRCLE 161 ON READER-SERVICE CARD

ELECTRONIC DESIGN • October 29, 1958

**GE** VITREOUS-ENAMELED  
RESISTORS



## “SNIP OR CLIP” TAB TERMINALS

Snip the lead, or clip the tab... get the exact terminal type you need! Save space and eliminate the need to stock two types of resistors. This unique feature is on General Electric 5-, 10-, and 20-watt resistors. For your vitreous-enameled resistor catalog, follow reader service instructions below. General Electric Co., Roanoke, Va.

784-12

Progress Is Our Most Important Product

**GENERAL ELECTRIC**

CIRCLE 162 ON READER-SERVICE CARD

ELECTRONIC DESIGN • October 29, 1958



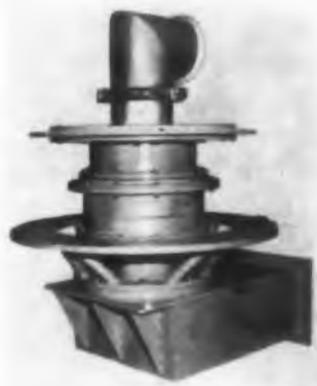
## Environmental Test Chamber

Has wide  
temperature range

Having a temperature range from  $-100$  to  $+800$  F, this test chamber is accurate to  $\pm 2$  F. The Freon 13-Freon 22 cascade type unit can dissipate 1600 BTU/hr at  $-85$  F and 500 BTU/hr at  $-100$  F. Internal capacity is 3.4 cu ft. Fiberglass is used as insulator.

Associated Testing Labs, Inc., Dept. ED, 112 Clinton Rd., Caldwell, N.J.

CIRCLE 163 ON READER-SERVICE CARD



## Rotary Joint

Handles 100 kw

This rotary joint, used in antenna systems, can handle 100 kw average power. Its operating frequency is 400 to 450 mc. The unit has a vswr of 1:15 (max). Size: WR2100 to 9 in. coaxial.

G. B. Electronics Corp., Dept. ED, 711 Stewart Ave., Garden City, N.Y.

CIRCLE 164 ON READER-SERVICE CARD

## Tube Tester

Offers multiplicity of peak conditions

For electronic and TV picture tubes, the 10-40 tube tester affords functional testing of voltage regulator tubes, ultrasensitive gas testing for amplifier tubes, and beam-current testing of TV tubes. Because the tubes under test are dynamically swept over a path of operation, on a sinusoidal time base, encompassing a wide range of plate family characteristic curves, they show their ability to operate at a multiplicity of peak conditions.

Precision Apparatus Co., Inc., Dept. ED, 70-31 84th St., Glendale, N.Y.

CIRCLE 165 ON READER-SERVICE CARD

# WHICH BENDIX TRANSISTOR IS BEST FOR THE JOB?

TYPICAL OPERATION AND MAXIMUM RATINGS OF BENDIX GERMANIUM PNP POWER TRANSISTORS												
TYPE NUMBER	PRIMARY APPLICATIONS				MAXIMUM RATINGS				TYPICAL OPERATIONS			
	Audio	Push-Pull	Switch	Power Supply	Col-lector Voltage (a)	Col-lector Current	Thermal Resistance (b)	Junc-tion Temp.	Current Gain		Power Output	
					Vdc	Adc	$^{\circ}\text{C}/\text{W}$	$^{\circ}\text{C}$	(c) —	Ic	db	Watts
2N234A	X				30	3	2.2	90	25*	0.5	30	2
2N235A	X				40	3	2.2	90	40*	0.5	33	2
2N235B	X				40	3	2.2	90	60*	0.5	36	2
2N236A	X				40	3	2.0	95	40*	0.75	33	4
2N236B	X			X	40	3	2.0	95	60*	0.75	36	4
2N285A	X			X	40	3	2.2	95	150*	0.5	39	2
2N399	X	X			40	3	2.2	90	40*	0.75	33	8 (e)
2N400	X			X	40	3	2.2	95	50*	1.0	36	6
2N401	X	X			40	3	2.2	90	40*	0.5	30	5 (e)
2N418			X	X	80	5	2.2	100	50	4.0	—	100 (d)
2N419				X	45	3	2.2	95	60*	0.5	—	5
2N420			X	X	40	5	2.2	100	50	4.0	—	—
2N420A			X	X	70	5	2.2	100	50	4.0	—	—
2N637	X		X	X	40	5	2.0	100	45	3.0	—	35 (d)
2N637A	X		X	X	70	5	2.0	100	45	3.0	—	70 (d)
2N637B			X	X	80	5	2.0	100	45	3.0	—	70 (d)
2N638	X		X	X	40	5	2.0	100	30	3.0	—	35 (d)
2N638A	X		X	X	70	5	2.0	100	30	3.0	—	70 (d)
2N638B			X	X	80	5	2.0	100	30	3.0	—	70 (d)
2N639	X		X	X	40	5	2.0	100	23	3.0	—	35 (d)
2N639A	X		X	X	70	5	2.0	100	23	3.0	—	70 (d)
2N639B			X	X	80	5	2.0	100	23	3.0	—	70 (d)
2N1031	X		X	X	30	15	1.5	100	40	10	—	75 (d)
2N1031A	X		X	X	40	15	1.5	100	40	10	—	125 (d)
2N1031B	X		X	X	70	15	1.5	100	40	10	—	250 (d)
2N1031C			X	X	80	15	1.5	100	40	10	—	250 (d)
2N1032	X		X	X	30	15	1.5	100	75	10	—	75 (d)
2N1032A	X		X	X	40	15	1.5	100	75	10	—	125 (d)
2N1032B	X		X	X	70	15	1.5	100	75	10	—	250 (d)
2N1032C			X	X	80	15	1.5	100	75	10	—	250 (d)

(a) Vce rating. Equivalent Vcb's are 20-50% higher (b) Collector dissipation is the difference between the maximum junction temperature and the mounting base temperature divided by the thermal resistance (c) hfe, AC current gain as noted with (\*). All others represent hFE, DC current gain. (d) Square wave output power (e) Push-pull output (f) 2N1031, 2N1032 series have lugs. 2N677, 2N678 series have straight pins. 2N1029, 2N1030 series have flying leads.

There is a Bendix power transistor to help you get the right power and gain on your job. When you buy Bendix you enjoy extra quality at no extra cost: low leakage, life stability, high breakdown voltage, low thermal resistance, and controlled temperature variation. Our volume production enables immediate delivery on most models. For details or help on circuitry problems, write: SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

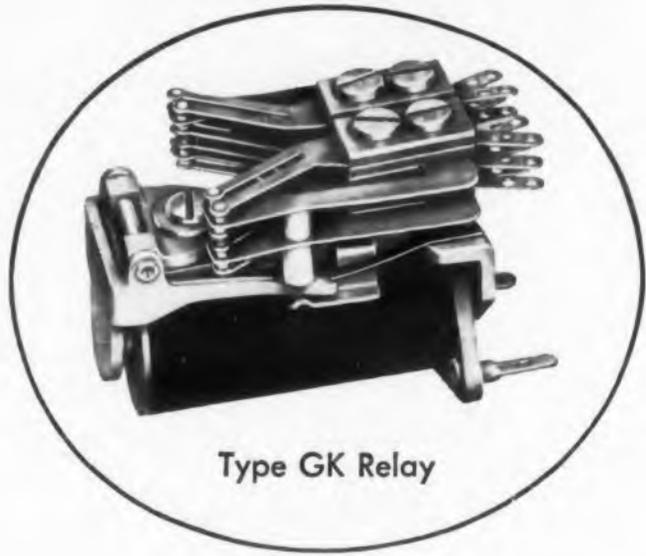
West Coast Sales and Service: 117 E. Providencia Ave., Burbank, Calif.  
Canadian Affiliate: Computing Devices of Canada, Ltd., P.O. Box 508, Ottawa 4, Ont.  
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**Red Bank Division** 

CIRCLE 166 ON READER-SERVICE CARD

# ALLIED's *New* General Purpose Relay\*

FOR D-C OPERATION



Type GK Relay

Long life, stability and high reliability are the features of this new general purpose relay.

Allied's type GK relay uses twin contacts with bifurcated stationary contact arms. Designed for a wide variety of Industrial and Military applications, Allied's type GK relay has a capacity of 20 springs which can be assembled in a variety of combinations of A, B, C and D contact forms.

Here  
are  
the  
facts:

**Operating Voltage:**

up to 220 volts d-c

**Contact Rating:**

up to 4 amperes at 150 watts

**Temperature Range:**

up to  $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

**Vibration:**

up to 10 to 55 cps at .062 inch double amplitude

**Operating Shock:**

up to 30 g

\*For complete details send for Allied's GK catalog sheet.



**ALLIED CONTROL**  
ALLIED CONTROL COMPANY, INC.,  
2 East End Avenue, New York 21, N. Y.

AL191

CIRCLE 167 ON READER-SERVICE CARD

## NEW PRODUCTS

**SPRAY CLEANER.**—Vythene-E, purified grade of Vythene, 20 times less toxic than carbon tetrachloride. Has no flash point and is highly stabilized to all metals.

Tect, Inc., Dept. ED, Northvale, N. J.

CIRCLE 168 ON READER-SERVICE CARD

**CENTRIFUGAL BLOWERS.**—Series LP low pressure units with diameters from 2 to 9 in. Deliver 20 to 2000 cfm.

The Torrington Mfg. Co., Dept. ED, Torrington, Conn.

CIRCLE 169 ON READER-SERVICE CARD

**ROTARY INVERTER.**—Model 4617 for inertial guidance systems. Delivers 750 va from 28 v dc input. Voltage controlled to  $\pm 0.2$  per cent, frequency to  $\pm 0.01$  per cent.

Varo Mfg. Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

CIRCLE 170 ON READER-SERVICE CARD

**POTTING COMPOUND.**—Temporell No. 1500 adheres to metal, paper, and wood, but not to rubber. Temperature range of  $-65$  to  $+1500$  F.

Orell, Inc., Dept. ED, Box 527, South Gate, Calif.

CIRCLE 171 ON READER-SERVICE CARD

**PHOTOJUNCTION CELL.**—Miniature type 7224 for sound movie projector and computer use. Covers 3500 to 19,000 angstrom range and has illumination sensitivity of 0.7  $\mu\text{a}$  per ft-c. Dissipates 0.03 w.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N. J.

CIRCLE 172 ON READER-SERVICE CARD

**MINIATURE CIRCUIT BREAKER.**—Klixon 7274-1 manual reset thermal breaker 1.42 x 0.75 x 0.56 in. Ratings from 0.5 to 5 amp.

Metals & Controls Corp., Dept. ED, Attleboro, Mass.

CIRCLE 173 ON READER-SERVICE CARD

**TANTALUM CAPACITORS.**—Foil-type electrolytic units that withstand 2000 hr life test. End seal of TFE-fluorocarbon resin is virtually leakproof.

Sprague Electric Co., Dept. ED, North Adams, Mass.

CIRCLE 174 ON READER-SERVICE CARD

**ACCELEROMETER.**—Gas damped model A501 for accurate measurement of acceleration changes flat up to 500 cps. Operates from  $-65$  to  $+200$  F without heater jacket.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 175 ON READER-SERVICE CARD

Now!

## Elastic Stop<sup>®</sup> Nut Miniatures to NAS 696-7-8, NAS1067-8



LHTE

LHTA55  
NAS 684

LHTA521  
NAS 686

LHTA51  
NAS 680

LHTM  
NAS 679

LHTA575M  
NAS 1067

LHTA2900  
NAS 1068

LHTA51M  
NAS 697

LHTA57M  
NAS 696

LHTG51  
NAS 688-692

LHTA517  
NAS 687

LHTA57  
NAS 682

LHTA55M  
NAS 698

These new miniature self-locking nut series added to the full lines of counterbored, low height NAS 679-695 parts previously announced, offer avionic engineers a wide variety of 550°F. fasteners to meet the severest application problems imposed by the space limitations of new missile and electronic designs. All of these new Elastic Stop nuts use ESNA's AN-approved offset locking closure which exerts locking torque radially and elastically for vibration-proof tightness and extended re-usability. Write Dept. S4-1057 for specification sheets on the new LHTA51 and LHTA51M series.



**ELASTIC STOP NUT CORPORATION  
OF AMERICA**

2330 Vauxhall Road, Union, New Jersey

CIRCLE 176 ON READER-SERVICE CARD

**TOUGH  
and tiny**

save SPACE  
and WEIGHT with

The  
**A. W. HAYDON COMPANY'S**  
Unique Line

of

**RELIABLE SUB-MINIATURE  
TIME DELAY RELAYS**

**TINY!**  
1 x 2 inch cross section  
7 1/2 ounce basic weight

**TOUGH!**  
Temperature:  $-54^{\circ}\text{C}$ . to  $85^{\circ}\text{C}$   
Vibration: 500 CPS, 10g  
Shock: 30g

Hermetically Sealed Housings!  
Direct Current or 400 Cycle Operation!  
Standard or Reverse Clutching!

Custom Designed to Meet Military Specifications!  
Write for Bulletin AWH-TD-502.

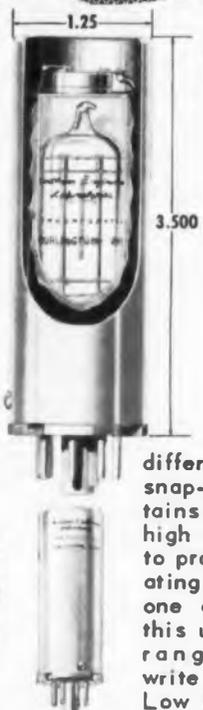


**A.W. HAYDON Company**

277 NORTH ELM STREET, WATERBURY 20, CONNECTICUT  
Design and Manufacture of Electro-Mechanical Timing Devices

CIRCLE 177 ON READER-SERVICE CARD

ELECTRONIC DESIGN • October 29, 1958



**NEW! RUGGED!  
RELIABLE!  
NE - 71 OVEN**

*designed for  
the most severe  
environmental conditions*

The new NE-71 Oven has been developed for our T-7 Series of Glass Sealed Crystals in the 10 to 350 KC range. Utilizing a close differential, hermetically sealed, snap-action thermostat. NE-71 maintains dependable close control under high vibration conditions. Recovery to proper temperature after non-operating exposure to low temperature is one of the outstanding features of this unit. Available in 6 to 115 volt range. For technical information, write for bulletin No. 7158, and for Low Frequency Crystal Catalog.

**Northern Engineering  
Laboratories, Inc.**

ROCKWELL 3-7155  
372 Wilmot Avenue

TWX: BURL WIS 426  
Burlington, Wisconsin

CIRCLE 178 ON READER-SERVICE CARD

**Count on SYSTRON  
RDB COUNTER  
with in-line readout**



**MEASURES**  
★ RDB Channels 1-18  
★ RPM  
★ Mass Flow Rate  
★ Frequencies  
★ 1 to 100,000 Periods

**FREQUENCY RANGE** . . . 5 CPS to 100 KC  
**ACCURACY** . . . ± 1 count, ± 1 part in 10<sup>5</sup>  
**READOUT** . . . Nixie, to 99,999  
**SENSITIVITY** . . . 5 Millivolts rms  
**TIME BASES:**  
RDB . . . . . 1/5 second  
CPS . . . . . 1 & 10 seconds  
RATE . . . . . Selectable 0.1ms increments  
to 10 secs.  
PERIOD 1 to 100,000 cycles of input

PRICE . . . . . \$1,550 F.O.B. Concord



950 GALINDO STREET CONCORD, CALIFORNIA  
REPRESENTATIVES IN PRINCIPAL CITIES

CIRCLE 179 ON READER-SERVICE CARD

ELECTRONIC DESIGN • October 29, 1958

**TEMPERATURE CONTROL SYSTEM.**—Model TLC-3297 3-channel warning and control system to monitor process-tube temperatures in nuclear reactors. Adaptable to any remote temperature monitoring application.

Amoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

CIRCLE 180 ON READER-SERVICE CARD

**DIGITAL VOLTMETER.**—Model DVA-410 ac-dc 4-digit unit has a range of 0.0001 to 999.9 v; ac accuracy of 0.1 per cent or two digits; and dc accuracy of ±1 digit. Transistorized; modular construction.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.

CIRCLE 181 ON READER-SERVICE CARD

**PUSHBUTTON SWITCH.**—Tri-Lite monitors three conditions with a three-color light assembly. Dual-purpose unit is for flush or subpanel mounting.

Electro Snap Corp., Dept. ED, 4230 W. Lake St., Chicago 24, Ill.

CIRCLE 182 ON READER-SERVICE CARD

**ELAPSED TIME INDICATORS.**—Series 53 units have self-starting synchronous motors and standard 5-digit registers. They are 3.5 in. round or square.

Marion Electrical Instrument Co., Dept. ED, Grenier Field, Manchester, N. H.

CIRCLE 183 ON READER-SERVICE CARD

**REGULATED POWER SUPPLY.**—Transistorized model SC-32-5 delivers 0 to 32 v, 0 to 5 amp. Under 0.01 per cent regulation for line or load.

Kepeco Labs, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N. Y.

CIRCLE 184 ON READER-SERVICE CARD

**RF CONNECTORS.**—Type 3000 cable plug, 3001 cable jack, 3002 panel receptacle, 3003 panel jack, 3004 cable feed-through, and 3005 right-angle plug are added to ConheX miniature hexagonal line.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N. Y.

CIRCLE 185 ON READER-SERVICE CARD

**INSULATION.**—Stanpreg P1 all-purpose glass fabric for use under MIL-R-7575A. Polyester resin preimpregnated. Supplied in roll form.

Standard Insulation Co., Dept. ED, 74 Paterson Ave., East Rutherford, N. J.

CIRCLE 186 ON READER-SERVICE CARD

**MOTORIZED TAPE PUNCH.**—For computers, data handlers, communication systems. Punches up to 8 columns on tapes up to 1 in. wide at speeds up to 27 cps.

Precision Specialties, Inc., Dept. ED, 1342 58th St., Kansas City, Mo.

CIRCLE 187 ON READER-SERVICE CARD



Exceptionally uniform coating on this MICO Teflon coated glass cloth is free from picks or bumps, is extremely tough and resistant to abrasion and cut-through.

**FOR OPERATION AT 250°C INSULATE  
ELECTRICAL EQUIPMENT WITH MICO  
TEFLON\* COATED GLASS CLOTH**

Heat resistance is just one of the outstanding characteristics of MICO's Teflon coated glass insulation. The exceptionally uniform coating permits close thickness tolerances. It also has . . .

- High dielectric strength, which minimizes dielectric failures even at temperatures up to 250°C.
- Extreme chemical resistance. It is unaffected by solvents, moisture and chemicals commonly encountered in electrical equipment.
- High flexibility, extreme toughness and abrasion resistance.

**APPLICATIONS INCLUDE:** tapes and wrappers for motor or generator coils, leads or cables. Slot liners for motors and generators. Gaskets, washers, seals and diaphragms for mechanical applications.

**ELECTRICAL PROPERTIES**

Finished Thickness, in.	Dielectric Strength, V/M. (S.T.)	Power Factor 60 Cycles to 1 megacycle
0.003	750	0.0006
0.004	800	0.0006
0.006	900	0.0006

**FOR DATA** on MICO Teflon coated glass fabrics, write to Mica Insulator, 2724 Broadway, Schenectady 1, N. Y. See how they can help you design more efficient electrical equipment, longer lasting fabricated parts.



**MICA  
INSULATOR**

DIVISION OF MINNESOTA MINING & MFG. CO.  
SCHENECTADY 1, NEW YORK

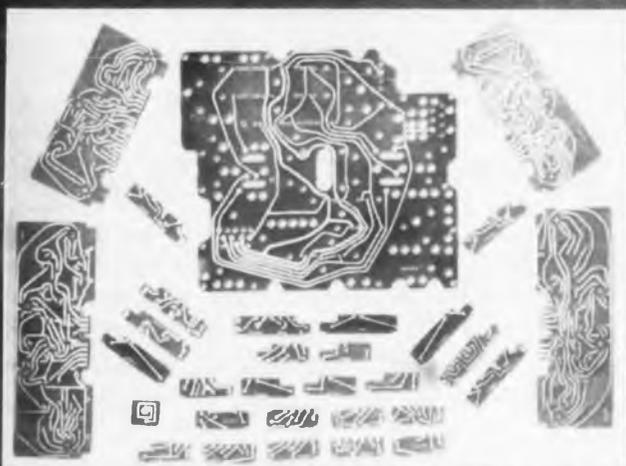
MICANITE® AND ISOMICA® PRODUCTS LAMICOID® LAMINATES &  
FABRICATED PARTS SILICONE & TEFLON COATED CLOTHS & TAPES

\*Reg. Trade Mark. E. I. DuPont de Nemours & Co.

CIRCLE 188 ON READER-SERVICE CARD



## Custom Printed MISSILE CIRCUITRY



**A** problem in management organization, engineering coordination, and production skill . . . . .

### Problems:

- 1 82 Kits of Parts, too few for production tooling, too many for hand means.
- 2 39 printed boards per kit.
- 3 31 different circuit configurations.
- 4 Close mechanical tolerances.
- 5 Duo-metal electroplating, gold and solder.
- 6 Running changes.

### Solutions:

- 1 A separate precision circuit organization.
- 2 Close customer liaison.
- 3 Personnel and know-how geared to military quality requirements.
- 4 Outstanding plant and equipment.
- 5 Large tooling and production resources.
- 6 High production momentum.

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**MILITARY CONTRACTS  
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**METHODE  
Manufacturing Corp.**

7447 W. Wilson Ave., Chicago 31, Ill.

CIRCLE 189 ON READER-SERVICE CARD

## NEW PRODUCTS

**MINIATURE AMPLIFIER.**—Model 2618 for use with the company's piezoelectric accelerometers. Completely sealed, it provides variable gain, 6 to 20, and operates continuously at 250 F. Distortion and non-linearity are under 1 per cent gain; stability is  $\pm 1$  per cent.

Endevco Corp., Dept. ED, 161 E. California St., Pasadena, Calif.

CIRCLE 190 ON READER-SERVICE CARD

**LIMIT SWITCHES.**—Series H11 for any exposed control or indicating application on aircraft or industrial machines. In 12 variations.

Electrosnap Corp., Dept. ED, 4230 W. Lake St., Chicago 24, Ill.

CIRCLE 191 ON READER-SERVICE CARD

**LOW-TEMPERATURE PROBES.**—Semiconductor 7XXXL units provide output in volts for a 20 F span in the LOX range. Can be used with almost any liquefied gas in the  $-240$  to  $-320$  F range.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

CIRCLE 192 ON READER-SERVICE CARD

**ELECTROSTATIC PROBES.**—For use with the company's absorption analyzer. Envelope, T, straight, and miniature types trace signals through hard-to-reach circuits.

Kingston Electronic Corp., Dept. ED, Medfield, Mass.

CIRCLE 193 ON READER-SERVICE CARD

**ENVIRONMENT CHAMBERS.**—Dry-ice operated subzero cabinets with  $+200$  to  $-120$  F range. Constancy within units is  $\pm 0.5$  at  $-100$  F,  $\pm 1$  F at  $+200$  F.

American Instrument Co., Dept. ED, 8030 Georgia Ave., Silver Spring, Md.

CIRCLE 194 ON READER-SERVICE CARD

**RF FILTER.**—Bandpass/band-suppression unit for simultaneous ATC transmissions on adjacent channels in the lower kmc range from a single antenna. Channels are separated better than 30 db, and loss in the pass frequencies is under 1 db.

Microphase Corp., Dept. ED, Box 1166, Greenwich, Conn.

CIRCLE 195 ON READER-SERVICE CARD

**MINIATURE TUBES.**—Types 6DT5 and 12DT5 9-pin beam power pentodes conservatively drive 110 deg vertical deflection systems. Units feature controlled high zero-bias plate current and low zero-bias screen current at a specified low plate voltage.

Westinghouse Electric Corp., Electron Tube Div., Dept. ED, P. O. Box 284, Elmira, N. Y.

CIRCLE 196 ON READER-SERVICE CARD



Stainless Star screws have clear, bright n shiny heads.

## GET YOUR COPY

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- 300 & 400 Series
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- Bolts
- Cap Screws
- Cap, Socket Head
- Cotter Pins
- Dowel Pins
- Hinges
- Machine Screws
- Nuts
- Set Socket
- Sheet Metal Screws
- Stud Bolts
- Taper Pins
- Washers
- Wood Screws

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Save time . . . save money. This book lists over 7,000 stainless steel fastenings available for immediate delivery RIGHT OFF THE SHELF!

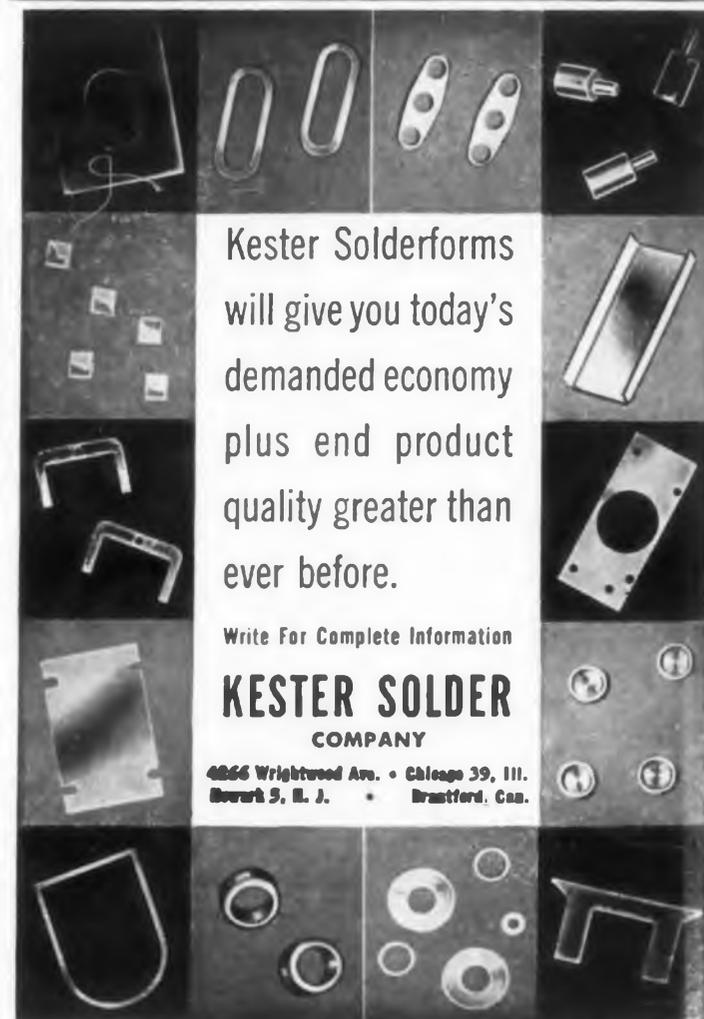
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Direct New York City phone: Wlscansin 7-9041  
Direct Philadelphia phone: WALnut 5-3660

CIRCLE 197 ON READER-SERVICE CARD



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4826 Wrightwood Ave. • Chicago 39, Ill.  
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CIRCLE 198 ON READER-SERVICE CARD

ELECTRONIC DESIGN • October 29, 1958

check  
the spec  
on this

## GORN MINIATURE ALTITUDE SWITCH

AMBIENT ABSOLUTE PRESSURE SWITCH (type GB300\*)

✓ WEIGHT	1.8 oz.
✓ ACTUATION SETTING RANGE OF TESTED AVAILABLE MODELS	5000 to 60,000 feet or 25 to 1 PSIA
✓ ELECTRICAL RATING	SPDT 18-30 VDC 2.5A Ind.
✓ TEMPERATURE RATINGS AVAILABLE	-65 to 160F -65 to 275F -65 to 400F**
✓ VIBRATION RATINGS UP TO 25G	5-500 5-2000 CPS
✓ EXPLOSION RATINGS TO SPECIFICATION	MIL-E-5272A

\*Switches can be supplied either factory pre-set or with means for external adjustment.  
\*\*Presently undergoing test.

for further information, write:



CIRCLE 199 ON READER-SERVICE CARD

## GREEN Pantograph Engravers

ELIMINATE DELAYS!

Keep the work in your own plant.



### PORTABLE 40-POUND BENCH-MODEL 106

Famous 2 or 3-dimensional engraver, successfully used by thousands, features 5 positive, accurate pantograph ratios. Versatile ball bearing spindle has three speeds up to 14,000 rpm; height of pantograph and position of cutter are continuously adjustable; one copy carrier (supplied) accepts all standard master type sizes.

The Model 106 has proven incomparable for speed and accuracy... yet reasonably priced

Cutter grinders, rotary tables, master letters, compound slides, name plates and all required accessories. For complete information, write to

### MODEL D2 HEAVY-DUTY 2-DIMENSIONAL

- 575 pounds — rigid, sturdy, precise
- Vertical adjustment of copy table automatic with Pantograph
- Unobstructed on three sides to take large work
- Micrometer adjustment for depth of cut
- Ball-bearing construction throughout — super-precision ball bearing spindle
- Spindle speeds up to 26,000 rpm for engraving or machining modern materials
- Ratios 2 to 1 to infinity — master copy area 26" x 10"
- Vertical range over 10"

**GREEN  
INSTRUMENT  
COMPANY, INC.**

361 PUTNAM AVENUE, CAMBRIDGE 39, MASS.

CIRCLE 200 ON READER-SERVICE CARD

ELECTRONIC DESIGN • October 29, 1958

**RF CONNECTORS.**—Series designed to prevent cable assembly contacts from disengaging in rapidly fluctuating ambient temperature.

Kings Electronics Co., Dept. ED, 40 Marbledale Rd., Tuckahoe, N. Y.

CIRCLE 201 ON READER-SERVICE CARD

**RADIO TELESCOPE RECEIVER.**—X-band radiometer EK/HII-X2C sensitive to noise radiation levels down to 0.01 Kelvin, with integration time constants down to 100 sec. Has 8 kmc operating frequency, 1 kmc bandwidth, 10 db noise figure, 86 db rf gain.

Ewen Knight Corp., Dept. ED, 206 A St., Needham Heights 94, Mass.

CIRCLE 202 ON READER-SERVICE CARD

**DIGITAL VOLTMETER SYSTEM.**—Model DVA-412 automatically measures ac-dc voltages and types results on electric typewriter. Over 0.0001 to 999.9 range, accuracy ac is 0.1 per cent or two digits; dc,  $\pm 1$  digit.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.

CIRCLE 203 ON READER-SERVICE CARD

**TRANSISTORIZED POWER SUPPLIES.**—From a 6 or 12 v battery, units provide outputs from 150 to 400 v dc up to 265 ma for operating radio receivers, transmitters, and mobile communication equipment. No moving parts.

Arnold Magnetics Corp., Dept. ED, 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 204 ON READER-SERVICE CARD

**PHOTOCELLS.**—Thirteen miniature cells together cover all the visible spectrum and more. Sensitivity to light flux is about 1 million times that of high-vacuum photoemissive tubes. Each has rectangular sensitive surface 3/16 x 3/64 in. Supplied with end or side view.

Clairex Corp., Dept. ED, 19 W. 26th St., New York, N.Y.

CIRCLE 205 ON READER-SERVICE CARD

**POWER OSCILLATOR.**—Model 150 supplies 160 va at a fixed frequency of 400 cps  $\pm 0.25$  per cent or a variable frequency of 350 to 450 cps. Output is 0 to 120 v continuously variable; regulation is 1 per cent no load to full load.

Industrial Test Equipment Co., Dept. ED, 55 E. 11th St., New York 3, N. Y.

CIRCLE 206 ON READER-SERVICE CARD

**PUSHBUTTON SWITCHES.**—Series 850 normally off switches for alarm devices, high fidelity equipment, and relays. Rated at 3 amp, 120 v ac or 1.5 amp, 240 v ac.

Alcor Mfg. Co., Dept. ED, 4444 W. Roosevelt Rd., Chicago 24, Ill.

CIRCLE 207 ON READER-SERVICE CARD

## NOW . . . FOR HIGH TEMPERATURE CAPACITORS



## NEW MICO ISOMICA® AND SAMICA® DIELECTRICS

### ADVANTAGES

- New Design Possibilities
- Cut Material Costs
- Eliminate Pin Holes and Voids
- Uniform Thickness and Properties
- Mica Component Stable Up to 1000 F

Now you can design more efficient rolled and stacked capacitors at lower cost. Capacitor Grade SAMICA sheet can be rolled and handled like paper, yet will withstand operation up to 1000 F.

ISOMICA continuous sheet is available in virtually any size at a fraction of the cost of imported mica films.

Both are production-proved and readily available.

WRITE FOR COMPLETE DATA OR SAMPLES to the nearest Minnesota Mining & Manufacturing Company sales office or to Mica Insulator Division, Minnesota Mining & Manufacturing Company, 3714 Broadway, Schenectady 1, N. Y.



## MICA INSULATOR

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CIRCLE 208 ON READER-SERVICE CARD



## Custom Printed MISSILE CIRCUITRY



**A** problem in management organization, engineering coordination, and production skill . . . . .

### Problems:

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- 4 Outstanding plant and equipment.
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- 6 High production momentum.

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**METHODE**  
Manufacturing Corp.

7447 W. Wilson Ave., Chicago 31, Ill.

CIRCLE 189 ON READER-SERVICE CARD

## NEW PRODUCTS

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Endevco Corp., Dept. ED, 161 E. California St., Pasadena, Calif.

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Electrosnap Corp., Dept. ED, 4230 W. Lake St., Chicago 24, Ill.

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Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

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Kingston Electronic Corp., Dept. ED, Medfield, Mass.

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American Instrument Co., Dept. ED, 8030 Georgia Ave., Silver Spring, Md.

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Microphase Corp., Dept. ED, Box 1166, Greenwich, Conn.

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**MINIATURE TUBES.**—Types 6DT5 and 12DT5 9-pin beam power pentodes conservatively drive 110 deg vertical deflection systems. Units feature controlled high zero-bias plate current and low zero-bias screen current at a specified low plate voltage.

Westinghouse Electric Corp., Electron Tube Div., Dept. ED, P. O. Box 284, Elmira, N. Y.

CIRCLE 196 ON READER-SERVICE CARD

Stainless Steel  
Star screws have  
bright n shiny h...



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- AN Drilled
- Fillisters
- Bolts
- Cap Screws
- Cap, Socket Head
- Cotter Pins
- Dowel Pins
- Hinges
- Machine Screws
- Nuts
- Set Socket
- Sheet Metal Screws
- Stud Bolts
- Taper Pins
- Washers
- Wood Screws

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Save time . . . save money. This book lists over 7,000 stainless steel fastenings available for immediate delivery RIGHT OFF THE SHELF®!

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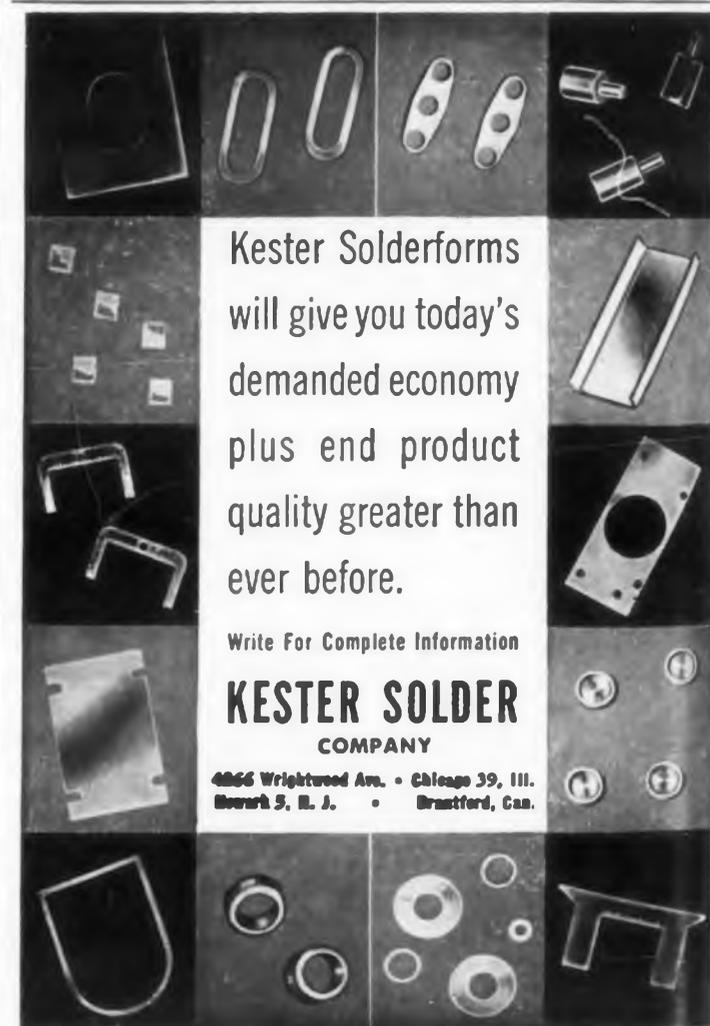


### STAR STAINLESS SCREW CO.

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RESISTANT

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Telephone Clifford 6-2300  
Direct New York City phone: Wisconsin 7-9041  
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CIRCLE 197 ON READER-SERVICE CARD



Kester Solderforms  
will give you today's  
demanded economy  
plus end product  
quality greater than  
ever before.

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CIRCLE 198 ON READER-SERVICE CARD

ELECTRONIC DESIGN • October 29, 1958

check  
the spec  
on this **GORN**  
**MINIATURE ALTITUDE SWITCH**

AMBIENT ABSOLUTE PRESSURE SWITCH (type GB300\*)

- |  |   |
|--|---|
| ✓ WEIGHT   | 1.8 oz.                                     |
| ✓ ACTUATION SETTING<br>RANGE OF TESTED<br>AVAILABLE MODELS | 5000 to<br>60,000 feet or<br>25 to 1 PSIA   |
| ✓ ELECTRICAL<br>RATING                                     | SPDT 18-30<br>VDC 2.5A Ind.                 |
| ✓ TEMPERATURE<br>RATINGS<br>AVAILABLE                      | -65 to 160F<br>-65 to 273F<br>-65 to 400F** |
| ✓ VIBRATION RATINGS<br>UP TO 25G                           | 5-500<br>5-2000 CPS                         |
| ✓ EXPLOSION RATINGS<br>TO SPECIFICATION                    | MIL-E-5272A                                 |

\*Switches can be supplied either factory preset or with means for external adjustment. \*\*Presently undergoing test.

for further information, write:



CIRCLE 199 ON READER-SERVICE CARD

**GREEN** Pantograph Engravers

ELIMINATE DELAYS!

Keep the work in your own plant.



**PORTABLE  
40-POUND  
BENCH-MODEL 106**

Famous 2 or 3-dimensional engraver, successfully used by thousands, features 5 positive, accurate pantograph ratios. Versatile ball bearing spindle has three speeds up to 14,000 rpm; height of pantograph and position of cutter are continuously adjustable; one copy carrier (supplied) accepts all standard master type sizes.

The Model 106 has proven incomparable for speed and accuracy... yet reasonably priced.

Cutter grinders, rotary tables, master letters, compound slides, name plates and all required accessories. For complete information, write to

**MODEL D2  
HEAVY-DUTY  
2-DIMENSIONAL**

- 575 pounds — rigid, sturdy, precise
- Vertical adjustment of copy table automatic with Pantograph
- Unobstructed on three sides to take large work
- Micrometer adjustment for depth of cut
- Ball bearing construction throughout — super-precision ball bearing spindle
- Spindle speeds up to 26,000 rpm for engraving or machining modern materials
- Ratios 2 to 1 to infinity
- master copy area 26" x 10"
- Vertical range over 10"

**GREEN  
INSTRUMENT  
COMPANY, INC.**

361 PUTNAM AVENUE, CAMBRIDGE 39, MASS.

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**RF CONNECTORS.**—Series designed to prevent cable assembly contacts from disengaging in rapidly fluctuating ambient temperature.

Kings Electronics Co., Dept. ED, 40 Marbledale Rd., Tuckahoe, N. Y.

CIRCLE 201 ON READER-SERVICE CARD

**RADIO TELESCOPE RECEIVER.**—X-band radiometer EK/HII-X2C sensitive to noise radiation levels down to 0.01 Kelvin, with integration time constants down to 100 sec. Has 8 kmc operating frequency, 1 kmc bandwidth, 10 db noise figure, 86 db rf gain.

Ewen Knight Corp., Dept. ED, 206 A St., Needham Heights 94, Mass.

CIRCLE 202 ON READER-SERVICE CARD

**DIGITAL VOLTMETER SYSTEM.**—Model DVA-412 automatically measures ac-dc voltages and types results on electric typewriter. Over 0.0001 to 999.9 range, accuracy ac is 0.1 per cent or two digits; dc,  $\pm 1$  digit.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.

CIRCLE 203 ON READER-SERVICE CARD

**TRANSISTORIZED POWER SUPPLIES.**—From a 6 or 12 v battery, units provide outputs from 150 to 400 v dc up to 265 ma for operating radio receivers, transmitters, and mobile communication equipment. No moving parts.

Arnold Magnetics Corp., Dept. ED, 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 204 ON READER-SERVICE CARD

**PHOTOCELLS.**—Thirteen miniature cells together cover all the visible spectrum and more. Sensitivity to light flux is about 1 million times that of high-vacuum photoemissive tubes. Each has rectangular sensitive surface 3/16 x 3/64 in. Supplied with end or side view.

Clairex Corp., Dept. ED, 19 W. 26th St., New York, N.Y.

CIRCLE 205 ON READER-SERVICE CARD

**POWER OSCILLATOR.**—Model 150 supplies 160 va at a fixed frequency of 400 cps  $\pm 0.25$  per cent or a variable frequency of 350 to 450 cps. Output is 0 to 120 v continuously variable; regulation is 1 per cent no load to full load.

Industrial Test Equipment Co., Dept. ED, 55 E. 11th St., New York 3, N. Y.

CIRCLE 206 ON READER-SERVICE CARD

**PUSHBUTTON SWITCHES.**—Series 850 normally off switches for alarm devices, high fidelity equipment, and relays. Rated at 3 amp, 120 v ac or 1.5 amp, 240 v ac.

Alcor Mfg. Co., Dept. ED, 4444 W. Roosevelt Rd., Chicago 24, Ill.

CIRCLE 207 ON READER-SERVICE CARD

NOW . . . FOR HIGH TEMPERATURE  
**CAPACITORS**



**NEW MICO ISOMICA®  
AND SAMICA® DIELECTRICS**

**ADVANTAGES**

- New Design Possibilities
- Cut Material Costs
- Eliminate Pin Holes and Voids
- Uniform Thickness and Properties
- Mica Component Stable Up to 1000 F

Now you can design more efficient rolled and stacked capacitors at lower cost. Capacitor Grade SAMICA sheet can be rolled and handled like paper, yet will withstand operation up to 1000 F.

ISOMICA continuous sheet is available in virtually any size at a fraction of the cost of imported mica films.

Both are production-proved and readily available.

WRITE FOR COMPLETE DATA OR SAMPLES to the nearest Minnesota Mining & Manufacturing Company sales office or to Mica Insulator Division, Minnesota Mining & Manufacturing Company, 3714 Broadway, Schenectady 1, N. Y.



**MICA  
INSULATOR**

DIVISION OF MINNESOTA MINING & MFG. CO.  
SCHENECTADY 1, NEW YORK

MICANITE® AND ISOMICA® PRODUCTS LAMICOID® LAMINATES & FABRICATED PARTS SILICONE & TEFLON COATED CLOTHS & TAPES

CIRCLE 208 ON READER-SERVICE CARD

# IDEAS FOR DESIGN—ENTRY BLANK

To the *Ideas-For-Design* Editor of **ELECTRONIC DESIGN** —  
830 3rd Ave., New York 22, N.Y. • PLaza 1-5530

Here is my design idea for possible publications in your *Ideas For Design* department.  
I can expect \$10 for this idea if accepted for publication.

(Ideas suitable include: 1. new circuits or circuit modifications, 2. new design techniques, 3. designs for new production methods, 4. clever use of new materials or new components in design, 5. design or drafting aids, 6. new methods of packaging, 7. design short cuts, or 8. cost saving tips)

## STATEMENT OF THE PROBLEM—

MY SOLUTION. AND WHY—(Please be explicit. Include sketches or photos that will help the idea across)

Signed \_\_\_\_\_

Title \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

(Place illustrations on separate sheet if necessary)

## NEW PRODUCTS

**HF POWER TRANSISTOR.**—Diffused base pnp germanium type 2N1046 for horizontal and vertical crt deflection circuits. Provides 15 w dissipation and a typical 12 mc alpha cutoff frequency.

Texas Instruments Incorporated, Dept. ED, P.O. Box 312, Dallas, Tex.

CIRCLE 209 ON READER-SERVICE CARD

**HAND PYROMETER.**—Portable model B measures temperatures of convex, rotating, or flat surfaces. For plastics, semifluids, liquids, gases, molten soft metals. Needs no power source.

West Instrument Corp., Dept. ED, 4363 W. Montrose Ave., Chicago, Ill.

CIRCLE 210 ON READER-SERVICE CARD

**INDICATING LIGHT.**—Incandescent type 855RE for edge-lighting Lucite panels. Jelly bean in size, it projects 0.125 in. in front of the panel.

The Sloan Co., Dept. ED, 4101 Burbank Blvd., Burbank, Calif.

CIRCLE 211 ON READER-SERVICE CARD

**PAPER ELECTRICAL TAPE.**—For identification of leads in stick wound coils, tape P comes in range of colors and standard widths.

Pee Cee Tape & Label Co., Dept. ED, 521 N. La Brea Ave., Los Angeles 36, Calif.

CIRCLE 212 ON READER-SERVICE CARD

**GEIGER-MUELLER TUBES.**—Range of alpha-beta-gamma end-window tubes with varying window thicknesses.

Nucleonic Corporation of America, Dept. ED, 196 Degraw St., Brooklyn 31, N.Y.

CIRCLE 213 ON READER-SERVICE CARD

**AIRCRAFT CIRCUIT BREAKER.**—Rated at 225 amp, 480 v ac, 400 cps, 3 phase; 500 amp, 250 v dc. Functions from -65 to +600 F up to 75,000 ft.

Westinghouse Electric Corp., Dept. ED, Lima, Ohio.

CIRCLE 214 ON READER-SERVICE CARD

**COMMUNICATION RECEIVER.**—Type 13A1 for high performance in the 55 to 260 mc range.

General Electronic Labs, Inc., Dept. ED, 195 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 215 ON READER-SERVICE CARD

**POWER SUPPLY.**—Transistorized model HY-CAL-10-10 is chopper stabilized with 1 mv regulation for line or load variation. Input, 105 to 125 v; output 1 to 10 v dc, 10 amp.

Hyperion, Inc., Dept. ED, 1447 Washington St., West Newton, Mass.

CIRCLE 216 ON READER-SERVICE CARD

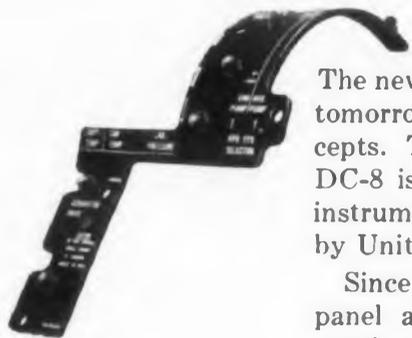




**DESIGNED BY U.S. RADIUM...**



**THE LATEST IN  
INSTRUMENT PANELS  
FOR THE NEWEST  
IN JETS**



The new Douglas DC-8 jet airliner reflects many of tomorrow's advanced aeronautical engineering concepts. Typical of the design refinements in the DC-8 is a new-type, integral edge-lighted curved instrument panel developed especially for Douglas by United States Radium Corporation.

Since introduction of the integral edge-lighted panel a short time ago, USR has developed a number of special-purpose units of this type for airborne application. The curved panel for the DC-8 is one example of compact design obtainable with a combination of unusual panel configurations and a flush-mounted printed circuit light assembly. Light assemblies can be oriented flush with either front or rear panel surface for conservation of vital control space. Additional advantages of USR-engineered panels include savings in light circuit wiring time; clearly-legible, optically-accurate markings; uniformity of lighting within the individual panel as well as between different panels; and stability and durability under operating conditions.

United States Radium Corporation remains a leader in development and production of regular edge-lighted dials and panels by Lackon® as well as various types of instrument and control panels for military and industrial application. The company's engineering staff is available to consult on design of dials and panels to meet your specifications.

Write for Bulletin 10.30D10.



**UNITED STATES RADIUM CORPORATION**

MORRISTOWN, N. J. Offices: Chicago, Illinois and No. Hollywood, Calif. Subsidiaries: Radelin Ltd., Toronto, Canada and United States Radium Corp. (Europe), Geneva, Switzerland

CIRCLE 229 ON READER-SERVICE CARD

## PRODUCTION PRODUCTS

### Zone Scanner

For metal purification

This vertical floating zone scanner is designed for high purity semiconductor and metal production. With top and bottom holders horizontally and vertically adjustable, the mechanism allows easy material and seed centering. It handles quartz protection tubes with OD's up to 35 mm.

Lindberg Engineering Co., Dept. ED, 2450 W. Hubbard St., Chicago 12, Ill.

CIRCLE 230 ON READER-SERVICE CARD

### Wire Cutter and Stripper

Processes over 9000 pieces per hour



All automatic, from unreeling insulated wire to stacking pieces in a trough, the Acme wire cutter and stripper processes over 9000 pieces an hour in 1 to 40 in. wire lengths. Rate for 80 to 120 in. lengths is 3000 pieces per hour. The machine handles stranded wires up to 10 gauge and solid wires to 12 gauge.

Jennings Machine Corp., Dept. ED, 3452 Ludlow St., Philadelphia 4, Pa.

CIRCLE 231 ON READER-SERVICE CARD

### Screen Printing Machines

Automatic and Semiautomatic

In automatic and semiautomatic models, these accurate machines screen print ceramics and mica for capacitors, small printed circuit boards, dials, thermistors, and other small parts. Print areas and speeds vary with the model and the type of part to be handled. The maximum area is 8.5 x 15 in.; top speed is 15,000 cycles per hour.

Automation Equipment, Inc., Dept. ED, Pine at Forest St., Manchester, Conn.

CIRCLE 232 ON READER-SERVICE CARD

# CUSTOM CABLES

—by Alpha Wire



any jacket  
any wire  
any  
termination  
no minimum

Alpha has the unique advantages of

- 38 years creative engineering
- specially engineered equipment
- 4000-item warehouse stock —

to offer you custom wire and cable fabrication with

- no minimum order
- practically overnight delivery
- maximum economy

Write for free Facilities Brochure.

ALPHA WIRE CORPORATION  
200 Varick St., New York 14, N. Y.

**ALPHA** electronics **WIRE**  
from prototype to mass production

CIRCLE 233 ON READER-SERVICE CARD

ELECTRONIC DESIGN • October 29, 1958



Thomas & Skinner's Orthosil® Wound Cores are ideal for special applications and can be specially tested to customer requirements prior to shipment.

These T&S Wound Cores meet and exceed customer requirements in respect to all magnetic characteristics.

Besides complete assurance of quality and specification conformity, T&S offers its highly qualified engineering assistance—based on more than 50 years of experience in the magnetic materials industry—to help you select the core best suited for any given application.

T&S's entire organization prides itself in anticipating a customer's problems in advance and providing the correct engineering recommendations to prevent such problems from materializing.

#### SPECIALISTS IN MAGNETIC MATERIALS

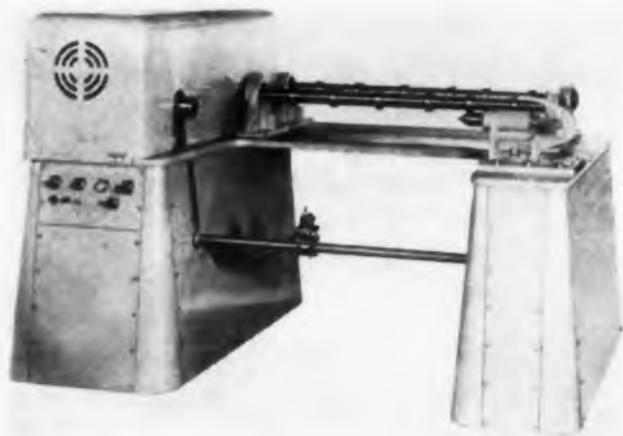
Permanent Magnets Magnetic Tapes   
Laminations and Wound Cores



1157 East 23rd Street, Indianapolis 7, Indiana  
CIRCLE 234 ON READER-SERVICE CARD

ELECTRONIC DESIGN • October 29, 1958

### Transformer Core Winder Semiautomatic



Transformer core winder model 151, semiautomatic, winds cores in variable lengths to a maximum of 10 in. in multiples of three. Maximum core OD is 25 in.

Geo. Stevens Mfg. Co., Inc., Dept. ED, Pulaski Rd. at Peterson, Chicago 46, Ill.

CIRCLE 235 ON READER-SERVICE CARD

### Automatic Sealing Machine Mass-produces glass inner terminal units

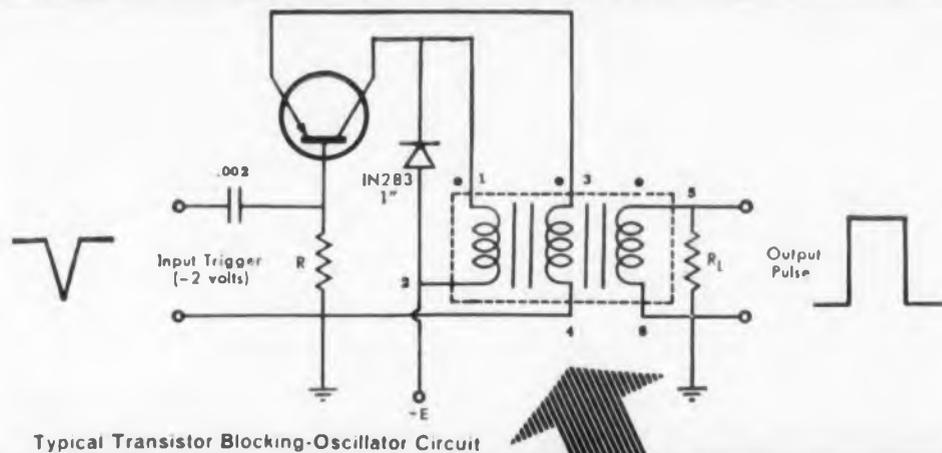


Mass production of glass inner terminal units for electron tubes is possible with the 13844 8-position, 8-head automatic sealing machine. Besides completing the glassing sequence, the machine positions a pin. Normal production is 480 units per hour, but the machine can produce 1700 units an hour if parts can be loaded that fast.

Kahle Engineering Co., Dept. ED, 1310 7th St., North Bergen, N.J.

CIRCLE 236 ON READER-SERVICE CARD

## ORDER THE PULSE TRANSFORMERS YOU WANT FROM STOCK



Typical Transistor Blocking-Oscillator Circuit

### ALADDIN MICRO-MINIATURE TRANSFORMERS



Don't DO-IT-YOURSELF! Look it up in Aladdin's encyclopedia. We'll bet we've already designed the transformer you need—and that we've got it in stock.

Here's a sample of what we've got for this typical blocking oscillator circuit, in our 105°C (94-series) micro-miniature line:

Pulse Width μ sec.	Rise Time μ sec. Max.	Max. Rep. Rate KC	Minimum Load Impedance OHMS (R <sub>L</sub> )	Output Volts	E Volts	R OHMS	Transistor	Aladdin Pulse Transformer Number
0.2	0.025	250	1000	6.5	-5	1000	2N346	94-672
0.2	0.025	250	120	2.0	-5	1000	2N346	94-675
*0.3	0.025	150	1000	6.5	-5	1000	2N346	*94-677
0.3	0.025	150	33	1.0	-5	1000	2N346	94-681
0.4	0.025	100	360	3.5	-5	1000	2N346	94-684
0.5	0.025	70	680	5.0	-5	1000	2N346	94-688
*0.5	0.025	70	120	2.0	-5	1000	2N346	*94-690
0.5	0.10	40	2200	18.0	-15	470	2N123	94-737
*1.0	0.10	20	2200	18.0	-15	470	2N123	*94-742
1.0	0.10	20	33	2.0	-15	470	2N123	94-746
1.0	0.04	45	680	5.0	-5	50	2N345	94-693
1.5	0.04	30	1000	6.5	-5	50	2N345	94-697
1.5	0.04	30	33	1.0	-5	50	2N345	94-701
1.5	0.10	15	1000	12.0	-15	470	2N123	94-748
2.0	0.10	10	470	8.0	-15	470	2N123	94-754
*2.0	0.04	20	1000	6.5	-5	50	2N345	*94-702
3.0	0.04	15	360	3.5	-5	50	2N345	94-709
*3.0	0.12	7	1000	12.0	-15	470	2N123	*94-758
4.0	0.12	4	2200	18.0	-15	470	2N123	94-762
4.0	0.12	4	470	8.0	-15	470	2N123	94-764
*4.0	0.05	10	680	5.0	-5	50	2N345	*94-713
5.0	0.06	9	1000	6.5	-5	50	2N345	94-717
5.0	0.06	9	33	1.0	-5	50	2N345	94-721
5.0	0.12	3	2200	18.0	-15	470	2N123	94-767
*5.0	0.12	3	470	8.0	-15	470	2N123	*94-769
6.0	0.07	7	680	5.0	-5	50	2N345	94-723
*6.0	0.07	7	120	2.0	-5	50	2N345	*94-725
8.0	0.09	5	680	5.0	-5	50	2N345	94-728
*8.0	0.09	5	33	1.0	-5	50	2N345	*94-731
*10.0	0.09	4	1000	6.5	-5	50	2N345	*94-732

\*For lab use, you can buy a kit containing one each of the ten micro-miniature transformers marked with an asterisk—\$49.95 complete.

NOBODY... BUT NOBODY—makes a more comprehensive line of low-power pulse transformers than Aladdin...

Commercial grades: -20° to 85°C • Military grades: -55° to 105°C • Military high-temp. grades: -55° to 130°C

Free Aladdin Pulse Transformer Encyclopedia gives detailed engineering information on pulse transformers. Engineering bulletins also available on IF and encapsulated inductors. Write on company letterhead.



715 Murfreesboro Road • Nashville 10, Tennessee

CIRCLE 237 ON READER-SERVICE CARD

# for **SSB** transmissions: a new rapid test instrument

- incredibly simple to operate
- compact complete unit occupies only 19 1/4" of panel height
- exceptionally low-priced



## PANORAMIC'S SSB-3

### a sensitive spectrum analyzer

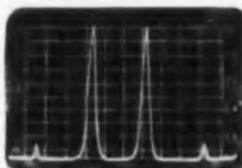
Panoramic's Model  
SB-12a Analyzer

### a stable tuning head

### a two-tone generator

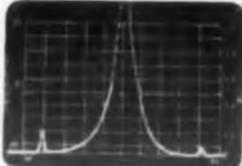
### internal calibrating circuitry

Now, Panoramic has incorporated in one convenient package the equipment you need to set up . . . adjust . . . monitor . . . trouble-shoot SSB and AM transmissions.



**Two Tone Test\***  
Fixed sweep width 2000 cps. Full scale log sideband tones 1.5 kc and 7.1 kc from carrier (not shown). Odd order I. M. distortion products down 37 db.

**Hum Test\***  
Indication of one sideband in above photo increased 20 db. Sweep width set to 150 cps reveals hum sidebands down 53 db and 60 db.



- pre-set sweep widths of 150, 500, 2000, 10,000 and 30,000 cps with automatic optimum resolution for fast, easy operation
- continuously variable sweep width up to 100 kc for additional flexibility
- 60 db dynamic range
- 60 cps hum sidebands measurable to -60 db
- high order sweep stability thru AFC network
- precisely calibrated lin and log amplitude scales
- standard 5" CRT with camera mount bezel
- two auxiliary outputs for chart recorder or large screen CRT

- 2 mc to 39 mc range with direct reading dial free of hum modulation

- two separate audio oscillators with independent frequency and amplitude controls
- output 2 volts max. per tone into 600 ohm load, combined in linear mixer
- I.M. of two tones less than -60 db

- two RF signal sources simulate two-tone test and check internal distortion and hum of analyzer
- center frequency marker with external AM provisions for sweep width calibrations

\* See Panoramic Analyzer No. 3 describing testing techniques, etc., for single sidebands. A copy is yours for the asking.

Write, wire, phone RIGHT NOW for technical bulletin and prices on the new SSB-3. Panoramic instruments are PROVED PERFORMERS in laboratories, plants and military installations all over the world. Send for our new CATALOG DIGEST and ask to be put on our regular mailing list for The PANORAMIC ANALYZER featuring application data.

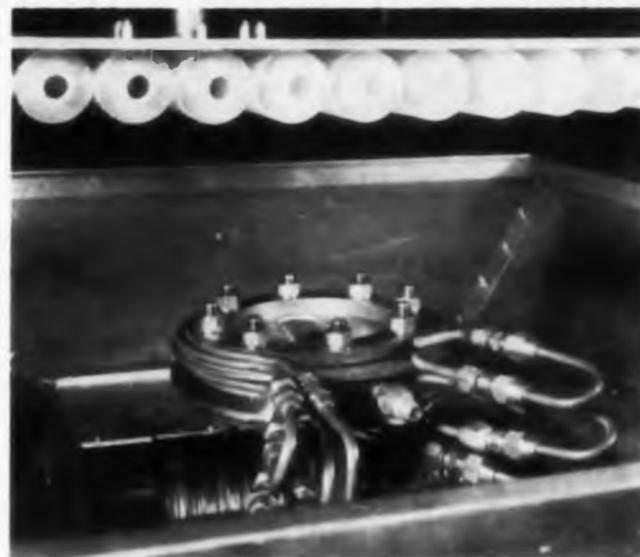
**PANORAMIC**  
RADIO PRODUCTS, INC.

dependable  
**CERTIFIED**  
SPECIFICATIONS  
for accurate  
data

524 So. Fulton Ave., Mount Vernon, N. Y. • Phone: OWens 9-4600  
Cables: Panoramic, Mount Vernon, N. Y. State  
CIRCLE 238 ON READER-SERVICE CARD

## SERVICES FOR DESIGNERS

### Radiation for Rent



At the Midwest Irradiation Center in Rockford, Ill., an 8 million volt linear electron accelerator can be rented by the hour. Available for both research and commercial radiation processing, the machine emits high energy electrons, X-rays, and neutrons. It can accommodate objects both thick and thin. It will irradiate materials of unit density up to 1 inch thick from one side, or sections over 2 inches thick from two sides. The picture shows polyethylene bottles passing under the accelerator window for irradiation that will increase their temperature resistance.

The installation is jointly operated by W. F. and John Barnes Co. and Applied Radiation Corp.

Applied Radiation Corp., Dept. ED, 2404 N. Main St., Walnut Creek, Calif.

CIRCLE 239 ON READER-SERVICE CARD

### Air Gage Tooling

West Coast precision part manufacturers now have a nearby source for air gage tooling equipment. The Dahl-Harvey Corp. in Pasadena is producing a complete line. The company has lab equipment that can make measurements internally or externally directly to 5 millionths of an inch. It also is equipped to design and build special application tooling. The equipment now being produced meets all the requirements and is guaranteed to work on dial and column type amplifiers.

Dahl-Harvey Corp., Dept. ED, 1145 S. Fair Oaks Ave., Pasadena, Calif.

CIRCLE 240 ON READER-SERVICE CARD

## CEC CUSTOM & STANDARD Delay Lines

Control Electronics Co. Inc. is a leading designer and mass producer of electromagnetic Delay Lines. A representative group is shown here with the available ranges of delays, bandwidths and impedances. Further information is readily available from our Engineering Dept.

BUILT TO MIL SPECS. FAST PROTOTYPE SERVICE . . . DELIVERY 1 TO 3 WEEKS.

### Distributed Constant Delay Lines



#### CEC DISTRIBUTED CONSTANT DELAY LINE FEATURES

- Lowest cost — reliable performance
- Maximum delay to rise time ratios
- Maximum delay per cubic inch
- Delays to 30  $\mu$  secs
- Impedances: 200 to 10,000  $\Omega$
- Bandwidths to 20 mcs
- Linear phase shift



### Variable Delay Lines

Infinite, incremental or decade variable delay lines available in any range of delays and impedances.



### Lumped Constant Delay Lines

DELAYS TO 20,000 MICROSECONDS.  
BANDWIDTHS TO 500 MCS.  
Z<sub>0</sub> FROM 50 TO 10,000 OHMS.



Multi-tapped Lumped Constants available in many configurations

### System Delay Lines

Complete delay and pulse systems designed to your needs.



**CEC**

NOTE: Data Sheets on request

**CONTROL ELECTRONICS CO., INC.**

10 Stepar Place  
Huntington Station, New York

CIRCLE 241 ON READER-SERVICE CARD

## ARNOLD transistorized power supply



... a regulated  
lightweight  
inverter,  
built to  
aircraft  
and missile specs.

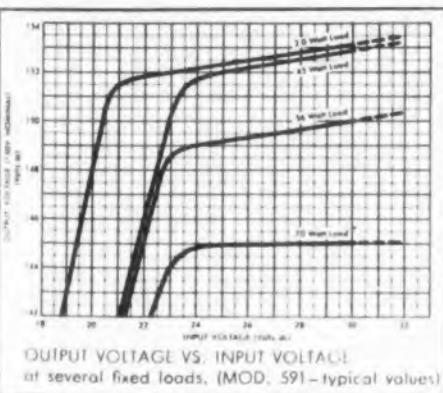
### FEATURES

- Constant output voltage as battery discharges.
- 1/5 weight, 1/2 size of comparable dynamotors.
- Withstands short circuit indefinitely.
- Withstands input voltage transients of 70 volts for 0.1 sec. and 60 volts, indefinitely.
- Output voltage drift only 1.5% from  $-55^{\circ}$  to  $+71^{\circ}$  C.

### SPECIFICATIONS

**D. C. OUTPUT** Model 591-A  
Input Voltage: 24-30 VDC  
Output Voltage: Any from 25-1200 VDC  
Output Power: 60 watts regulated  
Regulation: Line:  $\pm 0.5\%$  for 6V variations  
Load:  $\pm 1.0\%$  for  $1/2$  L to FL  
Ripple: 0.3% RMS  
Size & Weight: 3" OD x  $3\frac{3}{16}$ " high; 22 oz.

**A. C. OUTPUT** Model 591-AC  
Input Voltage: 24-30 VDC  
Output Voltage: 115 VAC, 400 cps, 1 phase  
Output Power: 50 V.A. square wave  
Regulation: Frequency:  $\pm 0.5\%$   
(line & load) Voltage:  $\pm 2.0\%$   
Size & Weight: 3" OD x  $3\frac{3}{16}$ " high; 22 oz.



Write or phone for literature



### ARNOLD MAGNETICS CORPORATION

4613 W. Jefferson Blvd.  
Los Angeles 16, Calif.  
REpublic 1-6344

CIRCLE 242 ON READER-SERVICE CARD

## Cine-Radiography Probes Sealed Packages

Rototest has a cine-radiographic facility that gives engineers an inside look at sealed packages undergoing environmental tests. The X-ray movies often save weeks of failure analysis, and sometimes they are the only way to solve a problem at all. So that users may be sure an assembly will X-ray clearly, they are given a free still of it in advance. Thus they need spend nothing until they are satisfied the method will succeed.

Rototest Labs., Inc., Dept. ED, 2803 Los Flores Blvd., Lynwood, Calif.

CIRCLE 243 ON READER-SERVICE CARD

## Ovens

Closely controlled vacuum



Semiconductor components can be outgassed and brazed or fused under closely controlled vacuum conditions in this oven. The vacuum baking oven has its own vacuum pumping system, heating equipment, and temperature regulating and indicating instrumentation. The vacuum chamber can be evacuated to a pressure of  $10^{-6}$  mm and heated to approximately 450 C. Upon completion of the bake, vacuum is broken to the inert-gas atmosphere of the dry-box.

F. J. Stokes Corp., Vacuum Equipment Div., Dept. ED, Philadelphia 20, Pa.

CIRCLE 244 ON READER-SERVICE CARD

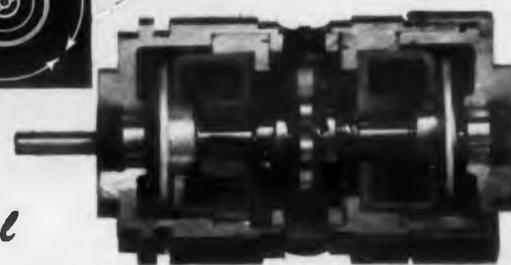
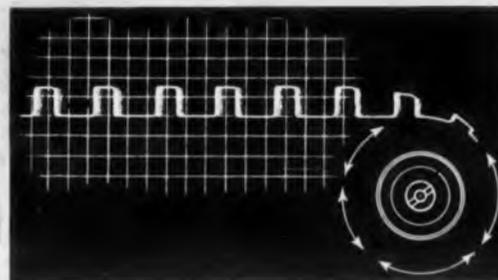
## Servo Components in A Hurry

A 24-hour shipment program for standard servo components is announced by the Daystrom Transicoil Corp. The service applies to 100 servo motors and motor generators listed in the company's new catalog. All units, available either with plain or hobbled shafts, are supplied with Teflon insulated leads 8 inches long. Stock List 158 details the program.

Daystrom Transicoil Corp., Dept. ED, Worcester, Montgomery Co., Pa.

CIRCLE 245 ON READER-SERVICE CARD

# STEPPER MOTOR



PROVIDES

*Bi-Directional*

PROPORTIONAL SHAFT

ROTATION FOR A GIVEN PULSED INPUT

### MODEL SM-300-1

- Angular increment per pulse —  $36^{\circ}$ .
- Stepping rate — up to 15/second.
- Voltage requirement — 28 V. D.C.

• Duty cycle —  $\left(\frac{\text{on time}}{\text{on time \& off time}}\right)$  56% max.

- Weight — 8 oz.
- Shock — 15 G's for 11 milliseconds duration each way along three major axes.
- Reliability — shall not fail to convert more than one pulse in 1,000,000 into equivalent angular rotation.

OTHER MODELS AVAILABLE WITH VARIATIONS FROM THE ABOVE SM-300-1 SPECIFICATIONS.

The two rotary solenoids contained in each motor produce the incremental motion of the output shaft in either direction. Energizing either of these solenoids produces a combination of linear and rotational motion which moves a ratchet gear axially into engagement with its mating ratchet gear and thus imparts a constant amount of rotation to the output shaft. The detent roller assembly insures constant, reproducible angular shaft rotation increments in either direction and maintains the output-shaft position while the motor is at rest with the power off.

Stepper Motors are adaptable to routine jobs such as driving mechanical counters. They also find excellent use in positioning devices that will set up a controlling voltage and/or a phase shift such as potentiometers and autosyns. They are widely used as a positioner for guided missiles to adjust heading, fuel flow, altitude, and circuit sampling for telemetering purposes. In one adaptation as a heading controller, two Stepper Motors are used to position a differential autosyn in steps of either vernier degree or coarse degrees per input pulse, bi-directionally, through a suitable gear train.

Write for more details—available upon request.

## STEPPER MOTORS CORPORATION

Subsidiary of California Eastern Aviation, Inc.

7443 West Wilson Avenue • Chicago 31, Illinois

CIRCLE 246 ON READER-SERVICE CARD

PYRAMID MYLAR ...

-30°C to +125°C ...

SMALLEST FILM CAPACITORS MADE!

Smallest film capacitors made... Pyramid Mylar capacitors have extremely high insulation resistance, high dielectric strength and resistance to moisture penetration.

Commercially available immediately, Pyramid Mylar capacitors have an operating range between -30° C to +125° C with voltage de-ratings above +85° C. Pyramid wrapped Mylar capacitors—Series No. 101, 103, 106 and 107 have the following characteristics:

Construction Styles:	Basic No.	Type Winding	Shape
	101	Inserted Tabs	Flat
	103	Extended Foil	Flat
	106	Inserted Tabs	Round
	107	Extended Foil	Round

**Tolerance:** The standard capacitance tolerance is  $\pm 20\%$ . Closer tolerances can be specified.

**Electrical Characteristics:** Operating range for Mylar capacitors—from -55° C to +85° C and to +125° C with voltage de-rating.

**Dissipation Factor:** The dissipation factor is less than 1% when measured at 25° C and 1000 CPS or referred to 1000 CPS.

Insulation Resistance:	Temperature	IR x mfd	Maximum IR Requirements
	25° C	50,000	15,000 megohms
	85° C	1,000	6,000 "
	125° C	50	300 "

Pyramid Mylar capacitors are subject to the following tests:

**Test Voltage**—Mylar capacitors shall withstand 200% of rated D.C. voltage for 1 minute at 25° C.

**Life Test**—Mylar capacitors shall withstand an accelerated life test of 250 hours with 140% of the voltage rating for the test temperature. 1 failure out of 12 is permitted.

**Humidity Test**—Mylar capacitors shall meet the humidity requirements of MIL-C-91A specifications.

Complete engineering data and prices for Pyramid Mylar Capacitors may be obtained from Pyramid Research and Development Department.

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ELECTRIC COMPANY

1448 Hudson Boulevard, North Bergen, New Jersey.

**CAPACITORS—RECTIFIERS  
FOR ORIGINAL EQUIPMENT—  
FOR REPLACEMENT**

CIRCLE 247 ON READER-SERVICE CARD

## NEW LITERATURE

### Plug-In Limit Switch 248

A precision limit switch which can be replaced in seconds is described in Bulletin No. 20, now released. All five actuator types available are included. Dimension drawings, mounting information, and prices are covered. Minneapolis-Honeywell Regulator Co., Micro-Switch Div., Freeport, Ill.

### Shaft Couplings 249

Couplings that are used where units are spaced apart and one bearing only is provided for one of the units are described in a 4-page brochure (Form No. 99), now available. Thomas Flexible Coupling Co., Warren, Pa.

### Precision Finishes 250

A 20-page brochure on precision finishes on metals is now available. Particular emphasis is placed on the "Hardas Process" which is one method of hard anodizing. Anachrome Corp., 10647 Garfield St., So. Gate, Calif.

### Thermal Elements 251

Selection of thermal elements for maximum resistance to corrosive atmospheres is made easy with a folder recently published. Called "Thermal Element Selection Guide for Corrosive Atmospheres," it lists more than 400 separate corrosive atmospheres into which temperature control elements are often immersed. Partlow Corp., 505 Campion Rd., New Hartford, N.Y.

### Tough Bolts 252

The fastener described in this brochure combines simplicity of design with superior strength and endurance. It was specifically designed for use in high performance aircraft and missiles. The brochure is well illustrated and gives detailed information on this bolt. Rivet Tool Co., 2600 W. 247 St., Torrance, Calif.

### Resistance Winder 253

Technical details on Model 209 Fully Automatic Continuous Resistance Winder which requires no operator are given on catalog page now released. Included are dimensions, types of windings, typical applications for round and flat material, and provision for adhesive application. George Stevens Mfg. Co., Pulaski Rd. at Peterson, Chicago 30, Ill.



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NOISE  
FIGURE  
measurement

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Detailed literature is available on request.



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- Plug-in interchangeable test jigs for all ASTM tests.
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MODEL	RANGE	PRICE
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PA-5-502	50,000 V rms. 2KVA	1675.00
PA-5-505	50,000 V rms. 5KVA	2050.00
PA-50-1005	100,000 V rms. 5KVA	4500.00

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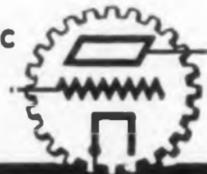


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## Selenium Rectifier Ratings 256

High current density Petti-Sel industrial type selenium rectifiers are described in bulletin No. 248A. The bulletin gives the ratings and dimensions, as well as data on uprating the rectifiers when cooled by forced air. Radio Receptor Co., Inc., Semiconductor Div., 240 Wythe Ave., Brooklyn 11, N.Y.

## Clutch Catalog 257

This 28-page, illustrated catalog covers a complete line of miniature and sub-miniature electromagnetic clutches and brakes. Information on each type of clutch and brake produced includes cutaway drawings, engineering data, schematic diagrams, dimensional data, minimum performance curves, oscilloscope readings, and other technical information. Autotronics, Inc., Rt. 1, Box 812, Florissant, Mo.

## Plastics 258

An illustrated 6-page brochure describes the physical and chemical properties of six special clear plastic materials, and a coating material for emergency repairs. The products offer many advantages including superior resistance to corrosion, abrasion, crazing, temperature, and shattering, as well as machinability. They can be used for television faces, instrument dial covers, and plotting boards. One type is permanently antistatic; another will not support combustion. The Homalite Corp., Wilmington 4, Del.

## Variable Transformers 259

The 100-page Powerstat variable transformer Bulletin P258G, an invaluable reference manual-catalog, is designed for those who specify or who want to know more about variable transformers. This comprehensive, easy-to-read, file-fitting guide is filled with product information, engineering data, outline drawings, connections, ratings, charts, and illustrations on all standard 50/60 cycle autotransformers plus some special use types. The Superior Electric Co., Dept. P258G, Bristol, Conn.

## Cathode Ray Tubes 260

Engineering data on Rayonic cathode ray tubes, including applications, characteristics and general information, is available. Complete electrical and mechanical data is supplied and a large variety of popular types and custom designs. Waterman Products Company, Inc., 2445 Emerald St., Philadelphia 25, a.

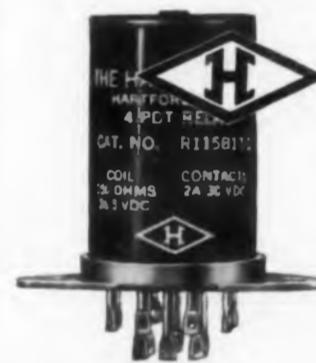


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- gold-plated grid for low grid emission

OPERATING CONDITIONS, AMPLIFIER, CLASS C, FM

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Screen Grid Voltage	180	200 volts
Control Grid Bias	-20	-20 volts
Plate Current	2x27.5	2x30 ma
Screen Grid Current	11	13 ma
Control Grid Current	2x1	2x1 ma
Driving Power	1.0	1.0 watts
Plate Input Power	2x5	2x6 watts
Plate Dissipation	2x2.1	2x2.25 watts
Screen Grid Dissipation	2	2.6 watts
Output Power	5.8	7.5 watts
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- 6360 High-sensitivity VHF/UHF twin tetrode; 14 watts anode dissipation
- 6146 High-sensitivity beam power tube
- 866AX Mercury vapor rectifier



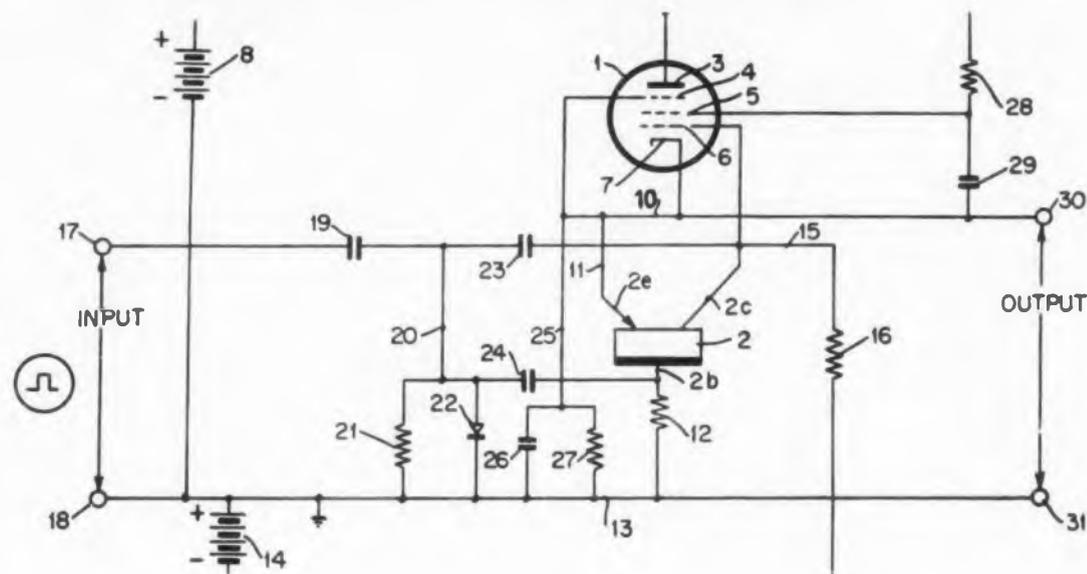
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# PATENTS



## Transistor Trigger with Tube Controlling Emitter

Patent No. 2,825,806. Carl A. Bergfors. (Assigned to International Business Machines Corp.)

A transistor and a vacuum tube connected in series are used to scale high frequency pulses in a binary counter. The circuit is particularly designed so that when the transistor and tube are both "on", the tube will respond to negative pulses to cut both off; when both devices are "off", the transistor can be triggered by negative pulses to make both tube and transistor conductive. Scaling or frequency division is thereby achieved.

To illustrate the operation, assume the tube and transistor are both "off". A negative impulse applied to the input will be coupled to base 2b, and, since emitter 2e is clamped to ground potential by condenser 26, the transistor will conduct and make the voltage on electrode 6 less negative. The tube will conduct through emitter 2e and cause the transistor to conduct more current and thus bias the tube for increased conduction. The action is cumulative to saturation with both tube and transistor quickly triggered to "on". A second negative impulse does not effect the emitter-base current since the transistor is at saturation. However, the negative voltage applied to electrode 6 causes the tube to conduct less, causing the emitter-base current of the transistor to be reduced. This results in less current

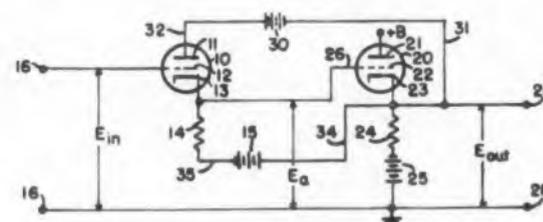
at collector 2c and a more negative bias at electrode 6. Again the action is rapid, causing a fast trigger. In this instance, however, both tube and transistor are triggered to "off".

## High Input Impedance Signal-Monitoring Apparatus

Patent No. 2,839,618. William J. Heacock Jr. (Assigned to Hazeltine Research, Inc.)

Cathode followers in cascade with current and voltage feedback comprise an impedance converter having an input impedance of 1,000,000 meg. 12AT7 in the circuit measures 100 v with negligible loading on the signal source.

The circuit is designed to select an operating point such that the grid current (input current) is of the order of



0.001  $\mu$ a. This is achieved by maintaining the tube current at about 60  $\mu$ a and by restricting variations in the instantaneous operating point within a very small area.

As shown, plate II is tied to cathode 23 such that voltage changes in load impedance 24 are fed back. The plate and cathode of tube 10 change in the

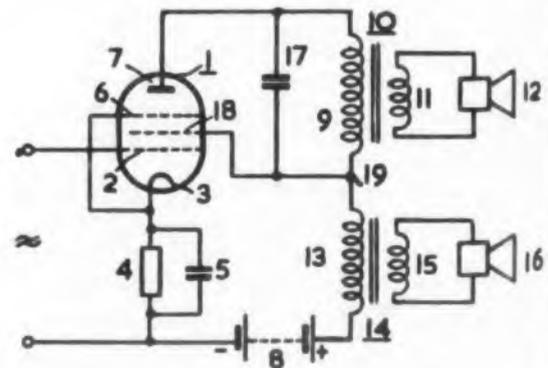
same sense with the input voltage. In effect the plate to cathode voltage remains at the quiescent value.

Cathode 23 is tied back to cathode 13 through resistor 14 and the voltage at either end of this resistor is the same. This insures constant current in tube 10 with high dynamic input impedance over a wide range of input voltages.

## Output Stages for Low-Frequency Amplifiers Comprising Two Loudspeakers

Patent No. 2,846,503. Johann Kump. (Assigned to North American Philips Company)

The circuit applies to advantage known concepts that triodes inherently produce less distortion, that a 1f speaker will not reproduce harmonic distortion and that the subjective impression of sound is unaffected if the low and intermediate frequencies are reproduced satisfactorily. Accordingly, the invention lies in a power output stage in which the amplifier tube is driven as a pentode for low frequen-







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### NEW AUDIO FREQUENCY OSCILLATOR HAS $\pm .002\%$ STABILITY AT 100 G's

Reeves-Hoffman's new audio frequency oscillator provides exceptionally reliable performance under high shock and vibration. Rugged construction and highly dependable oven control enables it to withstand as much as 100 G's while maintaining frequency stability of  $\pm .002\%$  over a temperature range of from  $-55^\circ$  to  $+85^\circ\text{C}$ . Equally reliable operation is assured under vibration of 2000 cycles at 10 G's! This new, hermetically sealed oscillator has a frequency range of 400 to 2000 cps, is compact, low in weight and meets applicable portions of specifications MIL-E-5272A. Available in transistor or tube types. Write for Bulletin TCO/300-OC.



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## Machlett ML-7120, 7121, 7124, and 7125

### New Low-Mu Triodes with Improved Electrode Geometry

Machlett Laboratories announces the availability of a new line of low-mu triodes designed to deliver uniformly high power in Class AB1 operation. Increased requirements of high-power, wide-band, linear amplifiers demand an electrode structure which combines proper electrical characteristics with mechanical sturdiness. This demand has been met in these new tubes by a novel application of a beam triode geometry. Relatively high perveance, sharp cut-off and low interelectrode capacitances have been achieved without resorting to extremely fine wires or unusually close spacings. The result is a rugged, reliable electrode geometry which can be adapted for use in low-mu triodes throughout a wide range of power levels.

Applications of these tubes include:

ML-7120 (water-cooled) and ML-7121 (forced-air-cooled)  
Capable of 20 KW output per pair as amplifiers or modulators in broadcast transmitters

Capable of 25 KW output per pair when used in Sonar equipments

Capable of 12.5 KW output per pair into a matched load in random noise amplifiers

ML-7124 (water-cooled) and ML-7125 (forced-air-cooled)  
Capable of 60 KW per pair as amplifiers or modulators in broadcast transmitters

Capable of 75 KW per pair when used in Sonar equipments

ML-7124 capable of 50 KW output per pair and ML-7125 of 25 KW per pair into a matched load in random noise amplifiers.



For full technical data on this or any other Machlett tube type, write: Machlett Laboratories, Inc., 1063 Hope Street, Springdale, Connecticut

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## BOOKS

### Physics and Mathematics in Electrical Communication

Dr. James Owen Perrine, John F. Rider  
Publisher, Inc., 116 West 14 St., N.Y. 11,  
N.Y., 268 pp, \$7.50.

This book offers a probing explanation of what happens in electrical circuits. The text contains numerous explanatory diagrams. On a foundation of associated mathematics made completely understandable and replete with numerical examples, the author ties together physical concepts and electrical communication. An entirely new approach is used in analyzing hyperbolic functions, exponential equations, and related functions.

### Transistor Technology Vol. 2

F. J. Biondi, Editor, D. Van Nostrand  
Co., Inc., 120 Alexander St., Princeton,  
N. J., 701 pp, \$17.50.

This volume brings together much of the recent literature on the technology of materials and principles of transistor design through the efforts of many contributors. The technology of materials focuses on the basic physical properties, the preparation of material, and the effects of processing treatment on materials properties. A number of papers take up the control of lifetime in germanium and silicon, and the removal of impurities from silicon. They introduce work on recombination centers in silicon, methods for growing germanium, and present a discussion of a chemical etching technique for finding dislocations in silicon.

Transistor design topics include a discussion of diodes emphasizing avalanche mechanism, large-signal behavior and switching design as well as principles related to frequency response of transistors in junction triodes. Other aspects covered are: base-layer design; complex switching devices; tetrodes; and radiation sensitivity device design including a discussion of the silicon solar energy converters.

### Engineering Electromagnetics

William H. Hayt, Jr., McGraw-Hill Book  
Co., 330 West 42nd St., New York 36,  
N.Y. 328 pp, \$8.50.

This book offers an introduction to electric and magnetic fields. The material includes electrostatics, the steady magnetic field, time-varying fields and Maxwell's equations, and includes a number of examples illustrating the applications of Maxwell's equations. Vector analysis is used throughout.

In order to illustrate and clarify the use of Maxwell's equations, the final two chapters provide an introduction to skin effect, wave motion, circuit concepts, radiation, and relativistic effects. The sections on relaxation and iteration methods of experimental mapping are another unique feature of this book.

### Oscilloscope Techniques

Alfred Haas, Gernsback Library Book  
Co., 154 West 14th St., New York 11,  
N. Y. 224 pp, \$2.90 paper, \$4.60 bound.

The book features photographs of 'scope patterns—many uncommon—explaining how to obtain these waveforms, and what they indicate. It is handy reference for anyone who uses the 'scope professionally or experimentally, and will suggest many new and varied uses beyond those in routine bench work.

### Better Report Writing

Willis H. Waldo, Reinhold Publishing  
Corp., 430 Park Ave., New York 22, N. Y.  
231 pp, \$4.75.

This desk guide presents ideas on scientific composition, style, division of reports, tables, illustrations, and use of words. It is written as a reference instead of a classical exposition of technical English. Three appendices condense information on abbreviations, symbols, and hyphenation. This is a guide in book form for anyone concerned with scientific report writing.

**Electronic Components Handbook,  
Volume Two**

Keith Henney and Craig Walsh,  
McGraw-Hill Book Co., Inc., 330 West  
42nd Street, New York 36, N. Y. 368 pp,  
\$12.50.

The second volume of the handbook for designers of military and commercial electronic equipment furnishes data on: power sources and converters; fuses and circuit breakers; electrical indicating instruments; printed wiring boards; solder and fluxes; choppers; blowers; rf transmission lines and waveguides. It is intended as an aid in selecting and applying the best unit for a particular job so that maximum reliability of the end product results.

The book lists the effect on each of unfavorable environment such as heat, humidity, altitude, pressure, shock, vibration, etc. Like Volume One, which covered resistors, capacitors, relays, and switches, this book concentrates on those kinds of component parts for which a coordinated tri-service military specification has been written. In addition, it also covers other component types for which only single-service specifications

or industrial specifications are available. A digest of the military specifications covering each kind of each component is given.

**Color TV Principles and Practices**

Prepared by General Electric Co., Owensboro, Ky. 135 pp, \$5.00.

Here are the three fundamentals necessary to service color: Colorimetry, the science of measuring and analyzing color; the standard color specifications of the National Television System Committee adopted by the FCC; and special receiver circuitry which translates colorimetry into electronics. The book covers the basic concepts of hue, saturation, luminosity, and the use of a chromaticity diagram—and clearly explains how relatively simple sub-circuits implement those principles.

The text is profusely illustrated with clearly-arranged diagrams explaining circuitry; humorous but pointed drawings which illustrate functions without tedious technical written explanations; and 18 color plates demonstrating service problems.

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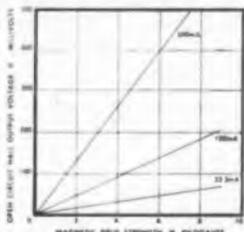


The HS-51 HALLTRON is based upon the Hall effect. Its output characteristics are related to the product of the input current and magnetic field, hence are useful in many new applications. The HS-51 Halltron is a fully developed production unit utilizing indium antimonide and is designed to work in the customer's magnetic circuit. The thin encapsulated unit provides the strength and durability necessary for circuit applications.

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  - Transducers
  - Circulators
  - Power meters
  - Control applications
  - Computer applications
  - DC to AC converters
  - Magnetic field measurement

Typical Room Temperature Characteristics

Typical open circuit Hall output voltage of an HS-51 HALLTRON vs. magnetic field strength for various values of control current I<sub>c</sub>.



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Part 4 of Professor Kharkevich's nomograph includes his Sections 6 and 7. In these sections, he discusses frequency multiplication, linearization, and nonlinear distortion. **ELECTRONIC DESIGN's** serial translation of this work has been a bi-weekly presentation since September 17th.

# Nonlinear and Parametric Phenomena in Radio Engineering

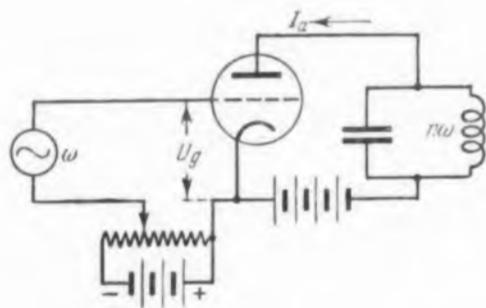
## Part 4

A. A. Kharkevich

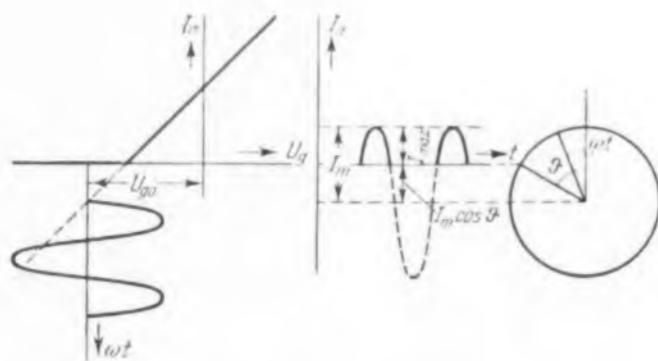
(Translated by J. George Adashko)

## Chapter 1

### Nonlinear Circuits and Fundamental Nonlinear Processes



**Fig. 9.** A typical frequency multiplier. The tank circuit is tuned to the  $n$ 'th harmonic of the signal applied to the grid.



**Fig. 10.** An approximation of the characteristics of the triode used for the frequency multiplier in Fig. 9.

### 6. Frequency Multiplication

A nonlinear system can be used for frequency multiplication, to obtain a frequency that is a multiple of an available one. Frequency multiplication is resorted to when direct generation of the required frequency is for some reason not feasible.

Multiplication is based on an exceedingly simple scheme. Voltage of the original frequency is applied to a nonlinear network to produce a current of high harmonic content. The harmonic of the desired frequency is separated by a filter.

One such circuit is shown in Fig. 9. A sinusoidal voltage of radian frequency  $\omega$  is applied to the grid of the triode; the tank in the plate circuit is tuned to the  $n$ 'th harmonic, which is selected by the tank circuit. The remaining harmonics, to which the tank-circuit presents little impedance, are filtered out. An adjustable negative bias, sufficient to cut off the triode, is applied to the grid. The result is the so-called "cut-off mode."

Let us approximate the characteristic of the triode by means of a broken line, as shown in Fig. 10. This approximation is sufficient for our purpose. We choose the operating point to the

left of the bend in the characteristic. When the operating point is in this position and if the applied grid voltage is sinusoidal, only short current pulses will flow in the plate circuit. The remaining portion of the sinusoidal current (shown dotted) will be cut off—hence the name of this operating mode. The mode is fully characterized by the cutoff angle, i.e., by the value of the argument  $\omega t$ , at which the current vanishes (reckoned from the instant of time when the plate current is maximum). Knowing the cutoff angle, it is possible to expand the expression for the plate current into a Fourier series. The plate current can be represented as a function of time in the form

$$I_p = I_m (\cos \omega t - \cos \theta) \quad (I_p > 0)$$

(The symbols are shown in Fig. 10). For the amplitude of the  $n$ 'th harmonic we have, from the known relation

$$\begin{aligned} I_n &= \frac{1}{\pi} \int_{-\pi}^{\pi} I_p(\omega t) \cos n\omega t \, d\omega t = \\ &= \frac{2}{\pi} I_m \int_0^{\theta} \cos nx (\cos x - \cos \theta) \, dx = \\ &= \frac{1}{\pi} I_m \left[ \frac{\sin(n+1)\theta}{n+1} + \frac{\sin(n-1)\theta}{n-1} - \frac{2 \cos \theta \sin n\theta}{n} \right] \\ &= I_m F_n(\theta). \end{aligned}$$

In practice one can specify not  $I_m$  (determined by the amplitude of the grid voltage) but  $I_{max}$  the peak value of the plate current. These two quantities are obviously related by

$$I_{max} = I_m (1 - \cos \theta).$$

Expressing now the amplitude of the  $n$ 'th harmonic of the plate current in terms of the peak value of the plate current, we have

$$I_n = I_{max} \frac{F_n(\theta)}{1 - \cos \theta} = I_{max} f_n(\theta).$$

Functions of the cutoff angle for various values of  $n$  are shown graphically in Fig. 11. These curves show how to select the cutoff angle to obtain the maximum amplitude of the desired harmonic. Thus, for example, we must use  $\theta = 40$  deg for frequency tripling, and so on.

### 7. Linearization and Nonlinear Distortion

Nonlinear relations play a double role in radio engineering. In many cases the nonlinearity determines the very nature of the process and is

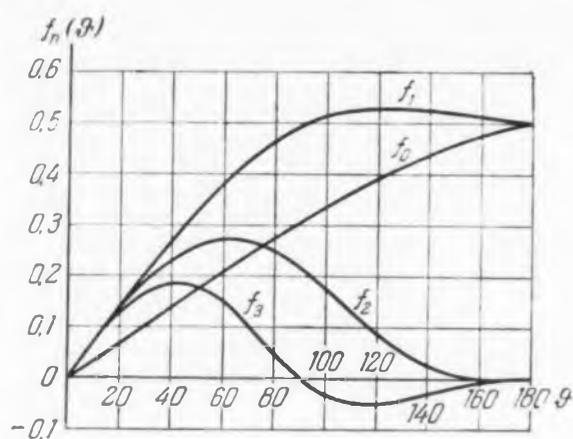


Fig. 11. Functions of the frequency multiplier cutoff angle for various harmonics.

used to obtain the desirable result. This takes place, for example, in frequency multiplication, in detection, and in many other important applications. But sometimes nonlinearity is not only unnecessary, but is harmful and undesirable. This occurs, for example, in amplification.

Waveform distortion and the resultant spectrum enrichment which are typical of a nonlinear system, are essential for frequency multiplication. In amplification, however, we deal with the inverse problem, that of retaining the initial waveform of the oscillations as much as possible. Any change in the waveform, resulting from the nonlinearity of any circuit element, is called nonlinear distortion. It is necessary to reduce this distortion, i.e., to eliminate the nonlinearity effect.

Strictly speaking, no system is linear. So-called "linear" systems are merely those whose nonlinearity can be neglected under the circumstances. The possibility of neglecting nonlinearity depends not only on the characteristic of the system, but also on the operating conditions. For example, in the case of amplification, the operating point is best placed at the center of the straight-line section of the tube characteristic, and the amplitude of the control voltage is best held within the limits of its straight portion. Actually, the characteristic is always curved, and when we speak of a straight portion, we mean one having a sufficiently small curvature.

Replacing a nonlinear relation by an approximate one, together with any measure aimed at improving the approximation, is generally called linearization.

The linearization concept will be explained first with a particular example. Consider the quadratic characteristic

$$I = aU^2.$$

This nonlinear relation cannot be represented by an approximate linear one in any manner whatever. But suppose that the voltage  $U$  consists of

## NEW Automatic Electronic Cable-making Machine Announced

(Los Angeles, California) After years of development, The Zippertubing Company announces production of a machine which automatically makes cables at speeds up to 900 feet per hour. This machine, occupying only 24 square feet of floor space, produces cables with up to 108 conductors and is so simple to operate that inexperienced personnel can make cables to any specification.

This new equipment utilizes the revolutionary Zippertubing cable jacketing, which is fed into the machine along with the required number of conductors. The Zippertubing then is automatically wrapped around the conductors, zipped closed and, if required, permanently fused with a chemical sealer. The completed cable automatically is wound on the take-up reel for storage or shipping. The machine will produce cable from 3/8" to 2 1/2" O.D. with larger sizes on special order.



Complete unit with wire reels in place.

### MULTI-JACKETED CABLES IN ONE STEP

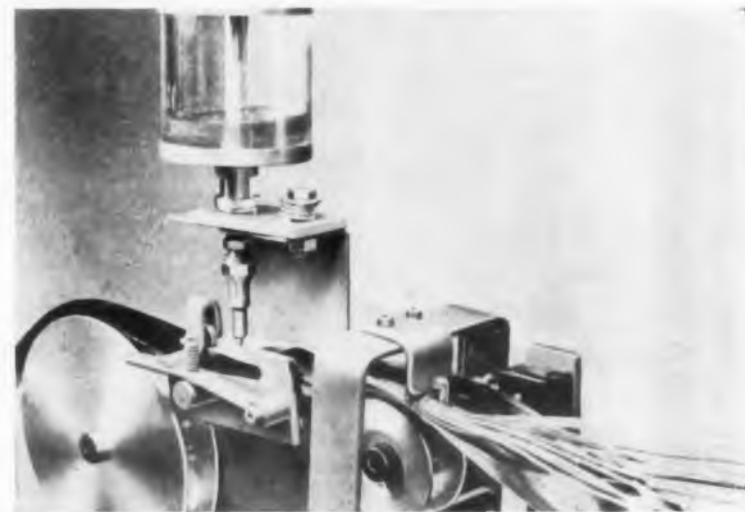
By using Zippertubing laminated materials, cables which require jackets of several different materials can be made in one step without costly re-handling. Available jackets include copper, aluminum or Co-netic steel in combination with such materials as vinyl, Mylar,\* or fiber glass. Other laminates for high temperature exposure, abrasion protection, etc., also may be used in the machine.

### SUBSTANTIAL SAVINGS

Up to 90% of the labor costs formerly involved in fabricating cables are eliminated through the use of the Zippertubing Cable Machine. Only limited floor space is necessary for long-run continuous lengths, and material waste, skilled labor investment and expensive extruding equipment no longer are required. Expensive "minimum" orders for custom extruded cabling as well as delay in deliveries also are eliminated. Because of the flexibility of Zippertubing, small

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cable runs for R & D work are economically feasible. Zippertubing cables can be re-opened for additional work on conductors, virtually eliminating the great costs formerly incurred in correcting mistakes in prototype development.



Close-up of head showing Zippertubing jacketing and conductors being formed into cable and automatically sealed.

### MEET MIL SPECS

Cables produced on this new equipment meet all necessary MIL specs, depending on the jacketing material and the purpose for which it is to be used.

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The Zippertubing cable machine may be ordered in three units: basic unit, which includes the head and sealing device; wire payoff unit, which contains the "tree" and spindles for holding the wire reels; power unit, which has the take-up reel spindle, frame and 115 V AC/DC motor that pulls the cable through the complete process.

For complete catalog information or field engineering service, write to the manufacturer: The Zippertubing Company, 752 So. San Pedro St., Los Angeles 11, California. TWX LA 840. Sales offices and warehouses are located in all principal cities.

(advertisement)

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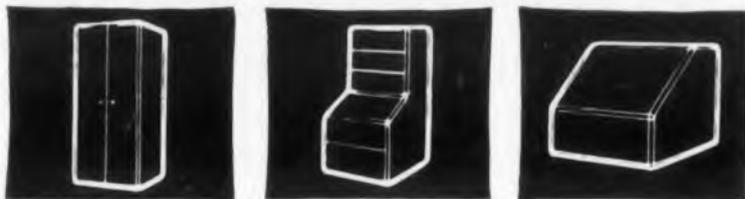
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a dc component  $U_0$  and an ac component  $\Delta U$ . We are interested in the latter only. Then

$$I = aU^2 = a(U_0 + \Delta U)^2 = a(U_0^2 + 2U_0\Delta U + \Delta U^2).$$

The current thus has three components: a dc component

$$I_0 = aU_0^2$$

a linear component

$$I_1 = 2aU_0\Delta U$$

and a quadratic component

$$I_2 = a\Delta U^2.$$

The dc component is usually of no interest to us. We write the increment of the current in the form

$$\begin{aligned} \Delta I &= I_1 + I_2 = 2aU_0\Delta U + a\Delta U^2 \\ &= 2aU_0\Delta U \left(1 + \frac{1}{2} \frac{\Delta U}{U_0}\right). \end{aligned}$$

We are justified in discarding the second term provided

$$\frac{\Delta U}{U_0} \ll 1,$$

i.e., the smaller  $\Delta U$  and the greater  $U_0$ , the better the linearization approximation. This result is illustrated graphically in Fig. 12, from which it is seen that by increasing  $U_0$ , the working point is shifted towards a section of the parabola with a smaller curvature, and at the same time, with a greater slope.

Reduction of  $\Delta U$  permits linearization of any nonlinear dependence.\*

To demonstrate this, let us assume that we are given a nonlinear characteristic in general form

$$I = f(U).$$

Let us expand the expression for the current in a Taylor series about the point  $U_0$ :

$$\begin{aligned} I &= f(U_0) + f'(U_0)\Delta U + f''(U_0)\frac{\Delta U^2}{2} \\ &\quad + f'''(U_0)\frac{\Delta U^3}{6} + \dots \end{aligned}$$

If  $\Delta U$  is sufficiently small, the higher-order terms can be neglected, and the linearized expression for the current becomes

$$I \cong f(U_0) + f'(U_0)\Delta U.$$

The dc component is determined by the ordinate of the characteristic at the operating point, and the slope is determined by the derivative at this point.

\*However, a linearized description of phenomena occurring in certain systems, has no physical meaning. We shall not encounter these exceptional cases.

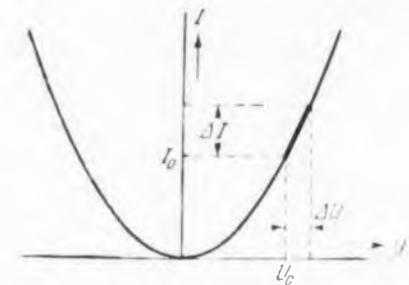


Fig. 12. In this parabola, as  $\Delta U$  decreases, or  $U_0$  increases, the  $\Delta I/\Delta U$  relationship becomes more linear.

The tangent to the characteristic at the operative point may turn out to be horizontal, i.e.,  $f'(U_0) = 0$ . In this case it is necessary to shift the operating point by changing  $U_0$ . Thus, in the quadratic example above we had

$$f(U) = aU^2, \quad f'(U_0) = 2aU_0$$

and had we taken  $U_0 = 0$  we would have obtained  $f'(0) = 0$ .

Nonlinear distortion in an almost-linear system must be estimated and measured by several methods, all based on the spectrum enrichment due to the nonlinearity. The first method consists of applying a sinusoidal voltage to the input of the system and determining the effective values of all output harmonics but the first. The ratio of this quantity to the effective value of the first harmonic (fundamental frequency) is called the harmonic distortion

$$k = \frac{\sqrt{I_2^2 + I_3^2 + \dots}}{I_1}$$

where  $I_1, I_2, \dots$  denote the amplitudes of the harmonics. Nonlinear distortion is assumed negligible if the harmonic distortion does not exceed one per cent. Commercial apparatus usually is specified to contain a harmonic distortion not exceeding five per cent.

The second method consists of applying simultaneously to the input of the system two sinusoidal voltages of different frequencies. In this case, as shown in Section 5, a rich spectrum of combination frequencies is formed. The coefficient characterizing the nonlinear distortion is determined in the same manner as the harmonic distortion.

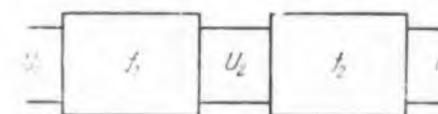


Fig. 13. A nonlinear two-port network with a second two-port correcting network.

Recently a new method was proposed for determining the nonlinear distortion. It is based on measuring the total power in a certain frequency band, produced in response to an input with a continuous spectrum, from which the same frequency band is first eliminated by means of a filter. If the tested system is linear, the frequencies eliminated from the input are absent from the output. Owing to nonlinearity, however, combination frequencies and harmonics, the so-called nonlinearity products, are produced within the eliminated band. It is this product that is measured. The new method corresponds more closely to actual operating conditions of the apparatus and gives a more correct estimate of the nonlinear distortion.

It should be pointed out that nonlinear distortion can be corrected in the same manner as frequency distortion. Let us assume that there is a nonlinear two-port network with a characteristic

$$U_2 = f_1(U_1).$$

Let us add to this two-port network a second network, serving as a corrector (Fig. 13). Its characteristic

$$U_3 = f_2(U_2)$$

should be chosen in such a way as to eliminate the nonlinear distortion, i.e., as to make

$$U_3 = AU_1.$$

This condition yields

$$\frac{U_3}{U_1} = \frac{U_3 U_2}{U_2 U_1} = \frac{f_2[f_1(U_1)]}{U_1} = A$$

$$f_2[f_1(U_1)] = AU_1,$$

i.e., the function  $f_2$  should be the inverse\* of the function  $f_1$ .

For example, if

$$f_1(U_1) = aU_1^2,$$

then we should have

$$f_2(U_2) = b\sqrt{U_2}.$$

With these relations we obtain

$$U_3 = b\sqrt{U_2} = b\sqrt{aU_1} = AU_1.$$

\*Let us recall the definition of an inverse function. If

$$y = f(x),$$

then, solving this equation for  $x$ , we get

$$x = \phi(y).$$

The function  $\phi$  is the inverse of the function  $f$ . Furthermore

$$\frac{\phi[f(x)]}{x} = \frac{f[\phi(y)]}{y} = 1.$$

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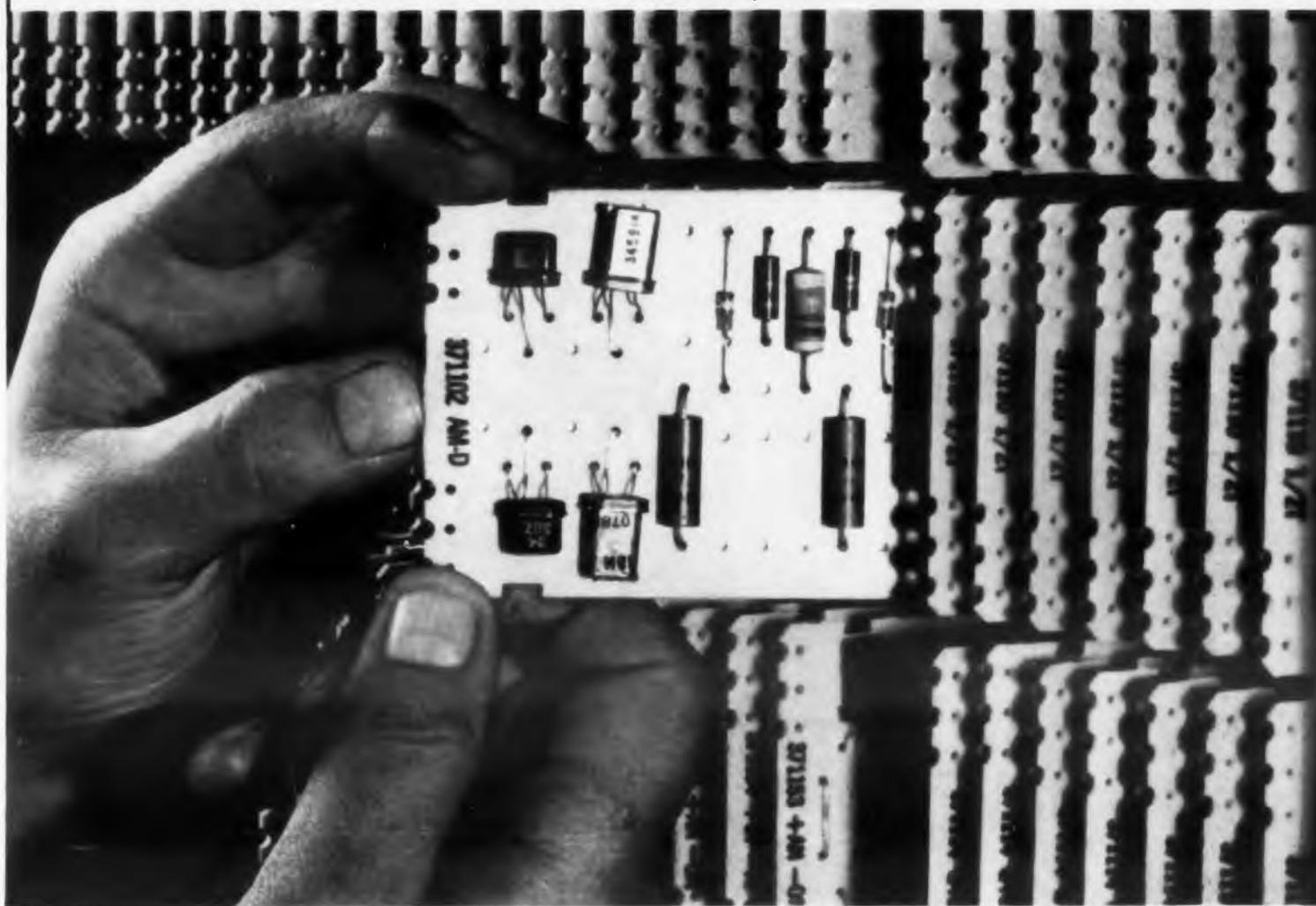


Photo of 729 Model III Tape Drive Unit (part of 705 Model III Data Processing System) courtesy of International Business Machines Corp.

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ELECTRONIC  
DESIGN

# Angular to Digital Conversions

Daniel Levine

Consulting Engineer  
Glendale, Ariz.

THESE TWO tables are handy compilations of data for engineers making angular-to-digital conversions. The first table consists of binary bits which can be transferred to digital computer notations, thusly:

Bits	Circle Parts	Notation
0	1	1
1	2	10
2	4	100
3	8	1000
	—etc.—	

The bits, therefore, represent powers of two.

The second table divides a circle by powers of ten. The decade block represents the power. Parts of a circle and the angular measure follow, respectively.

A useful addendum of angle to radian conversions ends the tables.

Shaft-to-digital encoding can find special application for the tables. In an encoder, the number of binary or decimal digits will indicate the angular accuracy in reading the shaft position. For example, if a technique of encoding employs 15 binary bits the shaft is divided into 32,768 parts and the angle can be read within 39.551 seconds.

# Engineering Data

## Angular-to-Digital Conversions

Bits	Parts of Circle	Angular Measure
0	1	360°
1	2	180°
2	4	90°
3	8	45°
4	16	22.5°
5	32	11.25°
6	64	5.625°
7	128	2.8125°
8	256	1.40625°
9	512	42.1875'
10	1,024	21.09375'
11	2,048	10.546875'
12	4,096	5.2734375'
13	8,192	2.63671875'
14	16,384	1.318359375'
15	32,768	39.55078125"
16	65,536	19.7753900625"
17	131,072	9.8876953125"
18	262,144	4.94384765625"
19	524,288	2.471923828125"
20	1,048,576	1.2359619140625"
21	2,097,152	0.61798095703125"

Decades	Parts of Circle	Angular Measure
0	1	360°
1	10	36°
2	100	3.6°
3	1,000	21.6'
4	10,000	2.16'
5	100,000	12.96"
6	1,000,000	1.296"

Angle-to-Radian Conversions	Angle	Radians
	1 deg	0.0174532925
	1 min	0.0002908882
	1 sec	0.0000048481



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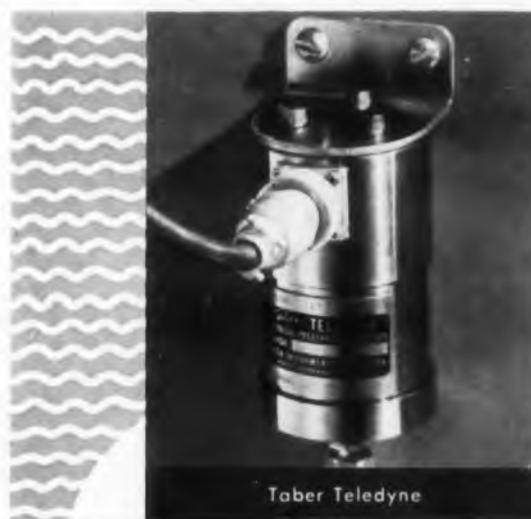
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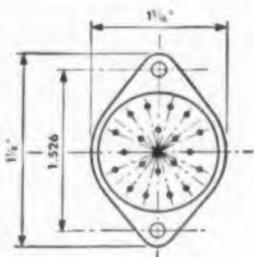
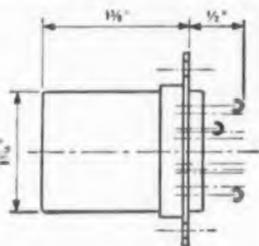
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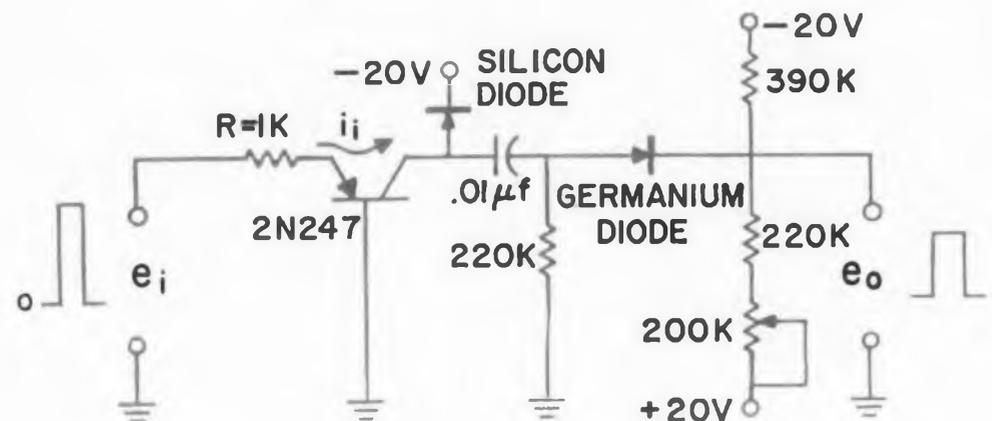


Fig. 1. Logarithmic video amplifier.

## A Logarithmic Pulse Amplifier

IT WAS necessary to design a pulse amplifier whose output was a logarithmic function of the input pulse amplitude over a wide dynamic range of input signal variation.

A high speed silicon diode served the purpose very well, as is shown in the circuit diagram in Fig. 1.

A curve showing  $e_o$  versus  $e_i$  for the circuit is shown in Fig. 2.

Since the plot in Fig. 2 is a semilog presentation, it can be seen that  $e_o = k \log e_i$  very closely over a 100 to 1 range of input voltage (40 db).

The circuit is based on the forward V-I characteristics of an ideal semiconductor diode as shown in eq (1).

$$I = I_s [e^{(KT/q)V} - 1] \quad (1)$$

where  $I$  = diode current

$I_s$  = saturation current of diode

$V$  = diode voltage

$K$  = Boltzmann's constant

$T$  = Absolute temperature

$q$  = Charge on an electron

Rearranging terms and taking the logarithm of

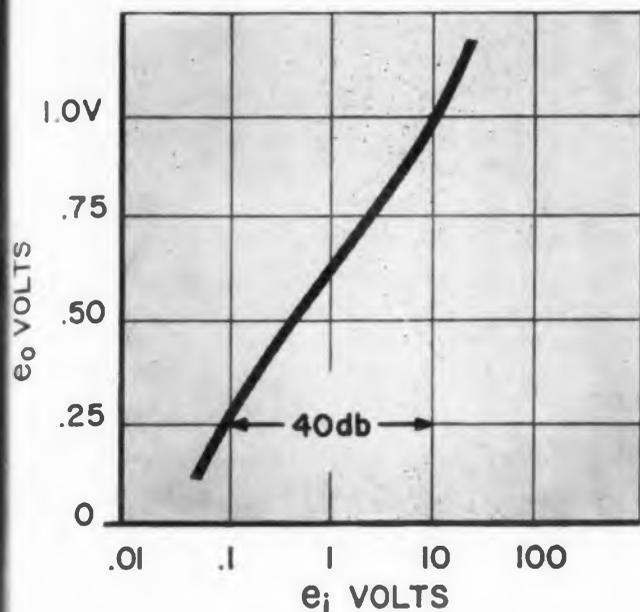


Fig. 2. Output voltage versus input voltage for log video amplifier shown in Fig. 1.

both sides of eq (1) results in eq (2).

$$(I + I_s) = I_s e^{(KT/q)V}$$

$$\log_e (I + I_s) = (KT/q)V + \log_e I_s \quad (2)$$

If  $I \gg I_s$  (which is the case for  $I > 10 \mu a$ ) then

$$V = K_1 \log_e I + K_2 \quad (3)$$

where

$$K_1 = KT/q$$

$$K_2 = \log_e I_s$$

The low input impedance and high output impedance of the 2N247 grounded base amplifier make  $i_i = (1/R) e_i$  (for  $e_i = 100$  mv). Then:

$$e_o = K_1 \log_e i_i + K_2 = K_1 \log_e (e_i/R) + K_2$$

$$e_o = K_1 (\log_e e_i - \log_e R) + K_2$$

$$e_o = K_1 \log_e e_i + K_4 \quad (4)$$

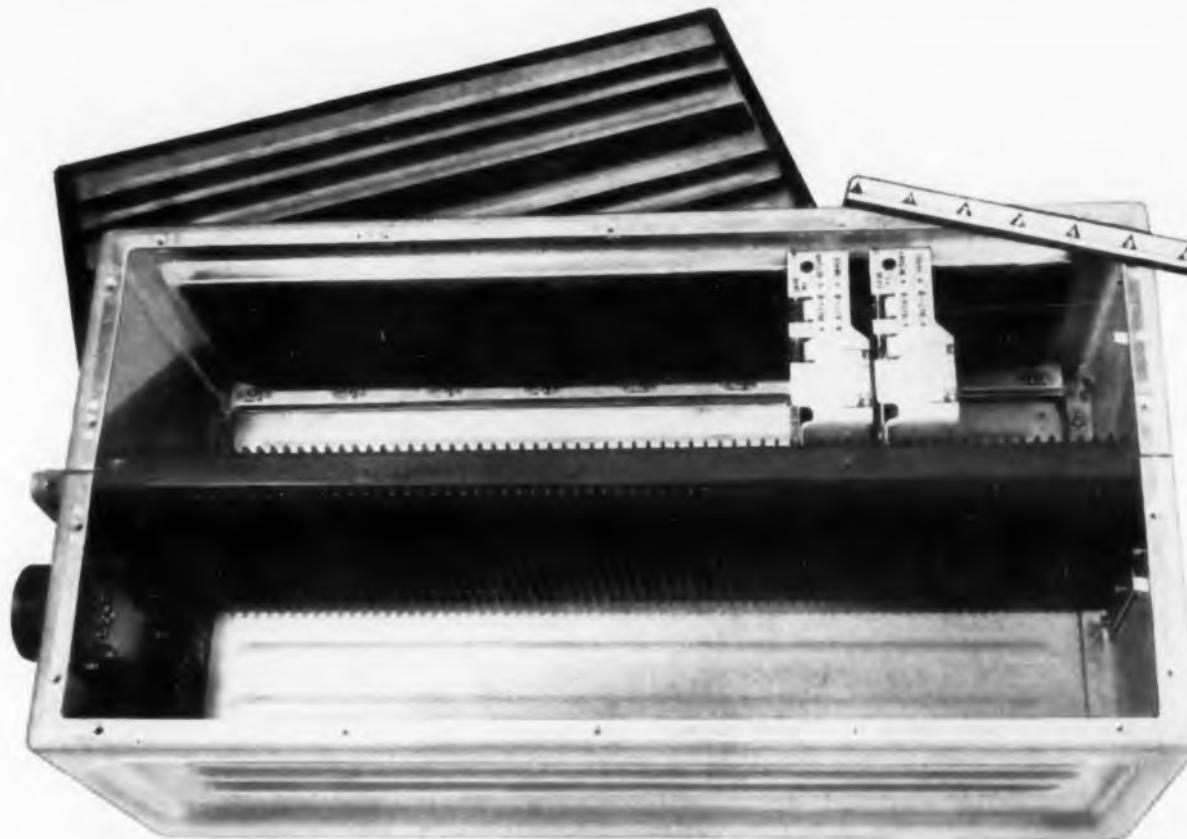
where

$$K_4 = (K_2 - \log_e R)$$

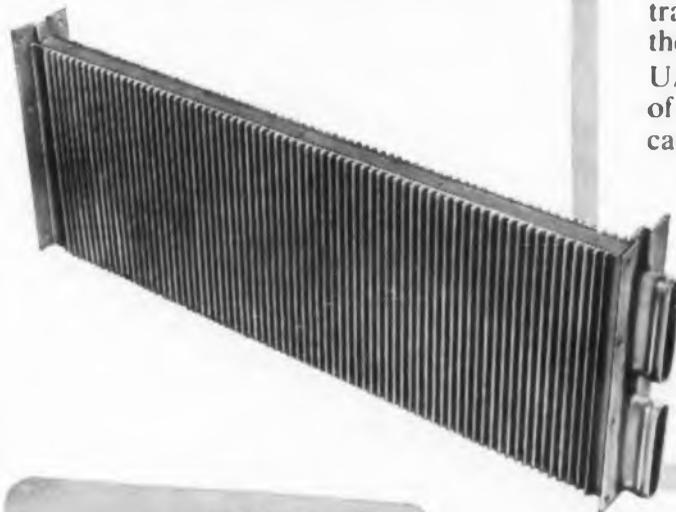
Eq (4) is the desired relationship except for the constant term  $K_4$ . This constant term is subtracted from the output by the back biased germanium diode and resistive network shown in Fig. 1.

For short pulse lengths, (1-10  $\mu$ sec), the Transiron S10G and SG226 silicon diodes work very well because of their low shunt capacity and fast switching time. For longer pulses a general purpose type 1N483 will perform very well over an even larger dynamic range than that shown in Fig. 2.

Eugene P. Hoyt, Motorola Research Lab., Riverside, Calif.



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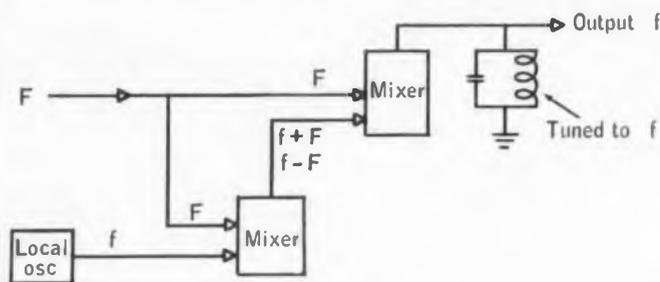
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The local oscillator can be crystal controlled, so the output frequency can be as stable as if it were crystal controlled.

*J. Frank Brumbaugh, Senior Marine Eng., Heath Co., Benton Harbor, Mich.*

### Noise Suppression in Automobiles

Automobile ignition interference is mainly due to shock-excitation, by each spark, of the wires connecting the ignition coil, the high voltage distributor, and the spark plugs.

The other sources of automobile interference, namely the sparks due to bad contacts or poor connections in the electrical equipment, are easily silenced by the use of standard anti-interference capacitors connected right across the spark sources, and due care.

However, ignition interference, which affects radio and television, is a different problem. The usual solution has been to insert, in each high voltage conductor, a special low value resistor to damp out the oscillations. There is generally one resistor on each spark plug and one in the wire connecting the ignition coil to the distributor.

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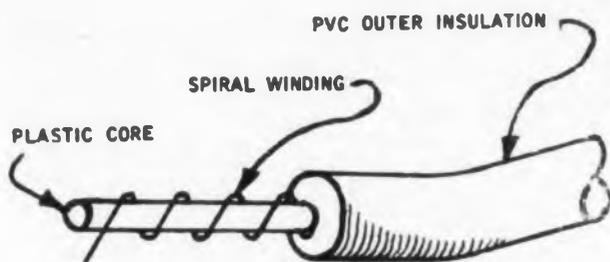
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A. V. J. Martin, *Carnegie Institute of Technology, Pittsburgh, Pa.*

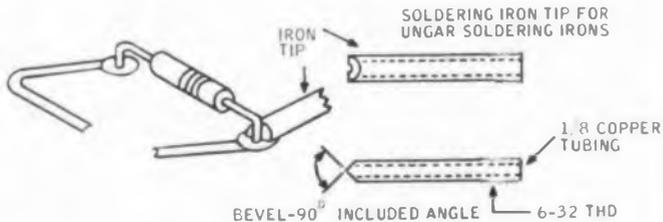
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R. A. Wyman, *Group Eng., Lockheed Aircraft Corp., Palo Alto, Calif.*



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## RUSSIAN TRANSLATIONS

# What the Russians Are Writing



J. George Adashko

### MEASUREMENTS

**Measurement of Peak and Instantaneous Values of Periodic Voltages and Currents** by A. D. Kratirov. EC 2/58, pp 65-70, 5 figs.

Describes how to measure peak and instantaneous periodic voltages or currents with the aid of detector instruments and with the aid of d'Arsonval meters with rectifiers of other types. Fundamentals of the procedure are given along with the basic diagrams of the measuring instruments and the possible field of their application. Measuring the alternating component (pulsations) of rectified voltages and currents with the aid of pointer-type voltmeters and ammeters is shown possible.

**Prototype of an Instrument for Checking UHF Standard Signal Generators by Measuring the Coefficient of the Depth of the Amplitude Modulation** by P. A. Shpan'on. Izmeritel'naya tekhnika 3-4/58 pp 78-82, 3 figs.

The instrument is based on the method of measuring the coefficient of depth of modulation of a small amplitude-modulated uhf voltage. The nonlinearity of

the amplitude characteristic of the amplifier does not affect in principle the error of the measurement.

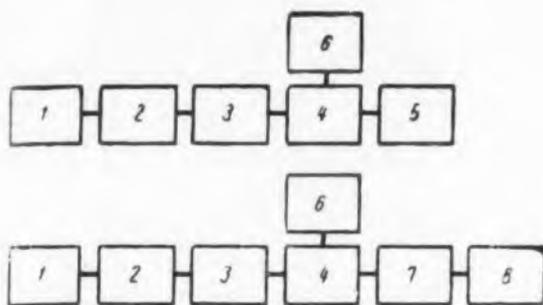
**Measurements by Means of a Broad-band Indicator in the Presence of Non-linear Distortion** by V. A. L'vov. EC 3/58, pp 54-57, 2 figs.

The errors involved in the attenuation of a two-port network with nonlinear distortion in the oscillator or in the two-port network is made as a function of the type of the measured frequency characteristic of the attenuation. A formula is obtained for the necessary attenuation in the measuring filter, connected at the oscillator output, to insure a specified measurement accuracy. The specific case of the measurement of attenuation in the rejection band of the high frequency filter is considered.

**Measurement of the VSWR of a Generator by Means of a Phase Shifter** by L. N. Bryanskiy. Izmeritel'naya tekhnika. 3-4/58, pp 87-88, 2 figs.

In the case of a generator with waveguide output the vswr can be measured in a simpler manner than with the usual slotted line technique. This can be done

by replacing the slotted line with a phase shifter and a probe. The same accuracy is obtained, although the cost of a probe and phase shifter is usually half of the cost of a slotted line. See Fig. 1.



**Fig. 1.** Block diagram of two equivalent methods of measuring vswr. 1—generator; 2—decoupling attenuator; 3—phase shifter; 4—probe; 5—short-circuiting plunger; 6—indicator; 7—auxiliary phase shifter; 8—stationary short circuit.

## TRANSISTORS

**Approximate Transient and Frequency-Phase Characteristics of the Intrinsic Current Gain of a Junction Transistor** by T. M. Agakhanian. RE 2/58, pp 3-13, 7 figs.

An exact solution of the transfer function for the intrinsic current gain of a junction transistor is quite complicated. The customary simplification is to replace the transfer function by two functions, one applicable for the initial instant of time, the second beyond this time. Even this approximation involves certain mathematical difficulties. The author proposes another simplified expression. The transfer function ( $t$ ) is represented by a single expression, and yet sufficient accuracy is retained. All three types of transistor connections are considered. Reference is made to many American articles on the subject.

**Contribution to the Theory of the Transfer Characteristic of a Transistor** by A. A. Grinberg. RE 2/58, pp 51-53.

The transfer characteristics are obtained for various transistor connections. The analytic form of the transfer characteristics makes it possible to account for the collector capacity and the load impedance of the transistor.

**Influence of the Dependence of the Frequency Properties of a Transistor on Its Electric Operating Conditions on the Duration of the Wave Fronts** by I. I. Litvinov. RE 2/58, pp 53-58, 5 figs.

Experience in the use of semiconductor relaxation oscillators with a single reactance has shown that if the peaks of the generated pulses are not steep, the duration of the trailing fronts turn out to be at times considerably greater than those of the leading fronts. This phenomenon cannot be explained by means of a pulse-shaping analysis that assumes the transistor frequency properties to be independent of its operating conditions. The reason for this contraction of the trailing front is the accumulation of minority carriers in the germanium during saturation. So far, only few attempts have been made to take this effect into account analytically.

**Equivalent Circuits of Transistors for a Broad Frequency Band** by K. Shul'gin. R 3/58, pp 52-55, 6 figs, 1 table.

Continuing a previous article in the November 1957 issue of "Radio," where only low-frequency equivalents were considered. In the present article equivalent circuits are developed for some Russian transistors for a wider range of frequencies.

**On the Parameter  $h_{11}/z_{11}$  of a Transistor and Generalized Characteristics of Impedances and Gains** by V. K. Labutin. RE 2/58 pp 59-68, 7 figs, 1 table.

A new transistor parameter, a ratio of the short-circuit to open-circuit input impedance, is used in the article to derive generalized characteristics and impedance and gain diagrams, which permit a lucid description of the amplifying properties of a transistor under small-signal conditions at low frequencies.

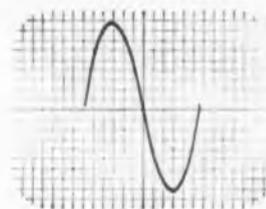
**Regeneration and Neutralization of Transistor Stages** by A. A. Rizkin. EC 2/58, pp 12-19, 11 figs.

The author indicates that certain concepts and formulations available in the literature concerning the internal feedback of a transistor stage and its neutralization are incorrect. The concepts of the internal feedback and the connection between the input and output circuits of the stage are delineated.

(Continued on following page)

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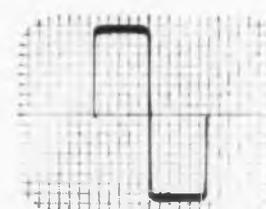
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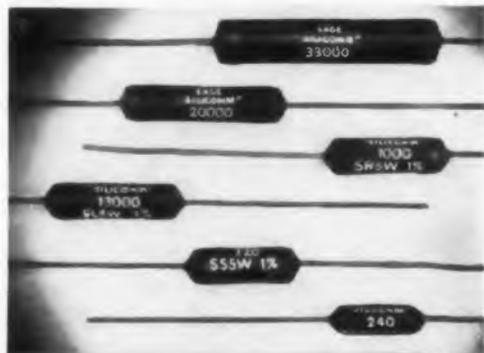
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SL5W	1 1/8"	X 5/16"	to 22500 "
SS7W	1 1/4"	X 5/16"	to 28000 "
S7W	1 3/8"	X 5/16"	to 32000 "
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## RUSSIAN TRANSLATIONS

### CIRCUITS

**Direct Coupled Transistor Amplifiers** by N. S. Nikolayenko. RE 2/58 pp 14-22, 8 figs.

The article analyzes ac transistor amplifier with direct coupling between stages. The circuit has many advantages, being simple to construct, containing a minimum number of parts, and permitting transistorized amplifiers to operate at temperatures up to +100 C.

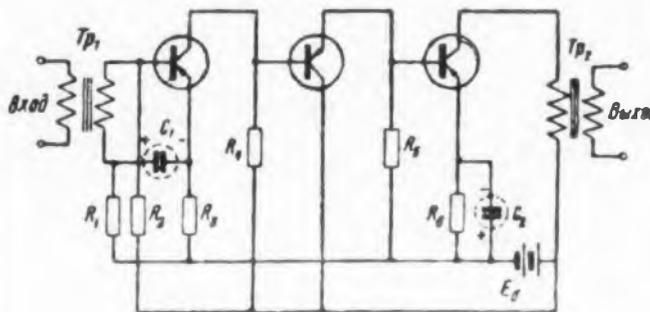


Fig. 2. Direct coupled transistor amplifier.

**Determination of the Parameters of Transistors** by K. Shul'gin. R 5/58, pp 58-60, 5 figs.

A continuation of previous articles on equivalent circuits of transistors, (Radio, November 1957 and March 1958). In this article it shows how, using equipment normally available to a radio amateur, the required parameters of transistors can be determined for evaluating the equivalent circuits.

**Group Mode of Multiphase Multivibrator** by Ya, Ye. Belen'kiy and A. N. Svenson. RE 3/58, pp 61-65, 5 figs.

The multiphase multivibrator was first described by the same authors in the August 1956 issue of Radiotekhnika. In the ordinary operating mode, the multiphase multivibrator generates sequences of pulses such as are used in electronic commutators. This article investigates an operating mode, in which each stage generates not one, but a group of pulses. The mechanism

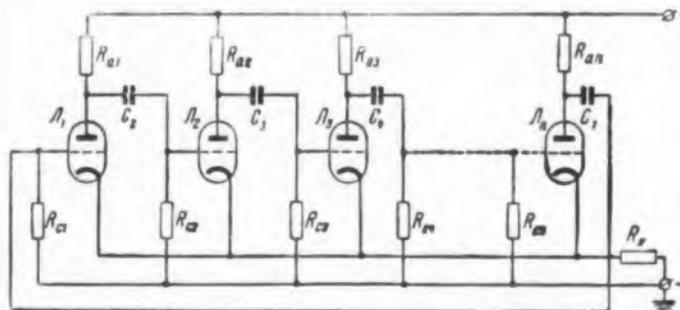


Fig. 3. Multiphase multivibrator.

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of operation of a multivibrator is described, and fundamental calculations and relations are given for this mode. See Figs. 3, 4 and 5.

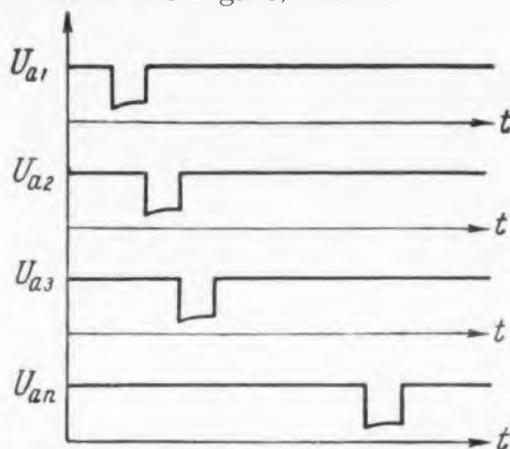


Fig. 4. Pulses produced by multiphase multivibrator in normal operation, and in group operation.

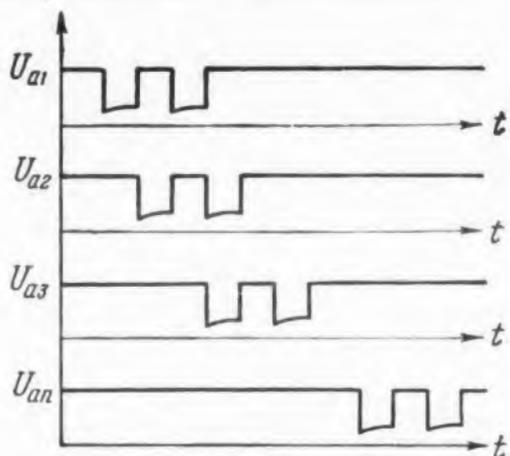


Fig. 5. The voltages are developed across the resistors bearing the same marking.

of operation of a multivibrator is described, and fundamental calculations and relations are given for this mode. See Figs. 3, 4 and 5.

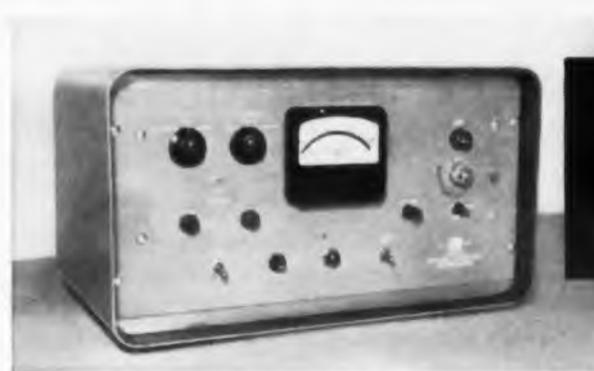
**On the Measurement of the Asymmetry of the Input of Radio Receivers by A. V. Fradin and V. A. Olendkiy. EC 4/58, pp 30-45, 3 figs, 3 tables.**

An analysis of the equivalent circuit of the input of a radio receiver and of its fundamental parameters. A procedure is examined for the measurement of the asymmetry coefficients of the receiver input on the basis of the measured impedances and voltages. Values of the input parameters are given for certain commercial receivers, experimentally obtained. The value of the reception coefficient of the feeder is discussed.

**Temperature Stabilization of Transistor Voltage Amplifiers by Yu. R. Nosov and B. I. Khazanov. RE 2/58, pp 28-35, 1 fig, 2 tables.**

The authors determine the condition of gain stability in a grounded-emitter circuit under temperature changes. They show the influence of the circuit parameters and of the transistors themselves on the satisfaction of these conditions. The theory proposed is applicable for both sili-

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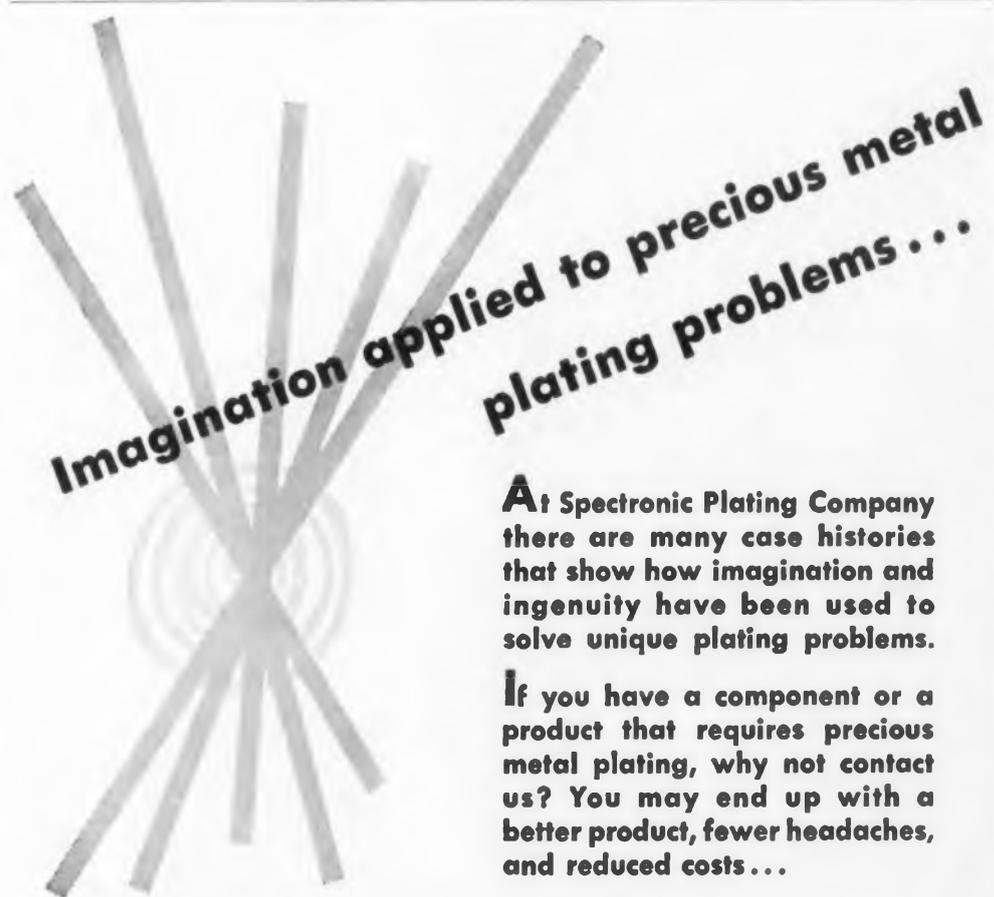
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**RUSSIAN TRANSLATIONS**

con and germanium transistors. They describe the change in the emitter current and analyze the cause of this change.

For thermal stability of the voltage gain, it is necessary that the voltage increments of the absolute temperature and of the emitter current be equal. The change in the emitter current should be due to a shift in the voltage-current characteristic. The effect of the change in the collector current should be reduced to a minimum. To accomplish this, it is advisable to use a low-resistance divider in the base circuit.

**ELECTROMAGNETIC THEORY**

**Secondary Diffraction of Electromagnetic Waves by a Ribbon** by P. Ya. Ufimtsev. JTP 3/58, pp 569-582, 13 figs.

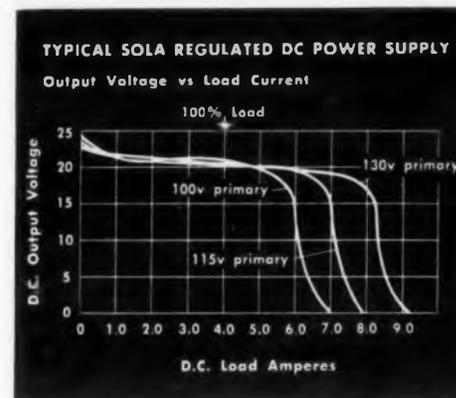
Secondary diffraction involves internal currents that flow at different elements of the surface of a body. In the case of diffraction by a ribbon, the role of this interaction becomes most substantial for directions of observation close to the plane of the ribbon, and also for glancing incidence of the illuminating wave. The approximate expressions obtained for the scattered field are suitable for all directions of illumination and observation. The results of the rigorous and approximate theories are compared.

**Axially Symmetrical Electrostatic Problems for a Conductor in the Form of a Semi Infinite Tube With Thin Walls** by N. N. Lebedev and I. P. Skal'skaya. JTP 4/58, pp 792-800, 6 figs.

An exact solution is obtained for the distribution of the potential near a thin semi-infinite cylinder (tube) located in an arbitrary axially-symmetrical external field. A new method is developed for the solution of one class of static problems. It is analogous to the method used to investigate a similar class of boundary problems in the theory of diffraction, encountered with problems of radiation of acoustic and electromagnetic waves from the open end of cylindrical and flat waveguides.

**Distribution of Electric Charges on Linear, Flat, Closed Conductors** by L. A. Druzhkin. RE 3/58, pp 3-7, 2 figs.

The author considers the distribution of electric charges on linear conductors, using a specially introduced linear-density function. It is shown that the solution proposed not only makes possible finding the potential and fields, but also leads to a substantial simplification of the analysis.



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## PROPAGATION

Scattering of Electromagnetic Waves by Sinusoidal and Trochoidal Surfaces With Finite Conductivity by V. I. Aksenov. REE 4/58, pp 459-466, 1 fig.

Using the Kirchhoff approximations, a solution is obtained for the problem of the scattering of electromagnetic waves by limited portions of a sinusoidal or trochoidal surface with finite conductivity. The solution makes it possible to calculate the scattered field in the far zone. A method is proposed for determining the amplitude of the wave in the maxima of scattering lobes. By way of an example, the author calculates the scattering of electromagnetic waves by a sinusoidal surface.

Asymptotic Solution of the Problem of Diffraction of a Plane Electromagnetic Wave by a Conducting Cylinder by A. S. Goryainov. REE 5/58, pp 603-614, 7 figs.

The diffraction by a round cylinder is first solved rigorously, and the resultant series are summed asymptotically. Simple formulas are obtained which give good agreement with the strict formulas at sufficiently close distance to the diffracting cylinder.

Determination of the Internal Field in the Perturbation Method With the Aid of the Solution of the Diffraction Problem by V. V. Nikol'skiy. REE 5/58, pp 690-697, 5 figs.

The perturbation method has recently solved problems involving gyrotropic bodies placed in waveguides and in resonators. The limitation is that its accuracy depends entirely on the way the perturbed field is determined (the internal field) from the known value of the initial field. This requires an independent method, for which the quasi-stationary approximation is ordinarily used. This imposes substantial limitations on the dimensions of the perturbation region. This article gives an example whereby this limitation is overcome. The method uses the diffraction of a plane wave by the perturbing body to determine the perturbed field in the closed system. The specific example is a dielectric cylinder in a rectangular waveguide, as being the simplest and most amenable to comparison with already-published works.

Induction Through Neighboring Third Circuits, Caused by Structural Irregularities in the Line by P. K. Akul'shin. EC 11/57, pp 73-82, 6 figs, 1 table.

The author has written several articles on the subject, the latest of which was published in the July 1957 issue of *Elektrosvyaz*. It is shown in

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## RUSSIAN TRANSLATIONS

this article that the structural irregularities of the line are the main cause of induction through third circuits, and limit the degree of shielding between circuits.

**Diffuse Propagation of UHF Waves in the Troposphere from Antennas With High Directivity by D. M. Vysokovskiy. EC 5/58, pp 16-22, 4 figs.**

The author has shown in a previous article (Geometrical Characteristics of the Scattering of Radio Waves by Turbulent Irregularities in the Troposphere, *Elektrosvyaz*, September 1957) that the basic characteristics of diffuse propagation are determined by the properties of the effective scattering volume. In particular it is determined by the ratio of the angular dimensions of this volume to the width of the directivity pattern of the antennas used at the terminal point of the communication route. Since in practice the antennas have directivity patterns that are narrower than the effective scattering volume, the net result is usually a reduced antenna gain in the reception of scattered radiation. Furthermore, the possible bandwidth of a given line is affected by the directivity of the antennas. The author therefore derives expressions for the scattering power for inhomogeneous turbulence, for the antenna-gain losses, and for the broadening of the directivity patterns in diffuse propagation.

## INFORMATION THEORY

**Phase Correlation Properties of Signals and Gaussian Noise in Two-Channel Phase Systems by V. V. Tsvetnov. RE 4/58, p 53-62, 5 figs.**

The author considers the correlation properties of the phase differences in two-channel phase systems under the influence of Gaussian noise. Relations are derived for the correlation functions of the phase differences for the case of pure noise and for the case of strong signals. The correlation properties of the phase differences are compared with the correlation properties of the envelope of the Gaussian noise.

**Statistical Properties of Sets of Messages by D. S. Lebedev. RE 1/58, p 3-10.**

The connection between the statistical properties of sets of messages and the problems of transmitting messages from this set over a communication system is developed within the framework of the discrete case. Messages are classified and an attempt is made to create a new statistical model for facsimile and television communication.

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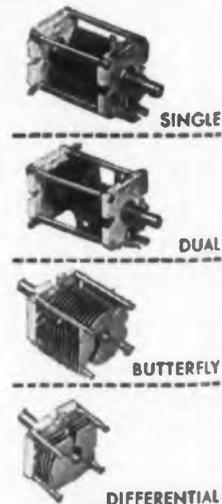
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**Contribution to the Theory of the Carrying Capacity in Binary Transmission by B. A. Varshaver. RE 1/58, pp 11-21, 7 figs.**

The general relations of communication theory derived by Shannon (The Mathematical Theory of Communications) and the theory of maximum interference immunity by V. A. Kotelnikov are used to determine the carrying capacity of the binary channel under various methods of manipulation. It is assumed that the channel is under the influence of fluctuation noise.

**Response of a Time Delay Pulse Detector to a Sequence of Pulses Modulated by a Random Process by G. P. Tartakovskiy and Yu. M. Seriyenko. RE 1/58, p 62.**

The authors show the equivalence of time delay pulse detector to a linear pulse circuit with negative feedback. Transfer functions of the latter network are derived. The spectral density of the random processes at the output of the detector is determined from known statistical characteristics of the pulse signal at the input of the detector.

**Suppression of Pulsed Noise by Nonlinear Transformation of the Form of Their Frequency Spectrum by A. A. Gorbachev. RE 1/58, pp 56-61, 8 figs.**

The various versions of linear transformation of the spectrum ahead of the amplitude limiter in a system designed for the separation of a signal from a noise background are investigated. The advisability of using tuned converters is indicated. Results of theoretical and experimental investigation are cited. Essentially the method is based on separating the signal from the noise by using the two differences (in amplitude and in spectrum) between the pulse noise and the signal.

### MICROWAVES

**Perturbation of the Natural Frequency of Electromagnetic Resonators by Ferrites by Yu. N. Dnestrovkiy. REE 5/58, pp 675-589.**

The method of successive approximations (the vector analog of the Kellogg method) is used to investigate the problem of large and small perturbations to the natural frequencies of electromagnetic resonators induced by ferrites. A convergence of the successive approximations follows from the general theorems for the systems of integral equations. This method estimates the accuracy of the results obtained by other investigators.

Effect of Radioactive compounds Co<sup>60</sup> and Po<sup>210</sup> on the breakdown power and on the statistical delay of microwave pulse discharge in

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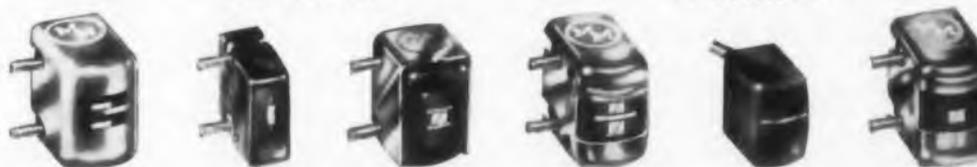


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**RUSSIAN TRANSLATIONS**

air was investigated. It is shown that the breakdown power remains unchanged over a wide range of compound activity.

**Electric Discharge in Air at 3.2 cm by V. Ye. Mitsuk, G. S. Solntsev, M. Z. Khokhlov, P. S. Bulkin, and G. M. Zastenker. REE 5/58, pp 698-703, 7 figs.**

A procedure is proposed for determining the breakdown voltage of the electric field and the statistical time delay at a wavelength of 3.2 cm. The experimental set-up is described, as are the devices that makes it possible to automatize the statistical measurements. The breakdown voltages were measured at pressures from 0.1 to 300 mm Hg. The results obtained are in agreement, within experimental accuracy, with those obtained by Posin ("The Microwave Spark," Physical Review, 1948, 73, 496) but the authors disagree with his conclusions.

**Approximate Method of Calculating the Induced Current in Cavity Magnetrons by S. I. Bychkov. REE 4/58, pp 530-536, 2 figs, 2 tables.**

The fundamental relations are derived for the induced current in a cavity magnetron. Starting with the assumed distribution of the radial velocities of the electrons, the dependence of the first harmonic of the induced current on the mode and the parameters of the magnetron are determined.

**MISCELLANEOUS**

**Radio Equipment for Simultaneous Translation of Speeches into Eight Languages by S. G. Kalikhman. CJ 5/58, pp 8-11, 8 figs.**

Block diagram and description of principal apparatus used for simultaneous translation of speeches and their translations in large halls. A fixed wavelength at 85, 100, 150, 130, 145, 40, 55 and 70 kc was used. No wires are used for transmission, although the system can be converted for such purpose. The equipment is capable of serving participants in a conference in a hall with an area up to 3000 m<sup>2</sup>. No indication is given as to where this equipment is actually installed.

**Pulsed Method for Determining the Location of Improper Pairing of Conductors in Cables by V. O. Shvartsman. CJ 2/58, pp 7-9.**

The author considers the theoretical fundamentals, the measuring apparatus required, and the results obtained when using a pulse method

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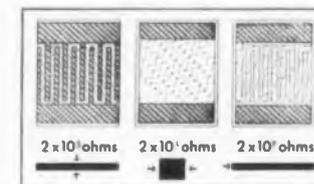
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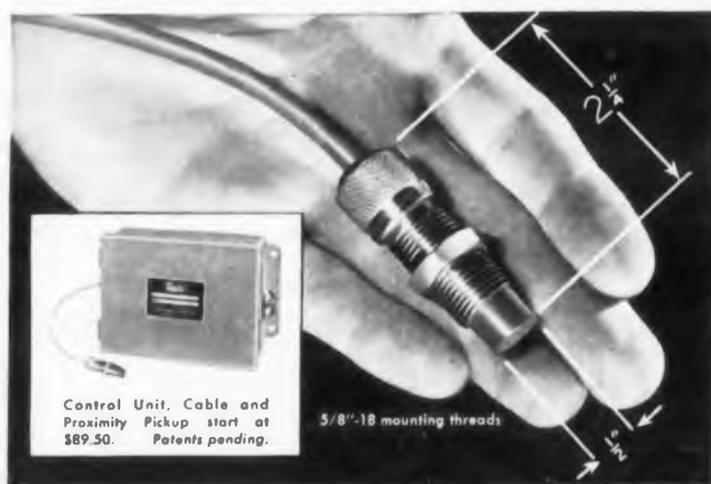
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for determining the points of incorrect pairing of conductors in municipal telephone systems. It is indicated that this method can also be used to locate faults of other types.

**Four-Electrode Piezoelectric Resonator for the Frequency Range from 250 to 600 kc by V. Ya. Gel-mont. CJ 3/58, p 12.**

Investigates four-electrode piezoelectric resonator, operating at the second harmonic, in filters. This circuit makes it possible to reduce by one half the number of resonators in quartz filters used to separate the group carriers in type V-12 high frequency carrier apparatus.

**Nonstationary Processes in a Waveguide by A. A. Kovtun. REE 5/58, pp 660-674, 6 figs.**

Investigates nonstationary processes in a cylindrical waveguide of round cross-section, excited by an elementary dipole. The method of incomplete separation of variables is used to obtain an exact solution to the problem. The solution is analyzed for cases when the conductivity of the waveguide wall is a large finite quantity or an infinite quantity.

**Design of Grounded-Grid Stage in the Critical Mode by Yu. V. Bogoslavskiy. EC 4/58, pp 36-40.**

A procedure is developed for the design of a grounded-grid stage in the critical mode. One of the initial parameters for the design is chosen to be the amplitude of the plate current, the oscillation power  $P_1$ , or the tank-circuit resistance.

### KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

- AJ Acoustic Journal (*Akusticheskiy Zhurnal*)
- AT Automation and Telemechanics (*Avtomatika i Telemekhanika*)
- CJ Communications Journal (*Vestnik Svyazi*)
- EC Electrical Communications (*Elektrosvyaz*)
- IET Instruments and Experimental Techniques (*Pribori i Tekhnika Eksperimenta*)
- JTP Journal of Technical Physics (*Zhurnal Tekhnicheskoy Fiziki*)
- ME Measurement Engineering (*Izmeritel'naya Tekhnika*)
- R Radio
- RE Radio Engineering (*Radiotekhnika*)
- REE Radio Engineering and Electronics (*Radiotekhnika i Elektronika*)



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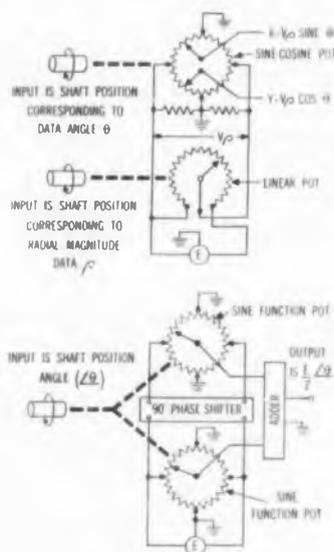


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## ABSTRACTS

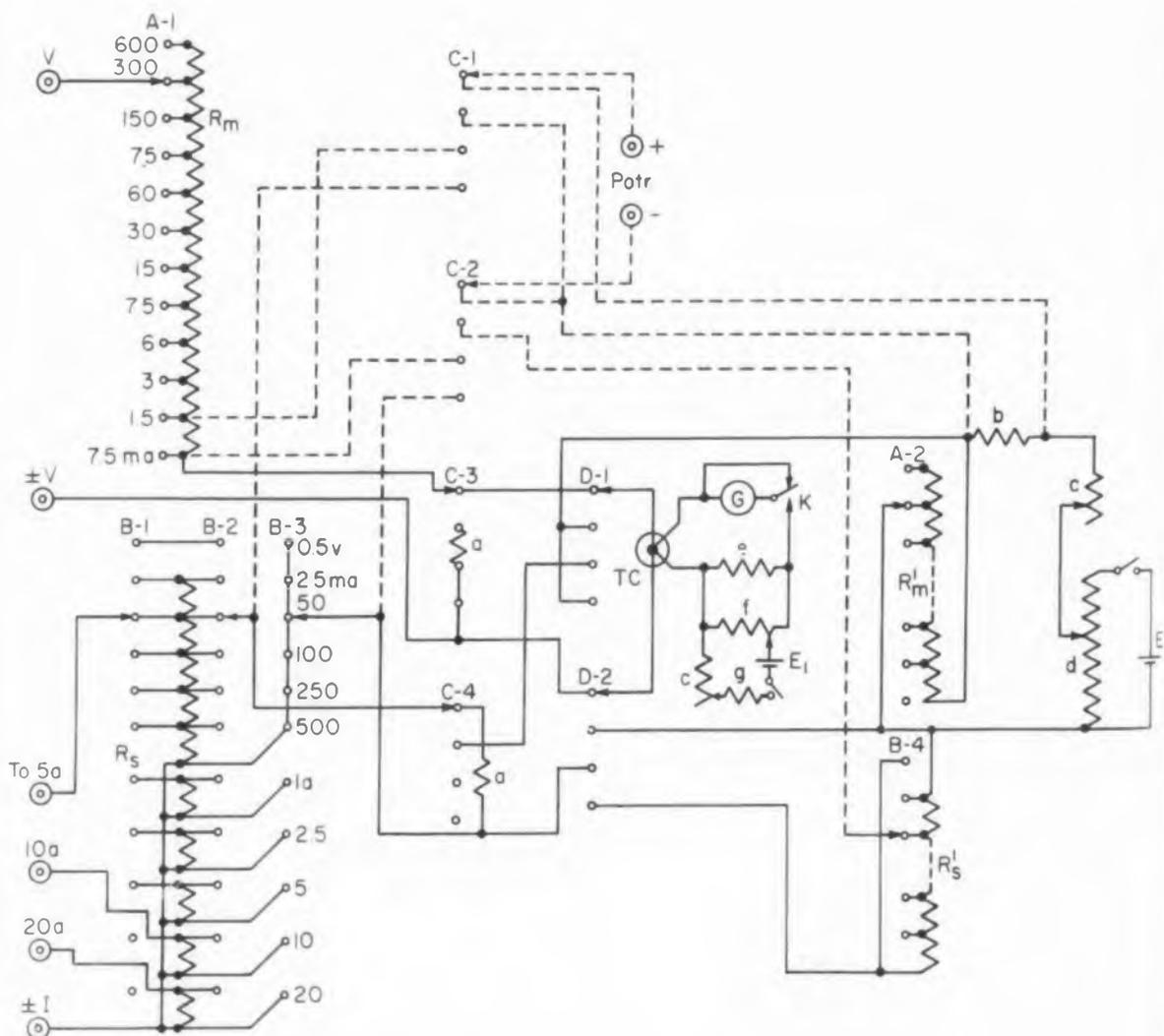
# Audio-Frequency Volt-Ammeter



**I**NCREASING use of audio frequencies, especially in airborne devices, has made necessary the development of special equipment and transfer standards for tests of instruments operating in this range. Toward this end the National Bureau of Standards has developed a self-contained, portable volt-ampere converter which measures voltage and current from 5 to 50,000 cps. As the primary electrical units are maintained by dc standards, all ac measurements of voltage, current, and power are actually based on transfer instruments, which are

standardized on dc and then used on ac. Twelve voltage ranges from 0.5 to 600 v and 11 current ranges between 7.5 and 20 amp have been designed. These ranges may be used either for dc or ac measurements with a 1.5 v potentiometer or for ac-dc transfer tests of instruments.

Like other transfer instruments for accurate standardization at the higher audio frequencies, the volt-ammeter, based on an earlier, more limited prototype, uses a thermal converter as the sensitive component. The thermal converter consists essentially of a conductor, heated



Wiring diagram of the volt-ampere converter for use in audio-frequency calibration work.

by the ac to be measured, and a thermocouple, thermally attached near the center of the heater. The output electromotive force produced in the thermocouple is first balanced against the voltage from an internal dc bucking circuit to obtain a null reading on a built-in galvanometer. Then the heater is switched to an internal dc circuit, which is adjusted to give the same output emf and therefore equivalent heater current and voltage drop. A simple multiplication of the voltage measured across a portion of this dc circuit yields the unknown alternating voltage or current. The 7.5 ma thermal converter used has excellent transfer characteristics, its ac-dc difference being less than 0.01 per cent at audio frequencies. Changes in heater resistance are compensated by connecting additional resistors in the circuit. Accuracy of the instrument is dependent only on the potentiometer used to measure the voltage and on the highly stable internal resistors. A function selector switch is used to connect the thermal converter circuit to the shunts for ac measurements and to the series resistors for alternating voltage measurements. For direct voltage measurements the 1.5 v section of the series

resistors is connected directly to the potentiometer, and for dc measurements the shunt voltage is connected directly to the potentiometer. This relatively simple switching permits the same resistors and shunts to be used for dc as well as ac measurements, thus greatly increasing the usefulness of the instrument.

Binding posts on the panel make possible the inclusion of a millimeter in the balancing circuit to measure the thermal converter output voltage. With these data and a converter characteristic curve, ac-dc difference tests can be made of voltmeters and ammeters with an accuracy of 0.02 per cent. In such tests the voltampere converter is connected in series with the test ammeter, or in parallel with the test voltmeter. Alternating and direct current are then applied successively to the arrangements. By using a more sensitive external galvanometer in place of the built-in galvanometer, the ac-dc difference of the test instrument can be obtained. Special precautions were taken to minimize reactance.

*Abstracted from National Bureau of Standards Technical Report, Audio Frequency Volt-Ammeter.*

## Spurious Radiation

**E**FFICIENT rf spectrum utilization and mutual interference reduction requires the imposition of limitations on harmonic and other spurious radiations from microwave electronic equipment. An experimental program was undertaken to extend the limits of existing interference specifications to cover the range 1 to 10 kmc, and to establish techniques for radiated interference measurements.

The following conclusions were reached:

- With horn-type directional antennas, it is feasible to make repeatable cw field intensity measurements in a shielded enclosure from 1 to 10 kmc.
- The optimum distance range for interference testing is 3 to 6 ft from the equipment in the frequency range.

The paper also proposes a method for near-field antenna calibration which gives good correlation between theoretical and experimental values.

*Abstracted from the article Measurement of Spurious Radiation from Missileborne Electronic Equipments by A. L. Albin and C. B. Pearlston, Jr., Filtron Co., Inc., delivered at 1958 IRE Convention.*

Quiggle  
Quells the  
Query



...where to get the best bandpass filters?

Major Quiggle\*, KC, AC, DC, MC, fixed his procurement manager with a withering stare. "So now our whole production line is held up," he barked, "while you try to find a good bandpass filter with a flat response between 17 and 20 kcs. And you also insist that it have sharp low and high frequency cut-off," he added.

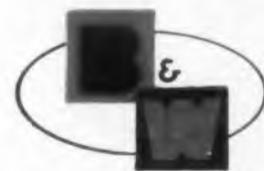
The manager reeled with the outburst. Never had he seen the old man in such a fury over a simple question of where to get the best bandpass filters.

Quiggle continued, "Haven't you been reading the trade paper advertisements? Why don't you call Barker & Williamson! They've been making filters of all types such as Band Elimination, High-Pass and Low-Pass for years . . . must be experts on the subject, they'll have the answer."

And B&W did have the answer. The Model 360 toroidal bandpass filter was perfect. With a flat response between 17.2 and 20.2 kcs, Quiggle's engineers found many other favorable characteristics when they obtained a spec sheet on the unit by the simple expedient of calling B&W.



\*Now a confirmed customer and friend, name is withheld intentionally



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#### SPECIFICATIONS

##### MODEL HFF BANDPASS FILTERS

**Center Frequency:** 30 to 1000 mcs (factory preset to customer specifications)  
**Bandwidth:** 5% to 25% of center frequency (factory preset)  
**Impedance:** 50 ohms  
**V.S.W.R.:**  $\leq 1.2$  in pass band (consistent with peak to valley ratio)  
**Insertion Loss:**  $\leq 1$  db  
**Peak to Valley Ratio:**  $\leq .5$  db  
**Selectivity:** Defined by number of resonant elements  
Doublets to sextuplets available  
**Power Rating (CW):** 25 watts  
**Connectors:** BNC or Type N  
**Finish:** Silver Plate; Rhodium Flash



### Model HFF-T-3 (Triple Tuned)

$f_0 = 425$  mcs  
B.W. = 50 mcs  
Insertion loss = 0.15 db

#### SPECIFICATIONS

##### MODEL HFF-T BANDPASS FILTERS

**Center Frequency:** 200 to 2000 mcs (factory preset to customer specifications)  
**Bandwidth:** 1% to 15% of center frequency (factory preset)  
**Impedance:** 50 ohms  
**V.S.W.R.:**  $\leq 1.2$  in pass band (consistent with peak to valley ratio)  
**Insertion Loss:**  $\leq 1$  db  
**Peak to Valley Ratio:**  $\leq .5$  db or less  
**Selectivity:** Defined by number of resonant elements  
Doublets to sextuplets available  
**Power Rating:** 100 watts  
**Connectors:** BNC or Type N  
**Finish:** Silver Plate; Rhodium Flash

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# MEETINGS

## Calendar of Events

OCT. 1958						
S	M	T	W	T	F	S
			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	

30-31 Electron Devices Meeting, Washington, D. C.\*

NOV. 1958						
S	M	T	W	T	F	S
						1
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9	10	11	12	13	14	15
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23	24	25	26	27	28	29
30						

3-8 International Plastics Standards Meeting, Washington, D. C.

5-7 Soc. for Applied Spectroscopy joint meeting with ASTM Materials Comm., New York, N. Y.

6-7 5th Annual National Meeting Professional Group on Nuclear Science, San Mateo, Calif.\*

10-12 2nd International Symposium on the Physics and Medicine of the Atmosphere and Space, San Antonio, Tex.

17-18 IRE Region 3 Convention, Atlanta, Ga.

17-20 Conf. on Magnetism and Magnetic Materials, Phila., Pa.\*

17-21 8th National Plastics Exposition, Chicago, Ill.\*

19-20 Northeast Electronics Research and Engineering Meeting, Boston, Mass.\*

19-21 Elec. Tech. in Medicine and Biology, Minneapolis, Minn.

DEC. 1958						
S	M	T	W	T	F	S
	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			

2-4 Reliable Electrical Connections, Dallas, Tex.\*

3-5 Eastern Joint Computer Conf., Phila., Pa.

3-5 Symp. on Global Communications, St. Petersburg, Fla.

\*Indicates meetings described in the following columns.

### Electron Devices Meeting, Oct. 30-31

Shoreham Hotel, Washington, D. C. Sessions to cover important new developments in devices and techniques essential to defense, industrial, and commercial electronics. Major aspects of recent electronic advances to be discussed: "Controlled Fusion," "P-N Junctions," "Panel Display Devices," "Parametric Amplifiers."

### 5th Annual National Meeting Professional Group on Nuclear Science, Nov. 6-7

Villa Motel, San Mateo, Calif. The conference will comprise four sessions: Electronics for Particle Accelerators; Electronics for Controlled Fusion Research; Reactor Instrumentation; Nuclear Radiation—Effects, Detection, and Measurements. Technical papers to be presented will cover applications of electronics to the problems of nuclear detection, measurement, and control. New developments covered at the Geneva and Paris Conventions will be discussed.

### Conference on Magnetism and Magnetic Materials, Nov. 17-20

Sheraton Hotel, Philadelphia, Pa. Sponsored by the Basic Science Committee of AIEE. For further information write C. J. Kreissman, Remington Rand Univac, 1900 W. Allegheny Ave., Phila. 29, Pa.

### 8th National Plastics Exposition, Nov. 17-21

International Amphitheatre, Chicago, Ill. To be held concurrently with the API Annual Conference at the Hotel Morrison. Sponsored by the Society of the Plastics Industry, Inc. Theme to be stressed: Plastics for Profits. Will cover materials, methods, machines, and techniques.

### Northeast Electronics Research and Engineering Meeting, Nov. 19-20

Mechanics Hall, Boston, Mass. Sponsored jointly by the Boston, Connecticut, and Western Massachusetts Sections of the IRE. R. R. Leonard, Datamatic Div., Minneapolis-Honeywell Regulator Co., Newton Highlands, Mass., has more information.

### 11th Annual Conference on Electrical Techniques in Medicine and Biology, Nov. 19-21

Nicollet Hotel, Minneapolis, Minn. Sponsored by IRE, AIEE, and ISA. The theme this year

is Biology and Computers. Sessions will cover possible applications of electronic computers in the fields of electrocardiography, electroencephalography, and biological logics. Further information may be obtained from Mr. Robert Erskine, Minneapolis-Honeywell Co., 2753 Fourth Ave. South, Minneapolis, Minn.

3rd EIA Conference on Reliable Electrical Connections, Dec. 2-4

Dallas, Tex. For information write W. O. Richards, 224 Cedar St., Syracuse 3, N.Y.

1959 Solid State Circuits Conference, Feb. 12-13, 1959

Philadelphia, Pa. Sponsored by IRE, AIEE, and Univ. of Pennsylvania. Devoted to transistor circuit technology, applications, and circuit techniques of a variety of solid state devices.

### Sections

A series of lectures on Space Technology, co-sponsored by the LI Section of IRE and the American Rocket Society are being held at the Garden City High School, Garden City, N.Y. Nationally recognized authorities in important areas of space engineering will discuss latest developments in space research and the problems which still remain to be solved.

### Seminars

R & D: American Management Assoc. to present five seminars. Nov. 10-14, Organizing and Controlling Research and Development; Nov. 19-21, Effective Utilization of Outside Research Facilities; Nov. 19-21, Effective Supervision of Engineering Projects; Nov. 19-21, Creating and Evaluating Research Projects; Nov. 19-21, Administering Salary Programs in the Technical Organization. Address enquiries to Registrar, AMA, 1515 Broadway, New York 36, N.Y.

### Paper Deadline

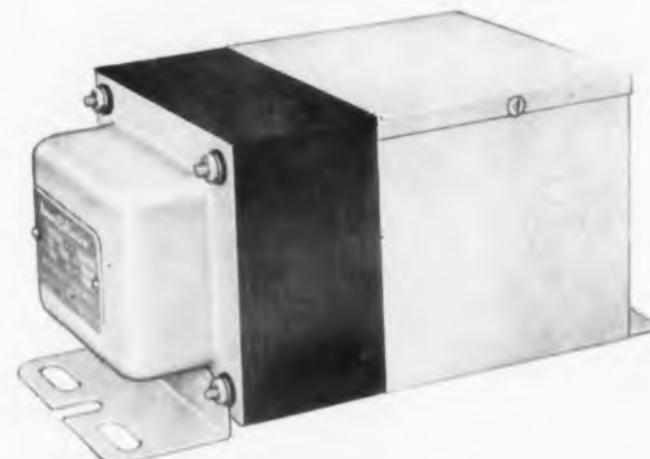
November 30: Deadline for papers (in triplicate) to be considered for inclusion at the International Convention on Transistors and Associated Semi-Conductor Devices to be held in London May 25-29, 1959. Before submitting papers, authors are asked to send a short summary of each paper of about 200 words, giving title and range of subject matter covered. Address enquiries to Industrial and Trade Fairs Ltd., Drury House, Russell St., London, W. C. 2.

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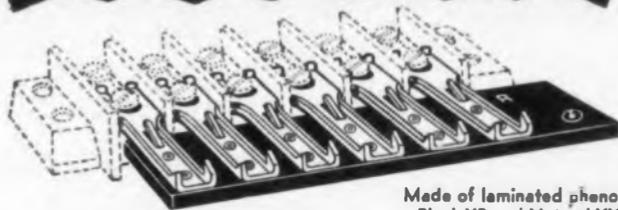
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## STANDARDS AND SPECS

Sherman H. Hubelbank

### Transistor Symbols

AIEE No. 426, PROPOSED STANDARD FOR GRAPHICAL SYMBOLS FOR SEMICONDUCTOR DEVICES, APRIL 1958

The first section of this standard sets forth the basic rules and symbol elements for the construction of graphical symbols for semiconductor devices. The second section is a glossary of device symbols. In this section, a listing is made of some semiconductor devices, together with their graphical symbols. It is recognized that in many cases it is possible to develop other device symbols using the standard symbol elements of section one. In general, the angle at which a connecting lead is brought to a symbol has no particular significance. Copies of this proposed standard are available without charge from the American Institute of Electrical Engineers, 33 West 39 Street, New York 18, N.Y.

### Cores

AIEE No. 430, PROPOSED RECOMMENDED PRACTICE FOR TOROIDAL MAGNETIC TAPE WOUND CORES, APRIL 1958

It is recommended that the nominal dimensions for toroidal strip-wound cores made from magnetic tape be between 0.014 and 0.005 inch in thickness and without regard to the type of magnetic material used. Bobbin-wound cores of ultra-thin magnetic tapes are not included. Also excluded from consideration are recommendations on dimensional tolerances, space factors, number of wraps of tape, core case shape or size, and particular values of strip thickness. Copies of this publication are available without charge from the American Institute of Electrical Engineers, 33 West 39 Street, New York 18, N.Y.

### Fuseholders

MIL-F-21346, GENERAL SPECIFICATIONS FOR BLOCK AND PLUG TYPE FUSEHOLDERS AND ASSOCIATED ELECTRICAL CLIPS, 24 APRIL 1958

Fuseholders for use with instrument, power, and telephone fuses and other widely used fuses are covered by this spec. Block and plug type fuseholders, and associated equipment such as electrical clips and electrical-clip assemblies are covered. The type designation for a typical fuseholder meeting this spec is FH20AM.

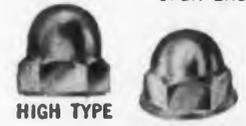
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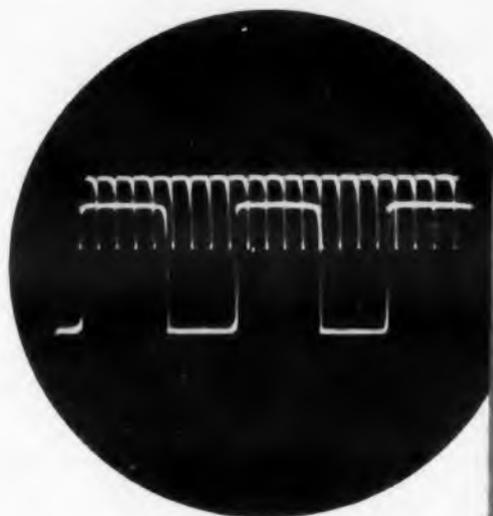
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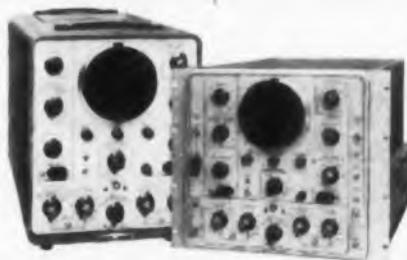


New 122A uses alternate sweep or 40 KC chopper for dual trace display

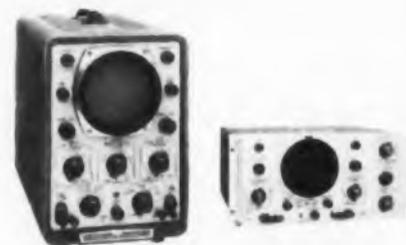


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rack mount

Other high performance, direct reading,



**-hp- 150A/AR, DC to 10 MC.** 24 sweep times, 0.02 sec/cm to 15 sec/cm. Plug-ins for high gain or dual channel use. Rack mount, \$1,200; cabinet model, \$1,100.



**-hp- 130B/BR, DC to 300 KC.** Similar X, Y amplifiers, 21 sweep times, 1  $\mu$ sec/cm to 12.5 sec/cm. Balanced input 5 most sensitive ranges. Includes times-5 magnifier. \$650.



**-hp- 120A/AR, DC to 200 KC.** 15 sweep times, 1  $\mu$ sec/cm to 0.5 sec/cm. Times-5 magnifier, automatic trigger. Simple to use, rugged, outstanding value. \$435.

# 200 KC SCOPE WITH TRACE PRESENTATION!

**Big-scope versatility at moderate cost!**

Here at last is a 200 KC oscilloscope — priced at just \$625 — giving you “big-scope” versatility and the time-saving convenience of simultaneous two-phenomena presentation.

Engineered to speed industrial, mechanical, medical and geophysical measurements in the 200 KC range, the new *-hp-* 122A has two identical vertical amplifiers and a vertical function selector.

*The amplifiers may be operated independently, differentially on all ranges, alternately on successive sweeps, or chopped at a 40 KC rate.*

## BRIEF SPECIFICATIONS

**Sweep:** 15 calibrated sweeps, 1-2-5 sequence, 5  $\mu$ sec/cm to 0.2 sec/cm, accuracy  $\pm 5\%$ . “Times-5” expander, all ranges. Vernier extends 0.2 sec/cm range to 0.5 sec/cm.

Trigger selector: Internal + or —, external or line. Triggers automatically on 0.5 cm internal or 2.5 v peak external. Displays base line in absence of signal. Trigger level selection —10 to +10 v available when automatic trigger defeated.

**Vertical Amplifiers:** Identical A and B amplifiers, 4 calibrated sensitivities of 10 mv/cm, 100 mv/cm, 1 v/cm and 10 v/cm;  $\pm 5\%$  accuracy. Vernier 10 to 1.

Balanced (differential) input available on all input ranges. With dual trace, balanced input on 10

Other significant features include universal optimum automatic triggering, high maximum sensitivity of 10 mv/cm, 15 calibrated sweeps with vernier, sweep accuracy of  $\pm 5\%$  and a “times-5” expansion giving maximum speed of 1  $\mu$ sec/cm on the 5  $\mu$ sec/cm range. Trace normally runs free, syncing automatically on 0.5 cm vertical deflection, but a knob adjustment eliminates free-run and sets trigger level as desired between —10 and +10 volts. Rack or cabinet mount; *rack mount model only 7” high.*

For complete details, write or call your *-hp-* representative, or write direct.

mv/cm range. Input impedance 1 megohm with less than 60  $\mu$ mf shunt. Bandwidth DC to 200 KC or 2 cps to 200 KC when AC coupled. Internal amplitude calibrator provided.

**Function Selector:** A only, B only, B-A, Alternate and Chopped (at approx. 40 KC).

**Horizontal Amplifier:** 3 calibrated sensitivities, 0.1 v/cm, 1 v/cm, 10 v/cm. Accuracy  $\pm 5\%$ . Vernier 10 to 1.

Bandwidth DC to 200 KC or 2 cps to 200 KC, AC coupled.

**General:** 5AQPI CRT, intensity modulation terminals at rear, power input approximately 150 watts, all DC power supplies regulated.

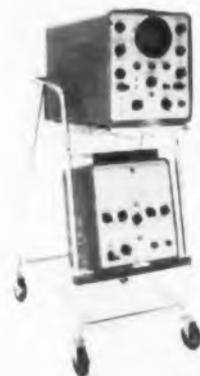
**Price:** (Cabinet or rack mount) \$625.00.

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

automatic trigger  oscilloscopes



**-hp- AC-21C Voltage Divider Probe.** 50:1 divider with 10 megohm input impedance and 2.5  $\mu$ mf capacitance. For *-hp-* 150A but usable with most scopes, VTVM's, preamps. \$25.



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of trouble-free service from 100  
RCA-6198 Vidicons  
...in Pennsylvania Station, N. Y.



*This is what James L. Lahey, General Manager of Dage Television Division of Thompson Products, Inc. says about the performance of RCA-6198 Vidicons:*

*"...all the RCA-6198 vidicon tubes performed satisfactorily in excess of 10,000 hours and, although a few have been replaced in the last few weeks, it appears that 80% will pass the 15,000 hour mark."*

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