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E L E C T R O N I C S I G N I C

APRIL 15, 1959

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# ENVIRONMENT

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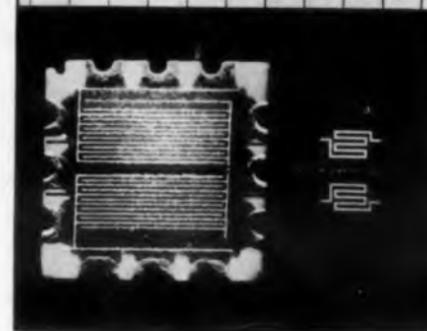
80 g's  
20 g's  
0 to 2000  
cps

800° F

1 Kilocurie for 2 weeks

### HIGHLIGHTS OF ISSUE

**ELECTRONIC  
DESIGN**



#### Microelectronics Now For Sale (cover) ..... 28

Microelectronics is fast becoming a reality. One sign of its coming out of the "blue sky" stage is the announcement of the availability of some of the components and subassemblies to electronics designers. The Daystrom—Weston wafer-type resistor artistically depicted on our cover is now for sale in sample quantities. RCA has also announced that it is offering a series of complete Micro-Module circuits for sale to electronics designers for developing prototype military equipment.

#### Look for Microelectronics Issue

Heralded as a revolution in electronics packaging, microelectronics is the subject of our special report coming in the April 29 issue of ELECTRONIC DESIGN. To bring our readers up to date, the report will discuss the latest techniques, processes and current status of work in this area. Two different approaches will be discussed. One is the Diamond Ordnance Fuze Laboratories approach where a complete circuit is made up on one small wafer. The other approach is the Signal Corps Micro-Module technique where one component is mounted on each ceramic wafer. The wafers are then combined to make up a subassembly. Our staff report discusses advantages and disadvantages of each. The report also details results of work on resistors, capacitors, inductors, semiconductors, and other components.

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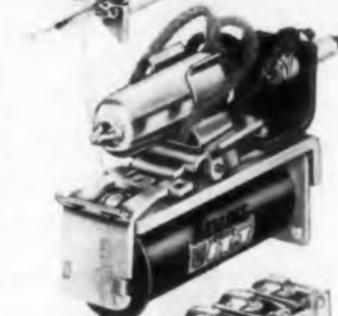
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## Industrial Relays by KELLOGG



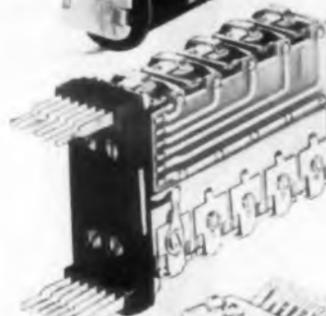
## Type "AK" Relay

Highly sensitive, adaptable for marginal operating; provides fast closing and opening of maximum number of circuits . . . long coil construction permits use of high resistance coils . . . may be engineered to operate on as little as .002 amps; slow operate or slow release models available.



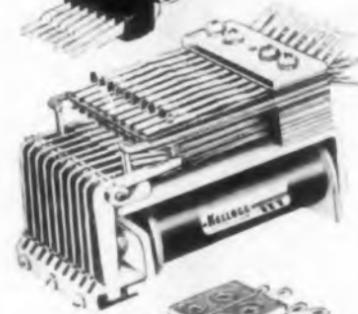
## Mercury-switch relay

For hazardous atmospheres: contacting elements hermetically sealed . . . will handle maximum of 25 amps., at 80 volts . . . must be mounted horizontally.



## Duo-Quintet Relay

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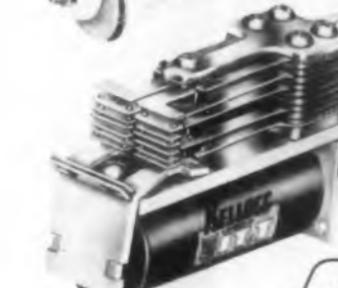
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specify



reliable

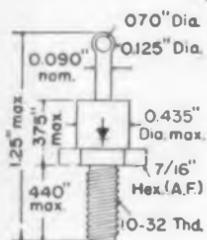
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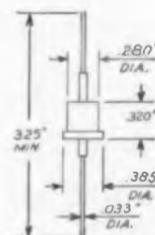
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	Volts	Amps.	25°C	150°C			Volts	mA	mA	mA	
1N253	95*	3.0	1.0*	10	10	1N536	50	750	250	0.40	
1N254	190*	1.5	0.4*	10	10	1N537	100	750	250	0.40	
1N255	380*	1.5	0.4*	10	10	1N538	200	750	250	0.30	
1N256	570*	0.95	0.2*	20	20	1N539	300	750	250	0.30	
CK846	100	3.5	1.0	2	2	1N540	400	750	250	0.30	
CK847	200	3.5	1.0	2	2	1N1095	500	750	250	0.30	
CK848	300	3.5	1.0	2	2	1N547†	600	750	250	0.35	
CK849	400	3.5	1.0	2	2						
CK850	500	3.5	1.0	2	2						
CK851	600	3.5	1.0	2	2						

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CIRCLE 3 ON READER-SERVICE CARD

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# BEHIND THE NEWS

## Latest Threat to the Transistor

### ... Nuvistor Tube Design ...

**T**UBE manufacturers have unveiled, in recent weeks, drastically new concepts and techniques aimed to keep them in the race with the transistor industry.

Tung Sol's cold-cathode development opens the way for low-power consumption, high-reliability tubes (*ED*, March 4, 1959, pp. 3-5). Sylvania's "sarong" cathode construction (*ED*, March 4, 1959, pp 52-53) offers more uniform characteristics, lower noise, and greater freedom from breakdown than possible with previous processes.

#### RCA Contribution

Smaller than a thimble, more rugged and efficient than present tube designs, and particularly suited for mechanized production, the "Nuvistor" represents a radical departure in the electron tube concept. Developed by the RCA Electron Tube

Division, triode and tetrode versions have already been demonstrated in TV tuners reduced to one third the volume of conventional tuners. Final development is underway on a beam power tube for audio and TV deflection circuit applications.

#### Construction Features

Construction of the Nuvistor starts with a strong ceramic base wafer serving as a platform for an array of tube electrode assemblies, see Fig. 1. Each assembly is held rigidly in place by a tripod-like structure, see Fig. 2.

The electrodes are strongly supported from one end in a cantilever fashion, eliminating the need for mica support discs or spacers. All electrodes are small, light cylinders capable of withstanding a high degree of shock and vibration due to their shape and low mass.

All the joints in the complete tube are processed at white heat (temperature of approximately 2000 F) in a brazing furnace and then in a vacuum-exhaust furnace. As a result, the parts are joined in their original strain-free positions. Since the tube elements are accurately secured in this manner, the possibility of shorts developing in the tube during operation is greatly reduced.

#### Advantages of Construction

- Cylindrical symmetry and cantilever support of the electrodes provide high cathode efficiency and permit the use of accurate jigs for parts assembly.

- By the use of brazing, rather than spot welding for the joining of materials, a potential source of failure is removed and residual strain in assembly is eliminated.

- There are no micas to fray under vibration or to interfere with high-temperature brazing and the exhaust processing of the tube.

- High-temperature processing eliminates many of the gases and impurities that are difficult to remove during manufacture of tubes of conventional design in which glass and mica limit the processing temperatures.

- Indexing lugs on the base of the Nuvistor



Fig. 1. Exploded view of development Nuvistor Triode.

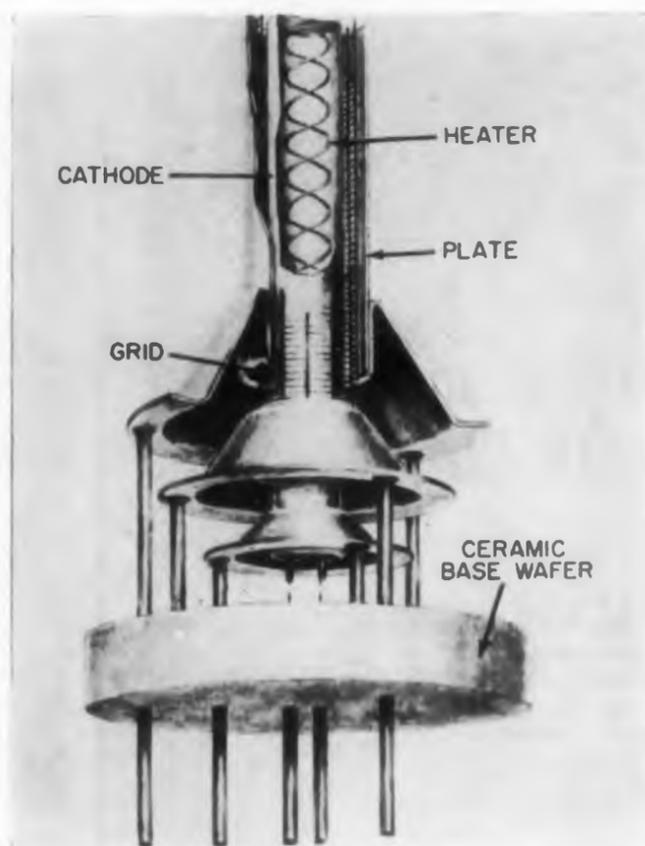
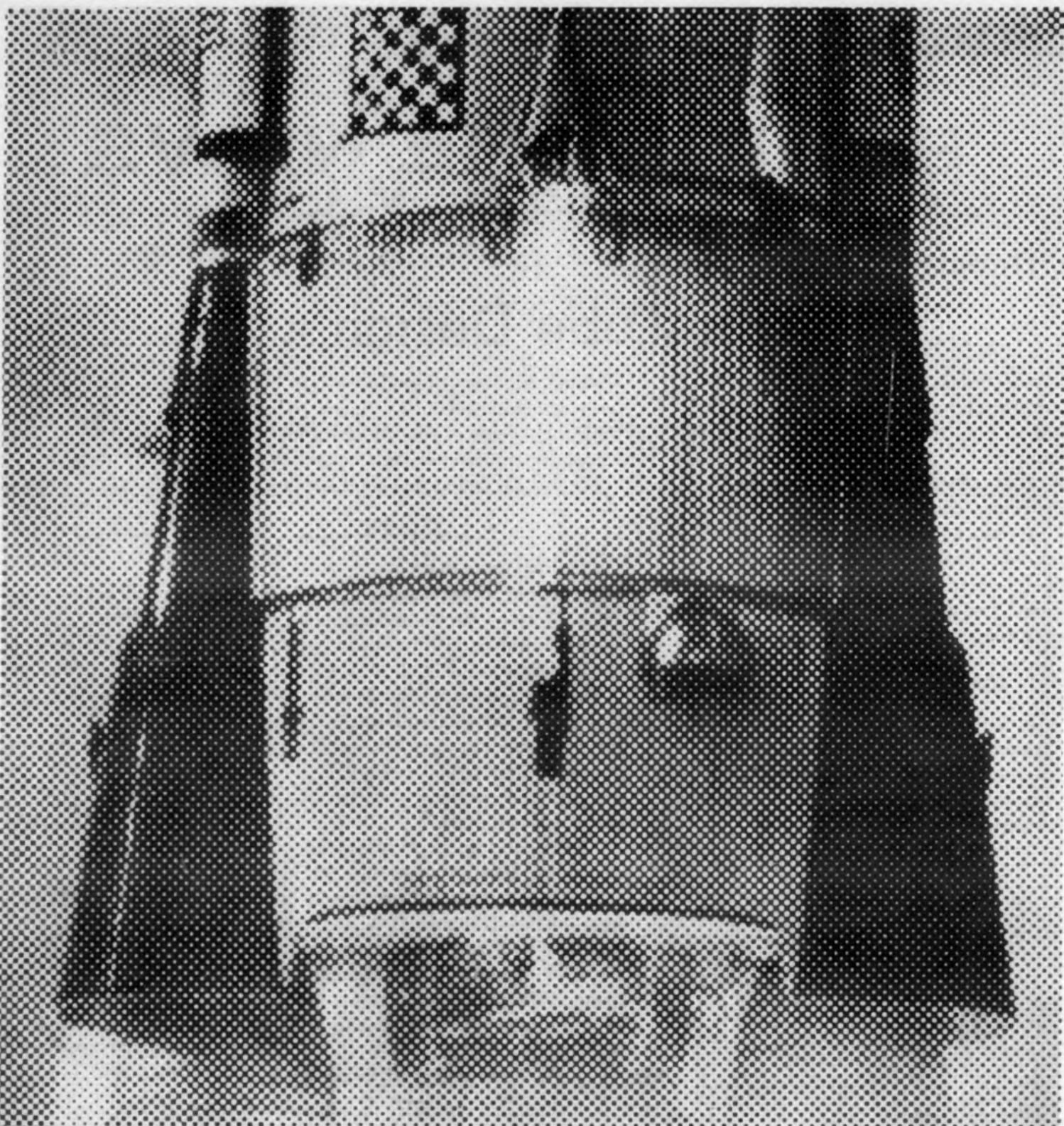


Fig. 2. Internal construction of Nuvistor Triode.



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## BEHIND THE NEWS

permit safe and easy insertion into the tube socket and prevent damage to leads, see Fig. 3.

■ Because the tubes have been degassed at high temperatures, they can be expected to operate at temperatures in excess of those permitted with conventional types.

### Electrical Characteristics

Theoretically speaking, a set of tube elements need be no larger than a grain of sand to perform 90 per cent of applications demanded. With present manufacturing techniques, however, proportional scaling to this level is not possible. By reducing electrode spacing by one factor and electrode size by a different factor, overall performance can be improved.

The development triode type offers transconductance figures identical to the conventional type 6BN4. When compared in a triode rf stage, the Nuvistor tube provided 3 db gain improvement with 1 db better noise figure. The Nuvistor triode was operated with 40 v on the plate and 0.9 w filament power; the 6BN4 had 120 v on its plate and used 1.3 w filament power.

Oscillator operation up to 800 mc is easily obtained with plate input power of only 0.5 w. Oscillation can be maintained with plate supplies as low as 10 v.

Tetrode types, for use in rf and i-f amplifiers, operate with 0.9 w filament power and plate and screen voltages of 75 v and 30 v respectively.



Fig. 3. Jumbo model of triode showing indexing lugs and sockets.



**Fig. 4.** Nuvistors compared with their present-day counterpart—triode (l), tetrode (c), beam power (r).

Relative size of the triode, tetrode, and beam power types are shown in Fig. 4.

#### Mechanical & Thermal Characteristics

Development units have successfully withstood half sine-wave shocks at 67 g's with a duration of 11 msec and impacts as great as 850 g transverse. Normal operation, within 10 per cent tolerance, is obtained over a temperature range of  $-190^{\circ}\text{C}$  to  $350^{\circ}\text{C}$ , a vital consideration in satellite and missile applications. Reports state that the tube is inherently less susceptible to radiation damage than solid-state devices.

#### Nuvistor vs Transistor

Although transistors are still a "natural" for many low-level applications, the Nuvistor does provide certain significant advantages:

- Electrode spacing can be 50 times larger in a Nuvistor—obviously, manufacturing tolerances are less stringent and assembly is less critical.
- Nuvistors, being in the tube family, are high impedance devices—circuit components are generally less expensive.
- Lower noise figures and higher frequency operation are obtained with Nuvistors.
- Costly selection processes, common with transistors, are not needed with the uniformly produced Nuvistors.
- Tubes can handle momentary overloads while solid-state devices generally will burn out.
- Stable operation is possible with Nuvistors over wide temperature ranges ( $-190^{\circ}\text{C}$  to  $350^{\circ}\text{C}$ ).

#### Future

RCA intends eventually to expand its Nuvistor line to a broad range of tubes—similar to its switch from the octal to the miniature line years ago. Rumors also point to the possibility of application of cold-cathode design to the Nuvistor—this combination could offer an even greater challenge to the transistor industry. ■ ■



### Subminiaturization—State of the Art

*The trend to new techniques in subminiaturization has brought up some weird approaches! While there may be some merit to the technique illustrated, there is a definite shortage of little people.*

Although this trend to smaller and smaller systems and components presents certain production problems, reliability is never sacrificed at Hughes. To provide you with subminiaturized products that stand up under the most severe of environmental conditions, Hughes utilizes the most advanced equipment in the industry.

The following three right-hand pages give you three specific examples of reliable Hughes components. You'll find full details on Hughes Zener

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*For additional information regarding any component or system please write: Hughes Products, Marketing Dept., International Airport Station, Los Angeles 45, California.*

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**RIPPLE:** Less than 1% RMS.

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MRST28-200	24-32	200	$\pm 0.1\%$	$\pm 6V$	22" x 36" x 22"	550
MRST28-300	24-32	300	$\pm 0.1\%$	$\pm 6V$	22" x 46" x 22"	700
MRST28-400	24-32	400	$\pm 0.1\%$	$\pm 6V$	28" x 58" x 24"	1250
MRST28-500	24-32	500	$\pm 0.1\%$	$\pm 6V$	26" x 68 1/2" x 32"	1650
MRST28-600	24-32	600	$\pm 0.1\%$	$\pm 6V$	26" x 68 1/2" x 32"	1650
MRST2440-250	24-40†	250	$\pm 0.1\%$	$\pm 2V$	26" x 68 1/2" x 32"	1650

\*FOR FULL LOAD CHANGE  
†IN 2 RANGES



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## TECHNICAL DESCRIPTION

These units use silicon power rectifiers for increased reliability and efficiency. Silicon rectifiers provide constant efficiency and exhibit no aging characteristics as is more common in other type rectifiers. Magnetic components utilize grain oriented silicon steel and Class B insulation for compact design and efficient operation. The power section consists of a 3 phase magnetic amplifier with extremely high gain. Preamplifier is fully transistorized and utilizes silicon zener diodes as a reference element.

## ADDITIONAL FEATURES

Output of units can be shorted without damage to the silicon rectifiers.

Units can withstand 400% overload for periods up to 1 second without damage to Power Supply components.

## Remote sensing low output impedance

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of above units  
are also available.*

*For additional data  
contact factory or sales  
offices below:*

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## BEHIND THE NEWS



## Electricity from Sun Light

Dr. J. C. R. Kelly, Jr., manager of the Technology Department of the Westinghouse Research Laboratories, is shown with experimental apparatus used to generate electricity from the heat of the sun. The sun's rays, gathered by the large concave mirror at the right, are focused on a special assembly of thermoelectric materials which convert the intense heat directly into electricity. Westinghouse research scientists are using the apparatus to study the feasibility of such a system for supplying the electric power requirements of space vehicles of the future.

## Nuclear Powered Merchant Marine

Nuclear propulsion for U. S. merchant ships is the objective of a new industry group comprised of Ford Instrument Co., Maryland Shipbuilding and Drydock Co., and Isbrandtsen Co., Inc.

Plans include development and construction of the nuclear portion of the propulsion plant, pre-testing and then installation into a hull section of a tanker. The reactor will then be floated to a remote location for final test and proving, and then floated to a shipyard and substituted for an existing section of a tanker. This concept departs radically from the usual procedure of building a land-base prototype, proving it out, and finally constructing an entirely new reactor together with a new ship. Considerable savings in cost and time are expected.

The reactor is a helium cooled unit which generates superheated steam through a heat exchanger. Pressures and temperatures are consistent with modern marine practices, allowing the use of conventional propulsion machinery.

Roll and pitch of the vessel will not affect the gas-cooled reactor and latest safety innovations for nuclear plants will be incorporated.

At present, there is no legislation for federal assistance to support the project, estimated at 15 million dollars. The group is seeking government aid.

#### Alternate Plan

Another advocate of an atomic-powered merchant fleet is the Esso Standard Oil Company, which recently offered to build and operate a nuclear-type tanker in cooperation with the U. S. Government.

Briefly, Esso is willing to pay the capital costs of building a conventional tanker with the government absorbing the additional cost for applying nuclear power to the vessel.

### Air Traffic Control for Aircraft Carriers

Development of an experimental system of air traffic control to bring aircraft onto Navy carriers at precisely controlled intervals was disclosed by the Cornell Aeronautical Laboratory.

Technically known as a "Wave Off and Transition Control Unit" (WOTCU) the local air-traffic-control system controls aircraft from a few miles aft of an aircraft carrier up to the point where an automatic landing system guides the pilot to a landing.

A modern, high-speed digital computer is the heart of the WOTCU system. Aircraft waiting to land are assigned to fly in a definite block or "bucket" of air space in a hexagonal pattern.

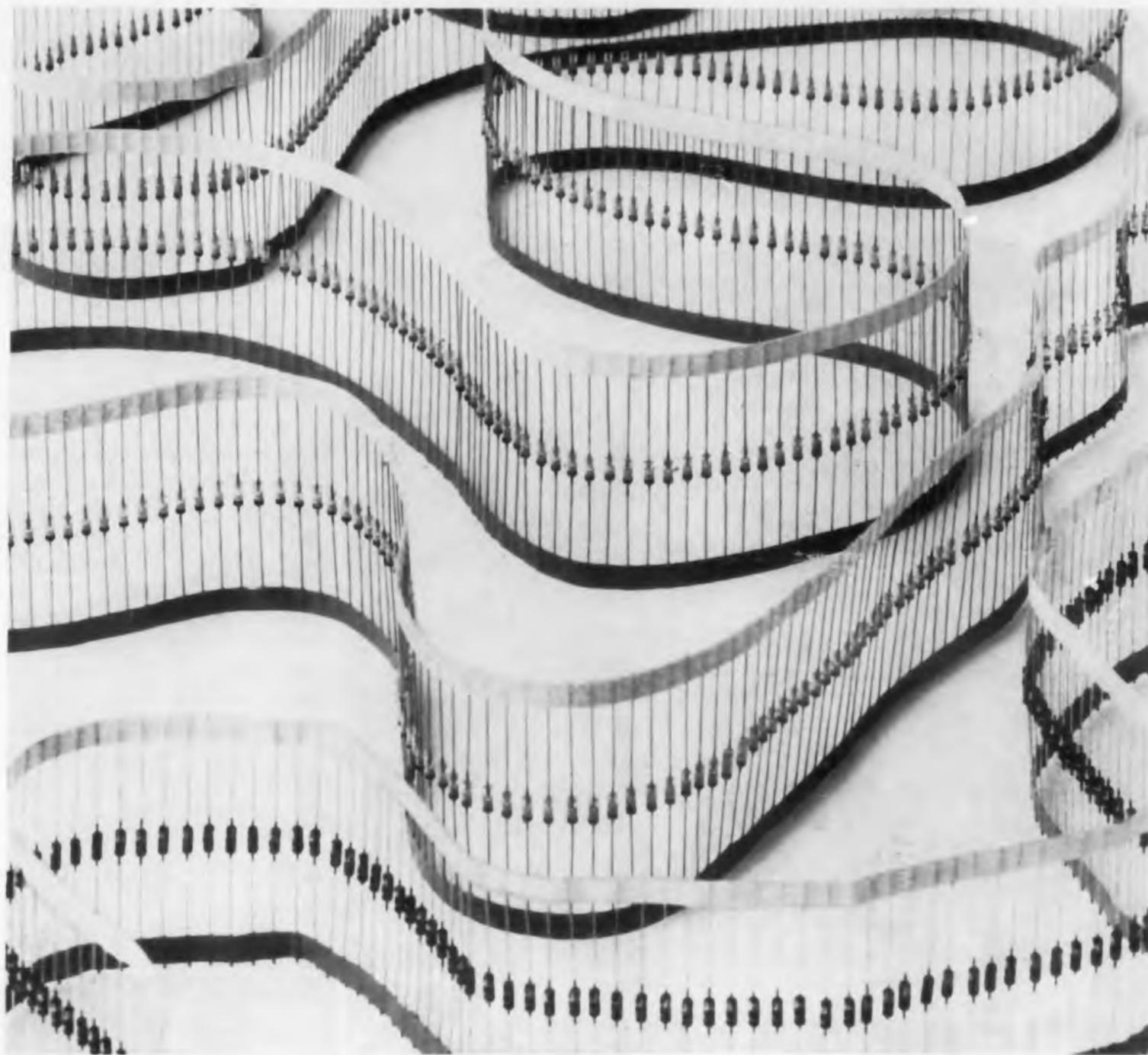
When the aircraft are cleared to land, these "buckets" move toward the carrier in single file, like an endless conveyor belt.

After receiving clearance, aircraft are sometimes waved off for another try at landing if their approach to the carrier deck is faulty. When this happens, the WOTCU system quickly fits them back into the stream of incoming traffic.

The Cornell system has several advantages over the procedures currently employed. Present procedures order aircraft to "stack up," that is, to maintain a given altitude a thousand feet apart over the carrier or airfield until they receive clearance to land.

These procedures are often difficult for pilots to follow, especially in bad weather or when aircraft are short on fuel after a mission.

With WOTCU, the time lag for landing after a wave-off is shorter than that involved in stacking. In addition, the exact position of the airplane is known at all times; more aircraft can be brought into the automatic system; several landing paths for aircraft may be used; and many aircraft of widely varying speed capabilities can be accommodated.



## ZENER DIODES IN A PROVEN GLASS PACKAGE

Now you can get high-performance voltage-regulator diodes in the famous, hermetically-sealed Hughes glass envelope. These diodes have an outstanding characteristic: sharp regulation of reverse voltage. This means that you can use them—with confidence—in clipping, clamping, coupling, and compensation circuits to obtain *dependable voltage regulation*. In addition, they retain this stability, together with low dynamic resistance, throughout a wide range of operating temperatures.

#### CHARACTERISTICS

Nominal Voltage: 2 volts to 30 volts  
Power Dissipation: 250 milliwatts  
Maximum Dynamic Resistance: 10 to 75 ohms  
Operating Temperature Range:  $-65^{\circ}$  to  $175^{\circ}$  C.  
Dimensions, Diode Glass Body: Maximum Length: 0.265" max.  
Maximum Diameter: 0.105" max.

To obtain your copy of specifications covering the family of more than a dozen types of Hughes Silicon Voltage-Regulator Diodes, please write: Hughes Products, Semiconductor Division, Marketing Department, P.O. Box 278, Newport Beach, California.

Creating a new world with *ELECTRONICS*

**HUGHES PRODUCTS**

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CIRCLE 7 ON READER-SERVICE CARD



**AMPHENOL**

*Quick-Crimp*

**BNC CONNECTORS**

**CUT ASSEMBLY TIME  
IN HALF!**

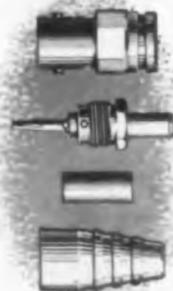
AMPHENOL's new *Quick-Crimp* Series BNC connectors\* obsolete just about every other BNC now on the market. Here's why:

- 1 QUICK ASSEMBLY** Only three basic parts (plus an optional boot) for you to assemble and crimp, as compared to as many as ten parts in a standard BNC! Assembly time is cut in half!
- 2 INCREASED RELIABILITY** Critical assembly operations have been eliminated; inspection is easier, faster, reliable. Cable retention and strain relief is greatly improved. Connectors are weather-proof.

The *Quick-Crimp* family consists of 19 connectors: Plugs, Right Angle Plugs, Jacks, Bulkhead Jacks and Cable Terminations. *Quick-Crimps* mate with standard BNCs. Center contacts are gold-plated, have AMPHENOL's patented captivated contact\*\* construction. Voltage rating is 500 V. peak. VSWR is low up to 10K mc.

\*U.S. PATENT PENDING \*\*U.S. PATENT 2,870,420

*Body Assembly, Ferrule Clamp  
Nut Assembly, Outer Ferrule and Boot  
—Only Four Parts to Assemble!*



**AMPHENOL** CONNECTOR DIVISION

AMPHENOL-BORG ELECTRONICS CORPORATION Chicago 50, Illinois

BEHIND THE NEWS

## Sort Mail Automatically . . .

Automatic equipment for culling and facing letter mail has been delivered to the U.S. Post Office Department and installed for testing in the Postal Laboratory located in the Main Post Office in Washington, D.C. This equipment has been developed by American Machine and Foundry Company to mechanize one of the many time-consuming and expensive manual operations.

The culling machine separates ordinary-size letters from bulk mail and stacks them preparatory to further processing in

the facing machine. After being dumped into a hopper, bulk mail traverses a series of inclined conveyor belts from which parcels, thick envelopes and tied bundles of letters are diverted into side bins. Single pieces of mail then pass along to subsequent stations where oversize pieces are removed from the stream, leaving the ordinary-size letters which are stacked horizontally for transfer to the facing machine.

The facing machine's function is to orient and cancel ordinary-size letters.

## . . . sort Transistors Au



An operator removes a tray of transistors from the "honeycomb" bins of an automatic tester-sorter.

Intrinsic qualities of as many as 1200 different levels of performance within transistors can be detected by an automatic machine developed by Raytheon Manufacturing Company's Semiconductor Division. The machine also automatically selects and sorts transistors four times faster than the best skilled operators using conventional test equipment.

The new machine now makes it possible for users to obtain transistors in quantity lots that have been presorted into the many categories which they desire. This is an important consideration, especially for computer manufacturers who often use tens of thousands of transistors of various types in a single computer. Formerly it was necessary to hand test and sort individual transistors for use in computers to be sure that they met the user's specifications. The new machine makes such special selection runs unnecessary.

To meet the needs of various transistor users, the machines first test the new transistors and then divide them into four

◀ CIRCLE 8 ON READER-SERVICE CARD



**Automatic-Mail Culling Machine** separates ordinary size letters from bulk mail and stacks them preparatory to being canceled.

Culled letters are fed into the machine one at a time and scanned photoelectrically to locate the stamp. Letters with the stamp in the proper position go directly to the canceling station while those with stamps out of position are directed through an inverting mechanism which orients them properly for canceling. At the final station, all letters are stacked in preparation for subsequent processing. Letters with no stamps are rejected.

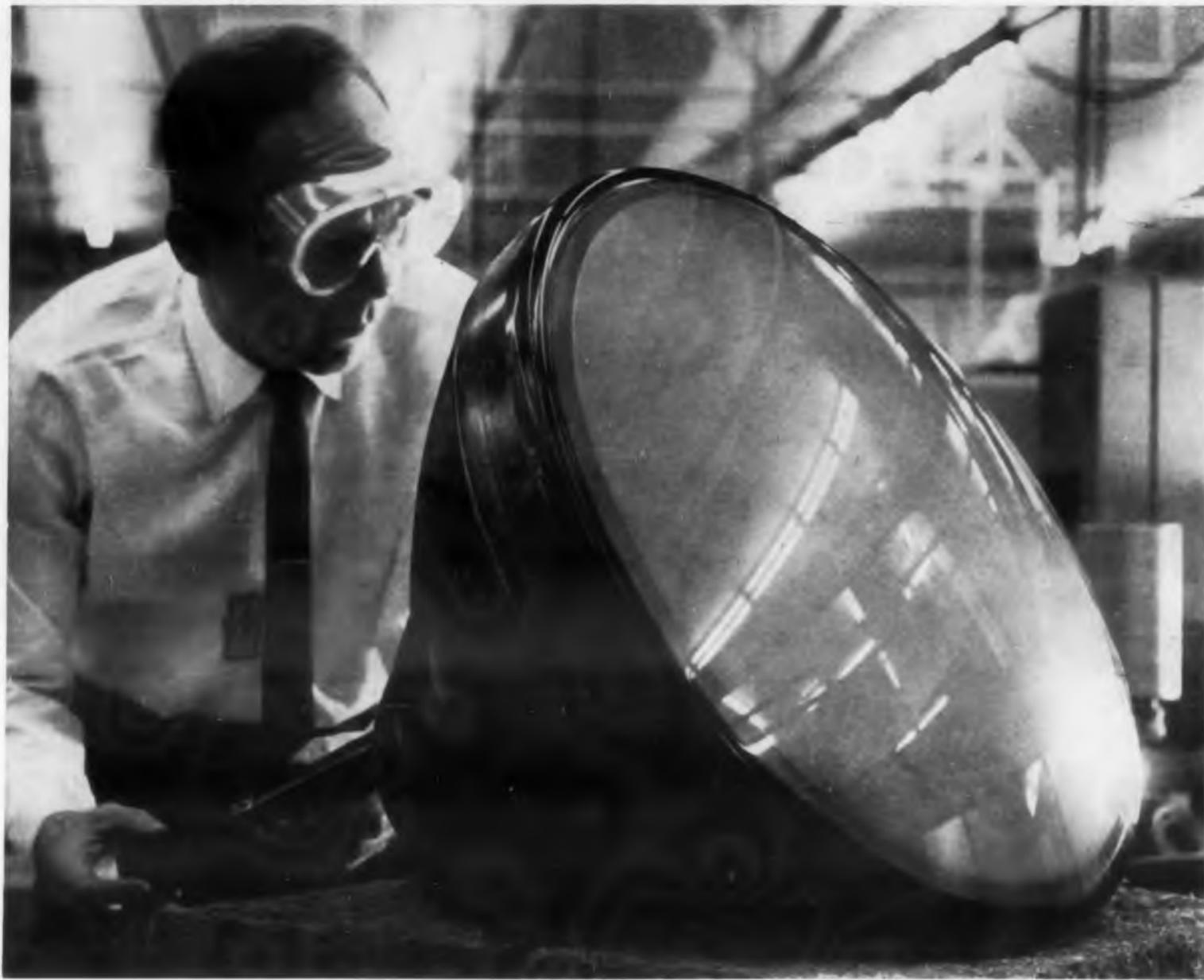
## Automatically

categories: computers, general purpose, entertainment, and specials.

Within the overall limits of these four families, the tester then reads the qualities that determine where and how the transistors will be used. These include: alpha cut-off level, collector cut-off current at high and low voltage, "punch-through" voltage, emitter cut-off current at high and low voltage, minimum beta, and input voltage.

Even a new, unskilled employee can operate one of the new tester-sorters after less than an hour's indoctrination. After placing the transistor to be tested and identified into the test socket, she presses a starting button. The machine then quickly hunts through a series of qualification levels and classifies the transistor into a narrow category.

From the test socket, the transistor is slotted into its proper bin in a "honey-comb" of removable plastic trays in which the tested and sorted transistors are delivered to the packaging room.



# THE FIRST 21" STORAGE TUBE

**High light output! Controlled Persistence! Full gray scale!**

The Hughes 21" TONOTRON\* tube offers you a new level of sophistication in displays for: Air traffic control, Combat situation plotting, Radars, Large-scale read-out, Medical diagnosis, Industrial television, and Slow-scan displays.

This new TONOTRON tube provides high light output, integration abilities, full gray scale, controllable persistence, and a very large display area—all in one envelope!

Hughes also announces a 21" character-writing TYPOTRON® storage tube, which gives you the *added* capability

of high-speed digital character display. The 21" TYPOTRON tube is ideally suited for any of your digital read-out requirements. In addition, this unique TYPOTRON tube offers you either character read-out or spot writing modes—or a combination of both capabilities.

Both the 21" TONOTRON Tube and the 21" TYPOTRON tube are now available for delivery. For additional information please write: Hughes Products, Electron Tubes, International Airport Station, Los Angeles 45, California.

Creating a new world with *ELECTRONICS*

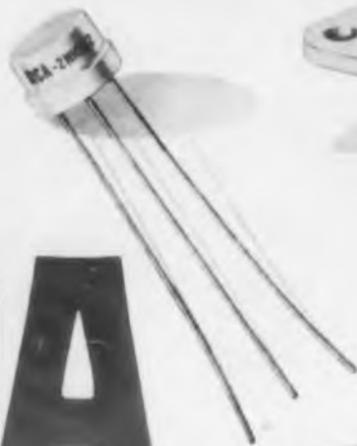
**HUGHES PRODUCTS**

\*Trademark of Hughes Aircraft Co.

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CIRCLE 9 ON READER-SERVICE CARD

# NOW...



# RCA

**DIFFUSED-JUNCTION MESA**

- 2N1092—medium power
- 2N1067—intermediate power
- 2N1068—intermediate power
- 2N1069—high power
- 2N1070—high power

# Silicon Transistors

...with excellent beta stability from  $-65^{\circ}\text{C}$  to  $+175^{\circ}\text{C}$  and exceptionally low saturation resistance!

Type	JEDEC Outline	ABSOLUTE MAXIMUM RATINGS		CHARACTERISTICS													
		V <sub>CE</sub> (volts)	V <sub>BE</sub> (volts)	Collector (amp.)	Transistor Dissip. (watts)	At Case Temperature of 25°C						At Case Temperature of 175°C					
						Saturation Resistance (ohms)			DC Current Gain (Beta)			DC Collector Cutoff Current (I <sub>CBO</sub> ) (μA)					
2N1092	TO-5	60	30	0.5	1	3	10	I <sub>C</sub> = 200 ma	20	10	I <sub>C</sub> = 200 ma	75	1000	I <sub>CBO</sub> = 30 volts			
2N1067	TO-8*	60	30	0.5	2.5	3	10	I <sub>C</sub> = 200 ma	35	15	I <sub>C</sub> = 200 ma	75	1000	I <sub>CBO</sub> = 30 volts			
2N1068	TO-8*	60	30	1.5	5	1	2.67	I <sub>C</sub> = 750 ma	18	15	I <sub>C</sub> = 750 ma	75	1000	I <sub>CBO</sub> = 30 volts			
2N1069	TO-3	60	45	4	25	0.7	2	I <sub>C</sub> = 1.5 amp	20	10	I <sub>C</sub> = 1.5 amp	150	2000	I <sub>CBO</sub> = 30 volts			
2N1070	TO-2	60	45	4	25	0.4	0.67	I <sub>C</sub> = 1.5 amp	20	10	I <sub>C</sub> = 1.5 amp	150	2000	I <sub>CBO</sub> = 30 volts			

\* "Heat Sink" mounting clamp supplied. † Collector to emitter breakdown voltage with base open. ‡ At a case temperature of 100°C.

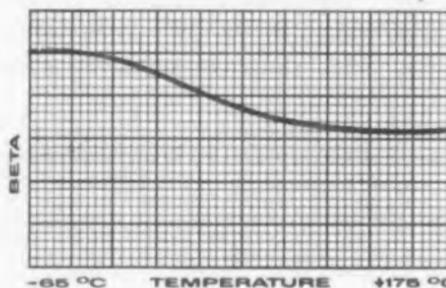


**RADIO CORPORATION OF AMERICA**

Semiconductor Products

Distributor Sales

Harrison, N. J.



AVAILABLE AT YOUR RCA SEMICONDUCTOR DISTRIBUTOR!

CIRCLE 10 ON READER-SERVICE CARD

## BEHIND THE NEWS



### Radiation Pattern Tests

Shown are three of Boeing's seven radiation-pattern measuring ranges used in antenna research and development. The towers roll on tracks and their distances from transmitting antennas inside the laboratory are remotely controlled. Airplane models weighing as much as 1000 pounds are mounted at the top of the towers and can be rotated remotely in either of two planes or in both planes simultaneously. Antennas under test are mounted in the airplane models and pick up beamed waves from the transmitters in the laboratory. The radiation patterns picked up by the rotating models are transmitted back to the laboratory and analyzed by electronic computers.

### New TV Camera Works from Sound, Not Light

A television camera which works from sound instead of light and can visualize the internal structure of engineering components, materials, and parts of the human body, has been recently demonstrated at the Institution of Electrical Engineers, London, England.

The new instrument, which may find considerable use in engineering and medicine was demonstrated by its inventor, Dr. C. N. Smyth, MA, BSc.

The ultra-sound "television" camera differs from an ordinary television camera in that the light-sensitive (photo-electric) image-receiving surface is replaced by a sound-sensitive (piezo-electric) image-receiving-surface. This is simply a bare

slice of crystalline quartz which, under the impact of sound, develops, on each point of its surface, a voltage proportional to the ultra-sound intensity. The value of this voltage is detected, point by point, by a scanning electron beam, and, after amplification, controls the brightness of a television receiver to produce a visible image of the invisible internal structure under examination.

The demonstrations of the new camera included the examination of objects immersed in a tank of water. Internal flaws in blocks of aluminum revealed their shape and size clearly. Electroplating that is poorly adherent to the base metal showed as dark patches.

It was stated that the sound intensities employed (milliwatts per square centimeter) are too small to have any adverse biological effects, a factor of prime importance particularly in the examination of regions of the body sensitive to the effects of X-rays.

To indicate the definition obtained, a piece of zinc anti-fly gauze (holes 3 mm apart) placed 2 ft from the camera was clearly resolved.

## TV with a "Memory"

Latest development in TV camera tube design permits the tube to "memorize" what it sees. The new tube, called "Permachon," operates as an "electronic film" and can freeze a scene on a television picture tube with only a split-second exposure.

Designed by Westinghouse Electronic Tube Division for use in a standard TV camera, it has a special photoconductor material on its faceplate that stores whatever scene the camera sees. After exposure, an electron beam scans this faceplate and transfers the image to a picture tube for periods up to one hour, so that it can be studied or photographed at leisure.

Among the immediate applications seen for the new development is air traffic control, where the tube can be used with a radar scope to produce a continuous visible trace of all aircraft in the area. And because it operates at low light levels, the tube is considered to have military value.

At racetracks, the device can give instantaneous "photofinish" results without the need for film developing. In the medical field, the "Permachon" could be used for memorizing X-ray fluoroscopic screen images for detailed study.

Pictures stored by the new tube are erased either by illuminating the faceplate or by interrupting the scanning beam. The memory device works electrically as well as optically—that is, it can store regular broadcast video signals and other information fed into it electrically.



## PRECISION PERFORMANCE LEVELS set by Hughes Crystal Filters

Now you can obtain high performance crystal filters previously available only for special military developmental contracts and Hughes-built systems. Utilizing unique design and advanced manufacturing techniques, these Hughes crystal filters provide a degree of performance previously unobtainable.

These crystal filters have center frequencies of 30 kc to 30 mc. In addition, you can take advantage of seven distinct features:

1. High frequency filtering
2. High selectivity
3. Low passband ripple
4. Low insertion loss
5. Small size and weight
6. Excellent temperature stability
7. Excellent shock and vibration stability

A complete engineering service for network and filter design is available to you. To obtain specifications for crystal filter types currently available, or for information concerning engineering capabilities, please write: Hughes Products, Marketing Dept., International Airport Station, Los Angeles 45, California.

### TYPICAL BANDPASS FILTERS DELIVERED BY HUGHES PRODUCTS

	No. 1	No. 2	No. 3
Center Frequency	30 mc	10 mc	6 mc
6 db bandwidth	170 kc	40 kc	2 kc
60/6 db bandwidth ratio	1.35	2.3	1.4
Minimum Stop-band Attenuation	60 db	60 db	60 db
Maximum Passband Ripple	±1 db	±0.6 db	±0.75 db

Creating a new world with ELECTRONICS

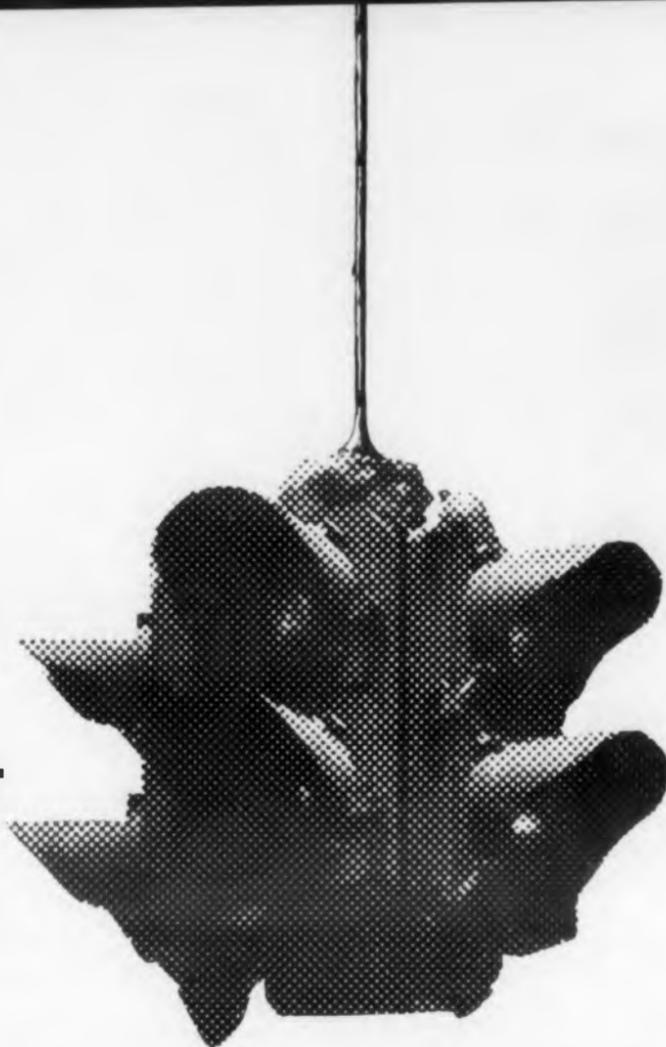
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CIRCLE 11 ON READER-SERVICE CARD

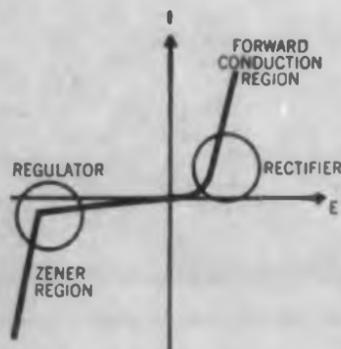
## THIS CIRCUIT PROBLEM HAD TO BE SOLVED



## FOR ELECTRONIC TRAFFIC CONTROLS



Hoffman Silicon Diodes were the solution



typical I-E characteristic curve for Hoffman Silicon Diodes



ELECTRO-MATIC<sup>®</sup> Traffic Controls manufactured by Eastern Industries Inc. of Norwalk, Connecticut, require stable circuitry under extreme environmental conditions.

Hoffman Silicon Diodes were chosen to be used as "clippers" in a relay circuit which is incorporated into the magnetic amplifier for a novel vehicle radar detector.

Hoffman offers the circuit designer the widest range of silicon diodes: to choose from, with PIV's from 6.8 volts through 470 volts and maximum forward current ratings of 130mA down to 9mA . . . extended operating temperature range of from -65°C to +200°C. Designed to operate under severe environmental conditions, Hoffman Silicon Diodes are encapsulated in an oil filled, hermetically welded can with compression type glass-to-metal sealing at the lead ends.

For details consult the Hoffman Semiconductor Applications Specialist in your immediate area or write Department SJD.

If you need a job in electronics done quicker and better, contact

**Hoffman Electronics**  
CORPORATION  
SEMICONDUCTOR DIVISION  
930 PITNER AVENUE EVANSTON, ILLINOIS



## BEHIND THE NEWS

### Electronic Computer Goes To Jamaica Track

An electronic automatic price computer, "Compu-Tote," will soon add a final electronic brain link to the established safeguards of "tote" calculation at the nation's major race tracks.

Beginning with the inauguration of the nine-race programs on the New York tracks at the Jamaica opening March 20 or 25, the automatic price computer will speed up posting of payoff figures to keep step with the shorter intervals in the racing card.

The "Compu-Tote" is a latest-type ultra-modern computer, streamlined and highly specialized for race track service, the joint product of engineers of the Universal Controls' American Totalisator Division and the Burroughs Corp.

### Video Tape of High Quality

Field rejections of video tape are expected to be reduced to less than 1 per cent by mid-March, according to the Minnesota Mining and Manufacturing Co. (3M).

This previously impossible rate of field rejections should come about when a new \$250,000 set of quality control equipment is fully operative. Equipment includes a video tape quality control machine—only such machine in existence—especially developed for 3M by CBS-TV; 2 Ampex video tape recorders, and space for 4 more as demand for video tape increases.

The 1 per cent field rejection rate compares with a high of about 20 per cent which occurred between September and January when networks tripled their orders for video tape to guard against a possible strike. Quality control in the infant industry was unable to keep up with the sudden surge in demand.

◀ CIRCLE 12 ON READER-SERVICE CARD

## Eight-In-One Computer For Business and Science

A new computer, the Honeywell 800, is so flexible it can process business data while making scientific computations and behave like eight separate computers. Developed by the Datamatic Division of Minneapolis-Honeywell Regulator Co. of Newton Highlands, Mass., the machine is completely transistorized and uses modular construction.

With a feature called "automatic parallel processing," the computer can handle separate and independent programs simultaneously and can communicate simultaneously with eight input and output devices.

A "multi-program control" allows the machine to divide itself into as many as eight separate computers automatically, with a corresponding decrease in operating speed. Thus, the machine can perform 30,000 three-address operations per second with one job, but will do 15,000 operations per second for each of two simultaneous jobs. When the computer finishes one of these jobs, it will process the other job faster. Naturally, the input and the output devices may limit the speed of one job.

Programming is simple, as each programmer need not worry about other programs.



## New SAGE Link

Fortress-like tower, containing high-powered air-search radar to guard against surprise attack, is now rising at Thomasville Aircraft and Warning Station, Ala. The equipment, under construction by Sperry Gyroscope, will become part of SAGE, which searches out and identifies missiles and aircraft through an intricate network of radar installations in the main Air Force system for United States' air defense. The concrete tower, which is 85 feet high and 60 feet wide, will house the radar equipment, electronic gear, personnel, machine shop, utilities, heating, air conditioning and electrical distribution systems. The gigantic antenna weighs more than 80 tons.

ELECTRONIC DESIGN • April 15, 1959

after routing,  
clip and save



a continuing series on technical topics of specific interest to engineers

## How important are the functions of various impregnants in paper capacitors?

Capacitors using impregnated kraft tissue paper dielectric are available with a variety of impregnating materials. These materials are generally waxes, oils, or thermo-setting plastics. The electrical "personality" and capabilities of the completed capacitor is, in part, determined by the characteristics of the impregnant. The components application engineer must be familiar with the available materials in order to judiciously prescribe the proper component for a given application.

**MINERAL OIL** is an excellent electrical insulating medium. It possesses low electrical loss factor, is quite stable in dielectric constant over operating temperatures ranging from  $-65^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and from low audio to radio frequencies. It exhibits extremely high dielectric strength and comparatively good insulation resistance characteristics. It is used to provide the operating conditions described as "E" characteristic in Military Specification MIL-C-25A.

**ANOTHER SPECIAL IMPREGNATING OIL** is used which is similar to mineral oil in physical and electrical characteristics, but is stabilized and purified to further improve the electrical characteristics and extend the operating temperature range to  $125^{\circ}\text{C}$ . This is supplied for "K" characteristic paper capacitors of specification MIL-C-25A. At Sangamo, the designation for this special impregnating oil is "Etherm".

**CHLORINATED BIPHENYL** is a synthetic oil that is manufactured under carefully controlled conditions of purity. Paper capacitors using this impregnant are often chosen for applications where fire hazards are a consideration because it is virtually non-flammable. Chlorinated biphenyl possesses a higher dielectric constant and provides an effective mechanism for decreasing the comparative size and cost of large value capacitors. It is used almost exclusively for impregnating capacitors designed for power frequency applications including those used for power factor correction in alternating current circuitry. This material is used to provide the "D" and "F" characteristics of MIL-C-25A. At Sangamo, the designation for Chlorinated biphenyl is "Diaclor".

**A POLYESTER RESIN** impregnant is a non-melting solid which is used where physically rugged capacitor sections of good electrical characteristics over an operating temperature range from  $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  are desired. Its dielectric constant falls between that of chlorinated biphenyl and mineral oils and its capacitance stability during operating life is excellent. At Sangamo, the designation for polyester resin is "Resinex".

**STABILIZED CHLORINATED NAPHTHALENE** is a wax which is often used in light weight capacitors of minimum size where some sacrifice in electrical characteristics, such as lower insulation resistance at all temperatures and somewhat higher power factors can be tolerated and where an operating temperature range from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  is acceptable. Its high

dielectric constant results in light weight units of small size and provides the "H" characteristic operating requirements of MIL-C-25A. At Sangamo, the designation for stabilized chlorinated naphthalene is "Sangwax".

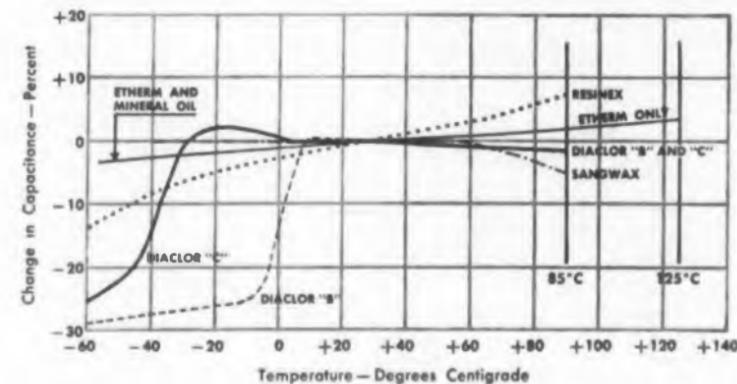
**SILICONE IMPREGNANTS** are chemically stable synthetic oils and are available over a wide viscosity range. They are used when extreme operating temperatures are specified and low dielectric losses are desirable. Silicone oils are liquid throughout their recommended operating temperature range.

### Specification Guide Of The Various Impregnants Used in Sangamo Paper Capacitors

IMPREGNANT	SANGAMO CAPACITOR TYPE DESIGNATION
Mineral Oil	Type 50, 60, 70, 42 and 43
Etherm	Type SB, SD, SMB, SMD, 50K, 60K and 70K
Diaclor	Type 71, 50, 60, 40, 41, 75 and 80 (Referred to as can, oil paper, types)
Resinex	Type 33 (molded tubular)
Sangwax	Type 50, SA and SC

NOTE: With the exception of the Type 33 all of these capacitors are housed in hermetically sealed metallic containers. The Type 33 is molded in a thermo-setting non-hygroscopic plastic case. The "S" series types are housed in tin coated brass tubular containers with compressed glass solder seal ends. These units are most applicable where "High Reliability" is a necessity.

Engineering Catalogs Numbers 2421 and 2422 give full information and are available upon request for your files.



Composite curve of paper capacitors using five Sangamo impregnants for capacitance variations with temperature at 1000 cycles per second.

SC59-2

**SANGAMO ELECTRIC COMPANY, Springfield, Illinois**

-- designing towards the promise of tomorrow

CIRCLE 13 ON READER-SERVICE CARD

# Semiconductor Solid Circuits

## ... Approach Ultimate in Component Density

**C**OMPONENT densities ranging up to 34 million parts per cubic foot are now possible with semiconductor solid circuits of silicon and germanium. By combining such semiconductor techniques as controlled masking, etching, and diffusion, Texas Instruments Inc. has successfully developed matchhead-size circuits, smaller than  $1/4 \times 1/8 \times 1/32$  in. Working models were demonstrated at the IRE Show held in New York City, March 23-26. This development complements, but also may foreshadow, the micro-module concept [See "Micro-Electronics Now for Sale" p 28, this issue].

### Initial Circuits

A multivibrator circuit, shown in Fig. 1, contains the equivalent of twelve components—two diffused-base transistors, eight resistors, and two capacitors. Its relative size is shown in Fig. 2 as compared with a conventional printed-circuit sub-assembly. The component layout is shown in enlarged form in Fig. 3.

A phase-shift oscillator circuit, containing one transistor, five resistors, and three capacitors, is shown in Fig. 4.

### Advantages

In addition to the obvious savings in weight and size, solid state circuits offer:

- Up to 75 percent fewer leads or connections than conventional circuits
- Predictable process control for the entire semiconductor assembly
- Tailor-made characteristics for each compo-

nent equivalent—thus, a few basic circuits could be altered in component value to fulfill a wide variety of applications.

Sample units are expected to be available for development work within several months time.

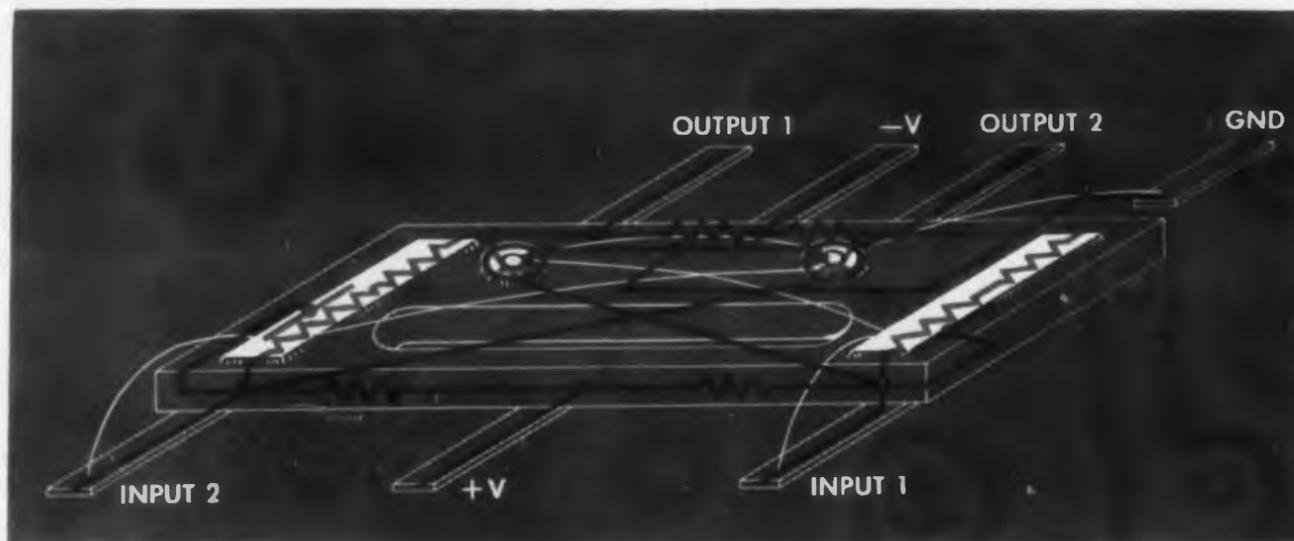
### 100 Million Next Step

Logic circuit elements, basic building blocks for computers, have been constructed at RCA Research Laboratories in a size so compact that 100,000,000 could be crammed into one cubic foot of space. Identified as the "integrated electronics" concept, the technique involves the combination of active and passive circuit elements

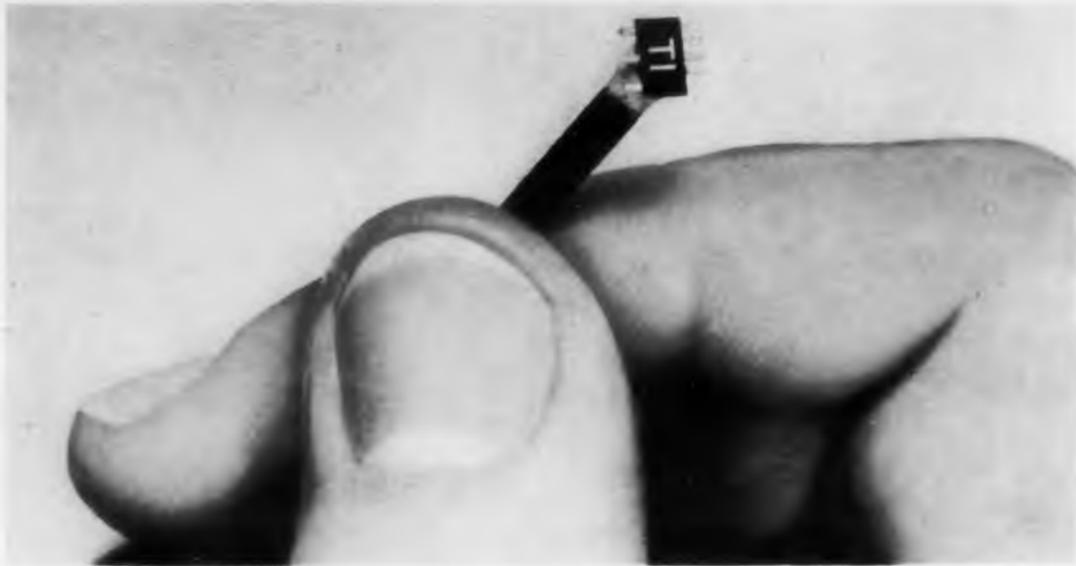
into a single semiconductor solid similar to that of TI.

Laboratory work has resulted in an integrated logic element, formed from silicon, only  $0.000016$  in.<sup>3</sup> By assembling the elements in varied arrangements, all functions of conventional logic elements can be duplicated.

Thus, present microminiaturization techniques offering 500,000 components per cubic foot will soon be improved to a figure of 100,000,000—a factor of 200. The ultimate in compact packing density is the neuron of the brain—upwards of 100 billion could be contained in one cubic foot. ■ ■



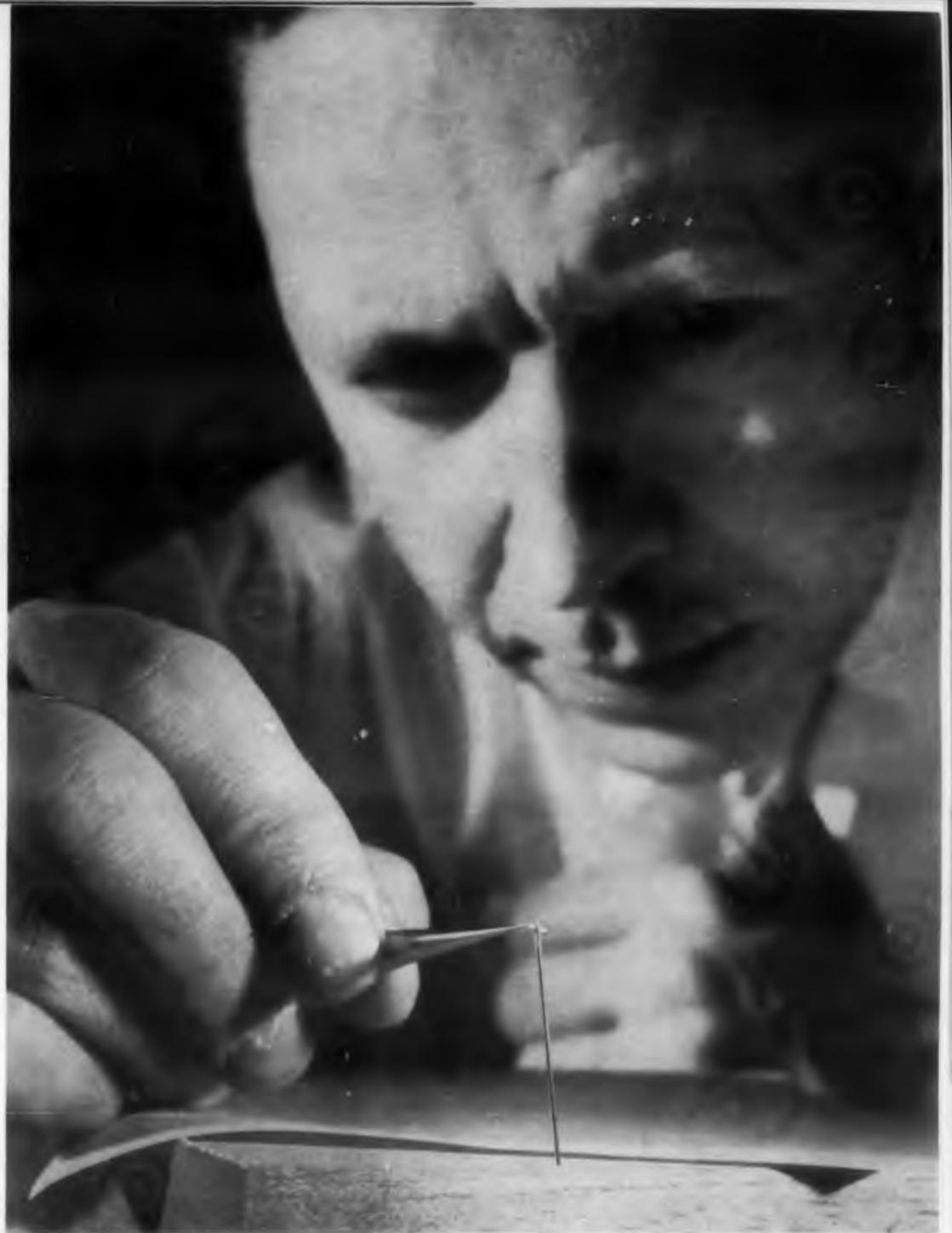
**Fig. 3.** Greatly enlarged sketch of all-silicon solid circuit multivibrator. The 12 equivalent components contained in the solid circuit are shown—two diffused-base transistors, two capacitors and eight resistors.



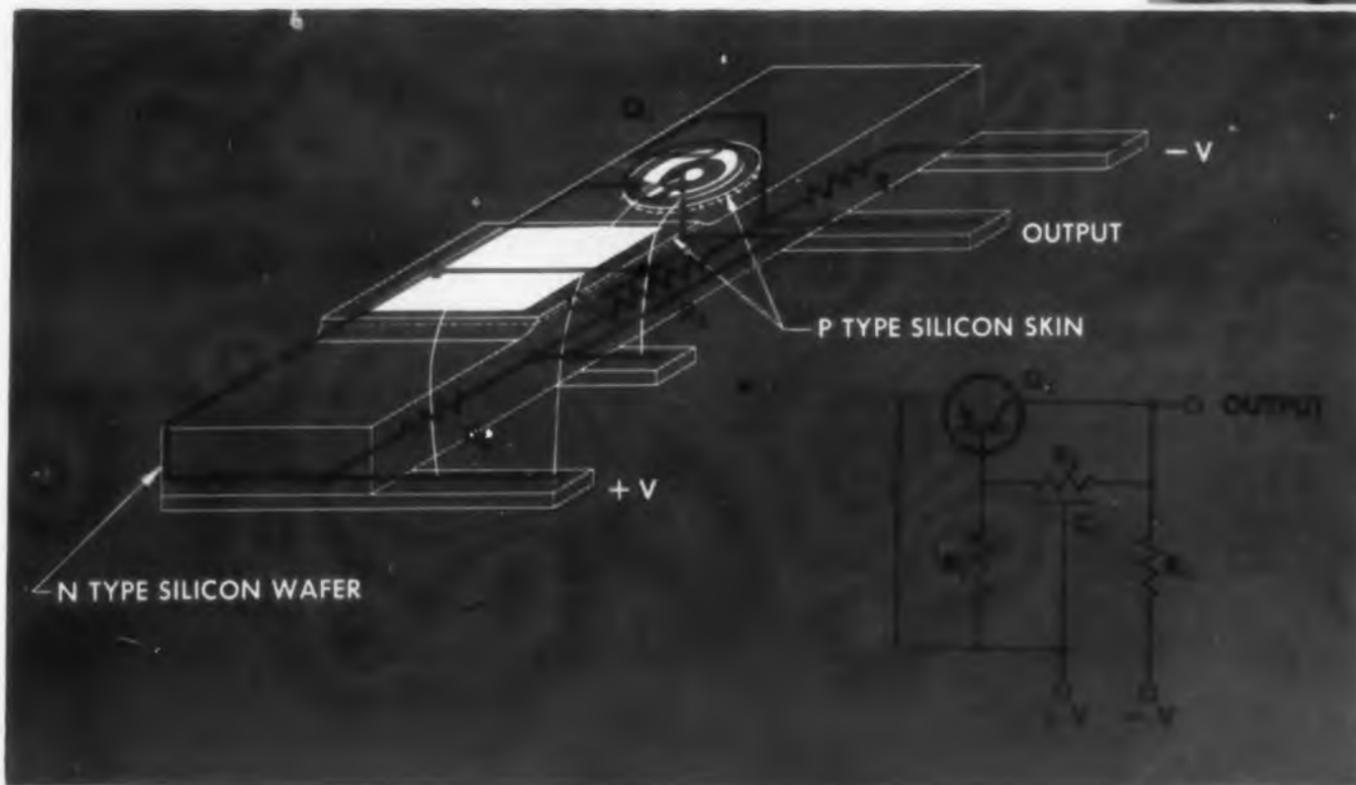
**Fig. 1.** Silicon solid circuit multivibrator is shown on the head of an ordinary paper match photographed twice actual size. The actual unit measures less than 1/4-inch in length, 1/8-inch in width and 1/32-inch in thickness.



**Fig. 2.** Finger points to solid circuit multivibrator assembly (left) and hermetically sealed unit (right) which are photographed actual size. Note comparison in size with a multivibrator unit constructed with conventional printed circuit (held in hand). The TI-built silicon solid circuit unit performs the same electrical function as the equivalent printed circuit multivibrator.



**Fig. 5.** Dr. J. T. Hallmark, of RCA Labs, inserts an integrated element into the eye of a needle to demonstrate its relative size.



**Fig. 4.** All-silicon solid-circuit phase shift oscillator, showing the nine equivalent components contained in the solid circuit—one diffused-base transistor, two resistors, and a distributed RC network acting as three resistors and three capacitors.

# Next, Thinking- Autos, Robots, and Satellites

Autos guided by radar, machines that learn by experience, and satellites with built-in electronic reporter-editors are beyond the science fiction stage according to engineers reading papers at the 1959 IRE National Convention. Although these subjects have been discussed before, the probability of their becoming real moves closer to the realm of certainty as studies now underway progress.

## Future Motorists to "Leave the Driving to Radar"

Motorists of the future will be able to travel from coast to coast fully relaxed while radar equipment in their cars makes all the driving decisions.

Dr. Yaohan Chu and P. N. Buford, of the Westinghouse Electric Corp. division at Baltimore, predicted that the program will be in experimental use in two years and may be in general use within five years.

Automobiles could follow a strip of foil or special paint down highways while all control functions—including steering, determination of speed and stopping—could be handled automatically.

The radar system could give a panoramic display of the roadway ahead for a distance of up to one mile and would be effective for day or night driving and in any type of weather in which cars could travel with reasonable safety. It could indicate the distance to other automobiles, the closing rate and give a collision signal if such a situation appears possible.

Code guidance signals could be read from the foil or paint strip on the road to program coast-to-coast driving with speeds pre-determined according to the safety conditions of the road.

The inventors calculate a complete system for

one car could be mass-produced for about \$250. It would weigh only 40 pounds and would fit either under the hood or behind the grill of an average-sized automobile. The only visible component would be the radar antenna mounted in the center of the grill.

## Machines That Learn By Experience

Design theory for automatic control devices that learn to improve their performance, based on experience, was presented by Robert Kalaba (written in conjunction with Richard Bellman) of the Rand Corporation of Santa Monica, Calif.

New mathematical techniques can be applied to devise a system of controls that improve their performance by adapting to circumstances as they find them. According to the authors, the military and commercial implications of such devices are impressive and considerable research on them is currently underway in both the United States and the Soviet Union.

Currently, mathematicians face problems involving control processes in which they do not have sufficient information concerning the underlying structure of the process to set up the usual mathematical models. They may not know cause and effect, may not know what types of control are available at the outset, how long the process is going to last, what the state of the system is at any time, and may not even know exactly what it is desired to do.

Such problems appear in different guises in the fields of engineering, economics, statistics, psychology, biology and computers. The study of efficient operation, under the handicap of uncertainty, is called the theory of adaptive control processes. There are two essential parts—the study of opti-

mal control and the study of feasible control. The latter may be far more important in many cases where it is not even possible to define what one means by "optimal."

In the field of computing devices, the problem is to adapt an all-purpose computer to the solution of a particular problem whose special features may not be completely known at the outset. Not only must the machine be instructed in the routine operations of arithmetic, but it must also be shown how to modify its routines in accordance with the nature of the solution.

The idea of "sequential computation" is basic in the theory and design of automata or robots, and in the construction of "thinking machines" of Sunday-supplement fame. It is important to note that machines do not do the thinking; men do the thinking and the machines carry out the policies.

## Electronic Reporter for Manned Earth Satellite

A novel electronic system, for reporting the condition of satellite passengers and sending brief releases only of "newsworthy" items, was proposed at the Medical Electronics session.

Miles A. Mc Lennan of the Aero Medical Laboratory, Wright Air Development Center, explained that it will be impractical to transmit large quantities of raw data about animals or humans in the satellite in an unedited form, as is done in unmanned satellite experiments, because of the excessive weight of the radio equipment. To reduce equipment weight to a practical level, it will be necessary for an "electronic reporter" to edit out unimportant information from the data to be transmitted.

He proposed that decision and logic circuits similar to those found in electronic computers, be



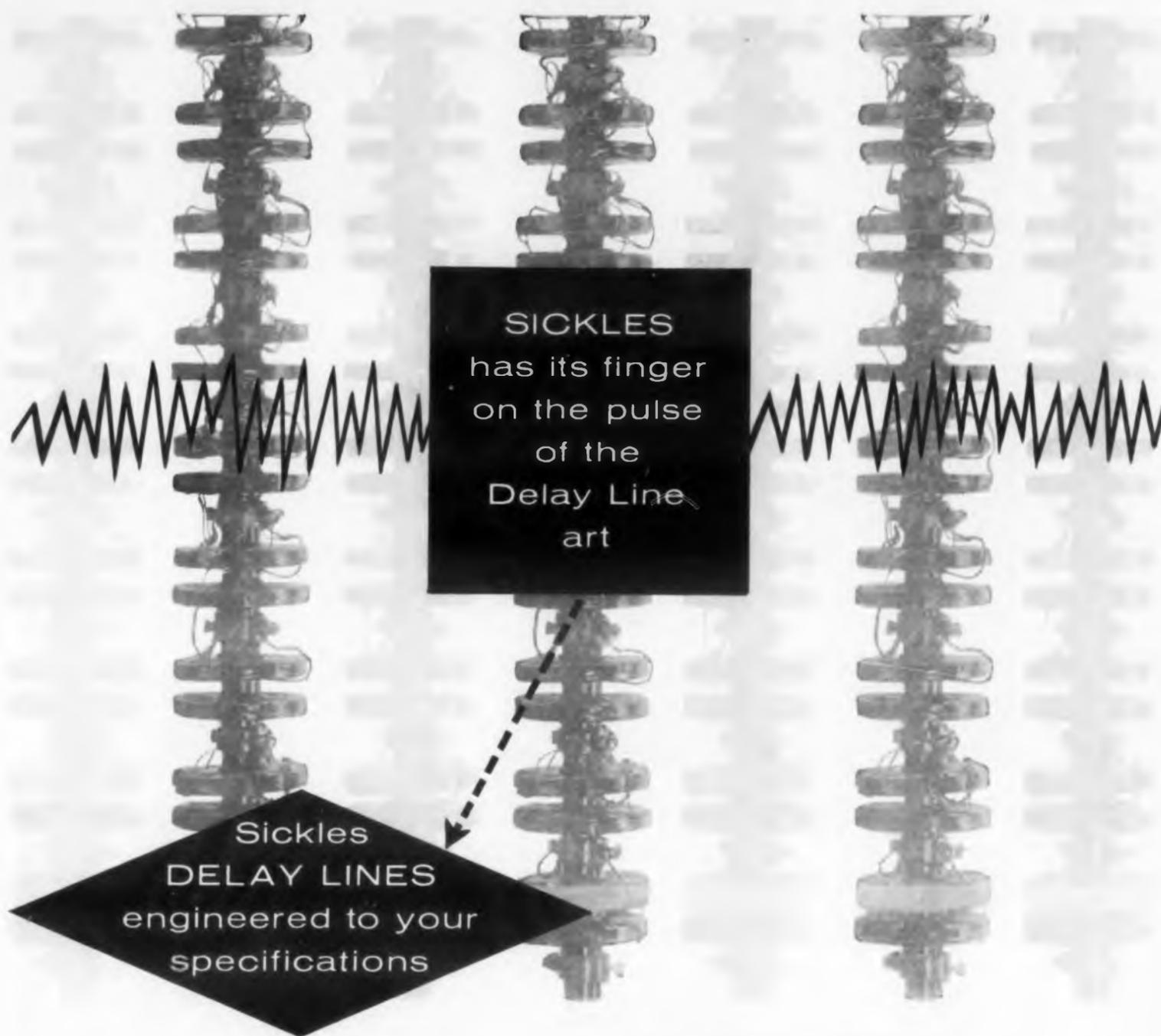
### Satellite Tape Recorder

Heart of the communications system in the Vanguard "Cloud Cover Satellite" is a more complex version of this basic tape recorder. Only 5 1/2-inches wide, the 1 pound 5 ounce device records "pictures" of weather on a global scale. It first became famous in December as the larynx of man's first talking satellite—the Atlas, which sent President Eisenhower's voice to earth from outer space. The recorder, developed by Minnesota Mining and Mfg. Co. plays an essential role in the current satellite series of both the Advanced Research Projects Agency and the National Aeronautics and Space Administration.

used to decide whether or not a signal is newsworthy enough to be sent. To save power, the newsworthy signals would be temporarily stored and transmitted only upon demand by radio from the ground.

A second, less reliable data system would also be used as an accessory or "fill in" system. Television, voice communication and certain non-vital classes of physical and physiological data would be handled by this system. The dependability of contact with ground would be marginal due to the use of minimum transmitter power for the second system.

Mr. Mc Lennan noted that an equatorial orbit would be highly preferable for a passenger-carrying satellite experiment, both from the data system standpoint and that of vehicular recovery, because an equatorial route minimizes the number of necessary ground stations as well as the tracking and searching area. A second preference, he said, might be the 90 degree or polar orbit, where the ground stations could be grouped near the North or South Pole.



The complexities of delay line design and manufacture hold no fears for Sickles. We've built up a 38 year record of success in precision coil winding — and since 1938 have produced delay lines for a host of applications including color TV, commercial air controls, computers, missiles and military guidance systems.

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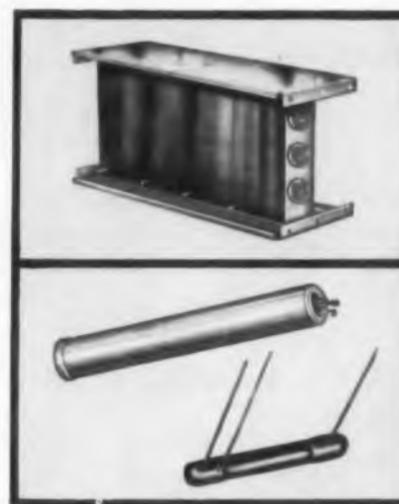
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GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC. AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

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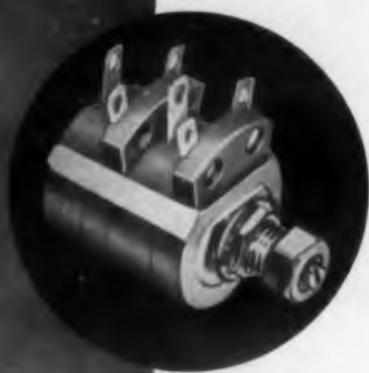
At upper left is a typical composite of 5 delay lines, hermetically sealed in a metal case which we have produced for ground-to-air traffic control. Its major lumped line has  $T_d = 20.3$  usec tapped at each 1.45 usec with a rise time of 0.5 usec.

Distributed lines, at lower left, can be supplied with time delays up to 25 usec with impedances of 300 to 5000 ohms. They may be hermetically sealed, potted, resin dipped or encapsulated.





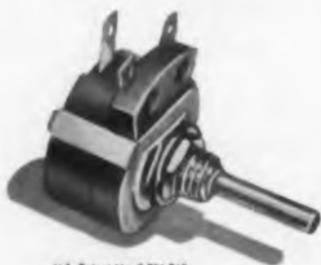
OFFICIAL U.S. NAVY PHOTOGRAPH



## Demonstrated Precision and Reliability

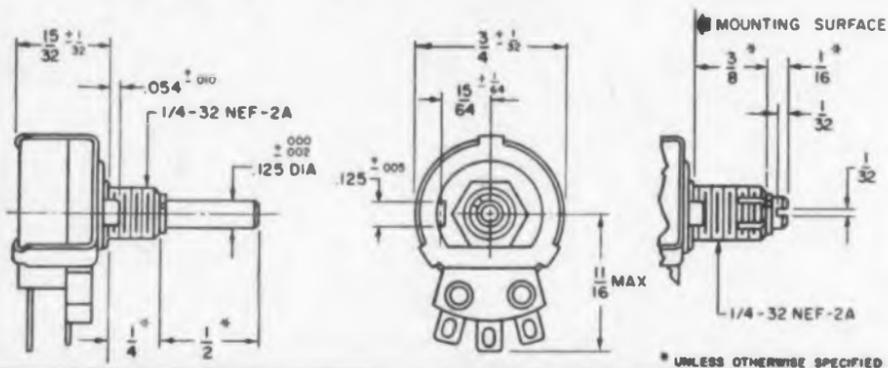
Clarostat Series 49M Miniaturized Wire-Wound Potentiometers are used in the critical electronic system of the famous air-to-air Sidewinder missile. This is one more example of Clarostat precision — precision you can count on.

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U.S. Patent No. 3,706,760

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### SPECIFICATIONS

Power Rating — 1.5 watts @ 40° C.  
 Insulation Breakdown Test — Between terminals and ground for 1 minute, 1000 V ac @ 3.4" Hg.  
 Resistance Range — 1 to 20,000 ohms.  
 Resistance Tolerance — ± 5%  
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 Torque — 0.5 to 3 oz. in. (Also available with locking type bushing up to 20 oz.in.)

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## WASHINGTON REPORT



Ephraim Kahn

### Bid Bonds Mandatory With Contract Bids

Bid Bonds, formerly subject to waivers, will have to be supplied with responses on all government contracts that require them. A ruling of the Comptroller General (B-137319), directed to the Secretary of the Army, but also sent to the "Heads of Departments, Independent Establishments, Agencies, and Others Concerned," sets forth the policy. In the past, the Comptroller General says, it has been held that a requirement in an invitation to submit a bid bond with a bid "may and should be waived if the failure to comply is due to inadvertence or other excusable cause not related to the bidder's financial ability to secure the bond." This rule will no longer be followed.

Instead, non-compliance with a requirement in the invitation that a "bid bond or other bid security be submitted with the bid will be held to require rejection of the bid as non-responsive."

### Too Many Changes of Mind

Under the rule permitting bid bond waiver, the CG said bidders could get "two bites at the apple." The net effect of the rule was to permit "fringe" operators to decide, after opening, when the bids of more responsible competitors have been made known, whether or not to attempt to become eligible for the award. By bidding without a bond, the bidder could look over his competitors' prices and then—if he deemed it to his advantage to become eligible for the award—submit "the required literature or samples in proper form." On the other hand, if the apparent low bidder decided the award would be undesirable, he could "submit literature or samples diverging so widely from the specifications as to cast substantial doubt on his ability to perform, thus in most cases accomplishing the rejection of his bid as a non-responsible bidder." This "tends to subvert the purposes of the statutes governing procurement under competitive procedures," the CG asserts.

### Bid Bond Waiver "Too Subjective"

The CG also believes that the weighing of evidence to decide whether a bid bond should be

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 ELECTRONIC DESIGN • April 15, 1955

# CALIBRATED MICROWAVE FIELD INTENSITY RECEIVER

## 1000 to 10,000 mc Absolute measurements of microwave interference and susceptibility



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For the first time, one single microwave test system—Polarad Model FIM Field Intensity Receiver—is capable not only of measuring the absolute level of radiated or conducted interference, but also of determining the signal susceptibility of other instruments and components to such external interference. It combines a calibrated antenna system, a calibrated receiver and an internal calibrated signal generator.

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Model FIM



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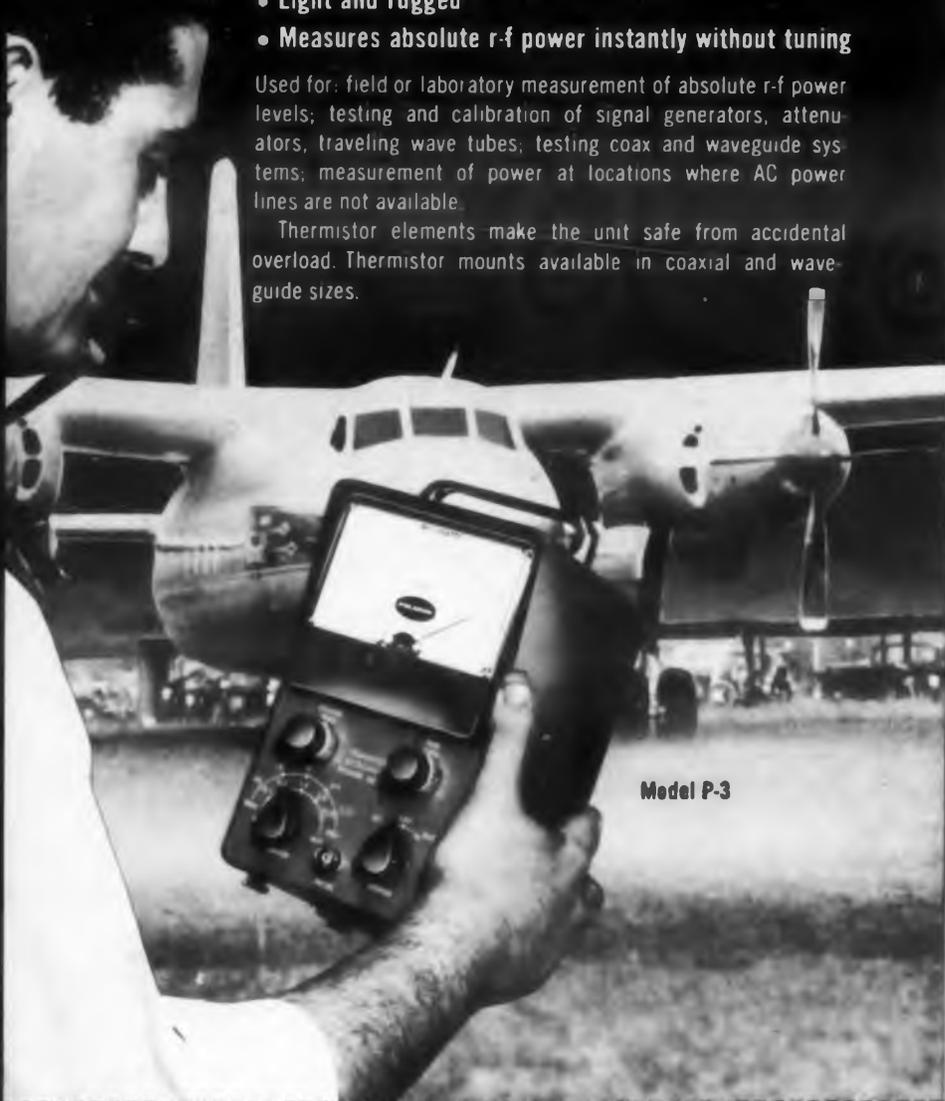
\*See reverse side of this page.

# PORTABLE TRANSISTORIZED MICROWAVE POWER METER

- 10 to 39,000 mc
- Battery or line operated
- Light and rugged
- Measures absolute r-f power instantly without tuning

Used for: field or laboratory measurement of absolute r-f power levels; testing and calibration of signal generators, attenuators, traveling wave tubes; testing coax and waveguide systems; measurement of power at locations where AC power lines are not available.

Thermistor elements make the unit safe from accidental overload. Thermistor mounts available in coaxial and waveguide sizes.



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waived is largely a subjective matter. He thinks it "quite likely that different contracting officers may arrive at opposite conclusions from sets of facts which are substantially similar." Though this subjectivity by itself is "undesirable," and even the more important factor is that it "must invariably give rise to the exertion of pressures on the contracting officer in favor of one conclusion or another which cannot but have an adverse effect on the integrity of the competitive bid system." Adds the CG: "maintenance of the integrity of the system is infinitely more in the public interest than a financial saving in an individual case."

### Performance-Incentive Bonus Plan

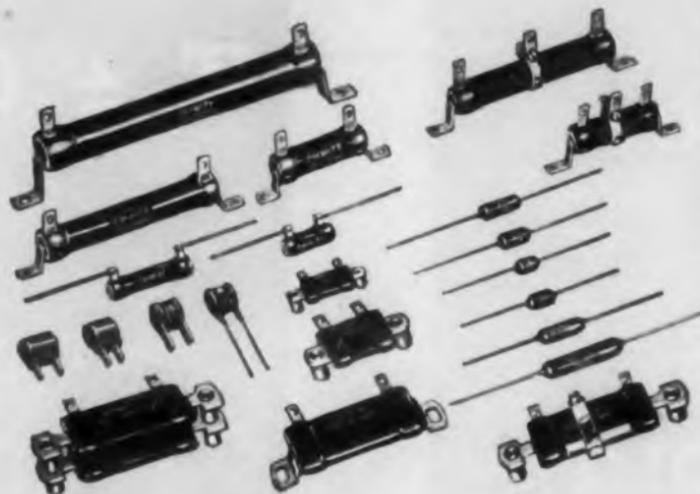
New types of incentives for defense contractors are being hammered out by the Defense Department. Of particular importance to electronics firms is the performance-incentive type, which the Pentagon believes to be particularly suitable for major weapons systems procurement wherein there are either substantial developmental goals or potentialities for significantly improved performance.

Under a performance-incentive contract, additional profits could be made by surpassing stated performance standards. "Performance," as the Defense Department uses it here, refers not only to the performance of the article being produced but to the performance of the contractor as well. It includes timeliness of delivery, capability and serviceability of the product, ease and simplicity of operation and economy of maintenance. Minimum performance under such a contract would be mandatory; it would not qualify for an incentive payment but rate only payment of the established basic price. Incentives would be paid for superior accomplishment only.

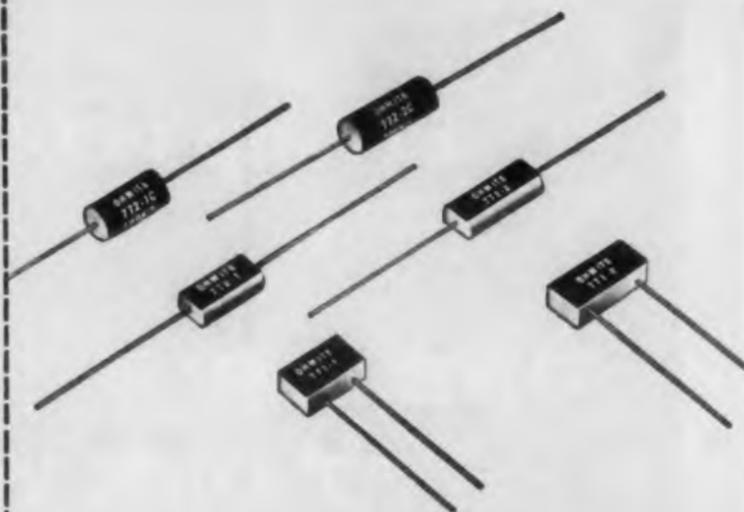
#### Value Engineering Encouraged

Incentive payments to contractors for "value engineering" have been made by the Navy Department in the past and other branches of the military are presently studying the practice. "Value Engineering" involves the encouragement of contractors to review the elements of the design, manufacture, procurement, inspection, installation, and maintenance of an item and its components. In so doing, particular attention would be given to making certain that every element of cost contributes proportionately to function, and that the necessary performance, maintainability, and engineering is being devoted to the item. The contractor would, of course, be expected to recommend changes or substitutions which will result in lesser over-all cost or increased efficiency.

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ELECTRONIC DESIGN • April 15, 1959

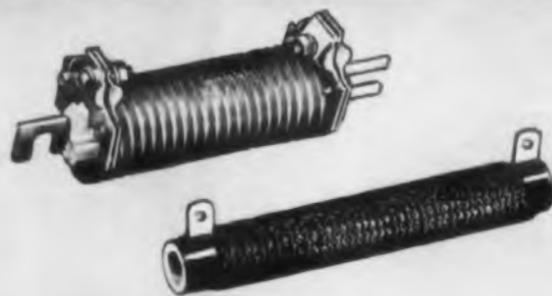


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#### OHMITE HAS EXACTLY THE RESISTOR YOU NEED

Ohmite offers the most complete line of high quality resistors on the market . . . fixed, adjustable, tapped, noninductive, and precision resistors in many sizes and types of terminals . . . in a wide range of wattages and resistances. All-welded construction. Ohmite application engineers will be pleased to help you in selecting the resistors for your job.

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Tubular vitreous-enameled resistors with special winding. Dummy antennas consist of assemblies of several resistors. Watts, 5 to 1000; ohms, 1 to 5000.

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allows more compact placement.

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Single  
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Provides matched coefficients of expansion of internal lead wire and diode case, prohibits separation even under extreme shock.

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# EDITORIAL

## Unfounded Optimism a Crime

Last issue in this editorial space we said dishonest bidding must go. The deliberate policy of bidding low on a cost plus fixed fee contract to get it knowing very well that the final cost will exceed the amount bid should not go unpunished. Just as big a crime, if not bigger, is the promising to deliver in say, nine months when a realistic delivery schedule is closer to twenty-four months.

Dishonesty in bidding, improper prices and impossible schedules, are the causes of over half of the Department of Defense's problems, according to informed military sources.

It is hard to say who the bigger culprit is—the bidder who says he can do it or the contracting agency who demands a ridiculous schedule in the first place. Scheduling is important for unless equipment is delivered on time, and fully operable, it may never play its intended role.

Air Force Lt. General Irvine says delivery on time is an absolute must. Not only must operational systems be ready, but the support equipment must be available when originally programmed. At the same time the delivered products must reflect engineering changes if the test stages show up deficiencies.

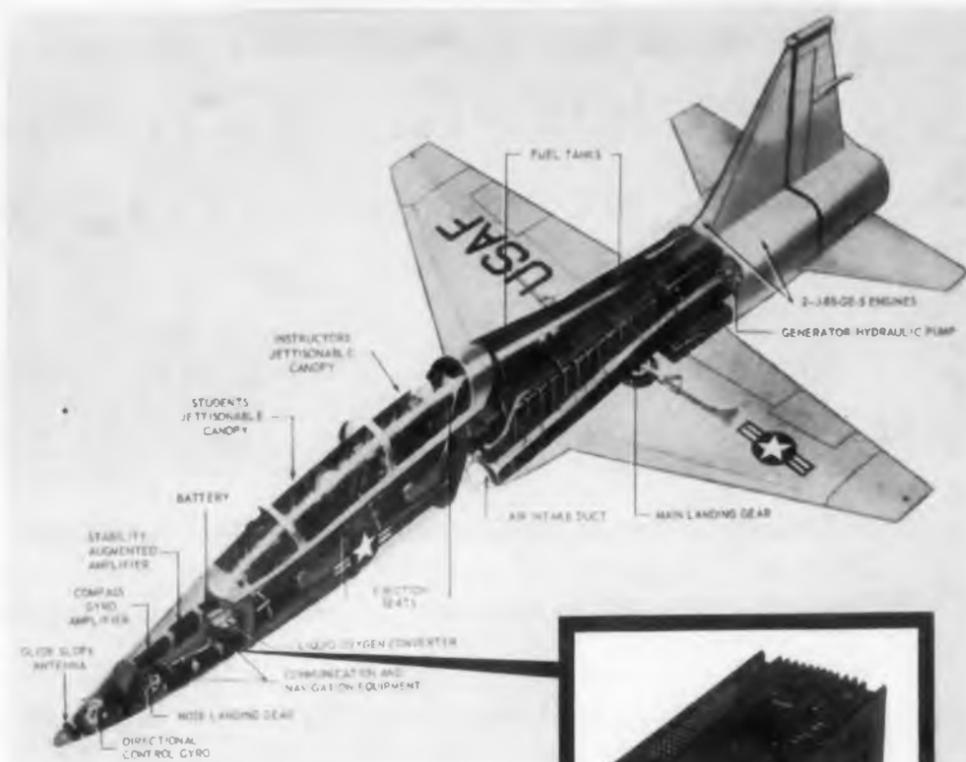
The terms used here "dishonesty" and "crime" are admittedly strong—let us say first degree charges. If premeditation is involved all would agree the practice is dishonest and a crime. But what if the act is only a result of "wishful thinking"? Wishful thinking may be simply an emotional trait as pointed out by A. L. Stanly in his article, "Logic and Illogic in Engineering and Management," *IRE Transactions on Engineering Management*, Dec. 1958, but results can be just as disastrous as deliberate dishonesty. Certainly wishful thinking is, at the very minimum, a third degree crime. Should not the perpetrators of such crimes be punished, too?

Perhaps there should be fines for late delivery—construction contractors frequently accept these terms. Better still a contractor should be required to show in his bid a scientific, working, scheduling plan for his plant. Such a plan should prove the realism of promises in a bid. (And if a contractor is bragging about an \$800 million backlog of order, his working plan must be accurate down to a few per cent plus or minus). Such plans which would show manpower and cost relationships, could show up unrealistic government demands.

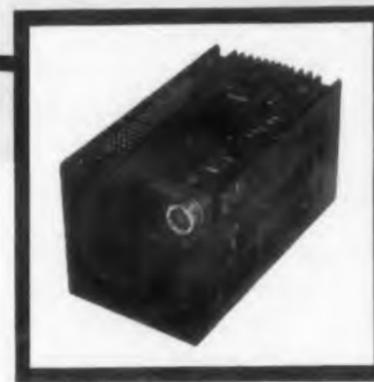
Mr. Stanly says a company is now practically forced, if it is to keep pace with competitors, to "play the national self-deception game." The stakes are mighty high—our national defense.

*James G. Kipp*

*Designed...  
...with a job in mind*



USAF - NORTHROP TALON T-38



The T-38 supersonic trainer, produced by Norair Division of Northrop, represents a departure from the current trend in operational military jet aircraft. High performance at low cost has become a reality in this bantamweight; infinite attention to detail and employment of techniques, materials and components representing the ultimate in the present day state-of-the-art have combined to produce a jet weighing little more than a pair of Cadillacs.

Canoga is proud to have designed and manufactured the transistorized power supply selected by Norair to power the AN/ARN-14 navigation receiver of the T-38. Weighing less than 5 lbs., this completely militarized unit provides regulated outputs of 28 vdc and 260 vdc from the T-38's 3-phase 400 cps primary power. Naturally, regulation is maintained from no-load to full-load, and over the entire operational range of input voltages and ambient temperatures.



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Following six years as an engineer developing test criteria for receiving tubes, Mr. Robb was put in charge of preparation of technical data for publication. He is, at present, a member of the Joint Electron Devices Engineering Council Subcommittee JJ-5.4 which did most of the development work for the "Design-Maximum Rating System."

# Design-Maximum Tube Ratings

**J. H. Robb**  
Supervisor, Receiving Tube Engineering  
General Electric Co.  
Owensboro, Ky.

Design-maximum, design-center, and absolute maximum tube rating systems are defined and compared. Methods of determining conformance are discussed and an example is carried through to illustrate simplicity of design-maximum system.

IMPROVED reliability and more efficient performance from receiving tubes are offered to the engineer using the design-maximum rating system. Proper interpretation of these ratings results in more satisfactory equipment as compared with results obtained from the design center rating system. At the same time, simpler procedures are required to determine whether tubes are operating within ratings as compared with the absolute-maximum rating system.

## Comparison of Rating Systems

To fully realize and appreciate the advantages offered by the design-maximum system, the basic differences in the three systems will be examined. It is first necessary to specify the meaning of the expression "bogey tube" and the word "ratings" itself. A bogey tube is a tube of a specified type which has each of its characteristics equal to the published average values. Because of the large number of characteristics involved, such a tube is often difficult to find; therefore, for practical purposes, only those characteristics directly related to the class of service being evaluated need to be considered.

Tube ratings are limiting values (minimum or maximum) for the operating or environmental conditions imposed on a tube, such as voltages, currents, dissipations, or temperatures. If reasonable assurance of satisfactory tube life is desired by an equipment manufacturer, the equipment must be designed so that tubes are not operated beyond these limiting values as given for individ-

ual tube types in the tube manufacturer's published data. Equipment designers must take into account not only the numerical values of the published ratings, but also the rating system specified, since the criteria for determining whether or not an equipment operates tubes within ratings are different for the three systems in use.

## Design-Center Ratings

The design-center rating system required that the specified numerical ratings are not exceeded with a bogey tube in the circuit being evaluated, and with all other components and conditions affecting the operation of the tube, such as resistances and line voltage, at their normal (average) values. If this condition is met, the tube is considered to be operated within ratings, even though the numerical ratings might be exceeded with a nonbogey tube in the socket and with variations from the average operating conditions. In determining the numerical value of the design-center ratings to be published for a tube, it is therefore necessary for the tube manufacturer to take into account the variations likely to occur both in tubes and in the operating conditions that will be imposed on them. This could be done satisfactorily when tubes were used in only a few well standardized circuits; however, a better rating system is needed to cope with today's ever-increasing variety of circuits. The disadvantage to circuit designers is that a design-center rating which included sufficient allowance for the most variable circuits employed with a given tube

would be unnecessarily conservative for other circuits which were inherently very uniform in their demands. Thus the designer of very uniform circuits is forced to operate the tubes at performance levels below those which could be safely utilized in his circuits.

## Absolute-Maximum Ratings

The absolute-maximum rating system answers these objections by requiring the circuit designer to make the necessary allowances for the variability in circuits, operating conditions, and tubes. Where a tube rating is specified as an absolute-maximum value, circuits should be designed so that this value is not exceeded with any tube of the specified type in the socket, even under the worst probable combination of operating and environmental conditions. "Worst" in this sense means worst in so far as tendency to cause a particular rating to be exceeded. The disadvantage of the absolute-maximum system, as compared with the design-center system, is the greater difficulty for circuit designers to determine whether tubes are operated within ratings.

## Design-Maximum Ratings

The design-maximum ratings system was developed by the JT-5 Committee of the Joint Electron Devices Engineering Council to provide the essential advantages of the absolute-maximum system, while reducing the complexity of the evaluation required to determine conformance. Where a rating is given as a design-maximum value, this value should not be exceeded with a bogey tube, even under the worst probable combination of operating and environmental conditions. The only difference from the absolute-maximum system is in specifying a bogey tube for the stage being evaluated, rather than requiring that the ratings not be exceeded with any tube.

## Determining Conformance to Design-Maximum Ratings

The advantage of the design-maximum rating system over the absolute-maximum system is the greater ease in determining conformance to ratings. This results from the specification of a bogey tube in the stage being evaluated. When checking conformance to ratings experimentally, the necessary measurements need be made on only a few approximately bogey tubes while varying line voltage, signals, control adjustments, and other circuit components over the full ranges of variation likely to occur in the field. Extreme variations which might possibly occur in rare cases, but which would result in completely unsatisfactory performance, need not be considered in determining conformance to ratings if it is not

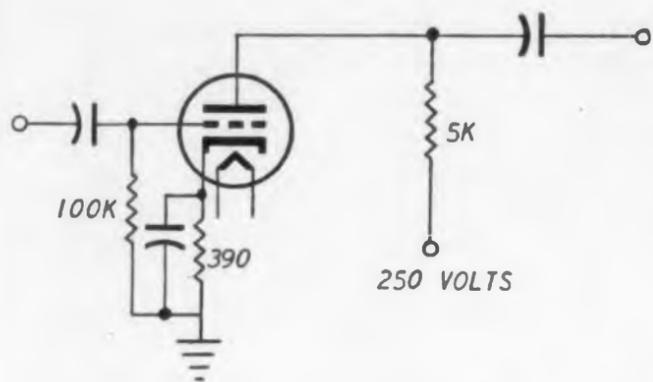


Fig. 1. Circuit used in example showing determination of conformance to ratings.

probable that equipment would be operated for any length of time under such conditions. In the few cases where operating conditions for the stage being evaluated are appreciably affected by variations in the tubes used in other stages, a full range of tubes should be tried in such other stages in order to take into account this contribution to worst probable operating conditions.

The greater ease in applying the design-maximum system is most evident when an analytical or graphical evaluation of conformance to ratings is made. The characteristic curves of a tube as published by the tube manufacturer may be used in such an evaluation, since they represent the characteristics of the bogey tube specified for the design-maximum system. Characteristic curves for the extreme tubes required for the absolute-maximum system are neither available nor easily obtained. An analytical evaluation is particularly useful since it can be made very early in the design procedure; this avoids spending much time on a design which might later be found to operate tubes outside ratings. There are, of course, some cases where a sufficiently accurate analysis cannot be easily made, and some measurements are usually required.

#### Typical Example

The Class A triode amplifier circuit of Fig. 1 is presented as an example where a preliminary analytical evaluation is useful, with supplementary measurements required to complete the evaluation. The values of the circuit parameters shown were selected for illustrative purposes only and do not necessarily represent an efficient design for any application. Details of an evaluation procedure for this particular example follow. Circuit designers can adapt this general method to other circuits, always keeping in mind the basic requirements given for determining conformance to design-maximum ratings.

#### Preliminary Analytical Evaluation

As the first step in the evaluation, the design-

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Now in production for virtually all leading manufacturers in the radar field are filter packages of 200 cps bandwidth with crossovers at the 1/2 db. point, and with insertion losses equal to within 0.3 db. from filter to filter.

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

Center frequency: 144.400 KC  
 Lower 1/2 db. point: 144.330 KC  
 Upper 1/2 db. point: 144.470 KC  
 Lower 3 db. point: 144.300 KC  
 Upper 3 db. point: 144.500 KC  
 40 db. bandwidth: less than 2 KC  
 Insertion loss: less than 1 db.  
 Ripple in pass band: less than 1/2 db.  
 Frequency variation of pass band: less than 10 cps  
 over temperature range of 0°C. to +70°C.  
 Size: 2½" W x 2" D x 1¼" H  
 Weight: less than 7 oz.

maximum tube ratings are listed by the circuit designer. This information, along with the corresponding nominal values occurring in the circuit are used to determine the areas where a further check on conformance to ratings is needed. For this example see list as shown in Table 1.

A very simple analysis based on the designer's knowledge of the variations expected in the cir-

cuit parameters eliminates most of the rated items from further consideration. The heater-cathode voltage rating of  $\pm 100$  v, for example, cannot be exceeded in operable equipment since the only source for heater-cathode voltage is the  $-4.45$  v across the cathode resistor. The only ratings requiring further study are plate dissipation, cathode current, heater voltage, and bulb temperature.

Table 1. Data for Typical Design Example

Item	Design-Maximum Rating	Nominal Value in Circuit	Unit
Heater Voltage	6.3 $\pm 10\%$	6.3	Volts
Plate Voltage	330	193	Volts
Positive DC Grid Voltage	0	—	Volts
Negative DC Grid Voltage	55	4.45	Volts
Plate Dissipation	2.7	2.2	Watts
DC Grid Current	3.0	0.01	ma
DC Cathode Current	18	11.4	ma
Heater Cathode Voltage	$\pm 100$	$-4.45$	Volts
Grid Circuit Resistance			
With Fixed Bias	0.5	—	Meg
With Cathode Bias	1.0	0.1	Meg
Bulb Temperature at Hottest Point	165	unknown	C

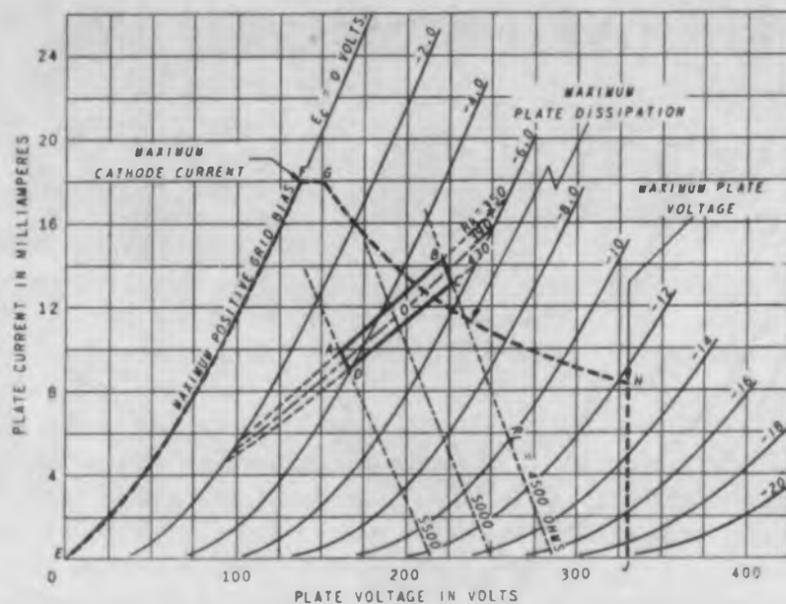


Fig. 2. Graphical construction for determining conformance to design-maximum ratings, using published plate characteristic curves.

Table 2. Nominal and Worst Probable Values for Example Given

Circuit Parameter	Nominal Value	Worst Probable Minimum	Values Maximum	Unit
Cathode Resistance	390	350	430	Ohms
Load Resistance	5000	4500	5500	Ohms
Plate Supply Voltage	250	215	285	Volts

Conformance to the design-maximum plate dissipation and cathode current ratings can be estimated by a graphical construction on the published plate characteristic curves, as shown in Fig. 2. The analysis will be made for the zero signal condition, since this produces highest plate dissipation in a Class A amplifier. The nominal and worst probable values of the circuit parameters, previously determined by the circuit designer, are shown in Table 2.

Under the nominal conditions, the operating point of the tube is at point 0 in Fig. 2. This point is within the boundary *EFGHJ* imposed by the design-maximum ratings. The area within which the operating conditions vary is *ABCD*, determined as follows: Line *AB* is the plot of plate current against grid bias for the minimum cathode resistance, 350 ohms; line *CD* is the same for the maximum cathode resistance, 430 ohms. Line *AD* is the load line for the maximum load resistance, 5500 ohms, intersecting zero plate current at the minimum plate supply, 215 v. Line *BC* is the load line for the minimum load resistance, 4500 ohms, intersecting zero plate current at the maximum plate supply, 285 v.

It can be seen that the tube is operated well within the cathode current and plate voltage ratings, but that it exceeds the plate dissipation ratings because part of the area *ABCD* is above the boundary *GH*. To determine a cathode resistor that will bring the tube within ratings, additional cathode bias lines similar to *AB* and *DC* may be constructed for the minimum and maximum values corresponding to other standard resistances until an area completely within the boundary *EFGHJ* is obtained. Alternatively, several other methods of bringing the design within ratings may be used, such as better regulation of the plate supply voltage and more precise resistors.

Where fixed bias is employed in the circuit rather than cathode bias, the plate characteristic curves for grid voltages equal to the expected minimum and maximum biases would be used for the lines *AB* and *CD* in place of the cathode bias lines illustrated in Fig. 2.

Although the example given is a very simple case, circuit designers may use a graphical construction for determining the conformance of a tube to its design-maximum ratings in any case where the nominal operating conditions can be determined by such a procedure. Similarly, where a formula or a numerical analysis can be used to determine nominal operating conditions, they may also be used to determine the conformance to design-maximum ratings under extreme operating conditions.

The accuracy of the results depends on the accuracy of the analytical procedure. In addi-

tion, some approximation is involved in that the combined effect of several maximum variations is determined without assessing the probability of their simultaneous occurrence. In general, this is smaller than the probability of occurrence of the maximum variation in any individual circuit parameter, so that the evaluation tends toward conservative operation. However, the neglect of variation in heater voltage of the bogey tube results in the opposite tendency. For these reasons, the analysis should be confirmed, by measurements made in the circuit, on any rated item for which the analysis indicates that the rating will be closely approached.

#### Measurements in the Completed Equipment

When the equipment has been built, measurements must be made to determine conformance to certain ratings not covered in the analysis. In the example given, bulb temperature and heater voltage were not evaluated. Assuming that the circuit design was altered to bring the plate dissipation just barely within the rating, the plate dissipation should be confirmed by measurement.

Before proceeding with measurements, a bogey tube must be selected. For this application, a tube having plate current and cutoff voltage approximately equal to the values listed in the "Average Characteristics" or "Typical Operation" sections of the published data will be considered bogey.

Next, the equipment is set up under the following conditions to obtain worst probable conditions for plate dissipation, bulb temperature, and high heater voltage:

1. Bogey tube in the stage being evaluated
2. Supply voltage at high line (129 v)
3. Cathode resistor at the minimum value normally encountered (350 ohms)
4. Load resistor at the minimum value normally encountered (4500)
5. Zero signal

Measurements are made of plate dissipation, bulb temperature, and heater voltage under these conditions. The supply voltage is then adjusted to low line (105 v) and heater voltage is measured. The measurements are compared with the corresponding ratings. If all items are within the maximum and minimum values specified, the tube is operating within its ratings. If any one rating is exceeded, the tube is operating beyond its ratings.

For a more detailed presentation of the design-maximum rating system, including a far greater variety of examples of the determination of conformance to these ratings by means of measurements, reference should be made to Joint Electron Device Engineering Council Publication J5-C3, entitled "The Design-Maximum Rating System for Electron Tubes." ■ ■

# Fansteel Announces the First Space-Age Breakthrough in the Fabrication of Tungsten!



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Once again, Fansteel has unlocked the door to unlimited new uses for a valuable metal! Now we have ways to fabricate tungsten into involved shapes heretofore impossible . . . and through such economical processes as spinning, deep drawing, hot extrusion and forging!

Now . . . tungsten—with its melting point of 6152°F., highest of all metals, its terrific strength at high temperatures, its outstanding density of .697 lbs./cu. in.—can be exploited to the fullest. Great advances can now be made in the fields of missiles, nucleonics, aviation, medicine . . . even consumer products. Fansteel has broken through to the secret of fabricating tungsten . . . its potential is now unlimited.

Imagine rocket nozzles with tungsten's fabulous heat/strength

properties. Or a tungsten-encased atomic power plant weighing just five pounds. Picture a pure tungsten gyroscope rotor, almost 25% smaller than is now possible, yet retaining complete functional reliability due to its low coefficient of expansion.

Tungsten electronic tube components, tiny wristwatch flywheels and thousands of other applications are now also feasible with Fansteel's tungsten fabrication know-how.

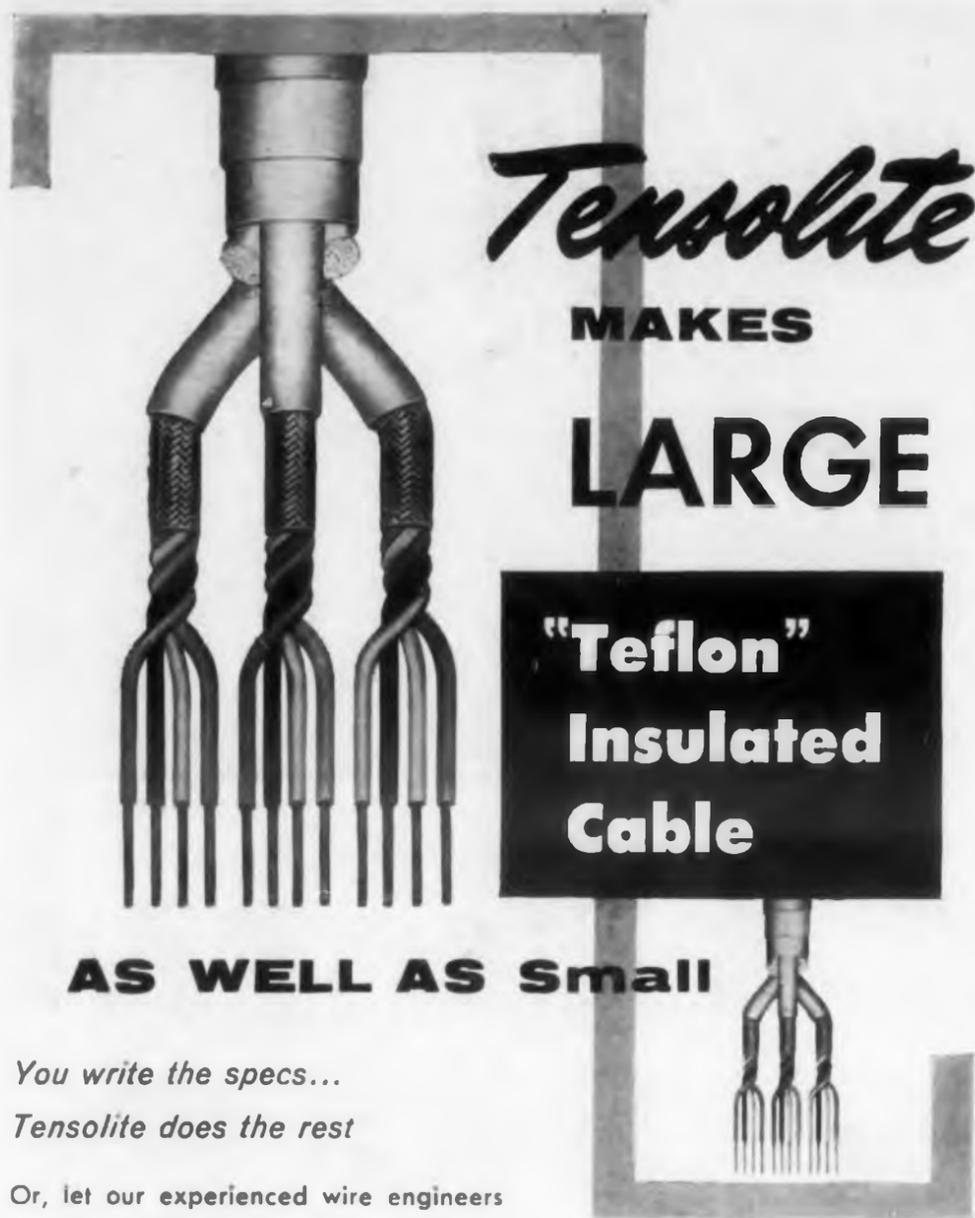
This revolutionary knowledge is so new that we can't supply bulletins, technical information, or other printed data. But our engineers will be glad to cooperate with your own designers and production people in adapting tungsten and these new fabricating techniques to your part or product. Just send print, part samples or call in the Fansteel representative.



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MAKES

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## Photorectifier Plates

### Save Space,

### Cut Costs

**D**ESIGNED to replace conventional diode lattices in digital computers, these photorectifier plates save space, cut costs and reduce installation time. Plates with 100 photorectifier cells per sq. in. are now being manufactured, although densities up to 256 units per sq. in. are possible.

The photorectifier plate is a sandwich consisting of a transparent conductor, a cadmium sulfide photoconductor and a rectifying conductor. When exposed to light the cells in the plate act like diodes, but in the dark they are the equivalent of an open circuit. Called Rex-Array, they were developed by MIT's Lincoln Laboratory and are made by Rex Corporation, West Acton, Mass.

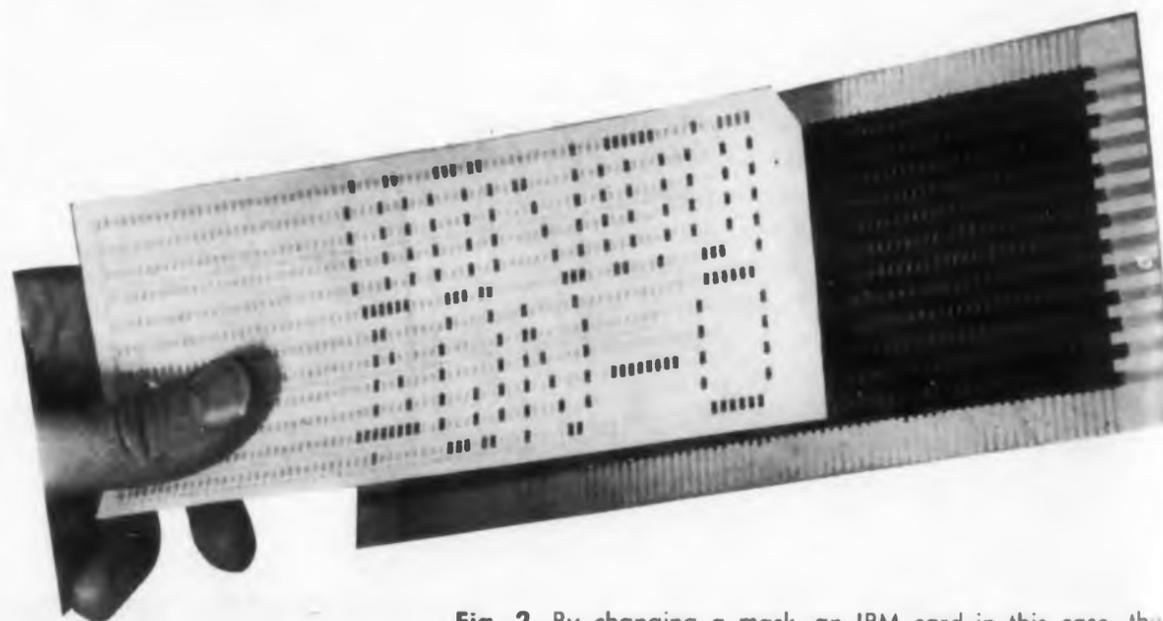
#### Masks Control Cells

Masks, in the form of punched IBM cards or photographic negatives, can be used to control the light striking the cells. Illuminated cells become part of the computer circuit and programming of the computer is quickly effected by changing the mask covering the photorectifier plate—not the diode network.

These plates can be used in existing computers in place of conventional diode networks. They occupy less than one twentieth of the equivalent diode space.

#### Applications

A typical application of photorectifier plates is in stores where merchandise is



**Fig. 2.** By changing a mask, an IBM card in this case, the function of the photorectifier plate is altered.

## PUTTING MAGNETICS TO WORK



**Fig. 1.** This photorectifier plate replaces 1600 diodes, like the one shown on it.

identified by small punched tickets. Instead of transferring data from the tickets to IBM cards for sales or inventory research, the tickets can be fed directly to a computer having these plates. This cuts down the chance of error during the transfer of data and increases the usefulness of the computer.

Other applications in computers include character recognition which occurs in searching through microfilm, mathematical analyses and language translation.

### Electrical Characteristics

Each cell has a forward resistance of from 10 to 20 K at 10 v under illumination. The back resistance is about 500 to 700. In the dark the cell is an open circuit with a resistance of hundreds of megohms.

Time to make the transition from the high impedance state (unilluminated) to the diode state (illuminated) is 100 msec. The electrical response in the diode is less than 1  $\mu$ sec.

Photorectifier plates can be packed in arrays as needed, with lug connections for wiring. An array of 12 x 80 cells requires 90 solder connections as compared to 1920 required for 960 diodes.

A cell 4 mils thick has a peak response to a light wavelength of 6700 A. Spectral response varies with cell thickness and copper concentration.

For more information on these photorectifier plates, turn to the Reader Service card and circle 101.



## How to keep your cut-off sharp!

Audio filter designers use molybdenum permalloy powder cores when they want razor sharp attenuation that will hold

Audio filter designers, faced with a crowded frequency spectrum, specify molybdenum permalloy powder cores to rigidly define channel cut-offs . . . with sharp, permanent attenuation at channel cross-overs.

Moly-permalloy, with virtually no resistive component, makes a core with almost no core loss. The resultant high Q means sharp attenuation of blocked frequencies in both the high and low band pass ranges. This is permanent—moly-permalloy cores were developed specifically to provide a very long term inductance stability.

Compare molybdenum permalloy to powdered iron. See the smaller size and the superior stability despite unusual fluctuations in current or temperature. Even unstabilized permalloy powder cores are more stable with temperature swings

than cores made of any other material. And . . . stabilized cores are at least four times more inductance-stable than unstabilized cores.

What's more, there's no longer any guesswork! We have published limits within which the designer can depend on core performance. These limits—and full information on our Performance-Guaranteed permalloy powder cores—await your inquiry. *Magnetics, Inc., Dept. ED 61, Butler, Pa.*

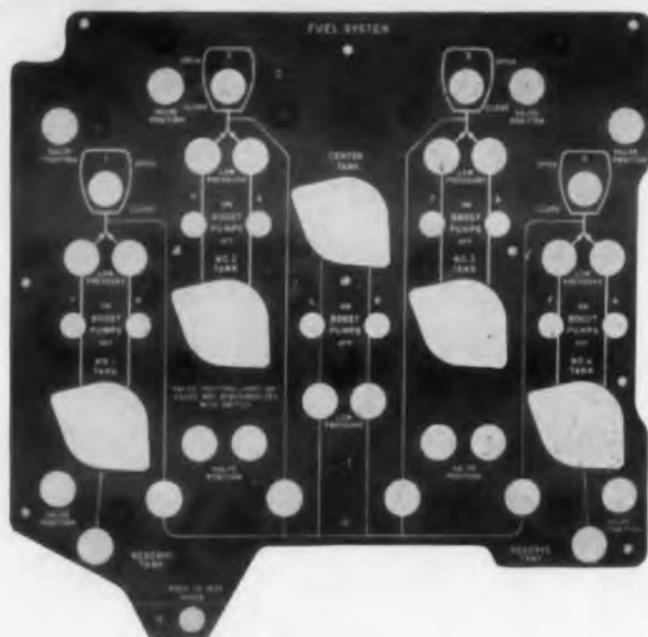
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in the Boeing 707...



## NEW INSTRUMENT PANEL GIVES ACCURATE FUEL DATA AT A GLANCE



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In designing the Boeing fuel system panels, as in production of its entire line of edge-lighted dials and panels employing the Lackon® process, U. S. Radium utilizes experience and facilities unsurpassed in more than 30 years of service to component fields. The company offers a complete selection of "light-engineered" dials and panels for military and non-military applications. Technical consultation is available on request.

Request Bulletin 10.30D4



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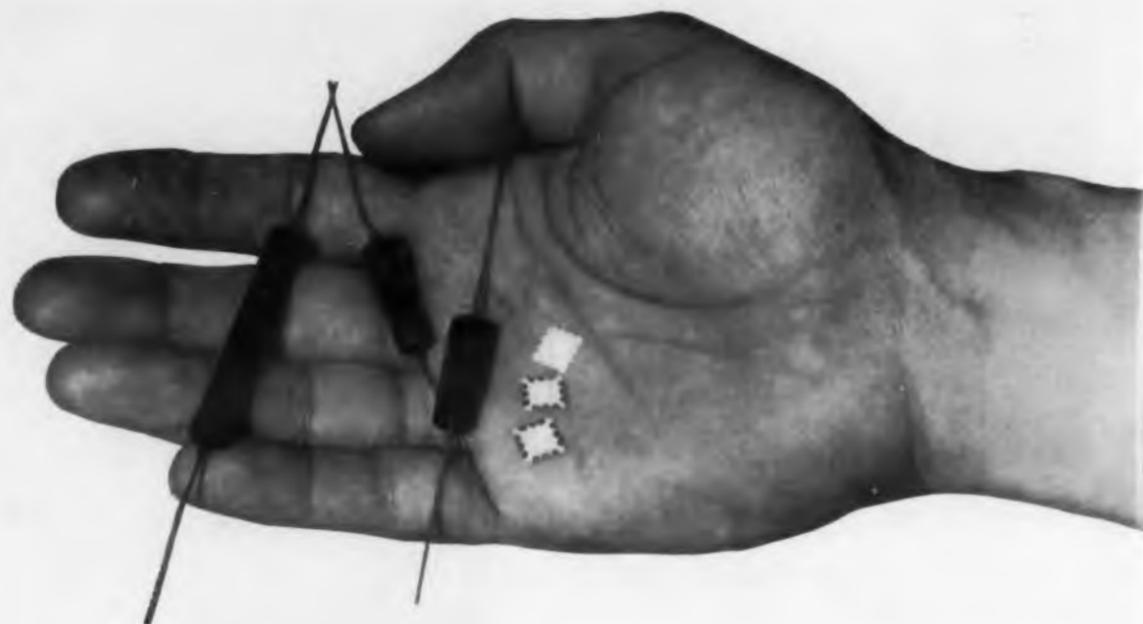


Fig. 1. Weston's wafer-type resistors compared with conventional resistors.

## Microelectronics Now for Sale

**M**ICROMINIATURE components and microminiature subassemblies are available in limited quantities for military electronics applications. Based on the Signal Corps Micro-Module program, the wafers and subassemblies will enable designers to take full advantage of the reader reliability and improved packing density offered by the development.

Daystrom-Weston Instruments has announced the availability of resistors mounted on ceramic 0.3-in. sq. wafers. Each wafer contains four resistors. They have a power rating of 1/8 watt at 70 C. Resistance values range from 100 ohms to 1/4 megohms in tolerances of 10, 5 and 1 per cent. Noise level is approximately -200 db.

Weston's resistors are made of a nickel-chrome alloy coated on an alumina-structured wafer in molecular thickness. After the resist coating is deposited, isolation lines are scribed on the metal film coating

as shown in Fig. 1.

These resistors fulfill the requirements of MIL-R-10509C. Their mean time to failure is estimated to be 100,000 hours. Failure is defined as a greater than 1 per cent resistance change at full power dissipation at 70 C.

Price of the resistors is \$20 per wafer. Sample quantities of 10 to 20 are available from Weston. More production, perhaps in quantities of hundreds, will be possible in about 6 months. In about 15 months, Weston expects to be making about 25,000 resistors a week. Resistance range of the units will be expanded also. It is expected to cover 10 ohms to 1 megohm at double the power dissipation.

As the resistors are constructed now, about 15  $\mu$ f capacitance exists between the two sides of the wafer. It may be possible to build a complete resistance-capacitance network by properly orienting the resistance patterns on the wafer.

### Complete Assemblies, Too

RCA has also announced the availability of their micromodule subassemblies in 15 circuit varieties. These RCA units, developed for the Signal Corps Micro-Module program, consist of assemblies of the standard 0.3-in. wafers, Fig. 2. The wafers are interconnected and encapsulated to form modules with parts densities up to 600,000 parts per cubic foot. This is a ten times reduction over the most miniaturized commercial equipment available today.

Initially, RCA will sell engineering samples of 15 circuits. They include:

Type	Description	Price
DM0013	Binary Divider (consists of 2 modules)	\$247.30
DM0014	Gate	70.45
DM0015A	IF Amplifier (4.3 MC)	69.35
DM0016A	Limiter (4.3 MC)	80.30
DM0017A	Discriminator	68.10
DM0018A	Audio Amplifier	97.60
DM0020A	RF Amplifier (49.4 MC)	71.75
DM0021A	Mixer (4.3 MC)	46.60
DM0022	Sawtooth Generator (8 KC)	94.20
DM0023A	Time Modulator	131.20
DM0024A	Oscillator (192 KC)	114.90
DM0025	Clipper	118.35
DM0026A	Pulse Shaper	134.45
DM0027	Output Amplifier	88.30
DM0028A	Pulse Generator	122.65

Circuits of the pulse generator and i-f amplifier are shown in Fig. 3.

Tentative data sheets are available from the RCA Semiconductor and Materials Div., Somerville, N.J. All of the modules are single solid elements of uniform shape. Using the modules, electronics designers will be able to construct a wide variety of assemblies in a number of shapes.

For more information on these micro-miniature components and subassemblies, turn to Reader-Service card and circle 107.



Fig. 2. Assembly of RCA's Micro-Modules now available to engineers designing military electronics equipment.

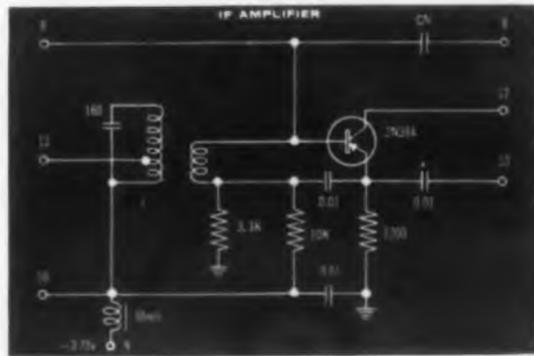
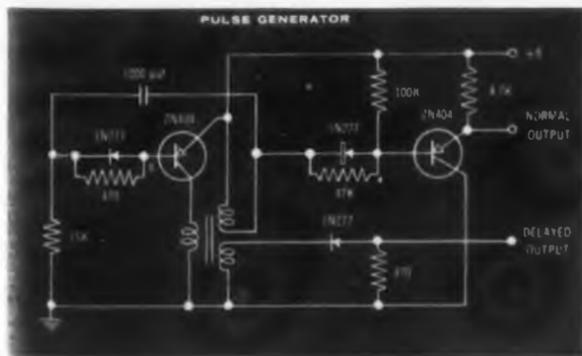


Fig. 3. Circuits of the pulse generator and i-f amplifier now being sold in Micro-Module form.

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### New DIGITAL MOTORS

Positive lock — bi-directional stepping motors

These bi-directional digital motors are designed to withstand severe environmental requirements and are operable under high shock and vibration. In its function the digital motor indexes and locks positively.

The motors are available for angular rotation of 30° or 36° at a rate of up to 40 pulses per second.

### ULTRASONIC DELAY LINES

Custom-designed



Development engineers can now employ new concepts in existing and projected applications. These delay lines are small in size, hermetically sealed and vibration proof.

#### SPECIFICATIONS

Delay range . . . 5 to 6000 microseconds  
Meets tolerances of . . . ±0.1 microsecond  
Signal to noise ratio . . . Greater than 10 to 1  
Input and output impedance . . . 50-2000 ohms  
Carrier frequency . . . . . 100 kc — 1 mc  
Delay to pulse rise time . . . . . Up to 800:1

### TIME DELAY RELAYS

Instant reset — voltage compensated



Curtiss-Wright "IR" thermal time delay relays reset the instant that they are de-energized. Variations from 22 to 32 volts will not affect the time delay specified.

#### SPECIFICATIONS

Time delay . . . . . Preset 20 to 180 seconds  
Contact arrangement SPST, SPDT, DPDT  
Temperature comp. . . . . -65°C to +125°C  
Weight . . . . . 4½ ounces  
Terminals . . . . . Hooked solder type  
Mounting . . . . . Bracket or stud

WRITE FOR COMPLETE COMPONENTS CATALOG 159

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# VHF UHF Broadband Balun Designs

F. J. Triolo & J. R. Christian

U. S. Army Signal Research And Development Lab.

Ft. Monmouth, N. J.

**T**HE PROBLEM of balanced-to-unbalanced impedance matching can be solved by using bifilar and line type baluns. Both transformers were found to be satisfactory electrically and their swr over the frequency range was well within the allowable 1.5 to 1. Both balun types have a potentially wide application in the vhf and uhf frequency range. The bifilar coil balun by not requiring a precise balanced compensating input section is especially attractive over a 5.0 to 1 frequency range where the swr can be relaxed to 2 to 1 and stringent balance requirements are not required.

## Bifilar Coil Type Balun

Operation of the bifilar balun is based on the transformer principle that two transmission lines can be connected in parallel at the input end of the balun and in series at the other end, providing inherently a 4 to 1 impedance transformation ratio. Figs. 1a and 1b show diagrams of 75 ohm to 300 ohm bifilar coil balun and its equivalent circuit. For application with a double rhombic antenna shown in Fig. 2, a 50 to 300 ohm (6 to 1) impedance transformation is required.

For matching different impedances with a quarter wave section of line having a characteristic impedance equal to their geometric mean which, in this case, is 122 ohms, a 6 to 1 impedance ratio can be obtained over a relatively wide

frequency range. Accordingly the bifilarly wound transmission line section is designed for the proper spacing to give a 122.0 ohm characteristic impedance. The length of line chosen is adjusted to a quarter-wave length at the geometric center design frequency of 490 mc. Two sections of transmission line are wound bifilarly on separate teflon coil forms and arranged as shown in Fig. 3.

Since the lines lay actually in two different media when wound on grooved coil forms (air and teflon), the formula for the characteristic impedance of lines using air exclusively as the dielectric does not yield the proper spacing for the wire size used and the characteristic impedance required. Using Eq. (1), the proper line spacing can be calculated. The formula for the characteristic impedance of a two wire line<sup>1</sup> in a homogeneous medium is:

$$Z_0 = \frac{120}{\sqrt{\epsilon}} \log_e \frac{2D}{d} \quad (1)$$

where:  $Z_0$  = characteristic impedance

$D$  = line spacing

$d$  = wire diameter (same units as line spacing)

$\epsilon$  = dielectric constant of the medium

For the condition where the line is imbedded partially in air and partially in another dielectric

in such a way that the cross-sectional view remains the same along the line, the formula is the same except that  $\epsilon$  is replaced by  $\epsilon(\text{eff})$  which is the "effective" dielectric constant. For the special condition that the medium is half air and half teflon, and the boundary between them is a plane through the axes of both wires,  $\epsilon(\text{eff})$  is simply the arithmetic average of the dielectric constants of air and teflon. This is the case in the bifilar coil balun transformer where the depth of the grooves in the coil form equals half the wire diameter.

To optimize design data and determine power handling capabilities, a number of experimental models of bifilar coil baluns incorporating various changes, number of turns, pitch and wire size can be constructed and tested. The data obtained from these experimental models lead to the design of the final model having 4 turns of #21 AWG wire wound bifilarly on teflon coil forms, wound with a pitch of 6 turns per inch. This arrangement proved to be satisfactory as indicated by an swr plot. The impedance curve is approximately centrally disposed in the frequency range around a normalized impedance of 50 ohms with a standing wave ratio of 1.23 to 1.

To determine the broadbanding capabilities of the transformer the impedance measurements are extended above and below the required frequency range. Results of these additional measurements indicate that the swr is 1.8 to 1 from 300 to 920 mc (3.06 to 1). Equipment for further extending the measurements especially below 300 mc is not available, but measurements on later models indicate that a bandwidth of approximately 5 to 1 is obtainable before an swr of 2 to 1 is exceeded.

## Obtaining Perfect Balance

The degree of balance at the output terminals of the above balun transformer is near perfect only at the design frequency. While this condition is acceptable for applications in which a high degree of balance throughout the frequency band is not required, it is not considered satisfactory for application as a component of the double rhombic antenna. Provision is made for obtaining an input to the final version of the bifilar balun which is precisely balanced regardless of frequency. This is accomplished by placing a shorted stub, with an adjustable short, across the input terminals of the bifilar balun and feeding the coaxial cable through one of the tubular conductors of the stub. The degree of balance depends only on the accuracy with which the construction is made physically symmetrical.

A shorted stub, however, represents a parallel inductance across the balun input terminals at frequencies below that for which it is a quarter wavelength long and a parallel capacitance at

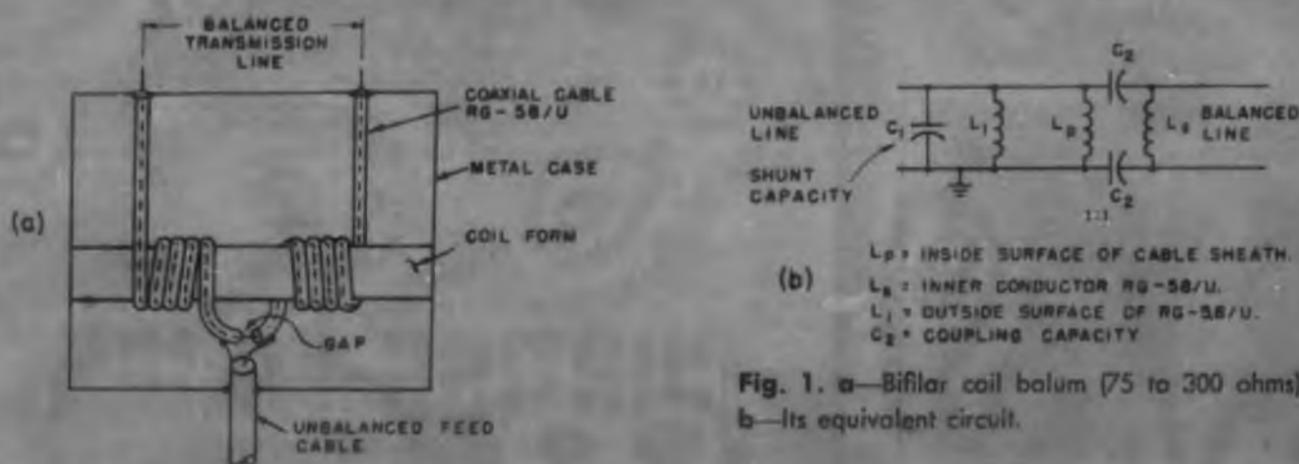


Fig. 1. a—Bifilar coil balun (75 to 300 ohms). b—Its equivalent circuit.

the higher frequencies. A means of compensating for this reactance consists of inserting an open quarter wave stub in series with the parallel combination of the shorted stub and the balun input terminals. Fig. 4a shows the physical representation of such an arrangement and Fig. 4b is the equivalent circuit. The following analysis of the equivalent circuit will show the proper conditions for optimum compensation.

Impedance  $Z$  into which the cable is looking is (neglecting stub losses):

$$Z = -j K_o \cot \beta_o l_o + \frac{Rj K_p \tan \beta_p l_p}{R + j K_p \tan \beta_p l_p}$$

where  $j K_o \cot \beta_o l_o$  = Input impedance of an open stub of characteristic impedance  $K_o$  and electrical length  $\beta_o l_o$

$j K_p \tan \beta_p l_p$  = Input impedance of a shorted stub of characteristic impedance  $K_p$  and electrical length  $\beta_p l_p$

$$\beta = \frac{2\pi}{\lambda} = \frac{\omega}{v} = \text{propagation constant}$$

$$Z = Rj K_p \tan \beta_p l_p \frac{[R - j K_p \tan \beta_p l_p]}{[R^2 + (K_p \tan \beta_p l_p)^2]}$$

$$- j K_o \cot \beta_o l_o$$

As long as the term  $K_p \tan \beta_p l_p$  is large compared to  $R$ , i.e. if the shorted stub is nearly a quarter wavelength long ( $\beta_p l_p$  90 deg.), the error made in neglecting the term  $R^2$  in the denominator is small of the second order. Therefore:

$$Z = R + j \frac{R^2}{K_p} \cot \beta_p l_p - j K_o \cot \beta_o l_o$$

For compensating conditions:

$$K_o \cot \beta_o l_o = R^2 \frac{\cot \beta_p l_p}{K_p}$$

In order to hold independent of frequency (within the limits for above approx.)

$$\beta_o l_o = \beta_p l_p \text{ or } \frac{l_o}{v_o} = \frac{l_p}{v_p}$$

where  $v_o$  and  $v_p$  are the propagation velocities of the shorted and open stubs respectively, and:

$$R = \sqrt{K_o \cdot K_p}$$

In the case of the bifilar coil balun transformer,  $R$  is given as 50 ohms. For the reason of making the above approximation hold true over as wide a frequency range as possible it is advisable to make  $K_p$  as high as possible. After consideration of the dimensions required for installation of the

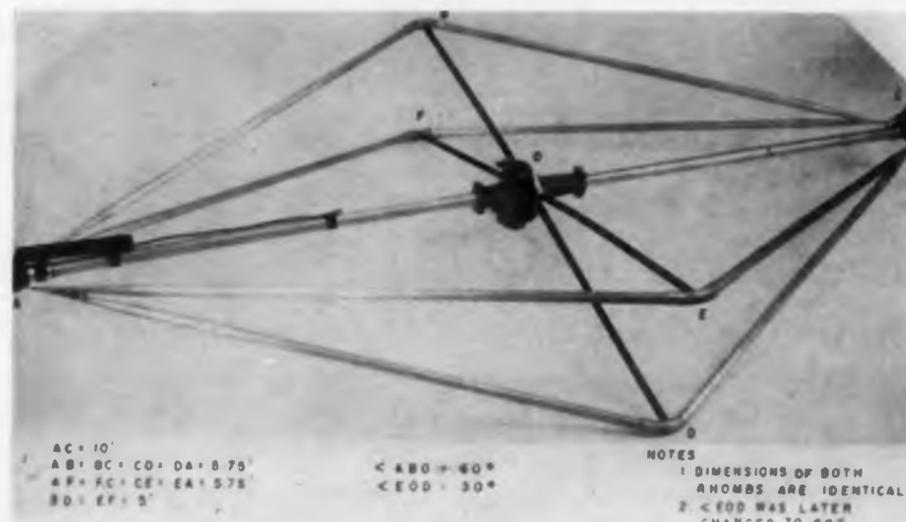


Fig. 2. Double rhombic, experimental antenna.

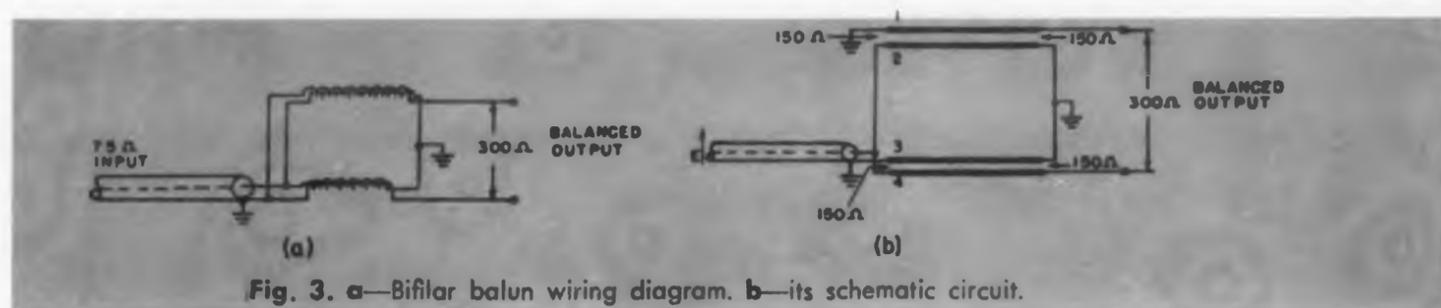


Fig. 3. a—Bifilar balun wiring diagram. b—its schematic circuit.

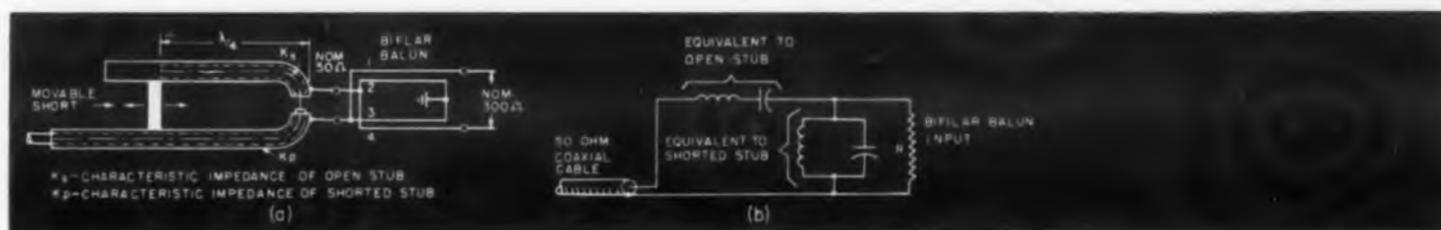


Fig. 4. a—Physical arrangement for connecting open stub in series with shorted stub across bifilar balun. b—equivalent circuit for Fig. 4a.

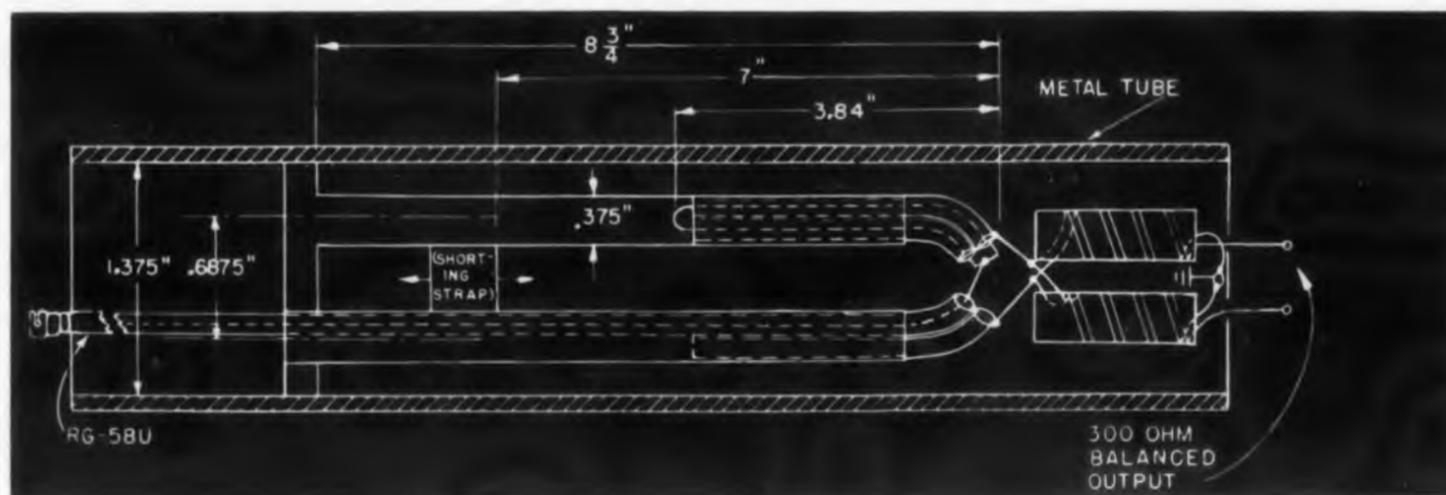


Fig. 5. Bifilar coil balun connected to its compensated input balun.

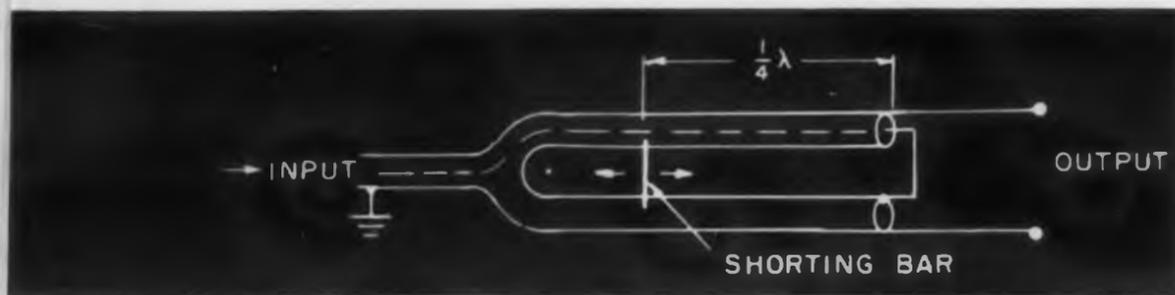


Fig. 6. Balun section.

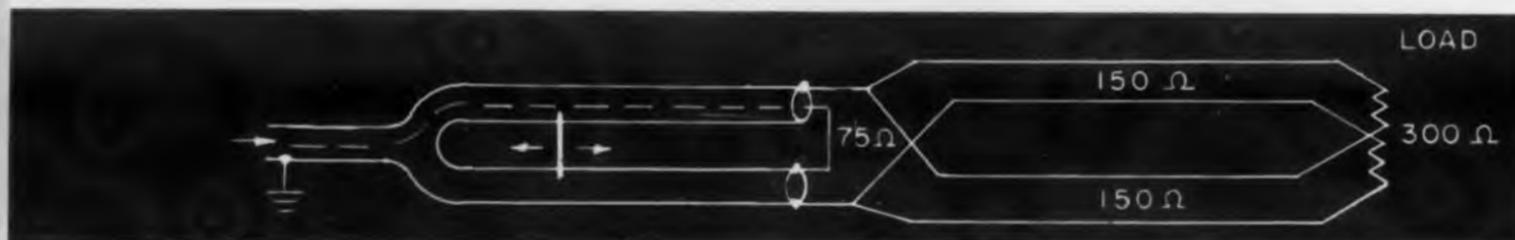


Fig. 7. Line type balun. Balun and transformer section combined.

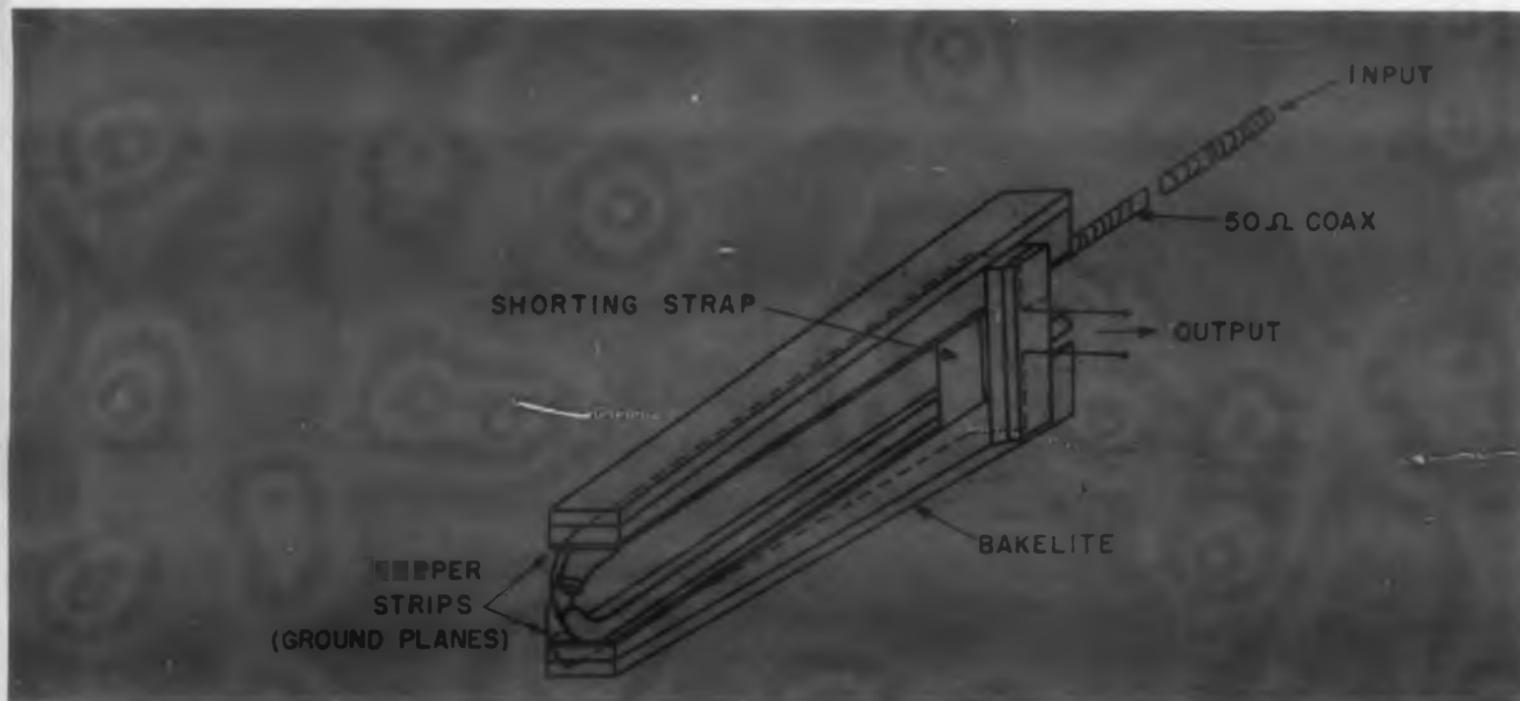


Fig. 8. Experimental line type balun transformer line sections tapered.

balun within the confines of the antenna diagonal tubular support (inside diameter of 1.375), a shorted stub was designed with a calculated characteristic impedance  $K_p$  of 116 ohms. With these values of  $R$  and  $K_p$ ,  $K_s$  is required to be 21.5 ohms. A cable with a characteristic impedance of this value was not available but by paralleling two sections of 50 ohm coaxial cable (RG-58/U) it is possible to obtain an open stub with  $K_s = 25$  ohms which was considered close enough to the desired value.

Utilizing the above mentioned values the input admittance of the compensated balun terminated into a 50 ohm load is calculated to determine the effect of this type of compensation. If the results are plotted, it will be noted that over the fre-

quency range of interest the calculated standing wave ratio obtainable is 1.04 to 1. A compensated balun can be constructed accordingly, terminated with the bifilar coil balun and measured with respect to input impedance over the frequency range. Fig. 5 is a diagram of a compensated balun constructed for making the required measurements. The measured swr over the 400 to 600 mc was found to be 1.34 to 1. The swr can probably be improved by making refinements in construction and more careful adjustments electrically, but this is not considered as warranted inasmuch as the swr of the load (bifilar balun) is measured separately as 1.23 to 1 in the 400 to 600 mc region and very little material improvement could have been effected.

#### Line Type of Balun Transformer

The line type of balun transformer combines the use of the potential transformer principle and a basic balun configuration to obtain an unbalanced to balanced impedance transformation.

The basic design can be separated into two distinct sections: the balun section and the transformer section. The balun section is constructed of a parallel coaxial quarter-wave section as shown in Fig. 6. A variable short is included for optimum adjustment at the design frequency. This section transforms the unbalanced input to a balanced output without any change in impedance. The transformer section consists of two parallel quarter wave line sections which, when connected as shown, inherently give a 4 to 1 impedance transformation. By connecting the balun and transformer sections as shown in Fig. 7, a line type balun transformer configuration with a 4 to 1 impedance transformation is obtained. This configuration may be made more compact by folding the transformer section back on to the balun section. For this arrangement the coaxial shield of the balun section is used as the ground plane for two separate quarter wave lines over and parallel to a reference ground plane. If an impedance transformation greater than 4 to 1 is required this can be achieved by tapering the line sections toward the output at an exponential rate necessary to give the desired ratio.

A model can be constructed employing an approximate exponential line in the transformer section to obtain the required 6 to 1 impedance transformation. This model is shown in Fig. 8. An swr plot over the frequency range proves to be well within the requirements. Since the balun eventually is to be encased within the horizontal diagonal metal support of the double rhombic antenna, its characteristics would change because of additional capacity effects when this is done. In anticipation of this effect the design of the exponential line showed up changed so that each conductor is imbedded in a "trough" type shield having a styrofoam dielectric. In this design, instead of the line spacing being tapered the conductor itself was tapered throughout its length. Measurements on the balun with "trough" line sections placed inside a length of tubing to stimulate its operational location indicated little change in the standing wave ratio over the frequency range. An open stub in series with the shorted stub across the input to the tapered line sections were also utilized with the line type balun.

#### Power Tests

The power handling capabilities of the final experimental models of both types of baluns can be determined by power tests, performed at 400 mc. A maximum power of 130 watts available is

fed into both models for a period of 6 hours. At the conclusion of the test both baluns are examined and their impedance measured. Standing wave measurements of the compensated bifilar type balun indicates no material change while those of the line type balun show extremely high standing wave ratios which indicate that this balun has failed sometime during the power tests. Apparent failure of the 50 ohm coaxial input cable is probably caused by excessive heat. Apparently when the coaxial cable shield is soldered to the trough type shield during construction a considerable amount of heat is applied which probably weakened the cable at the points of attachment. The application of sustained heat during the power tests eventually causes the failure. It is also noticed that the input leads of the tapered transmission line are not properly positioned and are subject to movement due to mechanical weakness of the styrofoam dielectric material used in this improvised model.

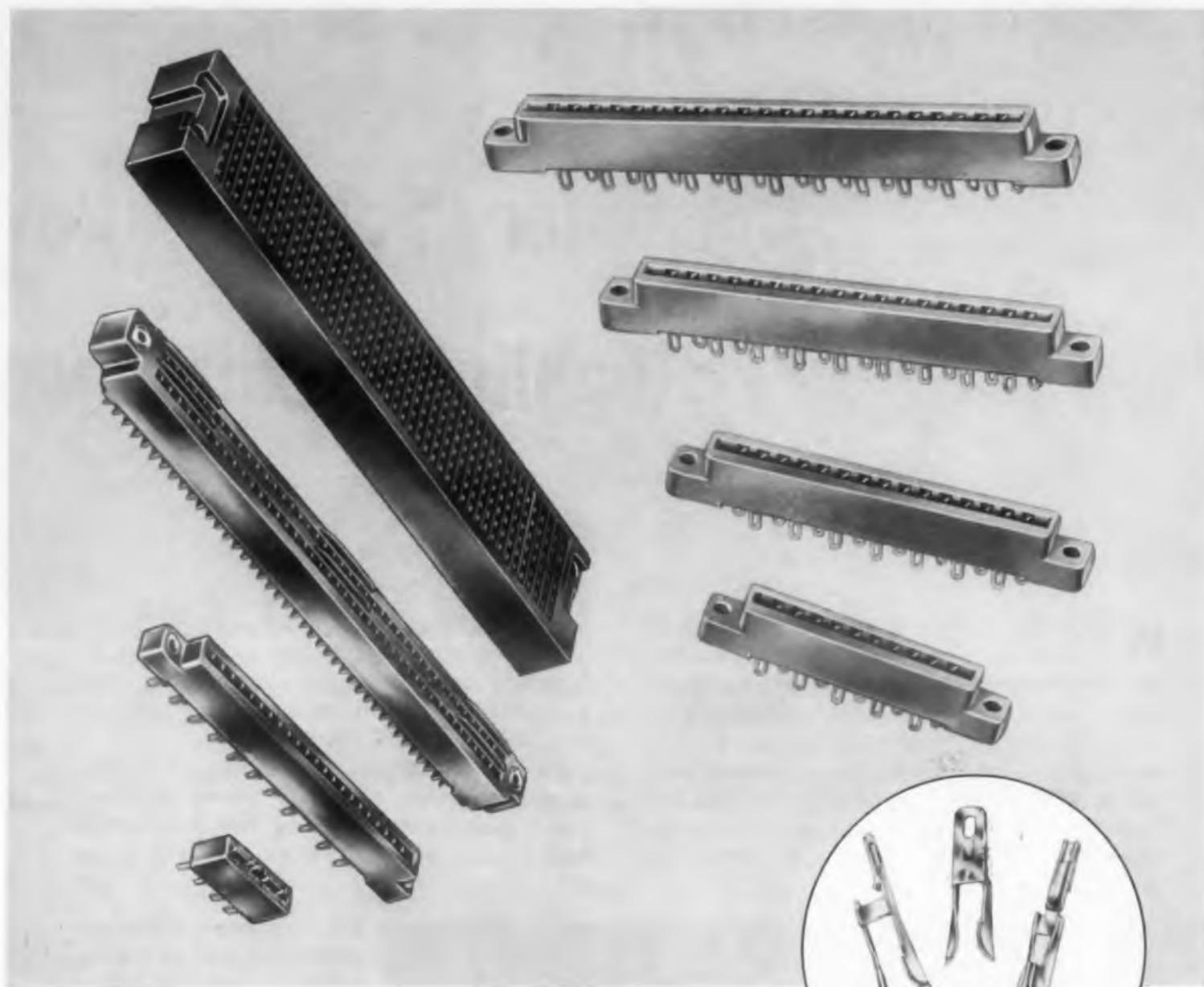
#### Evaluating Both Baluns

The final compensated bifilar coil balun meets all the mechanical requirements of size, configuration and general ruggedness. The line type balun, however, has a few mechanical defects and requires redesign before it can be considered acceptable. For instance, the styrofoam dielectric presently used in the "trough" sections of the balanced output side should be replaced with one having a greater rigidity. The use of another dielectric would necessitate a redesign of the trough sections both mechanically and electrically. Another change would require mechanical clamping of the coaxial cable to the trough sections. Excessive heat from soldering causes the dielectric in the coaxial cable to flow and introduces points of reflection due to change of the characteristic impedance of the cable at these points and eventually contributes to failure of the balun under high power.

In its present form the compensated bifilar coil balun transformer is capable of being used with the double rhombic antenna without any major design changes. As indicated above, the line type balun transformer is not suitable for use in its present form. There is no doubt, however, that this transformer would be equally satisfactory provided its mechanical defects were corrected. The bifilar balun is more costly to manufacture than the line type of balun but not excessively so. If the mechanical defects of the line type balun were to be corrected, it is possible that its cost of manufacture would very well equal that of the bifilar type balun. ■ ■

#### Reference

1. Reference Data for Radio Engrs, 3rd Edition, Federal Telephone and Radio Corp.



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# Computer "Forever" Devices

## Highlight Conference

T. E. Mount  
Assistant Editor

**N**OTABLE at the Western Joint Computer Conference in early March (San Francisco) was the increased emphasis over last year on the use of magnetic materials as computer components; a strong interest in information retrieval; and a push for education. The conference drew about 1800 people, somewhat more than last year. Seventy one papers were given during the three days. Exhibitors numbered 38 and used 64

booths to display their wares.

Three scheduled papers and a near-secret exhibit in a hospitality suite underscored the trend toward using magnetic materials as storage devices and in transfer circuitry.

The latter is of particular significance. Feeling at the conference was that "forever machines" (used properly, they should last indefinitely), built of chunks of ferrite and copper with no ac-

tive elements or diodes, would change computer design philosophy substantially. Consciousness of cost and size and availability of components influences the computer designer, just as it does any other designer.

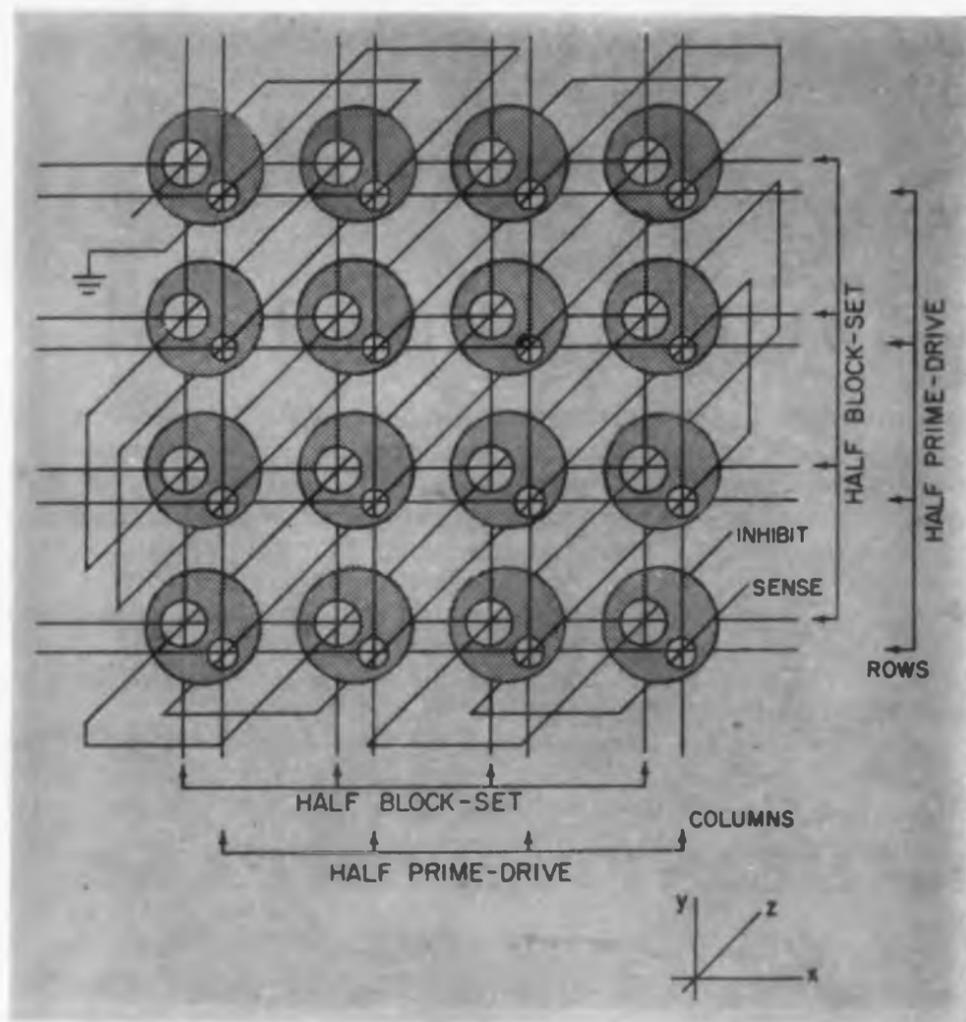
Up to the present, switching has been a big problem. There are lots of memories around—but drivers, selectors, switches, ways to get into and out of the memory—have been bulky and expensive. The new combination magnetic devices seem to be a good answer.

And they are here. AMP, Inc. of Harrisburg, Pa., was showing, by very special invitation, a ferrite core-and-copper demonstration shift register. It handles ten bits. There are no diodes in the device. What the cycling rate of the device was AMP declined to say, and we weren't able to tell from looking at it. The company is presently tooling for production, but market considerations require them to move cautiously. *ELECTRONIC DESIGN* will feature full details on the new shift register when it becomes available.

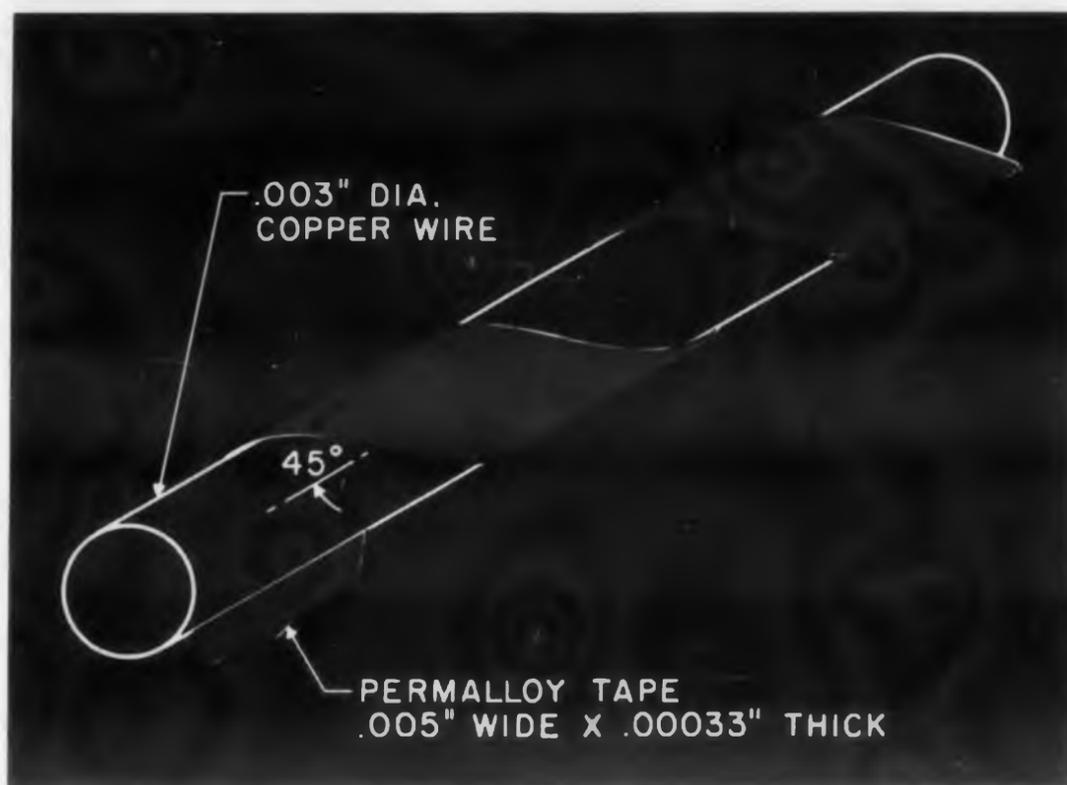
### Multiload Transfluxors

Multiload transfluxors were described in a paper by RCA's Hammel, Morgan and Sidnam. The original Rajchman and Lo two-hole transfluxor was announced two or three years ago at the WJCC. It is shown in Fig. 1. A high-remnant ferrite core with a large hole in the center, used for writing, and a small hole in the rim, used for reading, the transfluxor can perform a non-destructive readout. Transient noise may cause error, but does not affect the information in a transfluxor memory (since it doesn't have to be rewritten from the output). Upon detection of a read error, the computer can immediately repeat the read operation.

Since one of the attributes of the transfluxor



**Fig. 1.** A matrix of two hole transfluxors. Each of the two transfluxor holes has its own set of selection wires. Because of separate addressing systems for reading and writing and negligible interaction between aperture signals, writing and reading can be carried on simultaneously. Large hole is for writing; small for reading.



**Fig. 2.** Twistor wire used for nondestructive sensing. Three mil copper wire has a magnetic tape wrapped around it at 45 deg angle for helical magnetization. Material used is 4-79 permalloy. Tape has coercive force of 3 oersteds, cross-section of 5 x 0.3 mils. Length of wire per bit is 60 mils. Presence of external magnetic field has inhibiting action on twistor.



**Fig. 3.** Twistor matrix memory with 512 word, 26 bits per word capacity. Program or other semipermanent data is changed by removing plastic board with permanent magnets etched on it, substituting a new program. Size of module will soon be halved.

is signal isolation between the windings of the small hole and the large hole, it is possible to consider a transfluxor with three, four, five or more holes—the multiload transfluxor. The RCA paper described the basis of a new type of memory system, possible by taking advantage of the multiload transfluxor's nondestructive read characteristics, separation of the read and write functions, and ability to read from several memory locations into different loads while a simultaneous write instruction is executed.

Each readout is delivered to its own independent load. Rewrite time, necessary in conventional core memories, is eliminated by the nondestructive read property. These characteristics, say the authors, will give "considerably more flexibility and speed" to a transfluxor memory.

#### No Delays Needed

Perhaps more important is the fact that the independent operation of the various parts of the memory can facilitate communication between sections of a computer—or between two computers. *All parts of a computer network could operate without memory time-sharing delays.* Hammel, Morgan and Sidnam propose a five-hole transfluxor memory, and say three or more

computers could share a common memory if this were used. It promises to be a major advance in computer design.

#### MAD Circuitry

Bennion and Crane of Stanford Research Institute described the design and analysis of MAD—Multi-Aperture Device—transfer circuitry. Presumably AMP's shift register uses this system. The paper reviewed the basic approach, developed various schemes for improving the operational properties, and analyzed the coupling loop. A flux-gain equation was developed which showed that unity-turns-ratio coupling loops are practical in the system. Since a shift register is the simplest significant example of a sequential binary logic system, all the design and results were discussed in terms of such a structure.

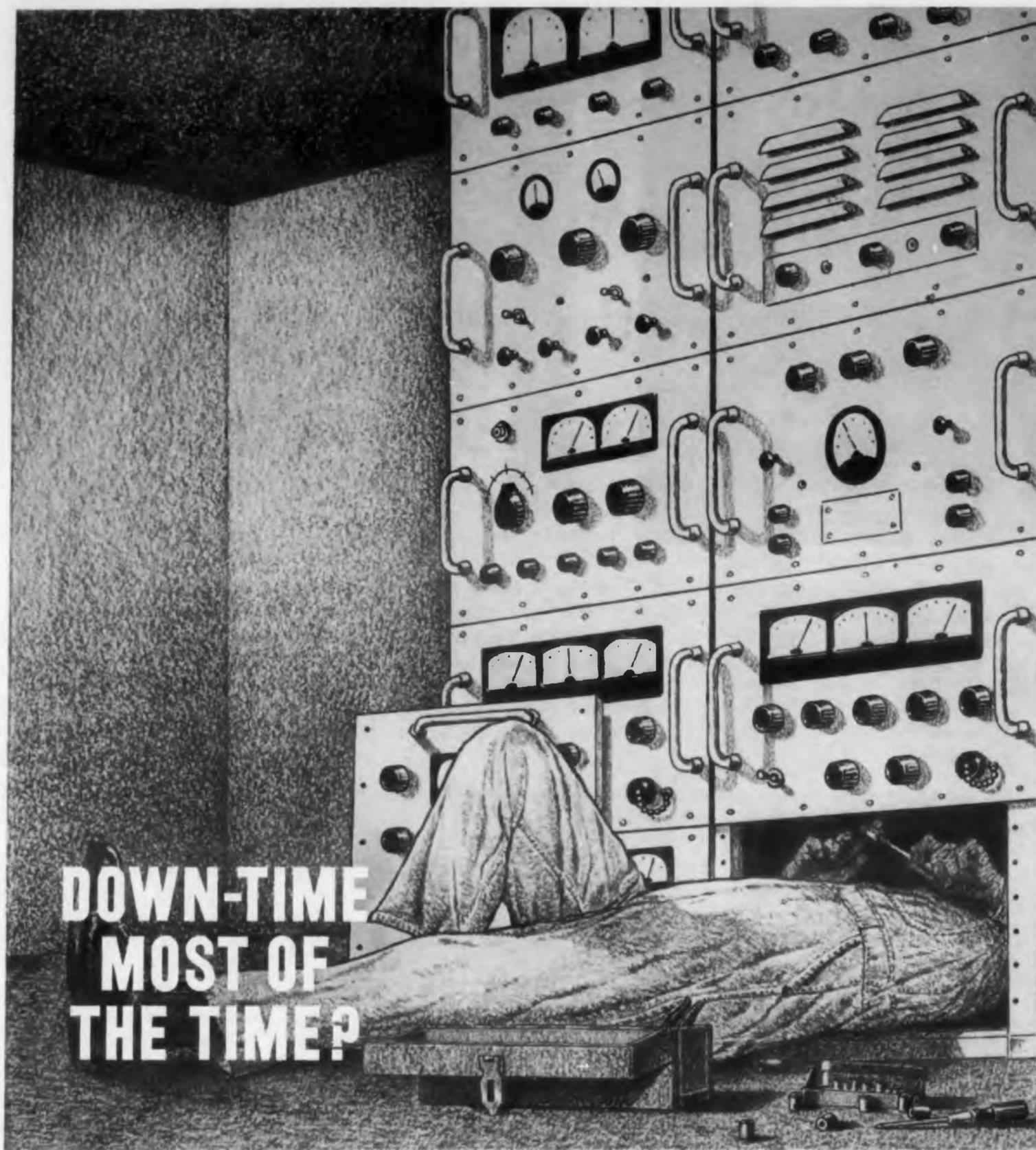
Another nondestructive readout memory was described in "A Twistor Matrix Memory for Semipermanent Information" by Bell Labs' Dunc Looney. It was designed for digital computers in which the program, translation data or other large blocks of information are seldom changed. The information is stored on an array of permanent magnets arranged on a plastic board. A permanent magnet's presence is sensed non-

destructively by the inhibiting action of its field on a twistor (shown in Fig. 2). Neither the read nor the reset operation depends on a coincidence of currents; consequently the time to complete an interrogation (5  $\mu$ sec in the Bell Lab setup) is determined by the access equipment rather than the memory itself. A stored word is read by a linear selection system using a biased core access switch. [See also the meeting report on the solid State Circuit Conference in this issue for more information on twistors.]

A 512 word, 26 bits per word module of this magnetic matrix memory (Fig. 3) was built as an initial model to show the scheme would work. "A Card Changeable Nondestructive Readout Twistor Store" by Janik, DeBuske and Simons, all also of Bell Labs, described the memory. The information on a card is in the form of permanent magnets, as above; a program or table is changed by removing a card and replacing it with a different one. The random access store has a five usec cycle time and is packaged as an integral removable unit. Looney predicts its size will soon be reduced by a factor of two or more.

#### Education

Outstanding was the enormous increase over last year in emphasis on academic education in



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computers. It is proverbial that everybody is an expert on education. This makes it tough, sometimes, to give you an informed report on what the trend is in this area—even when, as in this case, so many people are talking so interestedly about it.

But here are some of the signposts we noted: for the first time the Joint Computer Committee on Science and Education managed to get a special session on "Industry's Role in Supporting High School Science Problems" scheduled at the WJCC. Chairman of this session was Dr. Paul Hurd, of Stanford University.

Object of the session was to get school people to express what *is needed* in the way of material and personnel for a program to teach computer courses; engineers to tell what they *can do* along these lines; and high school students to show what they *will do* if they have the chance. Two case histories were presented: one program involved the use of an outside computer by regular classes; the other involved participation by engineers and scientists in after-hours study groups.

Louis Fein, a Palo Alto, Calif., consultant, gave a paper discussing the role of the university in computers, data processing and related fields. He recommended that universities install a graduate school of "Computer Sciences." In talking to him later we learned he restricted himself to recommending a graduate program only because he held no hope for persuading anybody of the advantages of an undergraduate or high school program.

Mr. Fein insisted that computer science should be a discipline, in much the same way that mathematics or physics is considered a legitimate discipline. A graduate might end up with an M. S. in Computers, for example. Or a PhD.

Deploring the attitudes engendered by an industrial computer "giveaway" program, Mr. Fein said, "The scramble to get a 'free' 650 computer from IBM is a disgrace in some cases. Course titles and contents have been created on the spur of the moment to fit the IBM requirements. Faculty have been assigned on the basis of their not having a full teaching load—more evidence of what is done without a clear, well-defined policy and program." He admits that for many universities a poor program is better than none. Without IBM or other companies "the university may never have gotten around to a program at all."

IBM has "given" some sixty computers to universities. Other companies involved in similar programs are Sperry Rand, Burroughs, Bendix, Royal McBee and National Cash Register. Mr. Fein thinks that computers are not, strictly speaking, necessary to teach a program. Universities should build strong computer programs and then take advantage of industrial giveaways.

We met Mr. Ken Swallow at the conference.

Swallow quit IBM some time back to start a computer program at Reedley Jr. College in California. Like Louis Fein, it is his conviction that a good computer course can be taught without the advantage of a real computer to work on. Reedley, he says, is a fruit-growing community some 200 miles from any computer. If the experiment works well there, he says, it should work well anywhere. The course has been in existence for about half a year; Swallow claims it is successful so far.

He feels that kids should be caught at the first year level in high school—many potential scientists are lost when first-year youngsters are not shown that mathematics can be useful.

#### Information Retrieval

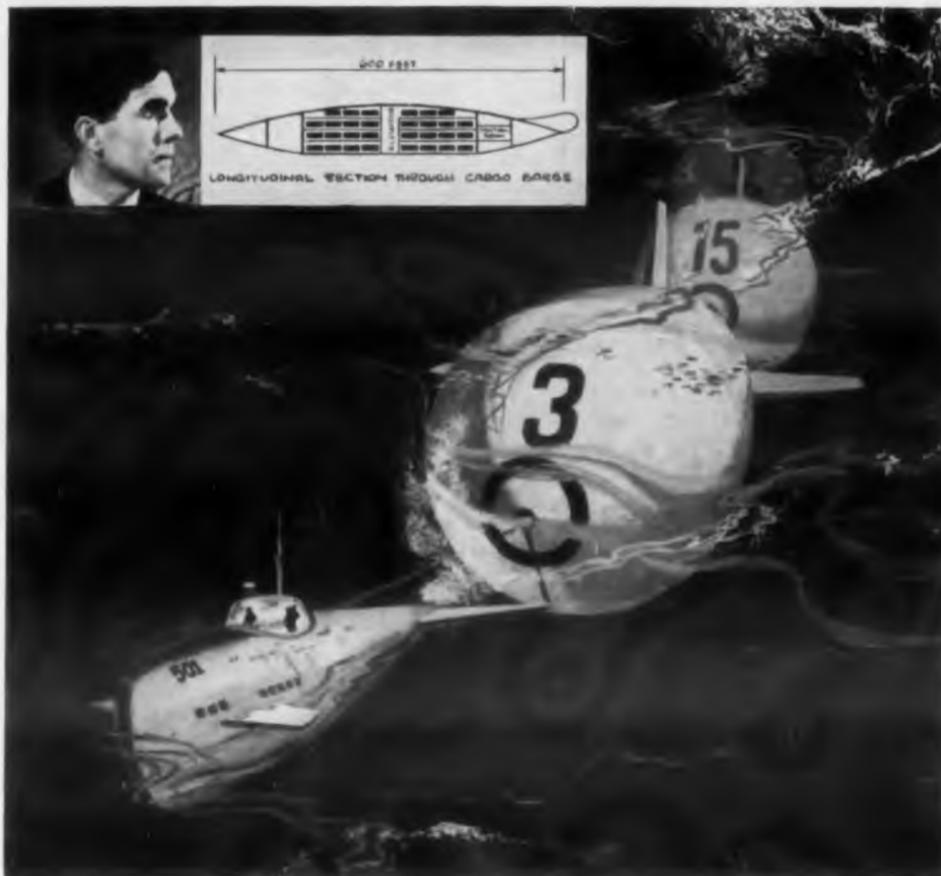
These sessions were filled to capacity at all times. A few of many approaches to the increasingly important problem of Information Retrieval and Machine Translation were presented by speakers from Rome Air Development Center, Systems Development Corp., Hughes Aircraft, General Electric, Zator Co., Computer Usage Co. and Time, Inc.

The last, a paper called "A Memory of 314 Million Bits Capacity with Fast and Direct Access—Its Systems and Economic Considerations" by N. Bishop of Time, Inc. and Arnold Dumey, a consultant, described a memory which will never be built for sale. It has direct, fast access to any of 256,000 storage locations, with a lower cost per bit than is presently available for the same access speed. But, according to Mr. Dumey, advances are being made so quickly in the field that in the four years it would take to build the machine it would be obsoleted by magnetic tape memories.

Two papers dealing with learning concepts and pattern analysis received considerable attention. "An Approach to Computers that Perceive, Learn and Reason," by P. H. Greene of the University of Chicago mentioned some of the central problems in constructing "thinking machines." "Some Experiments in Machine Learning" by American University's H. Campaigne described a technique which allowed the machine to make alterations at "random," and lent direction to the maneuver by monitoring the result. For the simplest task imaginable by Friedberg, the experimenter, the machine took several hundred thousand errors before the first successful trial.

Mr. Campaigne showed that a task compounded of two of these simple tasks would take several hundred thousand times as long, "perhaps a million computer hours." The technique doesn't look like a good way to program a computer. The paper's object was to point out the necessity for examining techniques to abbreviate the process. ■ ■

## No. 16 • Mars Outstanding Design Series



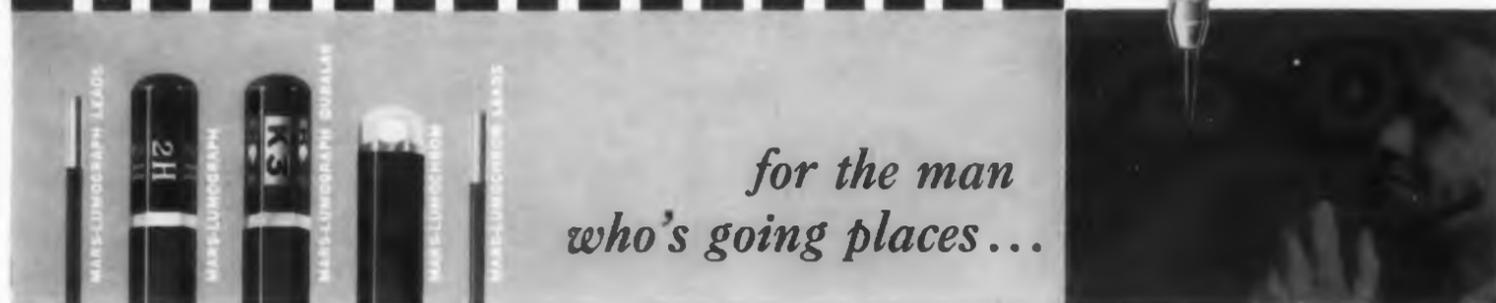
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# Thermal Mockup ...

## An Aid in the Design of Airborne Electronic Equipment

**William P. Rands**

Development Engineer

Minneapolis-Honeywell Regulator Co.

Aeronautical Division

Minneapolis, Minn.



Temperature problems are part of the packaging problems Bill Rands has been solving for the past 3 years. In his work with Minneapolis-Honeywell's Aero Div., he worked out a rather simple, direct method of determining what happens thermally inside a piece of equipment. With the advent of mach 3 flight and reentry temperatures, his mockup method may well become a common procedure in designing cooling systems.

**Fig. 1.** Completed calibration amplifier with case (a) and thermal mockup in plastic (b) shows similarity of structure to completed design. The cooling method was tested and evaluated at this stage of design.



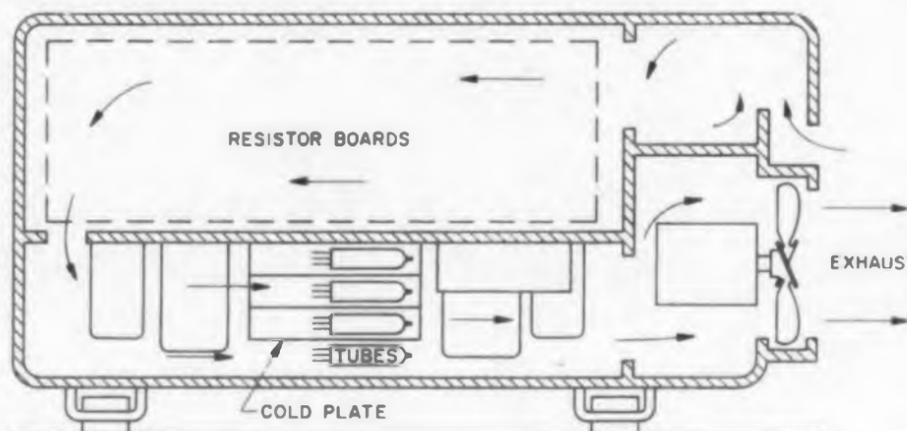
Excessive heating in electronic equipment may be detected and evaluated by building a thermal mockup of the proposed design. This article offers the designer a practical technique for solving the specific design problem of predicting the heating in an electronic package while the development work is still in the preliminary design stage. Evaluation of subsequent cooling methods may be made and the selection of a final design accomplished.

**T**HERMAL mockups simulate all the elements of the proposed package that effect heat generation, transmission, and dissipation. The extent of the completeness of construction of the mockup depends upon the character of information desired.

A designer may want only local temperature of a critical component when used with a particular type of heat sink. Another designer may need to know the effect of his device on adjacent equipment in its installation as a part in a larger system. The mockup may also be used for exten-

sive analysis of temperatures and air circulation throughout a package with various conditions of forced cooling air. A well-planned thermal mockup, properly used, is a big step toward assuring a smooth transition of a product from design to production release.

This thermal mockup technique was used successfully by the Aeronautical Div., Minneapolis-Honeywell Regulator Co., Los Angeles Engineering Section on an electronic flight assist unit now in production (Fig. 1). This project illustrates the use of a thermal mockup in a compre-



**Fig. 2.** Section diagram of unit, showing air circulation and general construction.

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Write today for complete information on the NLS V-34



Originators of the Digital Voltmeter

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## COMPARISON CHART

The few steps required by the NLS V-34 to make a typical measurement (3rd column) are compared with the many required by competitive meters. Note the blue "needless nines" in the middle column.

NO. OF STEPS	COMPETITIVE METERS	NLS V-34
0	+ .8888	+ .8888
1	+ .8889	— .8888
2	+ .8880	— .9888
3	+ .8890	— .0888
4	+ .8800	— .1888
5	+ .8900	— .1988
6	+ .8000	— .1088
7	+ .9000	— .1188
8	+ .0000	— .1198
9	— .0000	— .1108
10	— .0001	— .1118
11	— .0002	— .1119
12	— .0003	— .1110
13	— .0004	— .1111
14	— .0005	
15	— .0006	
16	— .0007	
17	— .0008	
18	— .0009	
19	— .0019	
20	— .0029	
21	— .0039	
22	— .0049	
23	— .0059	
24	— .0069	
25	— .0079	
26	— .0089	
27	— .0099	
28	— .0199	
29	— .0299	
30	— .0399	
31	— .0499	
32	— .0599	
33	— .0699	
34	— .0799	
35	— .0899	
36	— .0999	
37	— .1999	
38	— .1099	
39	— .1199	
40	— .1109	
41	— .1119	
42	— .1110	
43	— .1111	

THE MEASUREMENT IS COMPLETED IN JUST 13 STEPS BY THE NLS V-34

hensive study of a cooling method using forced circulation of ambient air. The mockup permitted observation of the circulation of air through the equipment, the measurement of local temperature data under varying conditions of air volume, and the evaluation of a special cold plate designed for cooling the subminiature tubes. In all, a general knowledge and preview of the cooling system was experienced allowing fabrication of the first article on schedule with confidence in the thermal package design.

#### Resistors are Heat Sources

Heat radiated by components is simulated in the mockup with a simple circuit of resistors employed as heaters. Power or heat output of each part and component is equaled, using the proper rated resistor. It may be useful to arrange this power circuit so that certain portions may be energized separately for special information.

Anticipation of the thermal problems to be encountered along with a basic knowledge of heat transfer is necessary in planning the construction of the mockup. Some designs will require a complete and accurate simulation of the product; short-cuts may be employed with others.

In the M-H project (Fig. 1), the entire chassis and enclosure were made of clear acrylic plastic so air circulation could be easily observed. All surfaces and passages are duplicated as close as possible to assure a representative air movement (Fig. 2, 3). Normally, this construction would be of aluminum to duplicate the heat conducting

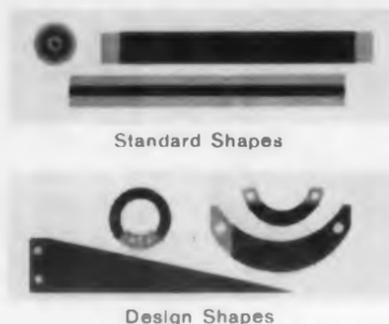
NLS — The Digital Voltmeter That Works . . . And Works . . . And Works!

CIRCLE 38 ON READER-SERVICE CARD

## IRC Resistance Strips and Concentric Disc Resistors

### BASIC CONSTRUCTION

Insulator coated with a resistance material. Insulator usually recommended is a paper grade of XXXP laminated phenolic but other fillers (such as fabric base, woven fiber glass, glass fiber mat or ceramics) are also supplied.



Standard Shapes

Design Shapes

### THICKNESSES

Standard: .027"  $\pm$  .005"  
Minimum thickness: .015"

### WIDTHS

Maximum: 5"

### TERMINATIONS

1. Conductive colloidal silver (available in a variety of terminal patterns). Nonsolderable; requires clips, spring jaws, rivets, eyelets, or other pressure contacts.
2. Solderable silver or conductive adhesives.
3. Copper laminated base for solderable applications.

### DESIGN CONSIDERATIONS

- a. Diameter of punched holes should be equal to, or larger than, thickness of material.
- b. Dimensions should not be less than 1½ times thickness of material.
- c. Distance from any outside edge to any hole should preferably be a minimum of 1½ times thickness of material, and never less than material thickness.
- d. Ratio of length of strip to width should be as large as possible.

### PROTECTIVE COATINGS

Where no contact is to be made to the resistive film, it may be coated for protection from handling and environment.

### RESISTANCE VALUES

Discs: 5 to 100,000 ohms.  
Strips: 19 ohms/square to 1.0 megohm/square

### RESISTANCE TOLERANCES

Discs:  $\pm$  20% Standard;  $\pm$  10% or  $\pm$  5% available.  
Strips:  $\pm$  20% Standard;  $\pm$  10% available.

### STANDARD DIMENSIONS

Discs: ¼" to 1½" Diam. Thickness—.027"  $\pm$  .005". Special diameters and thicknesses available.  
Strips: Length—12", Width—¾" to 2¼". Special lengths, widths and thicknesses available.

### MAXIMUM POWER RATING

Limited by surface operating temperature—which should not exceed 100°C.



## A Way to Miniaturize that Challenges Your Imagination

Electronic components are shrinking in size and weight: Important in the current miniaturizing process is a wafer-thin resistance material with startling design possibilities.

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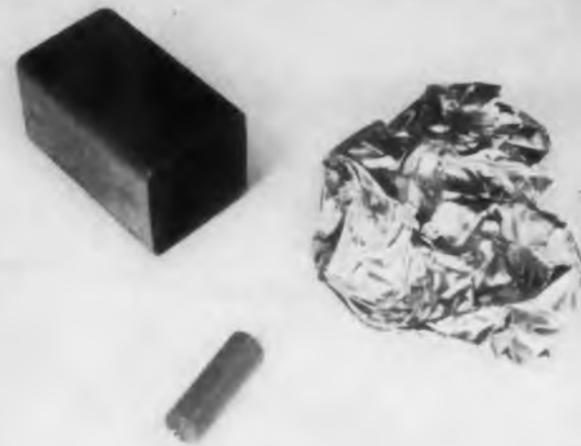


Fig. 3. Components were simulated, both geometrically and thermally, by installing a resistor packed in foil to supply heat from the inside.

structure of the proposed design. However, in this design, all heat is removed by forced air circulation of ambient air. Test results showed that the substitution of plastic for aluminum was considered acceptable.

### Must Duplicate Size Also

Electronic components such as relays, transformers, capacitors, tubes and other elements that would effect air passage had to be closely duplicated, both physically and thermally. This duplication of components is accomplished by mockups of the parts from a sheet metal shell of material such as brass or aluminum. A resistor of the proper rating to equal the power output of the part is packed into the shell with aluminum foil to provide a ready transfer of heat to the surface of the mockup shell (Fig. 4). The designer may often be able to save the fabrication of the mockup shell by borrowing the housing from an expendable part. If electrical requirements are convenient, the actual component may be used in the mockup.

Circuit boards that mount resistors, transistors, diodes and the smaller components can be simulated with only a few resistors. In one mockup, a half dozen resistors were selected to supply an equal power output of a cluster of five dozen small board-mounted parts. The difference in the physical arrangement in respect to its effect on the air flow is considered negligible.

In this M-II project, the principle source of heat is from 19 subminiature tubes. These tubes were mounted within heat conducting clamps on a cold plate which consisted of an aluminum bracket enclosing a core of thin finned surfaces through which the cooling air passes. An early evaluation of the effectiveness of this cold plate was of importance. If excessive heating of the bulbs should be evident due to a too low heat transfer rate, it would be necessary to increase the heat transferring surface by increasing the

size of the cold plate. This would require relocation of adjacent components which could be done at this early stage of development.

An accurate simulation of this miniature heat exchanger was fabricated with a resistor packed in aluminum foil installed in each tube clamp. Mockup cooling tests gave necessary cooling data and an adequate cold plate design was completed.

#### Need Variable Air Source

Cooling air that is circulated through an electronic mockup package should be supplied from a controlled source. Both air volume and temperature should be variable. If the design uses an internal blower, it will be necessary to employ the same arrangement in the mockup. By controlling the speed of the fan, the desired cooling air flow can be determined and the proper blower selected.

Using thermocouples freely throughout the mockup for measuring both air temperature and surface temperatures will result in a very comprehensive picture of the heating and cooling of the equipment.

At high altitudes the decrease in air density will greatly effect a cooling system. The effect of altitude change on a cooling system can be closely simulated with a thermal mockup by reducing the cooling air flow to equal the weight of the equivalent air density for that altitude.

The pattern of air circulating in the clear plastic encased mockup as constructed was observed by using a smoke wand. Liquid titanium tetrachloride, a small oil can and a glass tube, joined by a length of plastic tubing, make a simple smoke wand. The "liquid smoke" can be obtained from most chemical supply companies.

Holes in the outside case must be located to allow the insertion of the wand so locations of stagnant air could be observed. When not in use, these insertion holes are taped over.

#### Good Compromise

The use of the thermo-mockup procedure in the development of an electronic package is a practical compromise between the approach using all theory with calculations and the brutal "build it then cool it" method. The first method requires assumptions and extensive calculations that will give uncertain results due to the unforeseens that are expected when dealing with the complexities of heat transfer. The latter method is a gamble and can result in delays due to the need for redesign or, worse, even the delivery of an unqualified product, shadowed by requests or deviations in specifications. But it is important to understand that the use of a thermal mockup is not considered an end method, but rather an aid in solving the heating problem. ■ ■

# HIGH HIGH efficiency at HIGH operating temperatures



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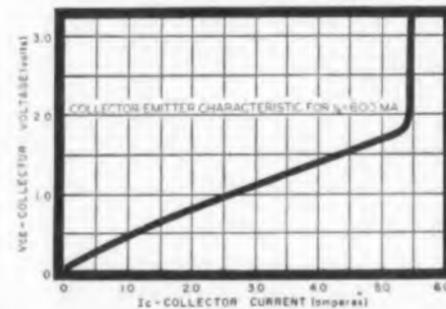
The Westinghouse Silicon Power Transistor pictured above is a highly efficient device which greatly increases the range of applications for transistors which must operate without high losses in the "true power range." Thanks to a remarkably low saturation resistance—less than .750 ohms at 2 amperes and .5 ohms at 5 amperes—these transistors possess very low internal dissipation, and can be efficiently used in applications where they must handle as much as 1000 watts. For example, as a DC switch, handling 750 watts (150 volts at 5 amps) the internal dissipation is about 9 watts, with an efficiency of better than 99%.

Additionally, and unlike germanium units which are limited to approximately 85°C, these transistors can operate in ambient temperatures up to 150°C. Thus, even where the higher power rating is not required, these units may be used for their high temperature capabilities.

There are a great many applications for which this new type of silicon power transistor is ideally suited. It will find use in inverters or converters (AC to AC; AC to DC; DC to AC; DC to DC), regulated power supplies, servo output, and other aircraft circuits, as well as in certain amplifiers and switching applications.

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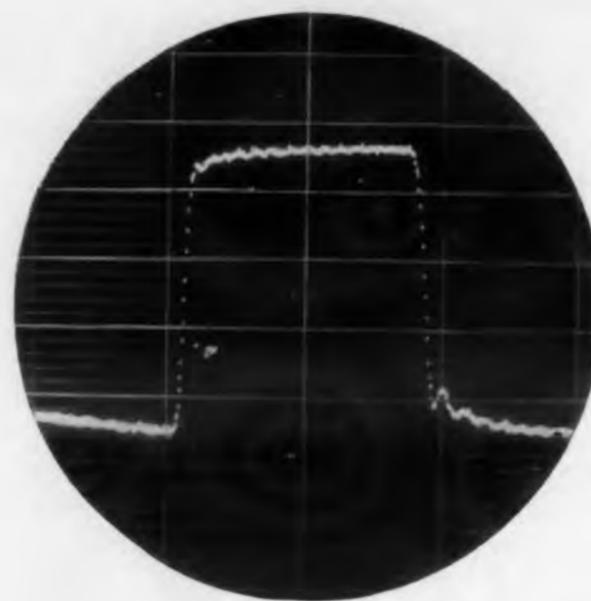


Fig. 1. Scope sweep of 5 milli- $\mu$ sec/in. shows this pulse with a 500  $\mu$ sec rise time, 10 mv amplitude and 10 milli- $\mu$ sec width.

## Pulse-Sampling Scope

### Reads Ultra-Fast Rise Times

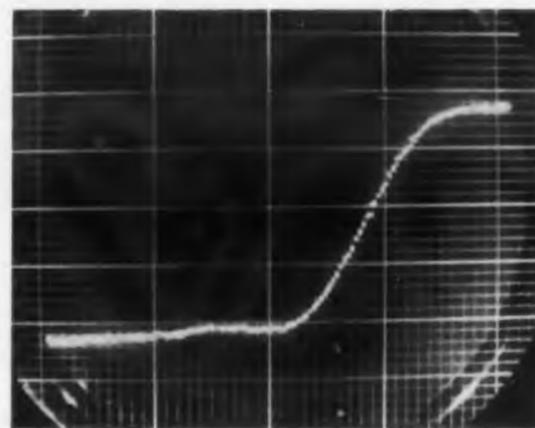


Fig. 2. This is the leading edge of the pulse of Fig. 1, as it looks with the scope sweeping at 500  $\mu$ sec/in.

DISPLAYED publicly for the first time at last month's IRE Show, this scope boasts a remarkable rise time of 400  $\mu$ sec with less than three per cent overshoot or ringing, coupled with a sensitivity of 2.5 mv/cm.

It features useful sweep speeds as high as 40  $\mu$ sec/cm, linear to within five per cent, in 42 calibrated settings. Stability is better than 20  $\mu$ sec.

Manufactured by Lumatron Electronics, Inc., 68 Urban Ave., Westbury, N.Y., the scope is far simpler than its unusual performance might suggest.

It does not require enormous crt voltages; the crt needs only 4 kv. The instrument doesn't need a small truck to move it around the lab; it weighs only 80 lb. And it does not require extremely delicate fussing to make it work; only two controls are manipulated—sweep speed and sweep delay. So stable are these controls that they can be changed at will to examine parts of a trace.

#### A Really New Scope

This scope, modestly dubbed the Mod 1



This scope features 400  $\mu\text{sec}$  rise time and 2.5 mv/cm sensitivity.

12, is the first really new oscilloscope to hit the market in many years. It employs a sampling technique to provide apparent sweep speeds that are ultra-rapid. Using this technique, delays can be measured down to 20  $\mu\text{sec}$ .

With this technique, a sampling or strobing technique, successive, repetitive pulses are sampled for about 400  $\mu\text{sec}$ . Each sample is taken slightly later than the preceding one.

The samples are amplified, then time-stretched for about a millisecond and displayed on the crt screen. The result is a dot-pattern of the pulse shape.

#### Needn't Touch Other Controls

Additional controls on the scope, six of them, are almost never touched during operation. They include: vertical gain, vertical position, trigger polarity, number of dots per scan, beam intensity, and particule illumination.

For more information on this unusual new scope, turn to the Reader-Service card and circle 102.



Fig. 3. With the scope sweeping at 500  $\mu\text{sec}/\text{in}$ , this picture shows the leading edges of two pulses with 500  $\mu\text{sec}$  rise time. The second pulse is delayed by 1 milli- $\mu\text{sec}$  to show the time scale and scope linearity.



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## MEETING REPORT

# Microwave Devices Accented at 1959 Solid State Circuit Conference

Alexander E. Takacs

Assistant Editor

**A**MONG THE many new devices disclosed at the 1959 Solid State Circuit Conference the varactor, having emerged from the research stage, will have the biggest immediate impact on audio and microwave equipment design. Noise performance of the now commercially available varactor, operating from audio frequencies to 6000 mc, is superior to conventional techniques using electron tubes, mixer crystals and transistors. Because of its inherent low noise qualities, the variable reactance diode is expected to extend considerably the range of communication, radio, astronomy and radar systems. This trend in amplification by nonlinear reactance was surveyed by A. Uhlir in the opening session of the Solid State Circuit Conference, held in Philadelphia, February 12 and 13.

Tests conducted with satellite tracking radar, IGY research receivers, uhf television and amateur radio reception showed substantial improvements in signal-to-noise ratio with measured noise figures of 1 db when using the diode in vhf and uhf regions. Because the diode does not need to be refrigerated for low noise amplification, it is attractive in comparison with present solid state maser which has to be cooled with liquid helium. Another feature that makes the diode attractive is its instantaneous recovery from nondestructive loads.

A 400-mc reactance amplifier using the varactor diode as the basic element was described by P. P. Lombardo of Airborne Instruments Laboratory. Fig. 1 is a block diagram of a balanced sum-frequency reactance amplifier. In this mode of operation the output signal frequency is the sum of the input signal frequency and the pump frequency. The theoretical available gain is simply the output sum frequency divided by the input signal frequency. The amplifier consists of a conventional x-band balanced mixer mount operated in the following manner. The 400-mc input signal is applied to the normal i-f output port, the 9300-mc sum frequency is taken from the normal local oscillator input port, and the conventional mixer diodes are replaced with the varactors.

### New Memory Techniques

A transistor driven buffer store with a capacity of 30 words of 22 bits each was described by K. Preston and Q. Simkins of Bell Telephone Labs. With this technique, access to the store is sequen-

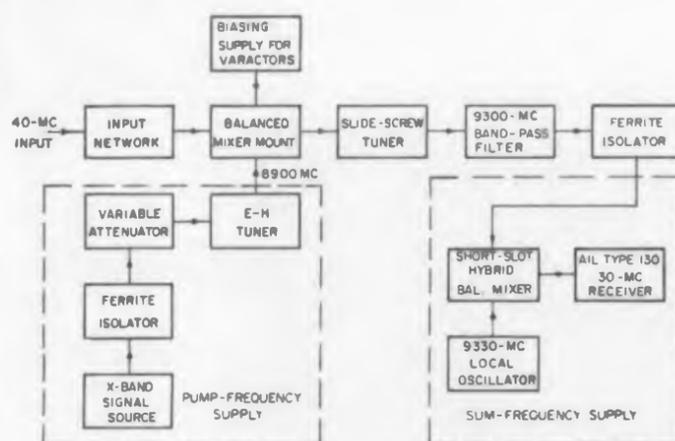


Fig. 1. Block diagram of sum-frequency reactance amplifier. For sum-frequency operation the ferrite isolator preceding the mixer is optional.

**Panel of experts** at the Solid-State Microwave Electronics informal session held during the 1959 Solid-State Circuits Conference. Left to right: W. R. Beam, RCA; C. Kikuchi, University of Michigan; A. Uhlir, Microwave Associates; Max Weiss, Bell Telephone Laboratories and W. From, Ewen-Knight Corporation.



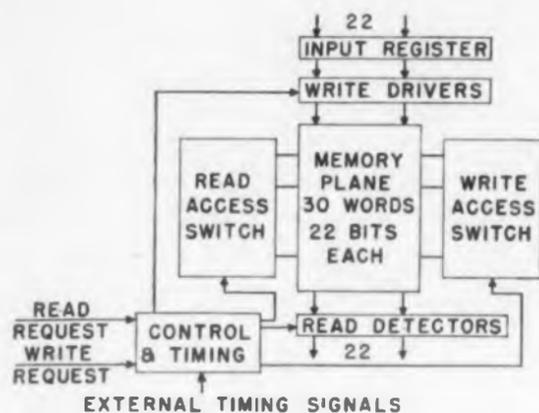


Fig. 2. Twistor buffer block diagram.

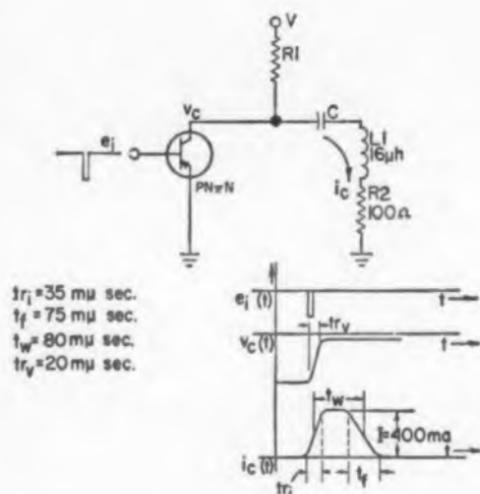
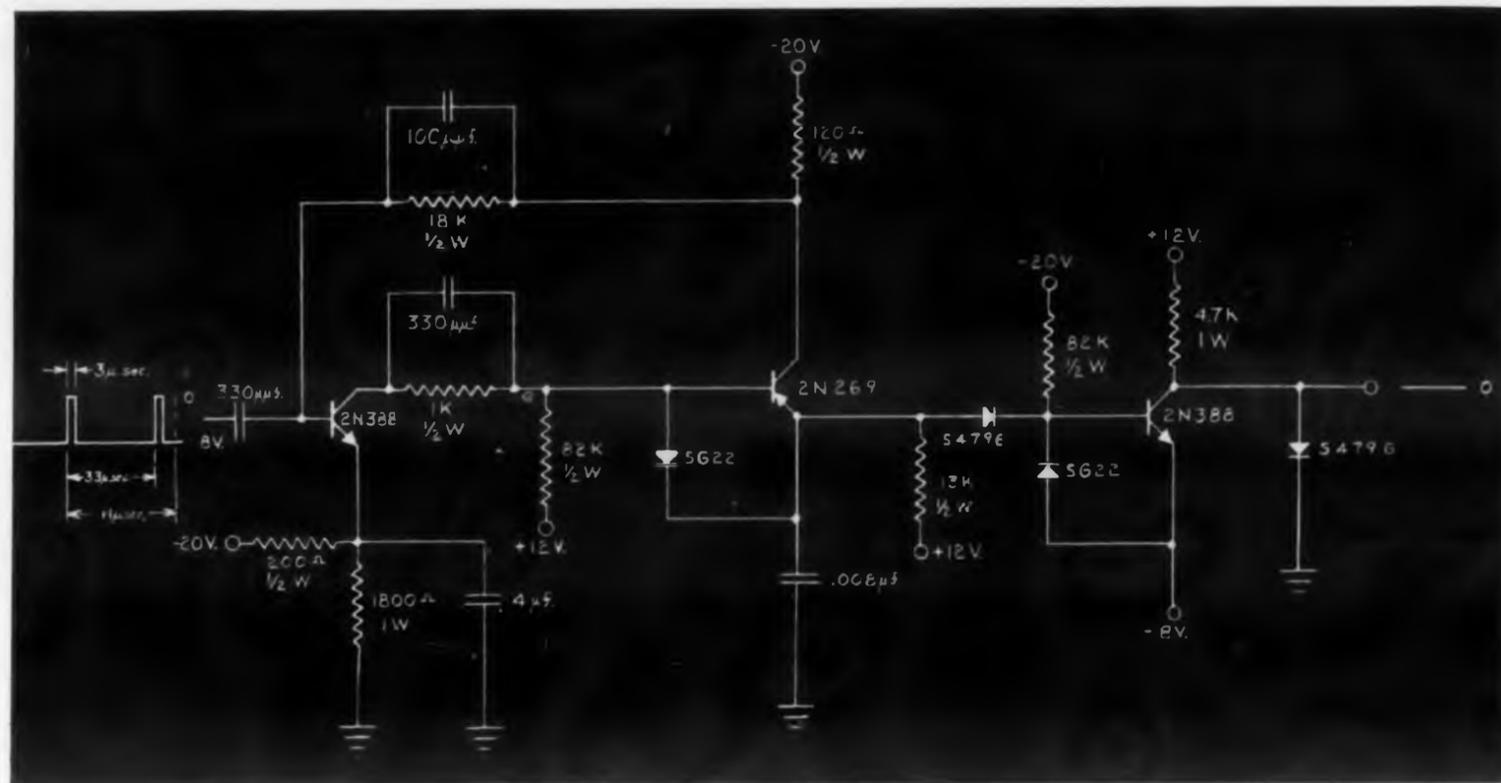


Fig. 3. Monostable memory core switch.

tial; i.e. the first word written in is the first word readout. Although the store operation is synchronous in that the 4-microsecond read-write cycle is controlled by a clock, writing and reading are independent, i.e., the data source may or may not present a new word to be written into the store during the 2-microsecond write interval and the data sink may or may not read out a word during the read interval. The organization of the experimental buffer is shown in the block diagram of Fig. 2. Because of the independence of writing and reading, separate sequential access switches are provided for reading and for writing.

The pro's and con's on a superconducting memory were discussed by IBM's C. Kraus. The most direct way to attain a faster computer is to increase speed of the random-access memory. In this connection, application of the principles of superconductivity to memory to attain rapid switching times is currently being given serious consideration. This paper discussed the advantages and disadvantages experienced during investigations on 8 x 8 memory planes.

While problems do exist such as providing low temperatures and lack of control over the parameters making production of very thin superconducting structure unreliable and costly, ap-



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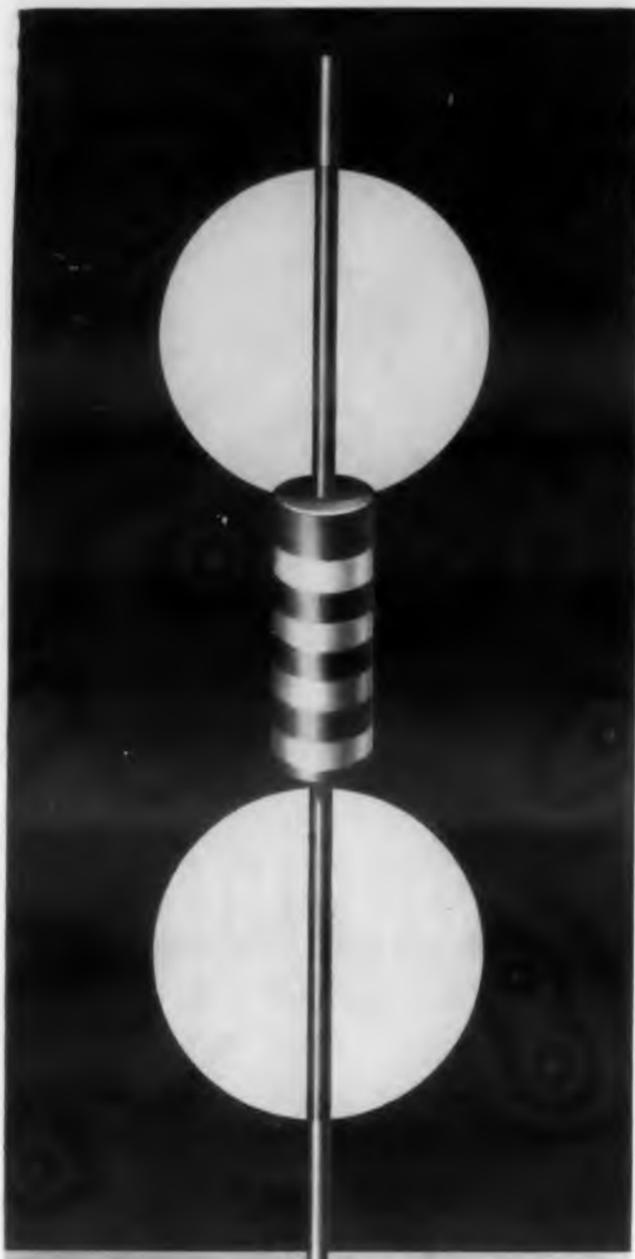
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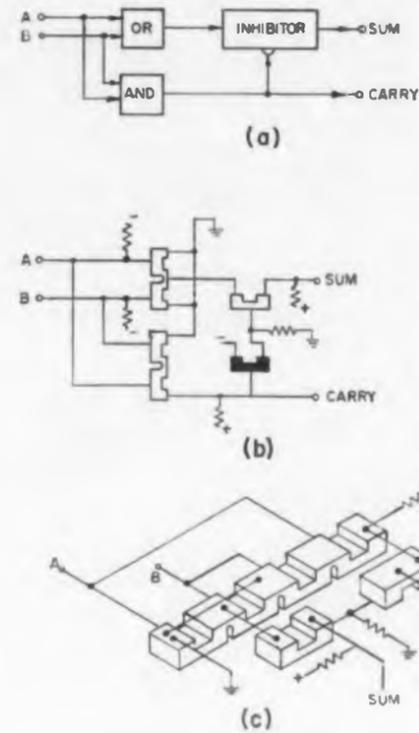


Fig. 4. Example of binary half-adder: (a) logic symbol, (b) DCUTL, (c) integrated DCUTL.

plication of superconductive materials has already made possible construction and operation of a high-speed random-access memory. There is encouraging indication that extended knowledge of the phenomena and refinement of fabrication-control techniques can result in substantial further increases in memory speeds and, consequently, in greater computer capabilities.

### New Device Applications

$p-n-p$  triode switch experimental applications were discussed by V. H. Grinich and I. Haas. The  $p-n-p$ , under development at Fairchild Semiconductor Corp., is a three-terminal diffused silicon device consisting of one high resistivity  $p$ -type layer (the region) with the  $n$  and  $n-p$  layers subsequently diffused on either side. Its electrical characteristics consist of a low conductivity state (about 500 megohms), a high conductivity state (0.5 to 1 ohm) with an intermediate negative resistance region.

As a result of the inherent bistability of the device, the  $p-n-p$  has a wide range of applications in logic circuits. Furthermore, as the ratio of breakover to holding voltage (the collector-to-emitter voltage when the device is in the high conductivity state) is very large, these circuits can be stabilized easily for temperature variations. This device is also practically noise insensitive because of the thresholds associated with the switching. In this manner, it is a relatively simple matter to use it in direct-coupled AND and OR gates, or in flip-flops.

Similarly, these advantages can be incorp

rated in impulse switching of memory cores, since these devices can be made to switch large currents (80 amps at 150  $\mu$ s and 20  $\mu$ s rise times, respectively) in a monostable mode of operation. These devices have been used to switch current pulses as high as 100 amps, even though the device is enclosed in a 2-watt package and the leads fuse at approximately 1 amp (rms). Fig. 3 shows a circuit for a monostable memory core switch.

A logic system using directly coupled unipolar transistor elements was described by J. Wallmark and S. Marcus. The function of a unipolar transistor closely resembles that of a relay in that the voltage applied to the gate varies the resistance in the channel from a low value, e.g., 2000 ohms at a gate voltage of  $-5$  v, to a high value, e.g., 2000 ohms at a gate voltage of  $-25$  v. Utilizing this change in resistance, most of the circuits well known from relay logic may be built by combinations of a standard building block consisting of a unipolar transistor and a resistor.

A novel feature of the DCUTL is its inherent adaptability to integration, the monolithic combination of groups of units and their attendant circuitry, on one piece of semiconductor material. In this way entire logic circuits, conventionally built of combinations of several types of separate components such as transistors, capacitors, resistors, transformers, etc., may be constructed from thin sheets of processed semiconductor material. The unipolar transistor seems much more adaptable to integration than does the bipolar transistor which is widely favored for conventional circuitry.

The main advantage of these integrated devices is their extremely compact form. The packing factor is as much as  $10^3$  times higher than that found in advanced microminiature circuits of today. This high packing factor is obtained by elimination of nonfunctional material and space: only what is absolutely necessary and functional is retained and as many functions as possible are combined in one piece of material. For example, instead of connecting two pieces of semiconductor by wires, the semiconductor is extended from one piece to the next, the bridge serving as connection and at the same time lending structural strength to the assembly. One example of a binary half-adder is shown in Fig. 4.

A digest of the papers presented at the conference may be obtained for \$4.00 by writing to Mr. Henry Sparks, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia 4, Pa. For further information concerning the variable reactance diode, a brochure describing the varactor and some of its many uses can be obtained from Microwave Associates Inc., Burlington, Mass. ■ ■

another **MOTOROLA** first

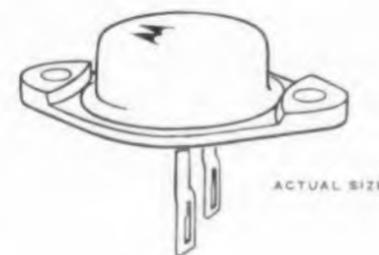


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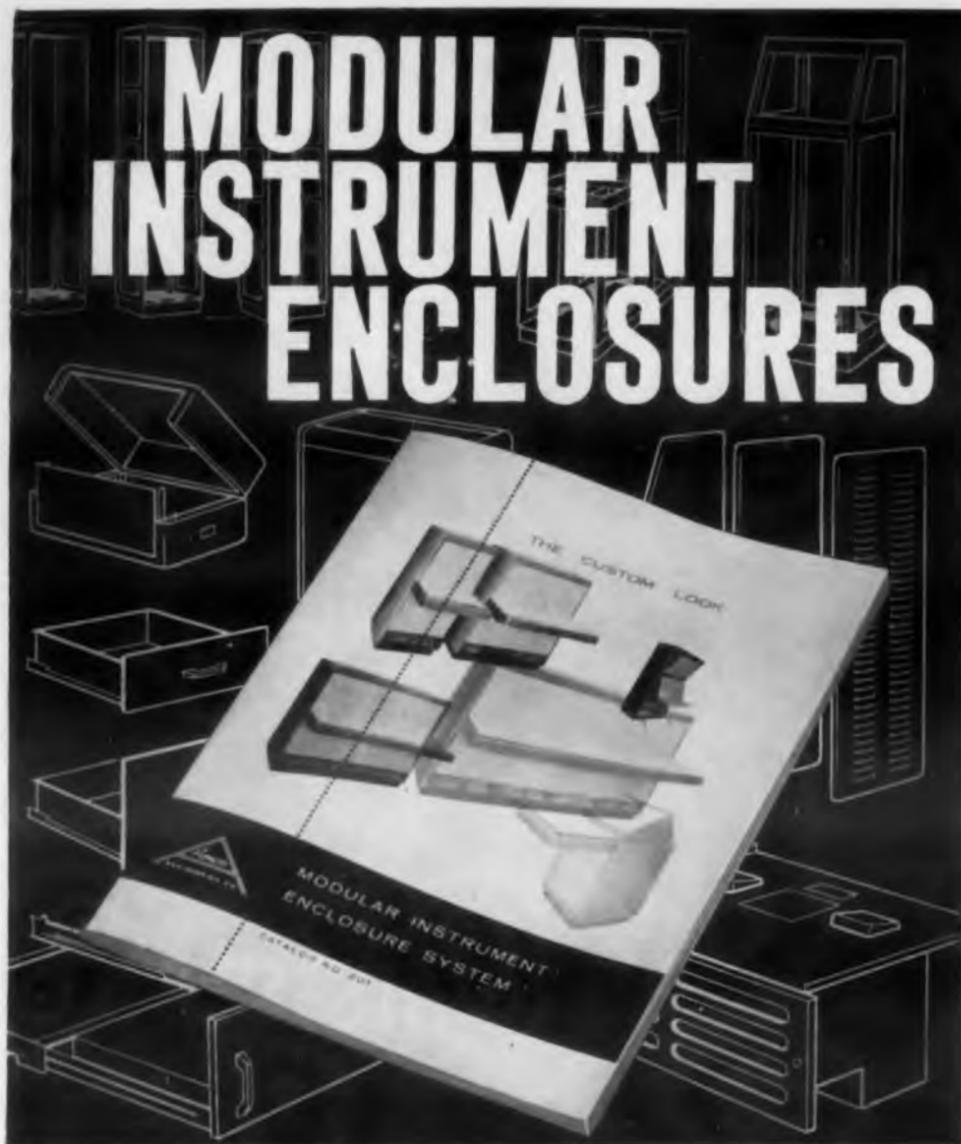


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## Multivibrator Driver For Relay Devices

Alexander Nyman

Anderson Nichols & Co.  
Boston, Mass.

Multivibrator drivers, for electromechanical devices, provide more effective use of pulse energy and are capable of higher repetition rates than thyatron-capacitor circuits.



In his capacity as an associate of a consulting engineering firm, Mr. Nyman is engaged in development work covering a wide range of electromechanical, optical and radio devices.

The accurate, high speed electromagnetic driver he describes is essential in high speed printers used for tabulating computer results; alternative systems require special paper for printing. Mr. Nyman points out the usefulness of this type of drive for automation purposes.

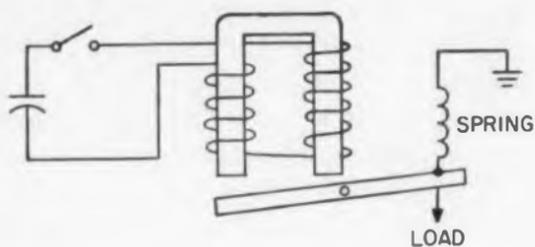
**M**ULTIVIBRATOR DRIVERS can supply maximum current to relay-type electromagnetic devices at the instant their air gap is at a minimum. This timing makes available maximum mechanical force for application to solenoids and high-speed machinery such as printing hammers.

### Conventional Approach

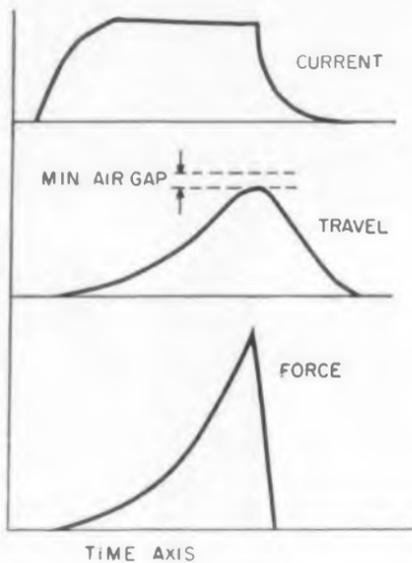
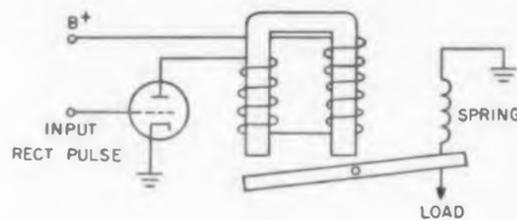
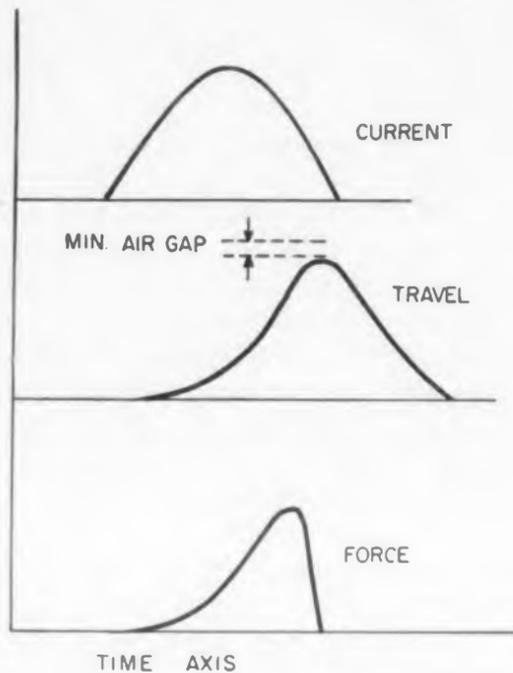
Large amplitude, short duration current pulses can be obtained by placing the magnetic device in the discharge path of a capacitor. During discharge, the current goes through a time cycle of a duration determined by the inductance of the magnetic device, the size of the capacitor and, to a certain extent, the mechanical loading of the driven element. Fig. 1a illustrates a magnetically driven element and Fig. 1b the current that will flow on closing of the switch. In case the switch is a thyatron tube, as in Fig. 3, which is often the case, the dotted part of Fig. 1b does not exist, since a thyatron passes current in one direction only.

Fig. 1c illustrates the resulting movement of the magnetic armature. It will be noted that for effective use of the whole pulse, the air gap in the magnetic structure reaches its minimum value while the current is decreasing. Therefore just at the time the maximum current could have exercised the maximum force, the relatively large air gap limits this force, as shown in Fig. 1d.

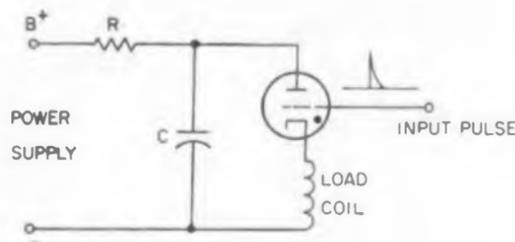
Fig. 2a illustrates a vacuum tube used as a



**Fig. 1.** Basic inductance-capacitor network with associated waveforms.



**Fig. 2.** Vacuum tube used as switch by application of rectangular pulse input.



**Fig. 3.** Thyatron used as switch by application of positive input pulse.

switch by applying a rectangular pulse to its grid. Fig. 2b illustrates the current pulse. Fig. 2c assumes the travel to be complete near the end of the pulse. Fig. 2d shows the rise of driving force to a maximum at the time the air gap is smallest, since the current is maintained at full amplitude. A more effective utilization of available pulse energy is thereby achieved.

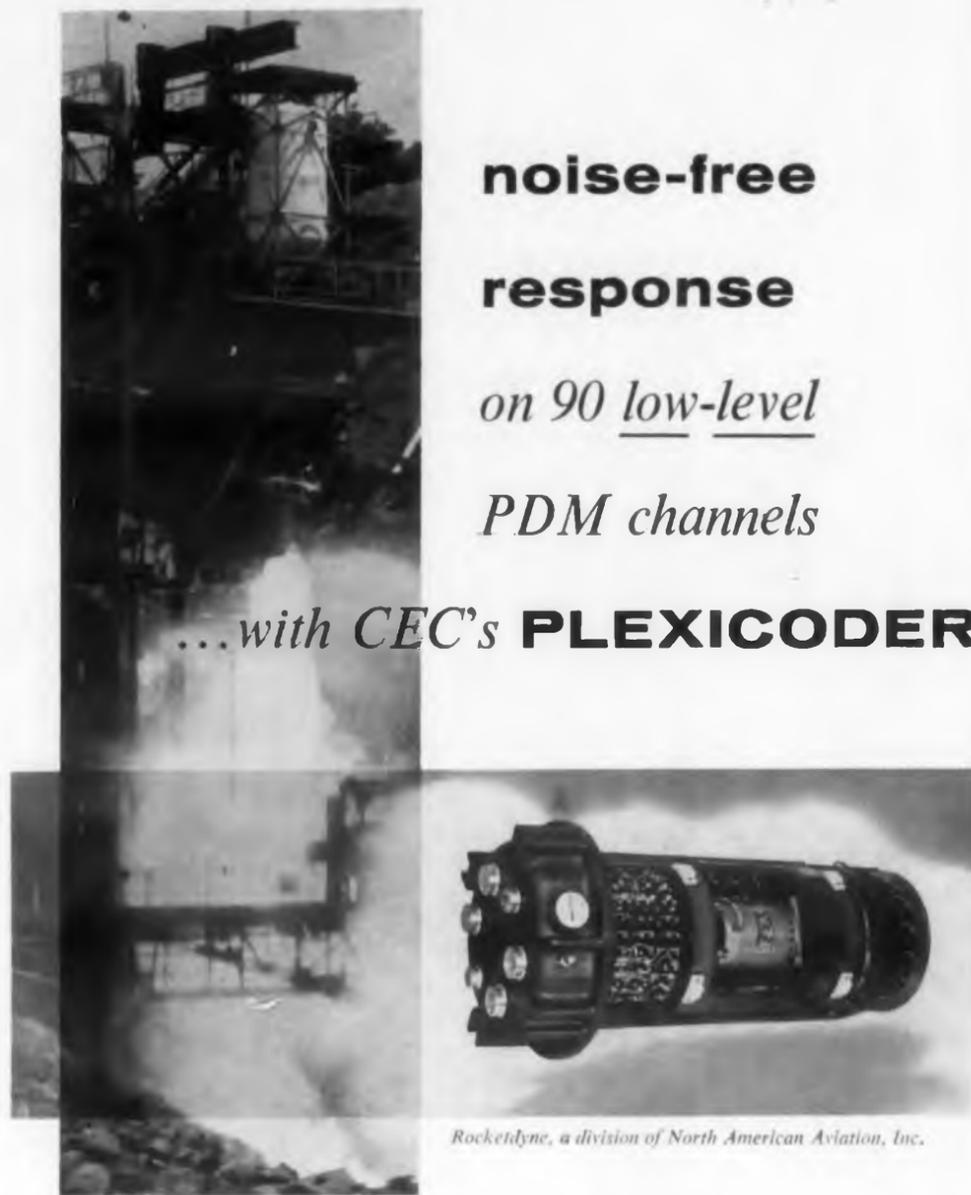
The electronic means for achieving a rectangular current pulse would, in general, include an additional double triode operating as a multivibrator. Thus it requires 2 tubes to produce a pulse in place of one thyratron and a capacitor.

There is, however, another advantage in using hard vacuum tube drive as compared to thyratron drive. The charging circuit of the capacitor, as illustrated in Fig. 3, must have high enough resistance ( $R$ ) to permit the discharge cycle shown in Fig. 1 to go through a 0 value to open the thyratron switch. The charging time of the capacitor is thereby limited and this, in turn, limits the rate of repetition of the operating cycle.

With hard tube drive, the only time limitation is the ability of the multivibrator to be restored to the firing condition. In general, this can be as low as 10 per cent of the pulse duration without making its operation critical. Thus very high repetition rate is possible.

#### Experimental Circuit

In order to reduce the number of operating tubes in a hard tube drive, experimental work



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1N253	100	1000	—	—	0.1*	Stud	1021A
1N254	200	400	—	—	0.1*	Stud	989B
1N255	400	400	—	—	0.15*	Stud	990B
1N256	600	200	—	—	0.25*	Stud	991B
1N538	200	—	750	250	0.350†	Axial Lead	1084A
1N540	400	—	750	250	0.350†	Axial Lead	1085A
1N547	600	—	750	250	0.350†	Axial Lead	1083A

\*Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current; case temperature 135° C.

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was carried out on a circuit illustrated in Fig. 4.

This is essentially a single shot multivibrator which carries the magnetic device in the plate circuit which is normally open circuited. The second plate normally carries a current which is only a small percentage of the maximum current in the first plate. The maximum energy is therefore drawn from the power supply only during the pulse. The operation of this device depends on the time constant of the grid network of the second tube element. A resistance feedback to the grid of the first element completes the multivibrator.

The particular circuit values were chosen for a solenoid of 0.4 for which an operating duration of 2 to 3 msec was needed. The value of the bypass capacitor was determined empirically to permit a rapid plate current rise time; this assures multivibrator action despite the inherent delay of the inductive load. The value of plate resistor determines the maximum plate current for any particular supply voltage. Values between 1 K and 2 K provide a range of current values within which the 6BX5 tube can operate at 120 pulses/sec without overheating.

Input diode, type IN63, blocks the negative kickback from the input capacitor. Interstage coupling diode, type IN70, permits rapid charging of bypass capacitor *C*<sub>1</sub> for multivibrator action and stabilizes pulse interruption.

The relatively high plate resistance (47 K) of the second element of the multivibrator limits the value of idle current between pulses.

Examination of Fig. 4 will show that a positive incoming pulse on the grid of the first element will send a negative voltage pulse to the timing network. The inductive kickback in the plate circuit of the first element is prevented from disturbing this network since it results in a positive potential to the diode.

#### Test Results

In Fig. 5 is shown the operating results ob-

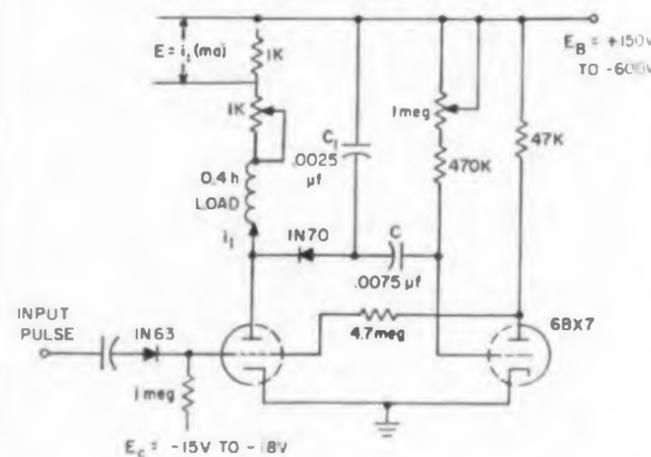


Fig. 4. Test circuit of single-shot multivibrator driver.

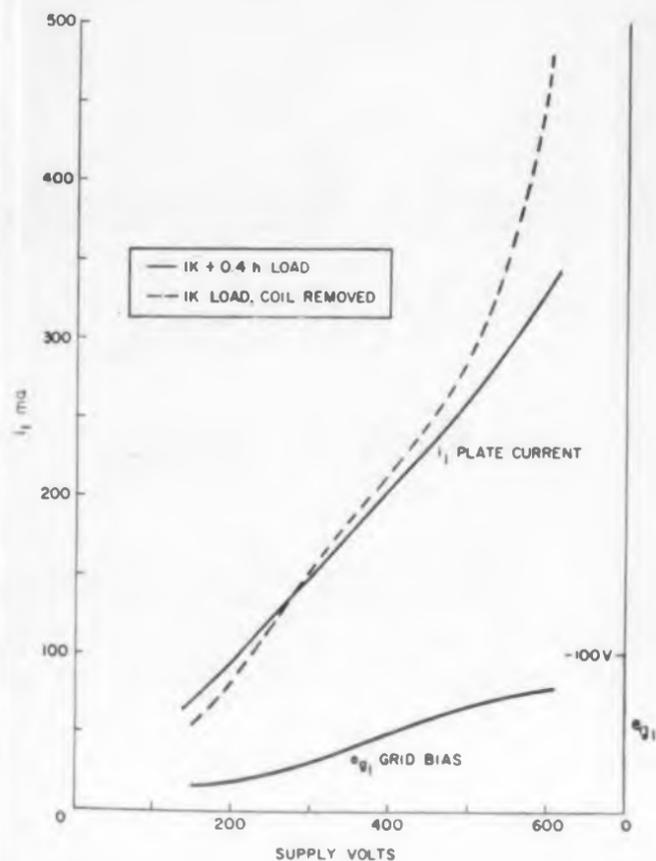


Fig. 5. Graphical display of operating results.

tained with this circuit. For a capacitor of  $0.0075 \mu\text{f}$  and resistor of 1 meg, the time constant of the circuit is:

$$TC = 0.0075 \times 10^{-6} \times 10^{-6} = 0.0075 \text{ sec.}$$

With the load inductance of 0.4, the operating values of pulse duration are 2.7 to 3.3 msec. By suitable adjustment, the pulse durations were reduced to less than 1 msec permitting repetition rates as high as 500 per sec. The current output of the circuit was 70 to 340 ma depending on applied voltage and the grid bias of the first element.

The tests of the circuit of Fig. 4 were carried out with 120 repetitions per second, the limitation being the available power supply voltage. The current was measured by observing the drop across a 1 K resistor connector in series with the load coil. (The current, in ma, is thus equal to the voltage reading.)

When the load coil was removed from the circuit, the current increased as indicated by the dotted line; the diode was not required. Without the inductance in the plate circuit, the pulse duration could be reduced to as low as 0.4 msec permitting operation at repetition rates up to 1200 per second.

In all of the above tests, the grid bias on the first element was adjusted for maximum plate current value. Although the value of this grid bias is not critical, it does influence the duration of the pulse and the maximum output current through the load. ■■



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Close tolerance zener diodes are generally on long delivery schedules and they're generally expensive. The two simple circuits in this article enable the designer to provide extremely tight reference voltages with inexpensive five or ten per cent zeners.

These circuits can eliminate costly delays and can provide increased design flexibility.

IT IS quite possible to use a zener diode, plus a few inexpensive standard components to immediately obtain an exact required voltage.

The two problems to be considered are:

1. When the required voltage is greater than that of the available zener.
2. When the required voltage is less than that of the available zener.

It is desirable to use the same basic components in both cases to reduce stockroom inventory. The circuits of Figs. 1 and 2 fulfill this requirement, since the only substitutions are in resistor values (which generally are stock items anyway).

### For a Higher Reference Voltage

Fig. 1 shows a reference yielding an output voltage higher than that of the zener. This is a shunt type circuit with  $R_s$  the series dropping resistor,  $R_1$  and  $R_2$  form a voltage divider, determining the output voltage. If  $R_1$  plus  $R_2$  be three

# Many Reference Voltages From One Zener Diode

**Bernard Daien**

Kearfott Co., Inc.  
Clifton, N. J.

times  $R_2$  alone, the output voltage will be three times the zener voltage.

The total resistance of the divider should be chosen to make the divider current large compared with the base current of the transistor.

$R_c$  compensates for input voltage changes, greater resistance resulting in less output voltage variation. Too large a resistor results in overcompensation, or negative resistance.

The collector to emitter voltage of transistor  $Tr$  would be the difference between the output voltage and the zener voltage, if it were not for  $R_d$ . Since the transistor collector current flows through  $R_d$ , the resulting voltage drop reduces the collector to emitter voltage, and consequently the transistor dissipation. This permits the use of inexpensive, low voltage, low power audio transistors.

The relatively small capacitor  $C$  appears by amplification as a large simulated shunt capacitance, thus reducing the need for input ripple filtering.

A typical reference using the circuit of Fig. 1 has the following values:

Output: 40 volts  $\pm 0.05$  per cent, 8 mV ripple.

Input: 55 volts  $\pm 10$  per cent (obtained from a 60 cycle half wave rectifier using only one 40  $\mu$ f capacitor as filter).

Zener: Approximately 7 volts.

$R_s = 3900$  ohms,  $R_c = 1200$  ohms,  $R_d =$

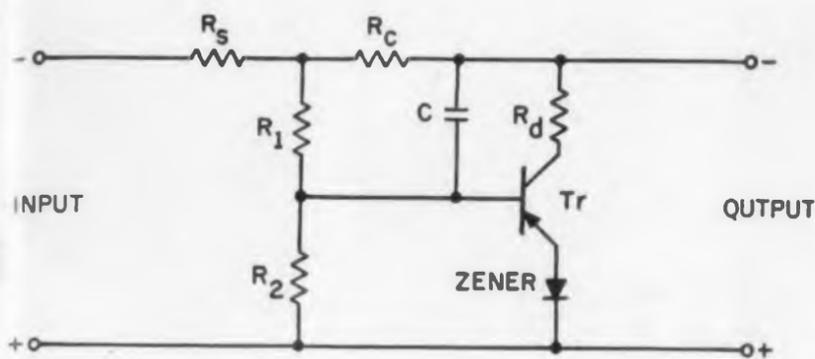
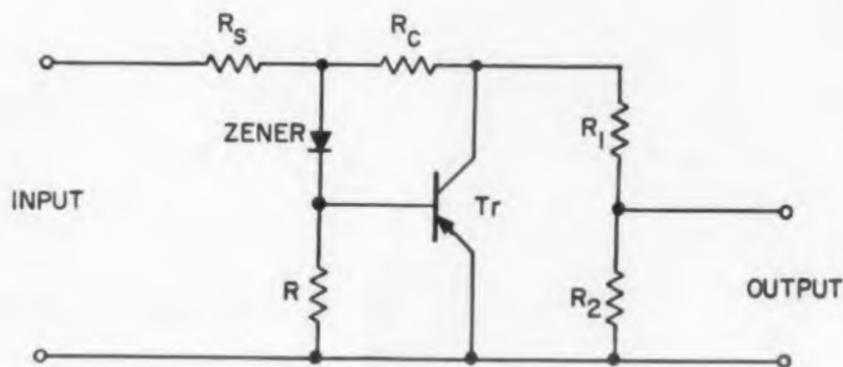


Fig. 1. This circuit provides a precise reference voltage higher than the zener voltage.

Fig. 2. A simple circuit for a reference voltage lower than the zener voltage.



8200 ohms,  $R_1 = 68\text{ K}$ ,  $R_2 = 14\text{ K}$ ,  $C = 0.1\text{ }\mu\text{fd}$ ,  $Tr = \text{Tungsol 2N382}$  or equivalent.

#### For a Lower Reference Voltage

Fig. 2 is a reference with output voltage lower than that of the zener. This is a shunt type circuit with  $R_s$  as the series dropping resistor.  $R_c$  compensates for input voltage changes. As in the previous circuit, an increase in  $R_c$  reduces output variation, but if carried too far results in negative resistance characteristics. The base to emitter return resistor  $R$ , reduces transistor leakage current.

$R_1$  and  $R_2$  form a divider delivering any fraction of the regulated output. This is practical since the current through the divider can be made quite large, thus "swamping out" the relatively small current generally drawn from reference sources. These resistors may be replaced by a potentiometer for convenience of adjustment.

A typical reference using the circuit of Fig. 2 has the following values and specifications:

Output: 6 volts  $\pm 5\text{ mv}$ , 1 mv ripple  
 Input: 19 volts  $\pm 10\text{ per cent}$  (obtained from a 60 cycle full wave rectifier, unfiltered).  
 Zener: Approximately 7 volts.  
 $R_s =$  two 270 ohm resistors in series.  
 A filter capacitor is added from the

junction of these two resistors as shown in dotted lines. The  $R_s$  performs the double function of dropping resistor and ripple filter.

$R_1$  and  $R_2$  can be replaced by a single 750 ohm potentiometer.  $R_c = 5.6\text{ ohms}$ ,  $R = 1200\text{ ohms}$ ,  $Tr = \text{Tungsol 2N382}$  or equivalent.

#### More Advantages

Aside from establishing control of reference voltage, there are further advantages derived from these circuits. Dissipation in the zener is reduced. In the low voltage circuit, the zener passes a maximum current of 250  $\mu\text{a}$ ! In the high voltage circuit the zener passes 3 ma, but at only 7 volts, for a maximum dissipation of 21 mw.

The zener may be chosen in the 6 to 7 volt region where its temperature coefficient is low and yet the knee of the  $E/I$  curve is quite sharp. The zener is in series with the forward biased diode of the transistor emitter-base junction. The emitter-base junction temperature coefficient is of opposite sign to that of the zener. This results in a better over-all temperature coefficient than would be realized from a zener regulator alone.

Both circuits have adjustable compensators which suppress input voltage variations to a greater degree than is possible with a simple zener circuit. ■ ■

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Pyramid new 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  $-30^\circ\text{C}$  to  $+125^\circ\text{C}$  with voltage de-ratings above  $+85^\circ\text{C}$ . Pyramid wrapped Mylar capacitors—Series Nos.: 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  $-55^\circ\text{C}$  to  $+85^\circ\text{C}$  and to  $+125^\circ\text{C}$  with voltage de-rating.

**Dissipation Factor:** The dissipation factor is less than 1% when measured at  $25^\circ\text{C}$  and 1000 CPS or referred to 1000 CPS.

Insulation Resistance:	Temperature	1R x mfd	Maximum IR Requirements
	$25^\circ\text{C}$	50,000	15,000 megohms
	$85^\circ\text{C}$	1,000	6,000 "
	$125^\circ\text{C}$	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  $25^\circ\text{C}$ .

**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.

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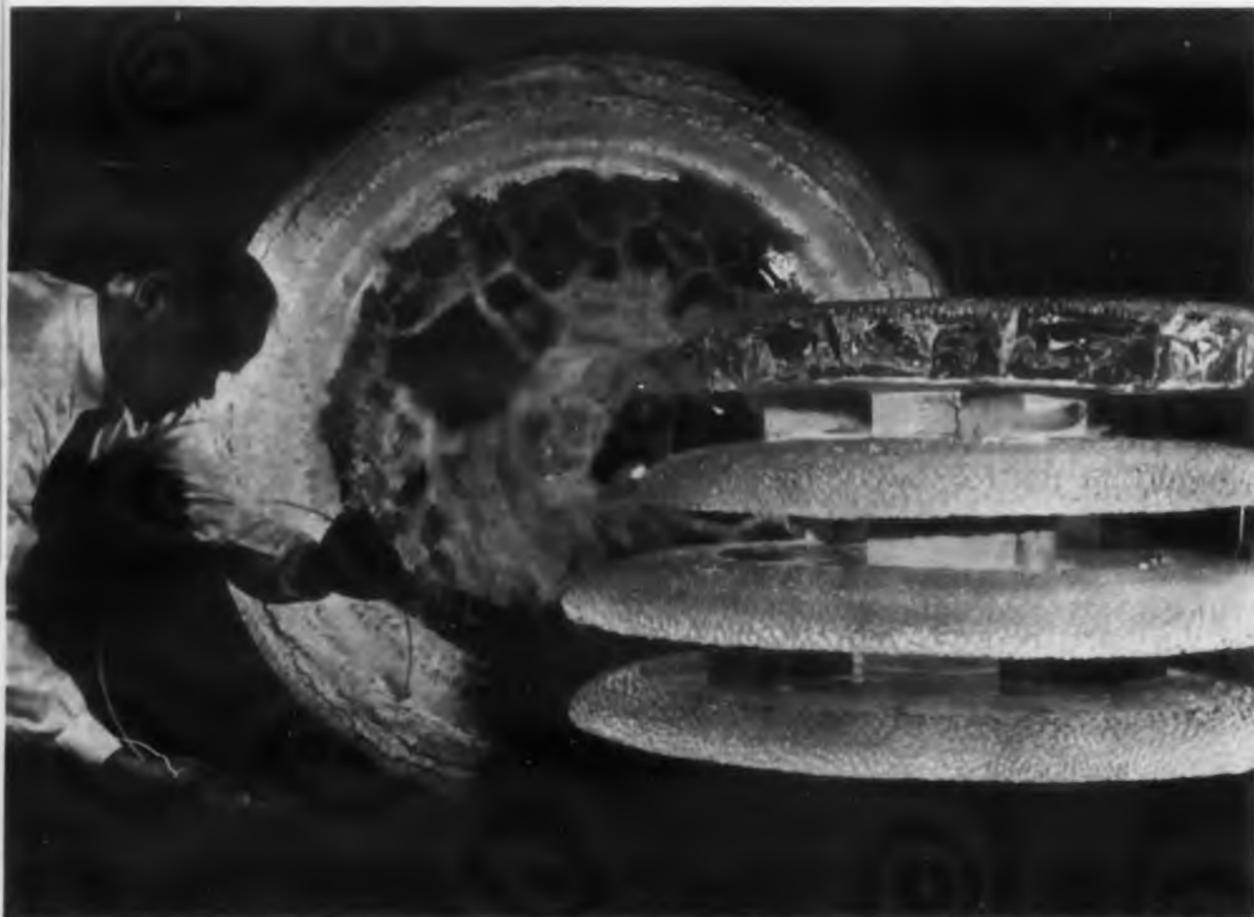
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Corning Glass Works, Dept. ED, Corning, N.Y.

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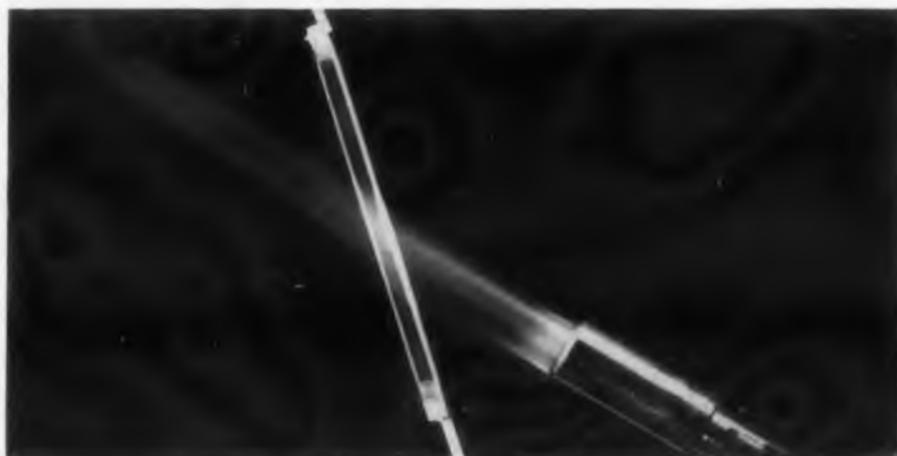


## SILICON CONTROLLED RECTIFIER

**Currents as high as 50 amp** in this silicon controlled rectifier can be regulated by as little as 15 ma. Rated at a peak one-cycle surge of 500 amp, the device has a turn-on time of 4  $\mu$ sec, and a turn-off time of 15  $\mu$ sec. The unit will shortly be available in sample quantities with piv ratings of 25 to 200 v. Present prototype unit, type ZJ-50, handles 50 amp at 125 C stud temperature, 70 amp at 100 C.

General Electric Co., Semiconductor Products Dept., Dept. ED, Syracuse, N.Y.

CIRCLE 56 ON READER-SERVICE CARD



## 500 C RESISTANCE ELEMENT

**Stable to 500 C**, this resistance element is produced by firing a metal resistance path onto ceramic at temperatures exceeding 600 C. Temperature coefficient is under 250 ppm per C over a range of  $-63$  to  $+150$  C. The metal resistance film can be made to cover an entire surface or an accurately defined pattern. Available in a wide range of ohmic values and for a variety of applications including a line of CeraTrols variable resistors and trimmer pots.

Chicago Telephone Supply Corp., Dept. ED, Elkhart, Ind.

CIRCLE 57 ON READER-SERVICE CARD



### STEPPING RELAY

**Three printed circuit boards:** switchboard, circuit board and code board, together with high speed stepping relay actuating a molded digital read-out wheel, are assembled to: auto-home to "0"; read-out 0 to 9 on switchboard; "carry" at 9; and direct read-out. The series 500 relay will auto-home at 50 pps and follow a square wave pulse of 25 msec. The unit operates on voltages from 24 to 115 v dc, and dissipates 20 w.

Hillburn Electronic Products Co., Dept. ED, 55 Nassau Ave., Brooklyn 22, N.Y.

CIRCLE 58 ON READER-SERVICE CARD



### TUNGSTEN

Several new tungsten fabricating methods permit extending the life of electronic tubes and controls and reducing component sizes and providing them with strength at high operating temperatures. Among the developments are seamless tungsten tubing; new processes include deep drawing tungsten and spinning tungsten. Shown are deep drawn, round tungsten cups, 20% more dense than tungsten alloys presently used, which permit decreasing the size of gyro controls.

Fansteel Metallurgical Corp., Dept. ED, North Chicago, Ill.

CIRCLE 59 ON READER-SERVICE CARD



Model QS173 (.6 to 5.5 pf.)



actual size

Patent Pending

NEW FROM



## COMPLETELY SEALED MINIATURE QUARTZ SEALCAPS

Moving upstairs? Then you'll welcome the new JFD precision Miniature Quartz Sealcaps that seal out moisture, seal in reliability and accuracy, regardless of atmosphere.

These new JFD variable trimmer piston capacitors combine the unique characteristics of Sealcap construction and miniature quartz capacitor design. Each is filled with dry nitrogen under pressure and then sealed to maintain the compression, prevent corona and voltage breakdown at high altitude. Linear tuning with fine resolution is assured permanently, without breaking of seal.

Sealcap design also blocks the formation of moisture inside the unit, increases insulation resistance and dielectric strength. The use of quartz dielectric results in high Q, ultra low loss high frequency operation, greater stability, and approximately zero temperature coefficient.

JFD Standard Sealcaps are available unpotted or encapsulated in epoxy resin for higher dielectric strength. Our engineering staff will welcome the

opportunity to relate the advantages of Sealcaps to your specific application. In the meantime, why not write for Bulletin No. 215? Also available in glass dielectric, Bulletin No. 207A.

#### FEATURES

1. Sealed interior construction locks out all atmospheric effects.
2. High Q.
3. Anti-backlash design assures excellent tuning resolution — no capacitance reversal while tuning.
4. Extreme stability at high and low temperatures.
5. Ultra linear tuning for accurate alignment.
6. Low temperature coefficient of capacitance.
7. Low-loss low inductance coaxial tuning for high frequency use.
8. Special alloy plating protects metal parts against corrosion.
9. Fused Quartz dielectric with excellent electrical properties offers no derating at 150° Centigrade.
10. Rugged construction for shock and vibration resistance.
11. Miniaturized construction supplies maximum capacity in minimum space.
12. Positive mechanical stops at both ends of adjustment.
13. Available in panel and printed circuit type mountings — unpotted or encapsulated for complete imperviousness to humidity and moisture.



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

Pioneers in electronics since 1929

**ELECTRONICS CORPORATION**

1462 62nd Street, Brooklyn, New York

Ranges from .6 to 1.8 pf. to .8 to 16 pf. in 12 standard models.

PHONE DEWEY 1-1000

JFD International  
15 Moore Street  
New York, New York

CIRCLE 60 ON READER-SERVICE CARD

# ACHESON

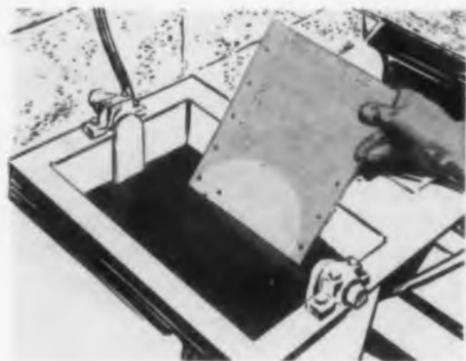
## dispersions digest

Reporting uses for



COLLOIDAL DISPERSIONS OF GRAPHITE,  
MOLYBDENUM DISULFIDE, AND OTHER SOLIDS

'dag' is a trademark registered in the U. S.  
Patent Office by Acheson Industries, Inc.



Copper-clad laminated phenolic sheets are shown being dipped in a solution of 'dag' 154 and alcohol.

### printed circuit cards for IBM's SAGE Computer

are produced for the U. S. Air Force at the company's Kingston, New York plant. High reliability of the circuits in these printed wiring-boards is essential. Basically, the process involves piercing copper-clad phenolic laminates and sensitizing the pierced holes

## FROM PRESS FITS TO PRINTED CIRCUITS

... Acheson colloidal dispersions are finding a variety of uses in the electrical and electronic industry. The unusual properties of 'dag' brand dispersions make them readily adaptable to a wide range of new design possibilities.

The following case histories represent improved levels of assembly and performance achieved through the use of Acheson products. Similar applications are meeting with equal success ... one of them may be yours!

### 'dag' dispersion solves an assembly problem at Marathon Electric

As one of the nation's largest producers of electric motors and generators, Marathon Electric Manufacturing Corporation must maintain high, uninterrupted production. Up until 2½ years ago, one of Marathon's chief problems came in the armature assembly of 15 to 25 HP generators. Four wound pole pieces with a male dove-tail are fitted to the four sides of a laminated generator spider. Both the spider channel and dove-tail are lubricated and the pieces slid together with machine pressure. White lead was used as the lubricant.

According to Ray Waldringer, Machine Shop Supervisor at the company's main plant at Wausau, Wisconsin, five or six armatures were scrapped every day when the spider fins sheared under assembly pressure. Damage was traced to insufficient, uneven lubrication.

In 1956 Marathon began using Acheson 'dag' 210 — a dispersion of colloidal molybdenum disulfide in an isopropanol carrier. Since then neither a pole piece nor a spider has been scrapped because of a lubrication breakdown at this vital point in assembly!

for plating. Actual printing is by applying a plating-resist to the copper sheet conforming to the circuit pattern.

The pierced sheets are first dipped in a solution of 'dag' 154 — colloidal graphite in alcohol. After rubber-rolling excess solution from the surface and oven drying, the graphite is automatically sanded off the surface of the sheet, leaving a graphite coating only



'dag' 210, brushed on generator components before press-fit assembly, has eliminated rejects at Marathon Electric.

'dag' 210 is also used at Marathon in the assembly of electric motors. Applied to die-cast aluminum motor end brackets before press-fitting bronze sleeve bearings into them, this microscopically thin dry film lubricant has completely eliminated rejects caused by distortion of one or both of these pieces.

on the walls of the holes. Conductors are then plated through these holes. International Business Machines Corporation is one of many leading companies using Acheson dispersions profitably.

For additional information, call in your Acheson Service Engineer. Or write direct for Bulletin No. 433. Address Dept. ED-49.



## ACHESON Colloids Company

PORT HURON, MICHIGAN

A division of Acheson Industries, Inc.

Also Acheson Industries (Europe) Ltd. and affiliates, London, England

Offices in: Boston • Chicago • Cleveland • Dayton • Detroit • Los Angeles • Milwaukee  
New York • Philadelphia • Pittsburgh • Rochester • St. Louis

CIRCLE 61 ON READER-SERVICE CARD

## NEW PRODUCTS

### Contact Making Meters

For precise current control



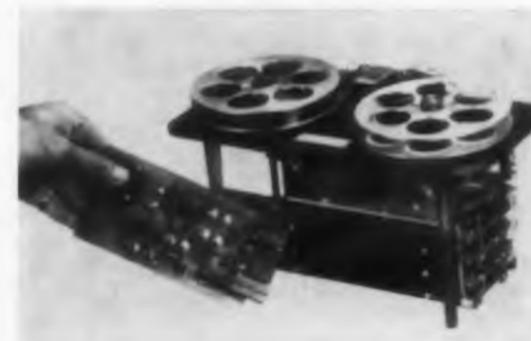
For precise control of electrical currents in mixing, blending, machining, and electrochemical operations, these contact making meters have a thermal type movement and will detect and control minute changes in ac currents or loads. A set of adjustable contacts on the indicating pointer is used to actuate a built-in relay which will handle loads up to 20 amp directly. The control mode is a two-position type with an adjustable differential gap, and the control span may be adjusted from 5 to 100% of the instrument scale. Ranges from 0 to 5 amp or 0 to 200 amp can be supplied for ac loads without using external current transformers.

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

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### Tape Recorder

Weights 5 lb



The miniature TT-100 tape recorder has up to seven channels of transistorized record-reproduce electronics. Suited for laboratory, airborne, and mobile use, it measures 12 x 6 x 8 in. and weighs 5 lb. The unit provides tape speeds from 0.05 to 1-7/8 ips and up to 60 hr of recording. It withstands 10 g vibration, 30 g shock, and -20 to +165 F temperatures. It operates from a 6 v dc battery.

Precision Instrument Co., Dept. ED, 1011 Commercial St., San Carlos, Calif.

CIRCLE 63 ON READER-SERVICE CARD

CIRCLE 64 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1957

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**ANALAC** is a true production-line wire. This film-insulated solderable magnet wire does away with pre-stripping before soldering, lends itself to gang soldering, to iron, gun and dip soldering.

## Now, just one step! Analac lets you solder without pre-stripping!

Anaconda's Analac\* magnet wire saves time and money on the production line. This film-insulated, solderable magnet wire can be used just as you use Formvar or Plain Enamel—with this plus advantage . . . it is solderable without pre-stripping the insulation.

Analac cuts down labor-time where many solderable connections are to be made. It's ideal, too, where removal of the insulation is a hazard to the wire. Soldering Analac by dipping, iron or gun produces a perfect joint.

It performs well in high-speed winding! Analac has the excellent abrasion-resistance and other mechanical advantages of the enamel wire you're now using.

Distinctive red color simplifies identification . . . is highly

visible, helping operators turn out higher quality work.

Analac, 105°C (AIEE Class A) wire, is available in sizes from 15 Awg to 46 Awg.

The Man from Anaconda will be glad to give you more information. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

\*Reg. U. S. Pat. Off. 5KJ62

SEE THE MAN  
FROM **ANACONDA**<sup>®</sup>  
FOR READY-TO SOLDER ANALAC MAGNET WIRE

For details on how you can save with Analac, and for engineering data—please turn the page!

**ANATHERM** 155°C (AIEE Class F)  
high temperature resistance

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

**FORMVAR** 105°C (AIEE Class A)  
established dependability

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

**EPOXY** 130°C (AIEE Class B)  
general compatibility





# MAGNET WIRE DATA SHEET

from  
Anaconda Wire & Cable Co.

## IMPORTANT FACTS FOR YOUR WORK...

### about Analac 105°C (AIEE Class A) Magnet Wire

**SOLDERABILITY.** Anaconda's Analac can be used to overcome high cost of insulation stripping by adapting your present system to automatic soldering techniques. Your Anaconda sales representative can arrange for cooperation from Anaconda's Research Laboratories to help you take full advantage of Analac's cost-saving possibilities.

Analac is versatile; lends itself to gang soldering, to iron, gun and dip soldering. Anaconda's Analac Booklet contains full information on soldering methods, fluxes, temperature control. Use the coupon below for your copy.

**WINDABILITY.** Analac is abrasion-resistant . . . has excellent lubricity and surface characteristics which make it readily adaptable to automatic high-speed winding operations. Can be used on your present equipment—no retooling is necessary to adapt solderable Analac.

**COMPATIBILITY.** Analac is compatible with most insulation varnishes presently being used.

## TECHNICAL PROPERTIES

### MECHANICAL PROPERTIES

Analac has excellent mechanical properties. The film possesses superior abrasion-resistance and flexibility under a number of varied conditions—such as heat, cold and moisture. The wire shows no cracks when elongated rapidly to the breaking point. It will also withstand 3 times diameter wrap after 20 percent elongation.

### MOISTURE-RESISTANCE

Analac's moisture-resistance is excellent, particularly in size range 25 and heavier. It offers moisture-resistance superior to most other film-type insulations.

## ELECTRICAL PROPERTIES

Analac has superior dielectric strength both in a dry condition and after exposure to high humidity. Meets NEMA twist test requirements. Analac has unusually low dielectric losses at high frequencies, which are only slightly affected by high humidity. Thus Analac is particularly suited for electronic uses.

ELECTRICAL PROPERTIES		Number of Tests Averaged			Volts per Mil at Breakdown				
Dielectric strength,	NEMA twist test, room conditions.	145				3500			
	NEMA twist test, dry.	30				4050			
	NEMA twist test after 6 hours exposure at 100% and 100% relative humidity.	30				4000			
	Layer test—double layer wind on 1-inch diameter mandrel, apply voltage between layers	30				2840			
Dielectric loss,	Dissipation factor at room temperature.	Frequency			Dissipation Factor—Cotangent of Angle of lag				
		Temperature—Deg C							
		cps	kc	mc	Room	85	125	155	
		100	10	100	1.00	—	—	—	
		1000			0.92	—	—	—	
		10			1.38	—	—	—	
	Dissipation factor at elevated temperature.	100-1000	10	40	1.90	—	—	—	
					1.97	—	—	—	
					1.93	—	—	—	
		100-1000	10	100	2.79	—	—	—	
					—	1.08	1.73	15.7	
					—	1.32	1.48	11.9	
Dielectric constant,	As measured by bridge and Q meter at room temperature.	Dielectric Constant K							
		Temperature—Deg C							
		cps	kc	mc	Room	85	125	155	
		100	10	100	3.00	—	—	—	
		1000			2.96	—	—	—	
		10			2.93	—	—	—	
As measured by bridge and Q meter at elevated temperature.	100-1000	10	40	2.65	—	—	—		
				2.54	—	—	—		
				2.52	—	—	—		
	100-1000	10	100	2.90	—	—	—		
				—	3.63	3.85	3.66		
				—	3.57	3.80	2.93		
—	—	—	3.51	3.69	2.49	—			
—	—	—	3.40	3.63	2.33	—			

## CHEMICAL PROPERTIES

Analac has good resistance to the action of solvents, water, and dilute acids and bases. Analac will withstand 24 hours' immersion at room temperature in most varnish solvents including naphtha, toluol, xylol, and ethyl alcohol. Shows excellent resistance to 5% sulfuric acid and 5% potassium hydroxide.

## THERMAL PROPERTIES

Analac is offered as 105°C (AIEE Class A) magnet wire, although its thermal stability shows it is capable of performance at much higher temperatures. Analac's thermoplastic flow cut-through data, obtained on basis of MIL-W-583A methods, has been above 200°C.

ED-59

*New Analac Booklet—yours for the asking!  
Latest information . . . full technical data.  
Mail coupon for your copy.*



**ANACONDA WIRE & CABLE COMPANY**  
25 BROADWAY, NEW YORK 4, NEW YORK

Please send copy of your Analac Magnet Wire Booklet. I am interested in heavy or intermediate size (15 Awg to 30 Awg)—; fine sizes (31 Awg or finer)—.

NAME & TITLE.....  
COMPANY.....  
ADDRESS.....  
CITY, ZONE, STATE.....

TEAR OUT FOR YOUR FILE

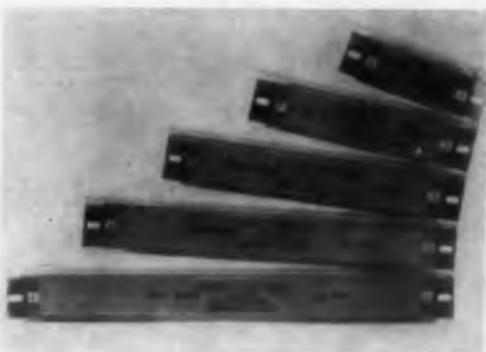
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## Power Resistors

For flight use



These resistors are designed to be mounted in direct contact with the inner surface of a chassis or case. In this manner 25 to 40% of heat generated is directly emitted to the atmosphere. Power ratings are: 40, 80, 120, 160 and 200 w. Envelope dimensions range from 7/32 x 1-5/16 x 4 in. to 7/32 x 1-5/16 x 12 in. Electrical insulation is silicone rubber which is operable continuously at 450 F. Mounting metal is Alclad aluminum and thermal transfer from resistor to mounting wall is through an adhesive.

Electro-Flex Heat, Inc., Dept. ED, 83 Woodbine St., Hartford 6, Conn.

CIRCLE 65 ON READER-SERVICE CARD

## Voltage Indicator

Can be automatically or manually programmed



This voltage indicator can be programmed either manually or automatically by the addition of external resistors. The automatic programming can be digital. Sensitivity of the indicator is 1 K per v, minimum center scale voltage is 1 v, and maximum center scale voltage is in accordance with customer specifications. The ac indicator maintains a 0.25% accuracy over a frequency range of 50 to 5000 cps. Temperature compensated indicators are available covering a range of -55 to +71 C, and, throughout this range, the dc unit will maintain a 0.2% accuracy, the ac unit, a 0.5% accuracy.

Voltron Products, Dept. ED, 1010 Mission St., South Pasadena, Calif.

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CIRCLE 64 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

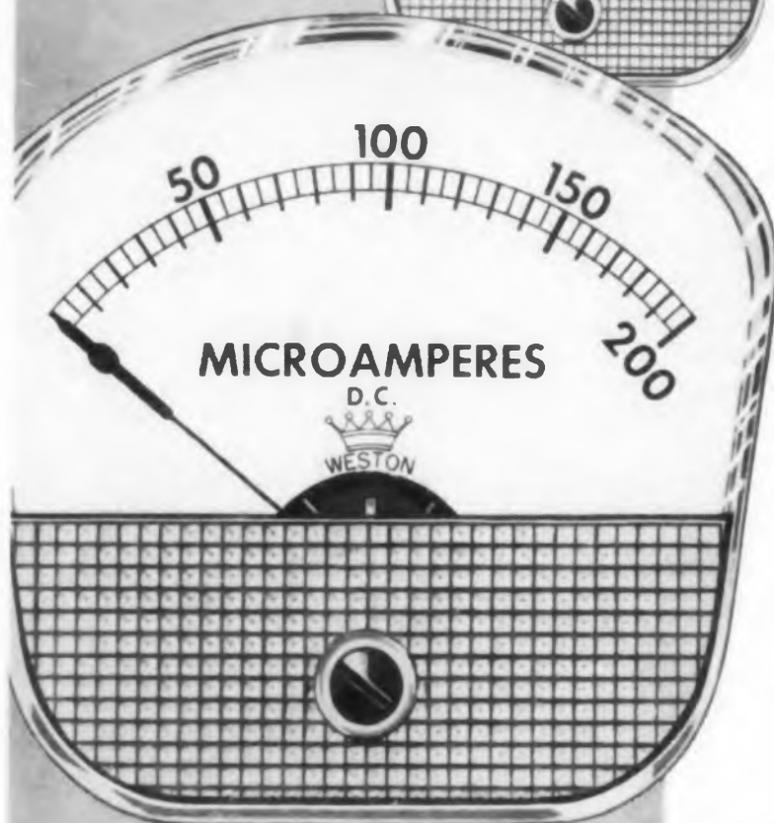
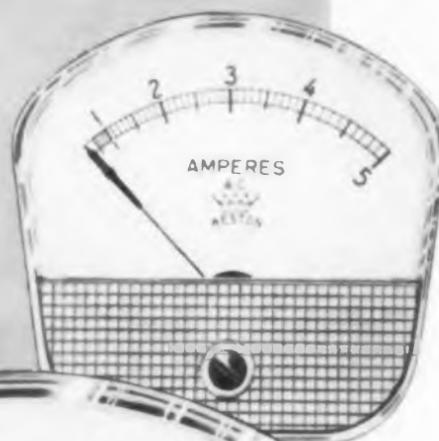
# Much Acclaimed in '58 Now Expanded in '59

THE WESTON

**CROWN LINE**



of panel  
instruments



Instrument men are still talking about the recently-introduced Weston CROWN line of panel instruments. But this great series is making news all over again. Because it's all new—again this year—with a lot more to offer: greater versatility, increased readability, greater accuracies . . . features that add up to a new standard of performance.

**NEW LARGER SIZE** — A completely new 4.5-inch group has been added to the line of D-C instruments—with basic accuracy within  $\pm 2\%$  of full-scale value, alternatively  $\pm 1\%$ .

**NOW AVAILABLE IN A-C, TOO** — In addition to the D-C models, a new moving iron A-C instrument, with improved ballistic characteristics—even to critical damping—is being offered in the 2½-inch size.

**EXTRA LONG SCALES** — 5.3 inches for 4½-inch model, 2.5 inches for 2½-inch D-C model—exceptionally long scales for their case diameters.

**FREEDOM FROM MAGNETIC INTEREFFECTS** — The incorporation of the famous Cormag® mechanism permits close grouping of instruments on magnetic and nonmagnetic panels—close to other instruments without special adjustments. The instruments are immune to the effects of stray magnetic fields.

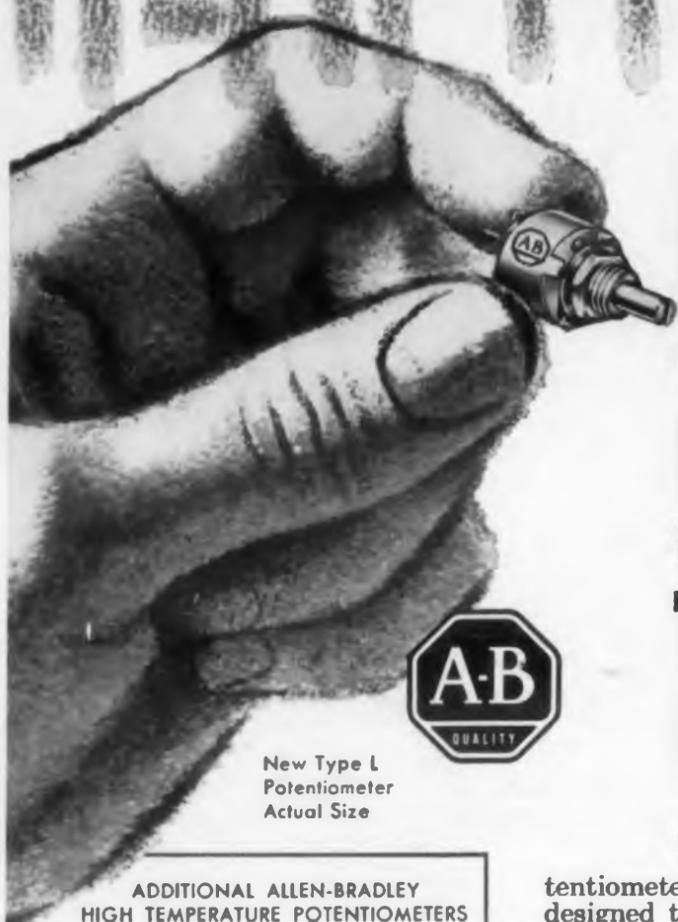
For full information, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.

**WESTON**

*Instruments*

CIRCLE 67 ON READER-SERVICE CARD

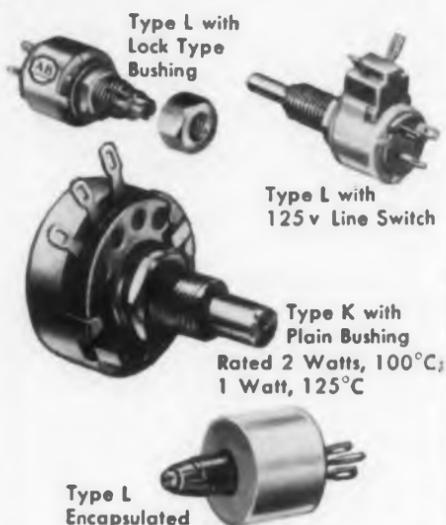
# HEAT PROBLEMS?



New Type L Potentiometer Actual Size

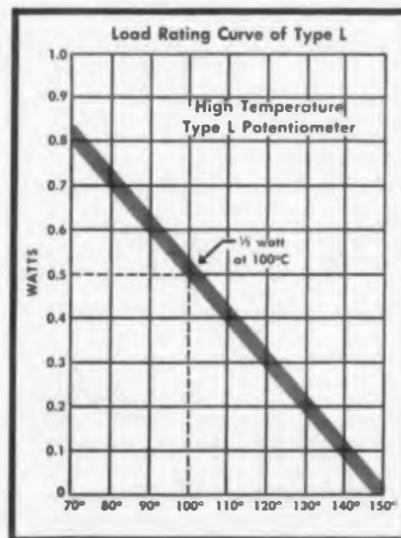
## NEW Allen-Bradley POTENTIOMETERS for use in TEMPERATURES UP TO 150°C!

### ADDITIONAL ALLEN-BRADLEY HIGH TEMPERATURE POTENTIOMETERS



This new Allen-Bradley potentiometer—the Type L—is especially designed to solve problems associated with high ambient temperatures—and space conservation. Although extremely compact—0.5 inch in diameter—the Type L control has a conservative rating of 0.5 watt when operating in an ambient temperature of 100°C. And, it provides reliable performance when operated at a temperature of 150°C—under “no load” conditions. (See graph at right.)

The new Type L control features the same solid, hot molded resistance element that has proved unequalled for long life, smooth operation, and low “noise” characteristic in Allen-Bradley’s popular Type J, Type K, and Type G potentiometers. When temperature and space problems in your designs plague you, this new A-B “high temperature” potentiometer is a reliable answer. Please send for complete information, today.



AMBIENT TEMPERATURE °C.  
Load Capabilities of Type L below the Critical Resistance Value. Type L Far Exceeds the Requirements of MIL-R-94B.

# ALLEN-BRADLEY

## Quality Electronic Components

Allen-Bradley Co., 1344 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

CIRCLE 68 ON READER-SERVICE CARD

## NEW PRODUCTS



### Computer Linkage Systems

Provide fast problem  
solution

These computer linkage systems couple the speed of an analog computer which simulates an industrial or experimental process and deliver a graphic result, with a digital computer, which presents its computation in numerical form. They employ a number of information channels to convert analog outputs into digital form and digital computer outputs into analog form, resulting in fast problem solution. Shown is the model 4.030 which links an IBM 700 series EDPM and an EAI analog computer by providing 20 analog to digital and 10 digital to analog information channels. The systems use a 20 channel solid state analog multiplexer to time share a single analog to digital converter, and more than 400 conversions per sec may be made on any channel with a conversion accuracy of  $\pm 0.5\%$ . Provisions are made for manual data entry to the analog to digital or digital to analog channels, and neon indicators and meters permit visual monitoring of the output of any channel. Programming control is accomplished within the digital computer which may read or write information on the various channels in any sequence at any time.

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

CIRCLE 69 ON READER-SERVICE CARD

### Navigation System For vhf operation

A complete vhf navigation system, the DN-560 uses the company's DR-560 receiver which tunes from 108 to 135.95 mc and has 560 channels. It also includes a model DNI-2 navigation indicator, a C/560-GS control for channel selection; and a DNC-4 transistorized converter with outputs for three deviation indicators, two flag alarms, and one to-from indicator. The system weighs 18 lb and is available for 14 and 28 v operation.

Dare, Inc., Dept. ED, Troy, Ohio.

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# CANNON PLUGS

## Schweber

**FOR  
IMMEDIATE  
LARGE  
QUANTITY  
DELIVERY  
AT  
FACTORY  
PRICES**

### 2500

**Yes!** You can now order up to 2500 each of such popular Cannon Connector types as Miniature D, KO, DPD, DPA, DPX, etc. Immediate shipment at factory prices.

## Schweber

**ELECTRONICS**

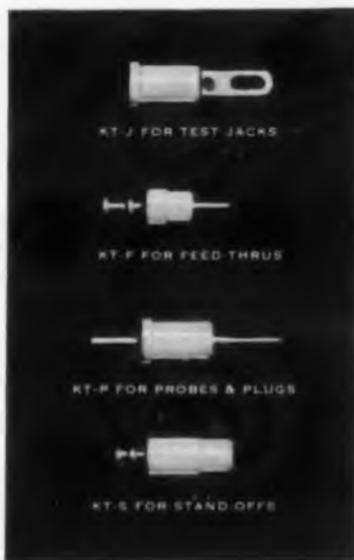
61 HERRICKS ROAD, MINEOLA, L.I., N.Y.  
PHONE 6-6520 TWX G-CY-NY-580

CIRCLE 71 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

## NEW! CANNON "KWIK-TERM" TERMINALS

EASE OF INSERTION—RELIABLE PERFORMANCE—TEFLON™ INSULATION



**PERMANENTLY INSTALLED IN 4 SECONDS OR LESS** by pressing the self-fastening insulator through pre-drilled mounting holes. The resilient properties of the "Teflon" insulation secures the terminal and provides permanent vibration proof installation, with no soldering or screw attachment needed to hold terminal in place. New Cannon "KT" Terminals offer simplified electrical connection especially adapted for circuitry in microwave communications, radar, scientific instrumentation and other crowded space applications. **VOLTAGE RATINGS FROM 2380 V. TO 4250 V.** (Sea Level) depending on size of terminal. Special types are available where higher operating voltages are encountered. **TEFLON BUSHINGS** available in diameters of 0.148" to 0.264." Terminal lengths range from 0.120" to 2.500." Standard pin diameters are 0.040," 0.046, 0.050," and 0.078." Pin material is brass with 0.003" silver plate. A wide variety of finishes, colors and soldering lugs can be supplied to order. **"KT"** Terminals are immediately available in a wide variety of sizes and shapes. Cannon also produces special configurations for specific applications: Write for Cannon Catalog KT-1. Please refer to Dept. 000, Cannon Electric Company—3208 Humboldt Street, Los Angeles 31. Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne and Tokyo. Distributors and Representatives in the principal cities of the world.

# CANNON PLUGS

CIRCLE 72 ON READER-SERVICE CARD

# Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON MANUFACTURING COMPANY, WALTHAM 54, MASS., Vol. 1, No. 2

## NEW ONE-WATT COMMUNICATION KLYSTRONS COVER GOVERNMENT AND COMMON CARRIER BANDS

Designed primarily for use in microwave relay links, the QK-661 and the QK-754, one-watt transmitter klystrons, operate at frequencies of 7,125 to 8,500 Mc and 5,925 to 6,425 Mc, respectively. The QK-661 is the first tube of its kind to cover the entire government band. The QK-754 is the first of a planned series of tubes to cover the entire communications band.

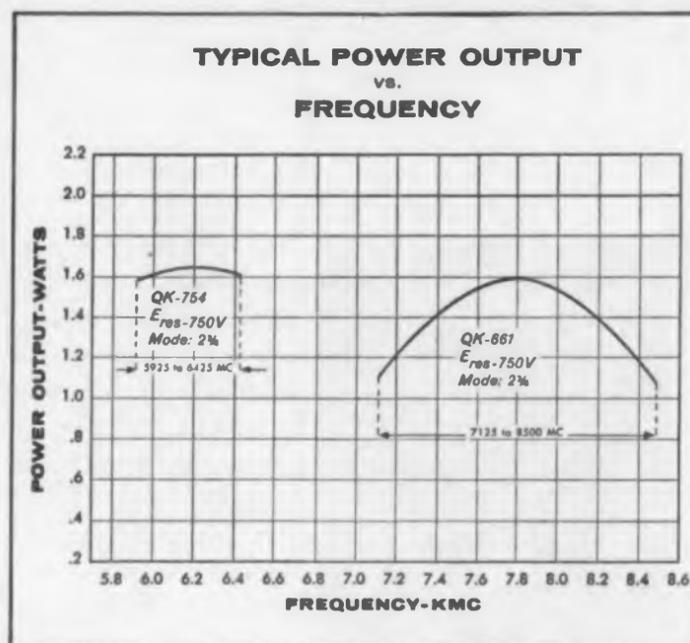
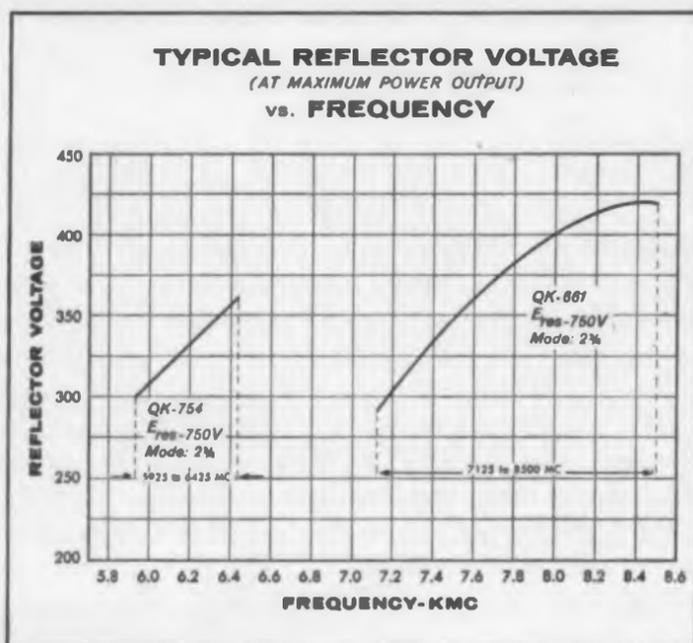
Both are mechanically tuned, integral-cavity, long-life, reflex-type tubes. The QK-754 uses a coaxial output; the QK-661, a waveguide output.

To insure efficient operation the tubes are available with integral cooling fins or with a heat-sink attachment suitable for connection to the chassis.



Typical operating characteristics

	QK-754	QK-661
Frequency Range	5925 to 6425 Mc	7125 to 8500 Mc
Power Output	1.5 watts	1.6 watts
Electronic Tuning (to half-power pts)	50 Mc	25 Mc
Modulation		
Sensitivity (10 V pk-to-pk mod volt)	1 Mc/V	600 Kc/V
Temp. Coefficient	$\pm 0.1$ Mc/ $^{\circ}$ C	$\pm 0.1$ Mc/ $^{\circ}$ C



You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Manufacturing Company, Waltham 54, Massachusetts

Excellence in Electronics

**RAYTHEON**

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

## NEW PRODUCTS

### Voltage Calibrator

For missile checkout



Designed for missile checkout and electronic data processing equipment, the model 55 calibration unit may be used manually or automatically with 12 measuring devices and their associated transducers. A remote calibration run may be programmed into the unit with the use of five available remote control leads to command a five range calibration run into the measuring devices.

Beckman Instruments, Inc., Systems Div., Dept. ED, 325 N. Muller Ave., Anaheim, Calif.

CIRCLE 74 ON READER-SERVICE CARD

### Tubing

For capacitor protection

Manufactured by Fritz Mueller "COROPLAST" K. G. of Western Germany, Coroplast Shrink Tubing provides contact protection for capacitors. It consists of a polyvinyl-chloride-base tubing that is mechanically dilated and will, under exposure to heat, shrink back to its original dimensions. The shrinkage, which takes place radially as well as axially, amounts to about 10 to 12 per cent and is induced by exposure to heat of 130 to 140 C for about 60 sec. Where it is necessary to work at lower temperatures, exposure time must be extended accordingly. The type of heat source, whether infrared, hot air, or drying oven, is immaterial. The tubing has a resistivity of 1000 meg per m length; a breakdown strength of 15 kv per mm wall thickness, and complete resistance to ambient temperatures up to 85 C.

F. H. Paul & Stein Bros., Inc., Dept. ED, 235 Fifth Ave., New York 16, N.Y.

CIRCLE 75 ON READER-SERVICE CARD  
◀ CIRCLE 73 ON READER-SERVICE CARD

## Industrial Counter

Embodies long-life plug-in unit

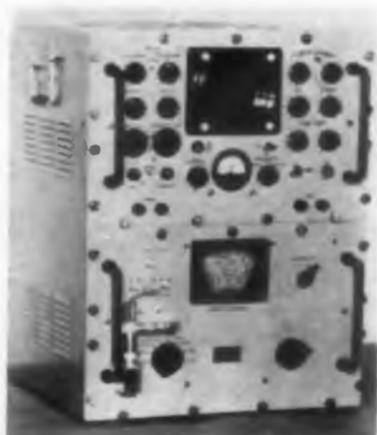
At a rate of 1500 a minute, the Robot-Eye RE-8 will detect and count objects 1/4 in. long moving as fast as 2 ft per sec. It consists of three units: a photo cell, a light source, and an amplifier-counter which can be remotely mounted. The photo cell and standard light source may be up to 10 ft apart. The unit has a button reset and a replaceable 6-digit plug-in counter with a life of over 100 million counts.

Standard Instrument Corp., Dept. ED, 657 Broadway, New York 12, N.Y.

CIRCLE 76 ON READER-SERVICE CARD

## Spectrum Analyzers

Have detachable mixers



Spectrum analyzers LA-18M and LA-20M use external detachable coaxial and waveguide mixers which enable them to cover 10 mc to 44 kmc and 1 to 44 kmc, respectively. The units have a sweep repetition rate of 0.5 to 30 cps free running or synchronized and a spectrum resolution of 10 kc at all frequencies measured at the 3 db points. Frequency calibration is accurate to  $\pm 0.1\%$  at the operating frequency of the local oscillator. Attenuator capacity is 0 to 60 db, step variable in 6 db steps accurate to 0.2 db. Power requirements are 115 v, 50 to 400 cps, 250 w.

Lavoie Labs, Inc., Dept. ED, Mattawan-Freehold Rd., Morganville, N.J.

CIRCLE 77 ON READER-SERVICE CARD

CIRCLE 78 ON READER-SERVICE CARD

# CLARE Lowers Prices

## on all Mercury-wetted contact relays

### Reductions range from 7½% to 10%

When prices for just about everything are continuing to rise, and all thinking men are concerned over the danger of inflation, it is important news when a manufacturer makes a significant price reduction.

Increased production resulting from the wide acceptance of Clare Mercury-Wetted Contact Relays, together with improvements in skill and in manufacturing equipment and methods, make it possible for Clare to reduce prices for these superior relays in spite of rising labor and material costs.

A price reduction ranging from 7½% to 10% will be applied to all orders placed after March 31, 1959, for Clare Mercury-Wetted Contact Relays—Types HG, HGP and HGS. The reduction will also affect multi-element relays such as HG2, HG3, HG4, etc.

These lower prices for relays whose life is measured in *billions of maintenance-free operations* will be exciting news to all designers of continuous-duty, high-speed switching devices and systems.

Write or Wire: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.



Type HG



Type HGP



Type HGS



Type HG2



Type HG4

## CLARE RELAYS

FIRST in the industrial field

**ISOMICA** Mica Paper Insulation. Epoxy and silicone bonded. Extremely uniform. High electricals. Heat resistance up to 300 C continuously. Thicknesses down to 0.001 in. For capacitor, transformer, motor insulation, cable tapes, coil covering.



**SILICONE** Coated Glass. Either silicone rubber or varnish coating. Cloth or tape form. High dielectric. Low power factor. Good moisture and chemical resistance. For Class B and H use, for coil wrappings, spacers in motors, generators, transformers and for cable wrapping.

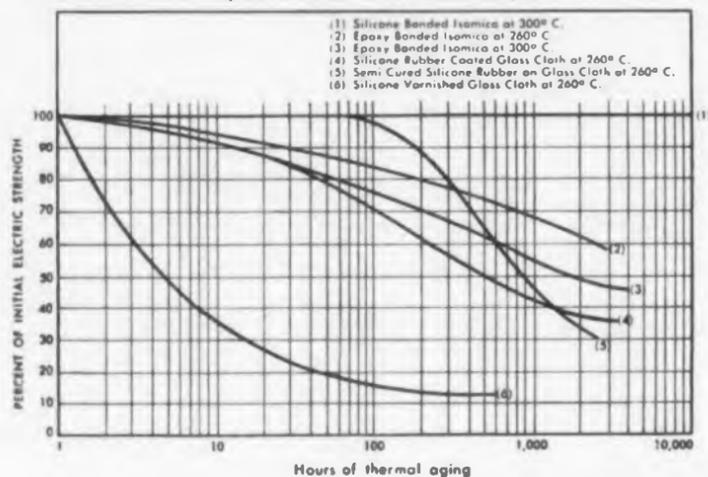


**TEFLON** Coated Glass. Coated on one or both sides. Exceptionally tough, resilient and abrasion resistant. Good electricals, chemical resistant. Very low power factor. Heat resistance up to 250 C. For coil wrappings, cable wrapping, high temperature lead wrapping on electronic gear, motors, transformers, generators.



Improve reliability, cut rejects of high temperature electrical equipment with a Mico flexible insulation

PERCENT RETENTION ELECTRIC STRENGTH VS. HOURS AGED  
(10 mil flexible sheet insulation)



Effect of Heat Aging on electric strength of MICO flexible insulating materials. Note relative stability of ISOMICA materials.

Looking for heat resistant cable tape, slot linings, capacitor or transformer insulation, coil wrappings or other flexible combinations?

Then take a look at Mica Insulator's broad line of flexible insulating materials — capable of operation at temperatures from 130 to 300 C, with almost limitless property possibilities.

FOR COMPLETE DETAILS on MICO flexible insulating materials, write MICA INSULATOR, 812 Broadway, Schenectady 1, N. Y., or contact the insulation specialist at the nearest 3M sales office.

## MICA INSULATOR

Division of Minnesota Mining & Manufacturing Company  
SCHENECTADY 1, N. Y.

MICANITE® AND ISOMICA® PRODUCTS

LAMICOID® LAMINATES

SILICONE AND TEFLON® COATED CLOTHS AND TAPES

\* Reg. T. M. E. I. DuPont de Nemours & Company

CIRCLE 79 ON READER-SERVICE CARD

## NEW PRODUCTS

### RF Power Amplifier

Has 25 w output



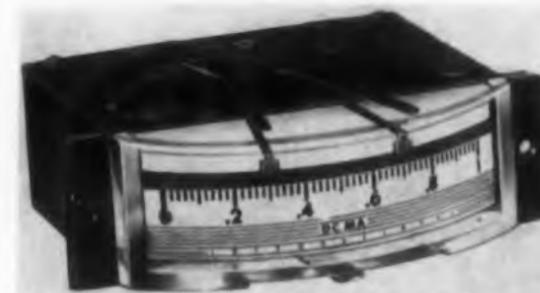
Designed for use with telemetering transmitters, the model A-25 rf power amplifier has a tunable range of 215 to 260 mc and a minimum bandwidth of 300 kc. It provides a 25 w output with a 2 w input drive. Built for severe environmental conditions, the unit requires no blowers or forced air cooling. It weighs 1.5 lb and measures 5 x 3.75 x 2.25 in. Input and output impedances are 52 ohms, and supply requirements are 450 v plate, 225 v screen, and 6.3 or 12.6 ac or dc filament. Mainly for fm or pm systems, the amplifier is adaptable for am with reduced power output.

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

CIRCLE 80 ON READER-SERVICE CARD

### Control Meter

Has no contacts



This miniaturized control meter, Model 2545, operates without the use of contacts at the set points. Since the movement is not stopped the full scale range of the meter can be read at all times. Control set arms are adjustable over 80% of the scale area from the front. A metal shield attached to the pointer is positioned so it will pass between two mutually inductive coils of a self-contained transistorized oscillator-amplifier. As the shield passes between the two coils, it decreases pickup signal and switches the output stage from a low conducting to a high conducting state sufficient to operate sensitive relays.

International Instruments Inc., Dept. ED, New Haven, Conn.

CIRCLE 81 ON READER-SERVICE CARD



 SEALED RELAYS—unmatched for reliability

NO ADMITTANCE  
EXCEPT TO EMPLOYEES

NO SMOKING  
IN THIS ROOM



## There's a G-E sealed relay for every circuit need—every reliability requirement

G-E miniature, sub-miniature, and micro-miniature relays combine small size with unusual reliability under severe temperature, shock, and vibration conditions to make them ideal for electronic jobs, both military and commercial. In addition to short shipment on production orders, G.E. is equipped to give rapid service on samples and prototypes.



**MINIATURE:** Long-life type; rated 5 amps at 28 volts d-c at 85 C; in 2-, 3-, and 4-pole double throw and 6-pole normally open forms.



**SUB-MINIATURE:** 2 amps at 28 volts d-c, 115 volts a-c, double-pole double-throw; .651 in. in diameter, 1.6 in. long, weighs one ounce.



**MICRO-MINIATURE:** Crystal-can type, 0.5 oz. Rated 2 amps at 28 v d-c or 115 v a-c. Grid-space type (terminals spaced for printed circuits) available.

For complete information on G-E's full line of sealed relays, mail coupon.

General Electric Company  
Section A792-13  
Schenectady, New York

Please send me a free copy of the sealed relay catalog.

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_

GENERAL  ELECTRIC

## Have you ever taken an air bath?

Special clothing, nylon overshoes, dust-particle counts, air baths—all are part of manufacturing the industry's most reliable miniaturized sealed relays.

The demand for greater and greater reliability of all electronic components has forced manufacturers to find new and improved production techniques. At General Electric a special "white room" was built to assure the closely controlled atmospheric conditions needed for the assembly of ultra high-reliability relays. In highly critical applications, particularly those involving dry-circuit switching, absolute cleanliness of relay in-

teriors is vital. Equally important is the extra care and precision with which "white room" relays are processed, tested, and inspected.

In General Electric's "white room" every precaution is taken to eliminate dust, dirt, and any other particles (as small as one micron) which might clog the contact points of hermetically sealed micro-miniature relays.

To maintain the controlled atmosphere within the room, dust counts and air samples are taken regularly. Employees wear special clothing and take air baths before entering the room

through the pressurized air lock. Temperature and humidity are continuously controlled and charted to provide optimum assembly conditions.

Obviously all relays do not require the exactness and care which is taken with these "white room" relays, but whatever your reliability requirements—there's a General Electric sealed relay to meet your needs. 792-13

*Progress Is Our Most Important Product*  
**GENERAL  ELECTRIC**

CIRCLE 82 ON READER-SERVICE CARD

when the heat's on, you can rely on

## DAYSTROM PACIFIC SQUARETRIMS

**PERFORMANCE  
UP TO 200° C.**

model 313



model 318



shown full size

**HIGH POWER RATINGS**..... 1-watt at 95°C;  
0.5-watt at 150°C.

**SUBMINIATURE PACKAGE**..... 1/2-inch square,  
aluminum case.

The Series 313 Squaretrims are the smallest, high-temperature, trimming potentiometers. The Series 318 Squaretrims are identical in performance to the Series 313, but they are adapted to mount base-down to a printed circuit board and remain secure under high vibration and shock loads. Both are available in humidity proof versions. For full environmental specifications, write for Data File ED-653-1.

**DAYSTROM PACIFIC**  
a division of DAYSTROM, INC.  
9320 LINCOLN BOULEVARD  
LOS ANGELES 45, CALIFORNIA

In Canada: DAYSTROM LTD.  
840 Caledonia Rd.  
Toronto 10, Ontario

Export: DAYSTROM INTERNATIONAL  
100 Empire Street  
Newark 12, New Jersey

potentiometers / gyro instruments / airborne systems

CIRCLE 83 ON READER-SERVICE CARD

## NEW PRODUCTS

### Memory Drum Head

Operates at high frequencies



The model HD-9 is a single track, low inductance head that will read and record information on magnetic memory drum systems at high frequencies. It allows a 2-1/2 to 4 mil spacing between head and recording medium with negligible loss in definition. Using a locking four conductor polarized plug, the unit is 2.186 in. long and 0.5 in. in diameter.

J. B. Rea Co., Inc., Dept. ED, 2202 Broadway,  
Santa Monica, Calif.

CIRCLE 84 ON READER-SERVICE CARD

### Coaxial Termination Resistor

For 3/8 line



The type 5098 resistor is a low temperature coefficient, metal film unit for use as a coaxial termination for 3/8 line. It is designed to permit the use of metal contacts or fingers whose OD is identical to the 0.125 in. OD of the inner conductor of the line. Properly mounted with type N connectors, it can provide a vswr of 1.05 from dc to 4000 mc, a range which can be extended to 10,000 mc by the use of suitable impedance matching techniques. Standard resistance is 50 ohms and standard tolerances are  $\pm 2$ ,  $\pm 5$ , and  $\pm 10\%$ . Other resistance values and  $\pm 1\%$  tolerances are available on special order. The units dissipate 1 w at an ambient of 150 C.

Filmohm Corp., Dept. ED, 48 W. 25th St., New York 10, N.Y.

CIRCLE 85 ON READER-SERVICE CARD

Burroughs  
NIXIE®

NUMERICAL  
READOUT  
TUBE



*Now!* ultra  
long life

DYNAMIC LIFE — 25,000 HOURS

STATIC LIFE — 5,000 HOURS  
(on one number)

ALL ELECTRONIC IN-LINE READOUT  
CONTAINING TEN DIGITS "0" THRU "9"

The Ultra Long Life Nixie Tube offers increased life for those applications requiring continuous display of one of the ten characters for extended periods of time. Under these stringent conditions a minimum of 5000 hours life on one numeral can be expected. Where the display is changed sequentially, even as infrequently as every 100 hours, life in excess of 25,000 hours can be expected.

NIXIE Tube Exclusive Features:

- ALL ELECTRONIC
- LOWEST COST
- LOWEST POWER
- LIGHTEST WEIGHT
- MOST READABLE FOR NUMBER SIZE
- SMALLEST VOLUME AND NUMBER SIZE
- MAXIMUM TEMPERATURE, SHOCK AND VIBRATION SPECS
- AND NOW, LONGEST LIFE

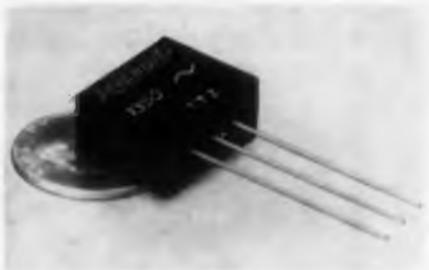
ANOTHER ELECTRONIC CONTRIBUTION BY  
**Burroughs Corporation**

ELECTRONIC TUBE DIVISION  
Plainfield, New Jersey

CIRCLE 86 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • April 15, 1969

### Band Pass Filter

Operates from 7.35 to 100 kc



Designed for use from 7.35 to 100 kc, the Microid type TTJ band pass filter is 1/2 x 19/32 x 15/16 in. and weighs 0.3 oz. Bandwidth is 15% at 3 db and +60%, -40% at 40 db. The unit provides surface economy on printed circuit boards and is completely encapsulated for resistance to acceleration, shock, and vibration.

Burnell & Co., Inc., Dept. ED, 10 Pelham Pkwy, Pelham Manor, N.Y.  
CIRCLE 87 ON READER-SERVICE CARD

### Decade Inductors

0.001 to 11.11 h range



For substitution in the design of equalizers and filters at audio and ultrasonic frequencies, these decade inductors have moisture protected, low distributed capacity coils wound on temperature stabilized molybdenum permalloy cores. Types DIA1 through 4 have one decade and ranges from 0.001 to 10 h; types DIB2 through 4 have two decades and ranges from 0.001 to 11 h; types DIC3 and 4 have three decades and ranges from 0.001 to 11.1 h; and type DID4 has four decades and a 0.001 to 11.11 h range.

Universal Mfg. Co., Dept. ED, 1168 Grove St., Irvington, N.J.

CIRCLE 88 ON READER-SERVICE CARD

CIRCLE 89 ON READER-SERVICE CARD

# digital programming and multiple display

at their best!

## unitized pulse control instruments

Burroughs offers the most complete line of matched pulse handling units performing basic functions that are complete within themselves and matched to each other. There are no problems of detailed circuit design. They are engineered to be interconnected to form an unlimited variety of pulse systems.

### The most complex digital program becomes routine in a matter of minutes.

Burroughs Pulse Control Instruments have an unparalleled record of performance and reliability.

More than 20 basic building block units available from stock including Pulse Generators above 10 mc and fractional usec delays.



1006 WIDE RANGE PULSE GENERATOR  
PUSH BUTTON TO 4.5 USEC



1105 TWIN FLIP-FLOP



1301 PULSE DELAY 1-80,000 USEC.



1751 MEGACYCLE VARIABLE SCALE  
COUNTER

ALL 10 OUTPUTS AVAILABLE

## the beamplexer



The Beamplexer is a ten position high speed electronic switch utilizing the Burroughs Beam Switching Tube. It provides a means of displaying up to ten separate channels of information on a conventional single-beam oscilloscope. Dual controls on each of the ten input channels allow both amplification and the vertical positioning of the signals, so that they may be superimposed on each other or placed in any desired relationship.

The simplest and most direct way of monitoring up to 10 channels simultaneously on a single viewing area.

Write for complete technical information.

ELECTRONIC CONTRIBUTIONS BY

**B**

ELECTRONIC TUBE DIVISION  
Plainfield, New Jersey

# NOW AVAILABLE FROM FILTERS, THE LEADER

First AC Powrmite<sup>®</sup> Micro-Miniature Relay



First Relays with built-in arc suppressed coil



AC Sub-Miniature Relays



.2 Grid Space Powrmite Micro-Miniature Relays  
with new "Sensi-Tork" motor



**New! First AC Powrmite micro-miniature relay.** The new Powrmite crystal can micro-miniature relay is the smallest, lightest AC relay made today.

**New! First relays with built-in arc suppressed coil.** In the same micro-miniature size Filters' Powrmite is also made with a built-in arc suppressed coil to cut radio interference a minimum of ten to one. Available also in four and six-pole sub-miniature relays, Filters arc suppressed relays increase life and reliability of associated circuitry.

**New! AC sub-miniature relays.** Filters now manufactures the smallest, lightest four and six-pole sub-miniature hermetically sealed relays for AC operation.

**New! .2 grid space Powrmite micro-miniature relays.** All types of Filters Powrmite micro-miniature relays are now available in .2 grid space in all mounting styles; .2 grid space relays feature Filters new "Sensi-Tork" motor, a Filters development for greatest reliability and sensitivity.

Filters, the leader, and specialist in the development and manufacture of micro and sub-miniature rotary relays makes a complete line of general purpose, latching (both 2, 4 and 6 DPDT) and 5/8" sub-miniature hermetically sealed relays. The Powrmite, Filters' popular micro-miniature relay, has long been acclaimed by hundreds of users as the most reliable in the field. Write for catalog!

Leading manufacturer of hermetically sealed rotary micro and sub-miniature relays.

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

## FILTERS, INC.

## NEW PRODUCTS

### Corona Regulator Tube

Low current



Type GV3A-700L corona type regulator tube is designed for operation at 700 v and for currents of 0.001  $\mu$ a or higher. Featuring economy of current drain from the primary power source, the unit can be used in nuclear battery regulation, solar cell regulation, and the regulation of transistorized power supplies.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

CIRCLE 91 ON READER-SERVICE CARD

### Compound Rotary Switches

For 6 and 12 pole operation

Complicated circuit switching without relays can be accomplished with type WC-1447 and WC-1433 rotary switches. The WC-1447 incorporates six 15 amp snap action pushbutton switches arranged individually around the periphery of an aluminum case. A cam coupled to the shaft holds five of the six switches in the operated contact position. As the shaft rotates, individual switches are successively transferred from the operated to the normal contact position. The WC-1433 is a 12-pole unit similar to the WC-1447. The individual switches are available in a variety of arrangements.

Hetherington, Inc., Dept. ED, Folcroft, Pa.

CIRCLE 92 ON READER-SERVICE CARD

◀ CIRCLE 90 ON READER-SERVICE CARD

## Differential Air Pressure Switches

For airborne use

For airborne use, these snap action differential air pressure switches open one circuit and close another at a preset differential pressure value within the range of 2-1/2 to 135 in. of water. Minimum switch differential values fall within a range of 3/4 in. of water. In the type 6580 there is one spdt switch element, and one adjustment changes the switch actuation point while another changes the magnitude of the switch differential value. For the type 6557, which has two spdt switch elements, the adjustments control the actuating point of each switch element separately, thus enabling the two switch elements to be operated together or at different points within the adjustment range. The units meet MIL-E-5272A requirements and operate from -65 to +250 F.

Consolidated Controls Corp., Dept. ED, Bethel, Conn.

CIRCLE 93 ON READER-SERVICE CARD

## DC Amplifier

Provides continuous gain



Model 512-A is a chopper stabilized dc amplifier that has 11 fixed gain steps with continuously variable gain between each gain setting. Drift is  $\pm 2 \mu\text{v}$ ; noise, 12  $\mu\text{v}$  rms; frequency response, 0.3 db from dc to 10 kc, down 3 db at 40 kc. Linearity is 0.1% and output is  $\pm 35 \text{ v}$  with resistance loads above 1 K and  $\pm 40 \text{ ma}$  with resistance loads of 4 to 400 ohms.

Allegany Instrument Co., Inc., Dept. ED, 1091 Wills Mountain, Cumberland, Md.

CIRCLE 94 ON READER-SERVICE CARD

CIRCLE 95 ON READER-SERVICE CARD



## ESC delay lines take off with America's talking satellite

On December 18, 1958, the world entered a new era of communications with the successful orbiting of an Atlas ICBM—the Talking Satellite that broadcast President Dwight D. Eisenhower's Christmas message to the world. Circling the earth at a speed of more than 17,000 mph, the Talking Satellite repeated the President's message, erased it, and received and rebroadcast new messages in both voice and code.

ESC Corporation is justifiably proud that its delay lines were selected to aid in this electrifying triumph for America and her electronics industry. Especially designed by ESC, these delay lines were used in the timing sequence for propulsion, the guidance system and the telemetering system.

As America's largest manufacturer of custom-built and stock delay lines, ESC has continually met the responsibility of leadership by providing virtually every type of delay line needed by defense and industry. If you have a delay line problem, let ESC's design staff suggest a custom-built answer.



# ESC

WRITE TODAY FOR COMPLETE TECHNICAL DATA.

exceptional employment opportunities for engineers experienced in computer components . . . excellent profit sharing plan.

**CORPORATION** 534 BERGEN BOULEVARD, PALISADES PARK, NEW JERSEY

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

Very Compact...



NEW RCA "VC" 110° PICTURE TUBES!

Here's a compact honey! The new RCA "VC" (*Very Compact*) Picture Tubes—now 2 inches shorter than their prototypes!

Now commercially available in the new "VC" 110° designs are the RCA-17DKP4 and RCA-21EQP4, all-new premium types. They utilize conventional 110° components and circuitry. And, with only slight changes in focusing-voltage control, they are unilaterally interchangeable with previous 110° types. RCA "VC" 110° types employ the same heater cathode assembly that has been used and proven for reliability over the past decade in RCA Picture tubes.

So, when the need arises for a slim, *very compact* TV-set design, contact your RCA Field Representative. Your pass words are RCA "VC" 110° Picture Tubes. For technical data, write RCA Commercial Engineering, Section D-18-DE-2, Harrison, N. J.



**RADIO CORPORATION OF AMERICA**  
Electron Tube Division  
Harrison, N. J.

**RCA FIELD OFFICES**

**EAST:** 744 Broad Street  
Newark 2, N. J.  
Humboldt 5-3900

**MIDWEST:** Suite 1154  
Merchandise Mart Plaza  
Chicago 54, Ill.  
Whitehall 4-2900

**WEST:** 6355 E. Washington Blvd.  
Los Angeles 22, Calif.  
RAymond 3-8361

**NEW PRODUCTS**

**Hermetically Sealed Relay**

Rated at 10 amp



A 4pdt aircraft and missile relay, the series 3205 exceeds MIL-R-6106-B, Class B requirements. Contact rating is 10 amp for resistive ac and dc, normally open or closed, and 6 amp for inductive dc or motor dc, normally open or closed. The unit incorporates a Deutsch DM 5600 series miniature receptacle and measures 1-21/32 x 1-7/16 x 2.063 in.

Guardian Electric Mfg. Co., Dept. ED, 1621 W. Walnut St., Chicago 12, Ill.

CIRCLE 97 ON READER-SERVICE CARD

**Rotary Switched Attenuators**

Provide 1 to 119 db attenuation



Rotary switched attenuator models 40-0, 41-0, and 42-0 have input and output impedance of 50, 75, and 90 ohms, respectively. They provide attenuation from 1 to 119 db in 1 db steps and operate from dc to 500 mc.

Kay Electric Co., Dept. ED, 4 Maple Ave., Pine Brook, N.J.

CIRCLE 98 ON READER-SERVICE CARD  
CIRCLE 96 ON READER-SERVICE CARD

## Lightning Arrester

Fits coaxial cable

This lightning arrester fits any standard coaxial cable, eliminating heavy static charge build-up and protecting radio equipment. Called the Blitz Bug, it will handle 1 kw, fully modulated, and protect cable from punctures caused by high standing wave ratios. It has no insertion loss and will not affect performance to 500 mc.

Cush Craft, Dept. ED, 621 Hayward St., Manchester, N.H.

CIRCLE 99 ON READER-SERVICE CARD

## Magnetic Predetermining Counter

1-1/8 x 1-5/16 x 2 in.

Without its optional panel mount case, model CV magnetic predetermining counter is 1-1/8 x 1-5/16 x 2 in. It receives dc pulses of any number from 1 to 899, as manually set. A subtractive counter always shows the remaining pulse count, and a set of contacts opens as the counter wheels pass zero count. Capable of making 1200 counts per min, the unit comes in 6, 12, 24, and 110 v dc models.

Abrams Instrument Corp., Dept. ED, 606 E. Shiawassee St., Lansing 1, Mich.

CIRCLE 110 ON READER-SERVICE CARD

## Magnetic Resonance Field Control

310 to 20,000 gauss range

For precise electromagnet regulation, the FC-501 nuclear magnetic resonance field control has a 310 to 20,000 gauss range with standard probes. It produces an error signal, derived from the field under control, suitable for closed loop regulation of the magnet power supply. With an external bridge, it can also serve as a null detector to control temperature, pressure, and impedance.

Harvey-Wells Electronics, Inc., Dept. ED, 5168 Washington St., West Roxbury 32, Mass.

CIRCLE 111 ON READER-SERVICE CARD

CIRCLE 112 ON READER-SERVICE CARD

# Introducing a NEW FAMILY OF MICROWAVE DIODES

## PHILCO sets the pace with outstanding crystal performance

Announcing a new family of low-noise microwave diodes. Here is a major step forward in the development and control of germanium and silicon crystal diode performance. Philco microwave diodes are designed to meet the most stringent military environmental and electrical requirements for shock, vibration, torque and strain. Each of these new diodes is unsurpassed for performance. When only the best will do . . . the experts choose Philco.

- Exceptionally Low Noise Figure
- Outstanding Performance at 150° C
- High Resistance to Burn-Out
- Absolute Hermetic Seal

 1N1838	The first and only Germanium Mixer Diode specifically designed for ultra-low noise performance in Doppler receivers. A noise temperature ratio specification of 24db max at 20kc guarantees this performance. Through Philco's exclusive anchor whisker construction the practical elimination of microphonics is assured. The 1N1838 is hermetically sealed and has been uniquely engineered for Doppler equipments operating at 8,800 and 13,500mc.	 1N263	Here's a Hermetically Sealed Germanium Crystal Diode designed for exceptionally low noise mixer performance at X-band. It has been engineered to such a degree that its tightly controlled characteristics assure that any two 1N263's will be a matched pair; its symmetrical construction allows easy polarity reversal in balanced mixers. The crystal may be used fixed-tuned over the range 8600 to 9600mc. IF impedance ( $Z_{if}$ ) . . . 140 to 210 ohms; RF impedance (VSWR) . . . 1.3 max; Overall noise figure ( $N_{Frec}$ ) . . . 7.5db max.
 1N26 1N26A 1N26B	These Silicon Mixer Diodes bring tremendously improved performance to this family designed for high reliability operation in the 24,000mc region. As a result of Philco's unparalleled engineering activity in this area, existing performance limits in the 1N26 series have been greatly extended: by addition of the 1N26B . . . maximum operating temperature more than doubled (to 150° C.); VSWR reduced to 1.5; IF impedance range narrowed (400 to 600 ohms). All members of this family have a metal-to-ceramic hermetic seal guaranteeing reliable performance under extreme environmental conditions.	 1N78 1N78A 1N78B 1N78C	These Silicon Mixer Diodes offer new and unsurpassed performance characteristics to this established family designed for maximum sensitivity operation in the 16,000mc region. The new member of this family is unilaterally interchangeable with existing types while incorporating strikingly superior features: conversion loss ( $L_c$ ) reduced to 6.0db max; IF impedance ( $Z_{if}$ ) range tightened (400 to 550 ohms); RF impedance (VSWR) reduced to 1.5; temperature range extended (150° C.). Engineered to meet the most demanding military applications, all the members of this series are packaged in a hermetically sealed case.

Write Special Components Dept., ED 359 Lansdale Tube Company Division, Philco Corporation, Lansdale, Pa.

**PHILCO**  
LANSDALE TUBE COMPANY DIVISION  
LANSDALE, PENNA.



(right) Checking accuracy of machine threads on a 30 inch magnification contour projector.

Nation's first successful re-entry tests were conducted with Lockheed X-17.



Optical gauge determines measurements within 5 millionths of an inch.



## QUALITY ASSURANCE

### Expanding the Frontiers of Space Technology

Quality assurance at Lockheed parallels in importance and augments the research and development, projects, and manufacturing organizations. Quality assurance engineers establish audit points, determine functional test gear, write procedures and perform related tests.

These activities, supported by laboratories, data analysis, establishment of standards, and issuance of reports—all insure that Lockheed products meet or surpass contractual requirements. Economy and quality are maintained at every stage to produce the best products at

the least cost.

With the company holding such major, long-term projects as the Navy Polaris FBM; Army Kingfisher; and Air Force Q-5 and X-7, quality assurance at Lockheed plays a key role in the nation's defense.

Scientists and engineers of outstanding talent and inquiring mind are invited to join us in the country's most interesting and challenging basic research and development programs.

Write: Research and Development Staff, Dept. D-2-21, 962 W. El Camino Real, Sunnyvale, California.

*"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics."* NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

**Lockheed** / **MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

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# WHEN YOU'RE REACHING FOR THE MOON

When you're designing a new missile gyroscope . . . a new computer . . . a new telemetering device . . . a new *anything* that calls for precision instrument ball bearings . . . you do well to turn to Fafnir. For no matter what your problem is . . . temperature extremes, low torque, load-life, low vibration or noise levels . . . Fafnir can help you solve it. Fafnir has the *diversity* — a wide variety of ball bearing types, designs, materials, and tolerances — and the uniformly high standards of *quality* to meet your needs precisely. The Fafnir Bearing Company, New Britain, Conn.



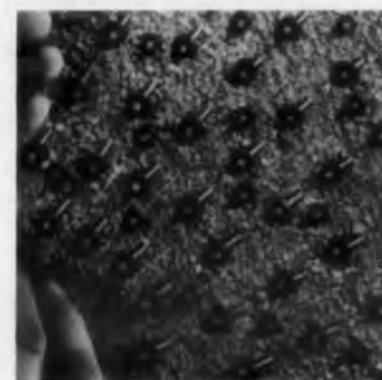
Three varieties of retainers available to you in Fafnir precision instrument ball bearings. From left: ribbon-type steel (for low torque), composition (for high speeds), and iron-silicon-bronze (for high-speed, high-temperature applications).



**FAFNIR**  
BALL BEARINGS

CIRCLE 113 ON READER-SERVICE CARD

## NEW PRODUCTS



### Silicon Rectifiers

58 types available

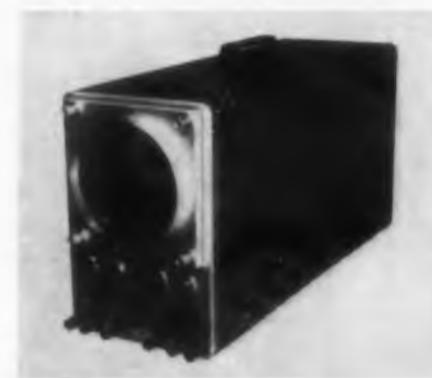
Pig-tailed lead rectifier cells 1N599 through 1N606 and 1N599A through 1N606A handle 400 ma at 100 C, and have piv ratings ranging from 50 to 600 v. Units 1N1100 through 1N1103, also pig-tailed can handle 250 ma at a temperature of 150 C, with no more than 0.3 ma reverse current. Piv ratings: 100 to 400 v. Units 1N332 through 1N349, stud-mounted, stand 100 to 400 piv. One group of this series is rated at 200 ma while the other group is rated at 400 ma, both groups having case temperatures of 150 C. Units 1N550 to 1N555 stand 100 to 600 v piv. At 100 C they provide an output of 500 ma. Maximum dc full load forward voltage drop at 25 C is 1.5 v. Series 1N607 through 1N614 and 1N607A through 1N614A provide 1 amp at 100 C. Piv rating: 50 to 600 v. Maximum forward voltage drop is 1.5 v at a dc output of 200 ma at 25 C.

General Electric Co., Semiconductor Products Dept., Dept. ED, Syracuse, N.Y.

CIRCLE 114 ON READER-SERVICE CARD

### DC Oscilloscope

Provides dc to 200 kc bandwidth



Supplied in kit form, model OR-1 is a 5 in. dc oscilloscope that covers 5 cps to 50 kc in four overlapping ranges. It has identical dc coupled vertical and horizontal amplifiers with low relative phase shift characteristics and a 5ADP2 flat-face crt. Both vertical and horizontal channels feature dc to 200 kc bandwidth and a sensitivity of 0.1 v peak to peak per cm.

Heath Co., Dept. ED, 305 Territorial Rd., Fenton Harbor, Mich.

CIRCLE 115 ON READER-SERVICE CARD

## VTVM

Covers 20 cps to 300 mc



Low cost vtvm model 1300 gives  $\pm 0.2$  db frequency response from 50 cps to 200 mc and  $-1$  to  $+1.5$  db from 20 cps to 300 mc. It measures ac voltages to 100 v, dc voltages to 300 v, and resistances from 50 ohms to 5 meg. Its dc input resistance is 90 meg.

Marconi Instruments, Dept. ED,  
111 Cedar Lane, Englewood, N.J.  
CIRCLE 119 ON READER-SERVICE CARD

## 1000 w Power Meter

Covers dc to 500 mc

This power meter provides 1 kw mean power absorption and 5 kw peak power. It covers dc to 500 mc with accuracies of 5% to 150 mc and 7.5% to 300 mc. The unit measures true mean power, irrespective of waveform.

Marconi Instruments, Dept. ED,  
111 Cedar Lane, Englewood, N.J.  
CIRCLE 120 ON READER-SERVICE CARD

## Fans

Deliver 160 to 750 cfm

Designed for ventilating standard enclosed electronic racks, these fans distribute air both axially and radially. They are available in diameters of 6-1/2, 8, and 10 in. and deliver from 160 to 750 cfm. Depths range from 2-7/8 to 4-1/2 in.

Kooltronic Fan Co., Dept. ED,  
Carter Rd. at Rosedale, Princeton,  
N.J.

CIRCLE 121 ON READER-SERVICE CARD

CIRCLE 122 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

# NEW FROM TI

## 1N2175 SILICON

## PHOTO-DEVICE

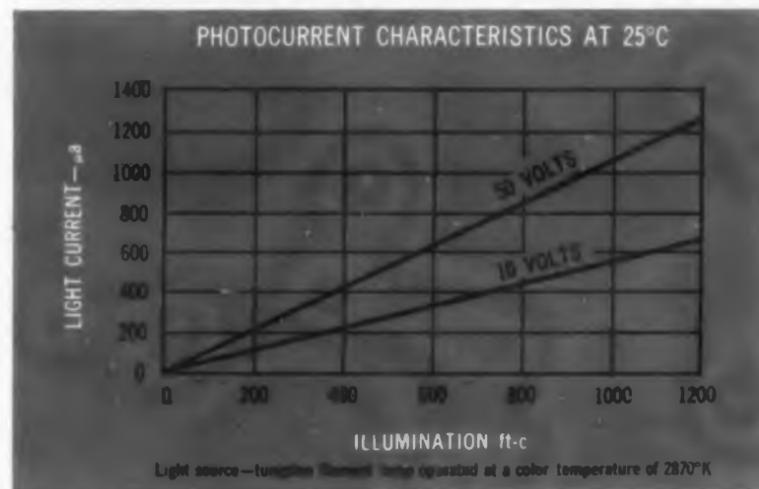
## SWITCHES FROM

## DARK TO LIGHT CURRENT

## IN 2 MICROSECONDS



**TI 1N2175 subminiature unit is ideal for punch-card or tape data processing, and many other control systems**



Now you can get quadrupled sensitivity and unprecedented design flexibility with the new subminiature TI 1N2175 Photo-Device.

Easily activated, the 1N2175 switches from a low dark current of only  $0.5 \mu a$  to a high light current of  $1200 \mu a$  at 1200 ft-candles — within  $2 \mu secs$ . Rated at 250 mw at 25°C, the 1N2175 operates over a range of 1-50 volts, and derates linearly to 125°C. Minimum operating temperature is  $-55^\circ C$ .

Specify the TI 1N2175 today and get immediate off-the-shelf delivery in 1-999 quantities from all authorized TI distributors and production quantities through TI sales offices.



from THE WORLD'S LARGEST SEMICONDUCTOR PLANT



**TEXAS INSTRUMENTS**  
INCORPORATED  
SEMICONDUCTOR-COMPONENTS DIVISION  
POST OFFICE BOX 312 • 13500 N. CENTRAL EXPRESSWAY  
DALLAS, TEXAS

## NEW PRODUCTS



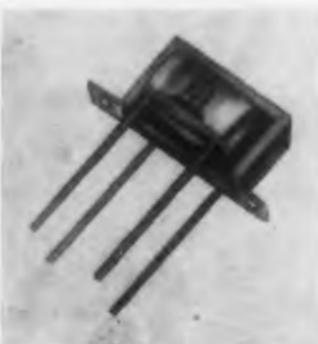
### Microminiature Relays

Four pole double throw

These two 4pdt microminiature relays withstand 100 g of shock for 11 msec, and up to 2000 cps of vibration at 30 g. Available in sample quantities, the units both have permanent magnets to prevent contact opening in either armature position during shock and vibration. The relays have a terminal header that permits mounting the unit in cable runs. The contacts can handle 2 amp, 30 v dc resistive loads or 1 amp, 115 v, 60 cps resistive loads.

Potter & Brumfield, Inc., Dept. ED, Princeton, Ind.

CIRCLE 123 ON READER-SERVICE CARD



### Transistor Transformers

Weigh 0.4 oz.

These miniature transistor transformers are available in open frame construction with standard channel or plug-in tab mounting channel. They occupy less than 1/2 cu in. and weigh about 0.4 oz.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N.Y.

CIRCLE 124 ON READER-SERVICE CARD

### Transistorized I-F Amplifiers

Have bandwidths from 1 to 20 mc

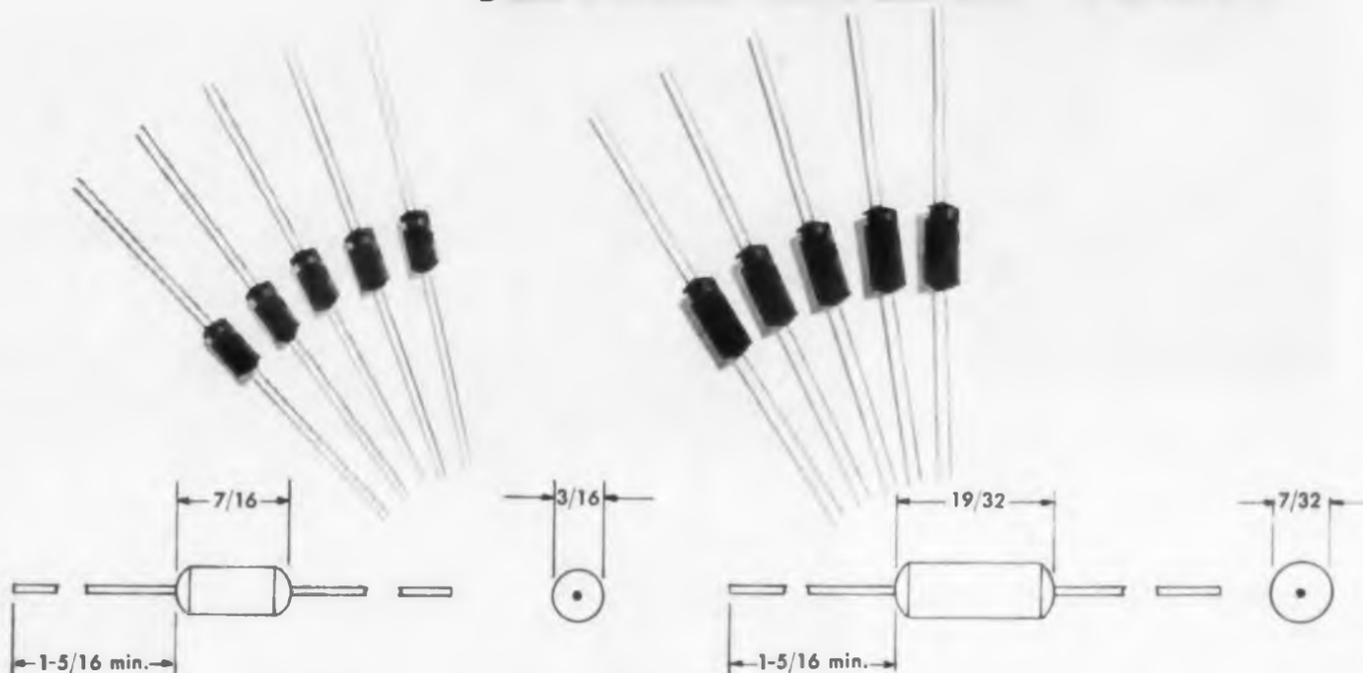
These transistorized i-f amplifiers have center frequencies of 30 or 60 mc and bandwidths of 1 to 20 mc. Model 81 is a low noise hybrid unit with a gain of 100 db and noise figures down to 1 db. Model 82D, for missile applications, will withstand 30 g shock, 5 to 2000 cps vibration, and 80 g acceleration. It provides 80 db gain.

LEL, Inc., Dept. ED, 380 Oak St., Copiague, N.Y.

CIRCLE 125 ON READER-SERVICE CARD

*Proved in design... construction...  
and performance*

## JEFFERS MOLDED COILS!



TYPE NO. 101

TYPE NO. 102

PART NUMBER	L-Microhenries	L-Tol. Plus or Minus	Approx. Fr Mc	Min. Q at MC	R dc Max. 25°C	Max. Idc. MA
10100-20	0.15	20%	540	45 25	0.03	3650
" -22	0.22	"	450	45 25	0.04	3160
" -24	0.33	"	385	45 25	0.07	2400
" -26	0.47	"	335	45 25	0.08	2230
" -28	0.68	"	285	40 15	0.15	1630
" -30	1.00	"	230	30 10	0.30	1150
" -32	1.50	"	190	30 10	0.50	900
" -34	2.20	"	155	30 8.0	1.10	600
" -36	2.70	10%	140	30 7.0	1.20	570
10102-20	3.30	"	80	25 6.0	0.15	1630
" -22	3.90	"	75	25 6.0	0.16	1580
" -24	4.70	"	70	25 5.5	0.22	1350
" -26	5.60	"	62	30 5.0	0.30	1150
" -28	6.80	"	55	30 4.5	0.40	1000
" -30	8.20	"	53	30 4.5	0.45	940
" -32	10.0	"	47	30 4.0	0.60	810
" -34	12.0	"	42	45 3.5	1.00	620
" -36	15.0	"	38	45 3.0	1.20	575

PART NUMBER	L-Microhenries	L-Tol. Plus or Minus	Approx. Fr Mc	Min. Q at MC	R dc Max. 25°C	Max. Idc. MA
10200-20	0.47	20%	335	50 15	0.06	3160
" -22	0.68	"	280	50 14	0.10	2400
" -24	1.00	"	230	45 10	0.15	2000
" -26	1.50	"	190	45 10	0.28	1450
" -28	2.20	"	155	40 8.0	0.50	1100
" -30	2.7	10%	140	40 8.0	0.70	920
" -32	3.3	"	120	35 6.0	1.40	650
" -34	3.9	"	112	35 6.0	1.50	630
" -36	4.7	"	110	35 5.0	1.80	575
10203-20	5.6	"	60	35 5.0	0.15	2000
" -22	6.8	"	54	35 4.0	0.20	1730
" -24	8.2	"	50	35 4.0	0.25	1550
" -26	10.0	"	49	35 3.5	0.30	1400
" -28	12.0	"	40	40 3.0	0.50	1100
" -30	15.0	"	37	40 2.5	0.60	1000
" -32	18.0	"	34	50 2.5	0.80	860
" -34	22.0	"	29	60 2.5	1.20	700
" -36	27.0	"	27	65 2.0	1.40	650
" -38	33.0	"	24	70 2.0	1.90	560
" -40	39.0	"	23	70 2.0	2.00	550

Jeffers Coils are designed to give circuit engineers a standardized inductor line on which they can rely. The millions of Jeffers Coils made and sold every year are proof that they give just what's promised: longer, *more useful* service life! Jeffers Molded Coils are engineered for dependability

by virtue of their rugged mechanical construction and through the use of time-proven materials and manufacturing techniques. Only three physical sizes are required to cover a wide inductance range. Small size and close dimensional tolerances of the Jeffers Molded Coils make them ideal for automatic insertion.

# JEFFERS MOLDED COILS

*proved in extended life-performance tests!*

Jeffers Molded Coils are engineered to provide stabilized electrical characteristics for many thousands of hours of useful life under a variety of operating conditions.

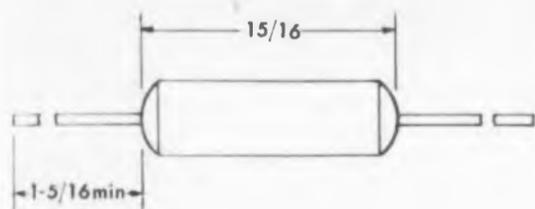
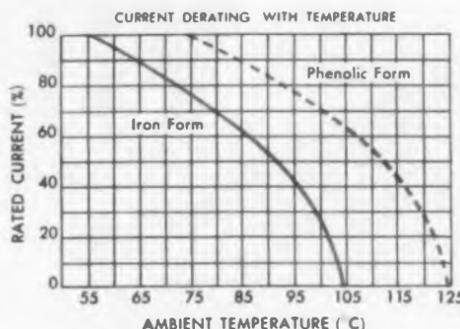


## TYPICAL CHARACTERISTICS FOR TYPE 101 COILS.\*

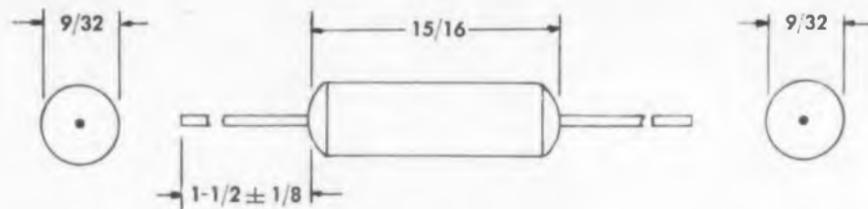
Moisture Resistance (MIL-STD-202, Method 106)

Change in: Inductance . . . . . Less than 2%  
 Change in: Resistance . . . . . Less than 2%  
 Change in: Resonant Frequency . . . . . Less than 4%  
 Change in: Q Value . . . . . Less than 10%  
 Life Expectancy . . . . . 20,000 hours plus at maximum operating temperature

\*(Data for other types available on request.)



TYPE NO. 104



TYPE NO. 404

PART NUMBER	L-Micro-henries	L-Tol. Plus or Minus	Ap-prox. Fr Mc	Min. Q	at MC	R dc Max. 25°C	Max. I dc. MA
10402-20	1.2	20%	200	60	10	0.09	2980
" -22	1.5	"	180	65	10	0.12	2580
" -24	2.2	"	145	65	10	0.20	2000
" -26	2.7	10%	130	55	8.0	0.28	1700
" -28	3.3	"	125	50	6.0	0.32	1580
" -30	3.9	"	110	45	5.0	0.50	1260
" -32	4.7	"	100	45	5.0	0.60	1150
" -34	5.6	"	90	45	5.0	0.95	920
" -36	6.8	"	85	40	4.0	1.10	850
" -38	8.2	"	80	40	4.0	1.20	810
" -40	10.0	"	70	40	3.5	1.80	670
" -42	12.0	"	60	40	3.0	2.70	545
" -44	15.0	"	57	40	3.0	3.00	510
" -46	18.0	"	53	35	2.5	4.80	410
D404-20	22.0	"	27	40	2.5	0.30	1630
" -22	27.0	"	25	40	2.0	0.36	1500
" -24	33.0	"	22	45	2.0	0.60	1150
" -26	39.0	"	20	45	1.8	0.80	1000
" -28	47.0	"	18	70	1.5	1.20	820
" -30	56.0	"	17	70	1.5	1.30	780
" -40	68.0	"	15	75	1.5	1.90	650
" -32	82.0	"	14	85	1.2	2.20	600
" -34	100.0	"	13	85	1.0	2.80	530
" -36	120.0	"	11	85	1.0	4.00	450

JEFFERS PART No.	Mil Type Designation	Inductance UH	Q Min.	Meas. Freq. MC	Self Res. Freq. MC	DC Res. Max. Ohms	DC Current Rated MA
40402-1	LT8K001	1.1 ± 20%	60	10.0	200 ± 10%	.09	2800
40402-2	LT8K002	2.2 ± 20%	65	10.0	165 ± 10%	.20	1800
40402-3	LT8K003	3.3 ± 10%	50	6.0	130 ± 10%	.32	1500
40402-4	LT8K004	4.7 ± 10%	45	5.0	100 ± 10%	.60	1100
40402-5	LT8K005	6.8 ± 10%	40	4.0	90 ± 10%	1.10	800
40402-6	LT8K006	10.0 ± 10%	40	3.5	70 ± 10%	1.80	600
40402-7	LT8K007	15.0 ± 10%	40	3.0	55 ± 10%	3.00	500
40402-8	LT8K008	22.0 ± 10%	30	2.5	27 ± 10%	.30	1500
40402-9	LT8K009	33.0 ± 10%	45	2.0	21 ± 10%	.60	1100
40402-10	LT8K010	47.0 ± 10%	70	1.5	16 ± 10%	1.20	700
40402-11	LT8K011	82.0 ± 10%	85	1.2	14 ± 10%	2.20	600
40402-12	LT8K012	100.0 ± 10%	85	1.0	14 ± 10%	2.80	500
40402-13	LT8K013	120.0 ± 10%	85	1.0	13 ± 10%	4.00	400

\* Per MIL-C-15305A, MS 91189 (15 December 1953)

**JEFFERS ELECTRONICS DIVISION**  
 Speer Carbon Company,  
 Du Bois, Pennsylvania



**AND DON'T FORGET JEFFERS TECHNICAL SERVICE!** You're invited to submit your inductor design problems for evaluation and solution at no cost or obligation. You can be sure you're getting the *right* answer from Jeffers.

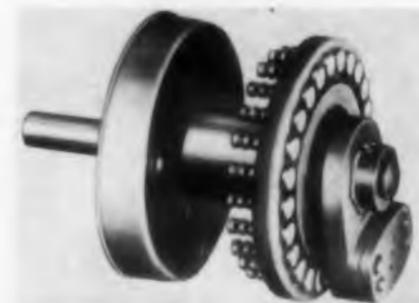
Light face type denotes coils on phenolic coil forms.  
 Bold face type denotes coils on powdered iron forms.

CIRCLE 126 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

## Rotary Switches

Have gold laminated contacts



A single-pole, 32 position, shorting type switch, the 11-CM-32 has gold laminated contacts and slip rings for use in highly corrosive atmospheres. The company's other switches can also be provided with these contacts and slip rings.

The Daven Co., Dept. ED, Livingston, N.J.

CIRCLE 127 ON READER-SERVICE CARD

## Analog to Digital Converters

High speed



Series 7000 transistorized analog to digital converters can make up to 1000 conversions per sec. They have 0.01% sensitivity and resolution, automatic polarity, three or four digit in-line display, and transistorized logic circuits.

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

CIRCLE 128 ON READER-SERVICE CARD

## Deviation Bridge

For testing resistors, capacitors, inductors

Produced by Bruel & Kjaer, Denmark, the model 1505 fast reading deviation bridge is designed for comparison testing of resistors, capacitors, and inductors. It provides a test frequency of 10 kc and has a 6 in. illuminated meter with three interchangeable scales for direct reading of the positive and negative deviation in impedance and phase measured against a standard. When calibrated by means of the built-in references, the accuracy of impedance measurements is better than 0.03% for deviations close to zero.

B & K Instruments, Inc., Dept. ED, 3044 W. 106th St., Cleveland 11, Ohio.

CIRCLE 129 ON READER-SERVICE CARD

## NEW PRODUCTS

### Miniature Rotary Relay

Switches 5 amp



Having a volume of less than 1 cu. in., this relay is rated at 5 amp for 100,000 operations, 10 amp for 25,000 operations and 15 amp for 2500 operations. The unit operates under vibration of 15 g from 55 to 2000 cps with a shock rating of 100 g, and weighs 1.5 oz. Temperature range is from  $-65$  to  $+125$  C. Designated the VG series, the relay is hermetically sealed to withstand rugged environmental conditions, and they meet MIL-R-5757C. Contact material is silver-magnesium-nickel alloy, gold flashed and units are dpdt.

Elgin National Watch Co., Electronics Div., Dept. ED, 2435 North Naomi St., Burbank, Calif.

CIRCLE 130 ON READER-SERVICE CARD

### Card Punch Coupler

Transfer counter data to IBM card punch

The DY-2512 card punch coupler transfers staircase decimal data of the form produced by the company's electronic counters to the ten-line input circuits of the IBM model 523 summary card punch. It transfers up to 11 decimal places of counter information and supplies up to eight additional pieces of auxiliary numbers preselected on front-panel controls or by external programming devices. The maximum punch rate is that of the card punch, approximately one complete punch per second.

Dymec, Inc., Dept. ED, 395 Page Mill Rd., Palo Alto, Calif.

CIRCLE 131 ON READER-SERVICE CARD

ANOTHER **FIRST** BY THOMAS & BETTS

THE NEW



# VIBRA-STAKE<sup>(TM)</sup>

TERMINAL ATTACHING MACHINE



for self-insulated STA-KON<sup>®</sup> wire terminals in  
**AIRCRAFT, MISSILES,  
ALL ELECTRONIC EQUIPMENT**

Self-Insulated STA-KON Terminals attached with the VIBRA-STAKE machine meet all Military Standard Specifications and performance requirements.

# Here's a brand new concept in attaching machines for STA-KON® terminals

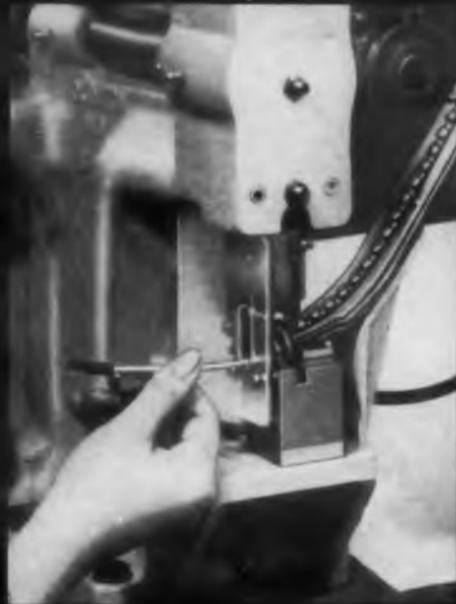
LOOK AT THESE  VIBRA-STAKE FEATURES

## Flexibility

For the first time, you need only one stock of standard—not special—terminals for both hand tool and machine staking! One machine accepts a wide variety of Sta-Kon terminals and connectors, 22 through 10 wire sizes. SPEED—The VIBRA-STAKE machine is faster because—it is easier to load and operate, simpler to maintain, more consistent in operation. These, and other important features, permit higher production rates—resulting in lowest installed cost.

## Reliability

Installations have high strength and positive electrical contact. Protective plating always covers the entire terminal—never leaves any bare spots.



### FREE DEMONSTRATION — at your request.

Descriptive literature also available. Mail coupon today!

T&B Sta-Kon Terminals and the VIBRA-STAKE machine are sold by local T&B distributors throughout the country, as part of their complete line of fine electrical fittings and tools.

All T&B products available only through authorized T&B distributors

## THE THOMAS & BETTS CO.

28 Butler Street, Elizabeth 1, N. J.



Thomas & Betts, Ltd.,  
Montreal, P.Q., Canada

MANUFACTURERS OF FINE ELECTRICAL FITTINGS SINCE 1898

The Thomas & Betts Co., Inc. 92  
 28 Butler Street, Elizabeth 1, N. J.  
 Yes! I'm interested in the following:

A free demonstration of VIBRA-STAKE electric terminal attaching machine.

Descriptive literature fully explaining the benefits of VIBRA-STAKE machine.

A call from my local T&B representative.

Name \_\_\_\_\_ Title \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

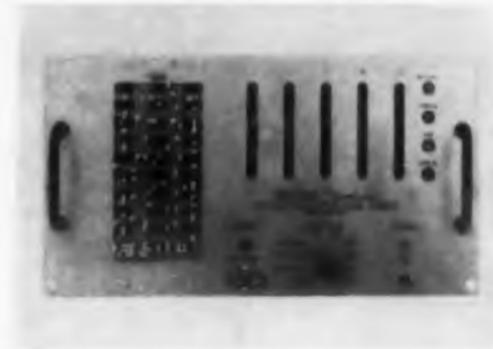
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 132 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

## Counter and Timer

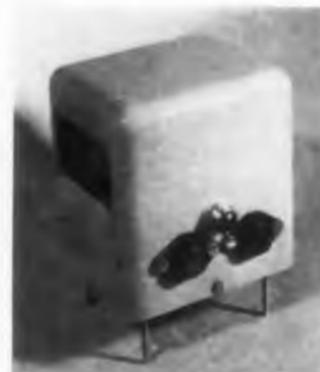
Has 20 pairs of high-low limits



The model 5690-80 preset counter and timer can measure the frequency of a sine wave input from 10 cps to 1 mc and time intervals in milliseconds from 1 to 99,999. To measure frequency, it counts pulses for 0.1, 1, or 10 sec and displays the total on a bank of five decimal counting units. The unit provides 20 pairs of high-low limits which are set up by means of a pinboard and which may be used to activate alarms. This feature makes it useful in missile checkout or other systems where it is necessary to monitor and alarm frequency or time interval measurements.

Beckman Instruments, Inc., Systems Div., Dept. ED, 325 N. Muller Ave., Anaheim, Calif.

CIRCLE 133 ON READER-SERVICE CARD



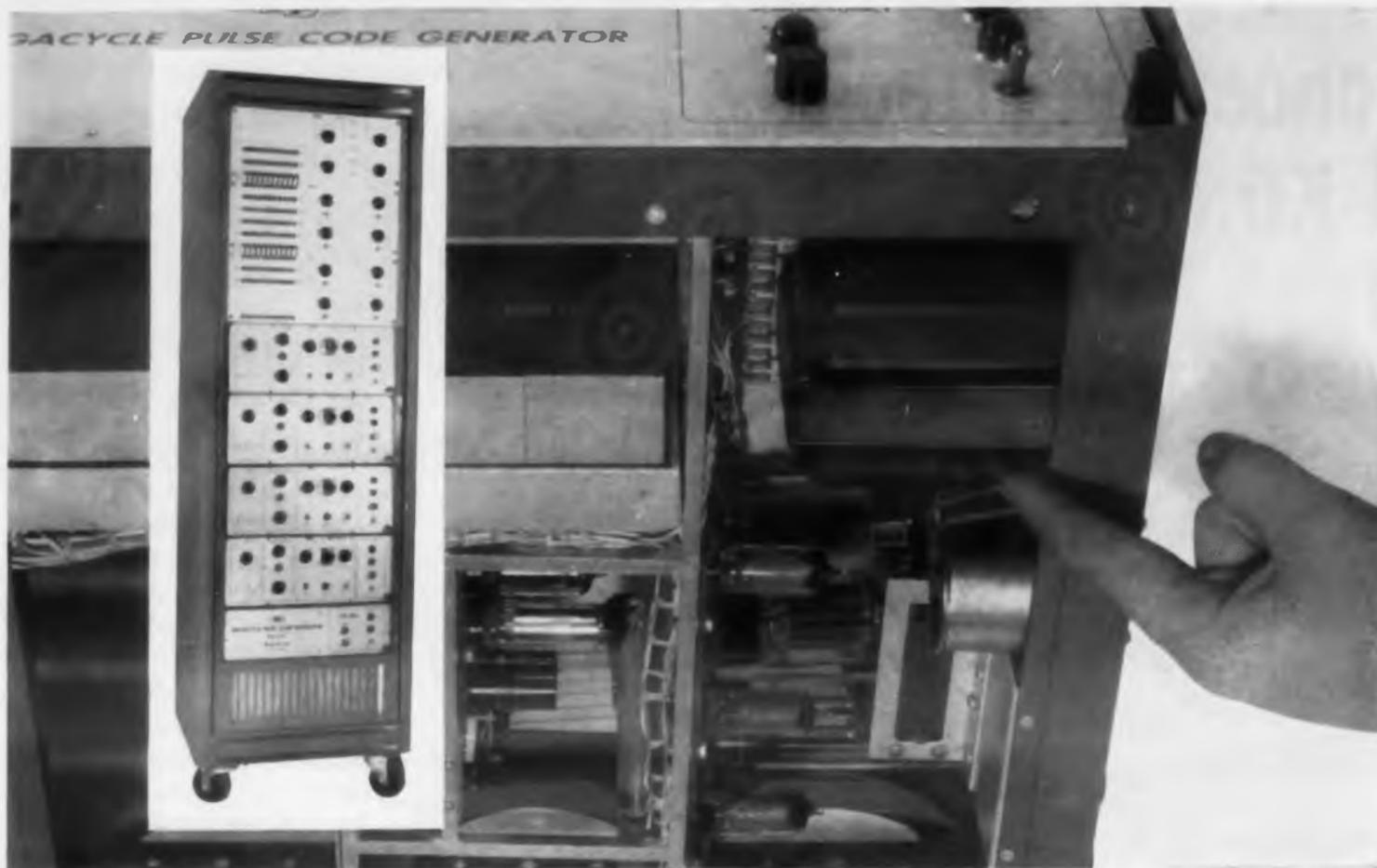
## DC to DC Converters

Efficiency up to 90%

Model 12-500D series dc to dc static converters, encapsulated and ruggedized, have an efficiency as high as 90%. All units are protected against overload and short circuit. Dc output ripple is less than 0.02% and dc input switching hash is less than 50 mv rms. Standard units are non-regulated, but regulation to  $\pm 0.1\%$  is available. Operating temperature range is from  $-40$  to  $+70$  C. Input voltage: 12 v dc. And dc output voltage is 500 v at 200 ma, 250 v at 100 ma continuous, 500 v at 300 ma and 250 v at 100 ma intermittent for the various units.

Static Inverters Corp., Dept. ED, 2501 East 68th St., Long Beach, Calif.

CIRCLE 134 ON READER-SERVICE CARD



*Sola Constant Voltage Filament Transformer is an integral part of this Electro-Pulse, Inc. Megacycle Pulse Code Generator. It provides regulated filament voltage for reliable operation of the equipment and for full life of its electron tubes.*

## Sola transformer regulates filament voltage within $\pm 1\%$ —protects tubes from inrush currents and line transients

Fluctuations in supply voltage for electron tube filaments can be costly . . . in shortened tube life . . . in substandard performance . . . in equipment downtime. Electro-Pulse, Inc. solved its filament voltage problems through this straightforward approach: the company's Megacycle Pulse Code Generator includes a Sola Constant Voltage Filament Transformer built-in as part of its power supply.

This versatile unit does the step-down job of a conventional transformer and it also regulates the filament supply — a task that ordinary filament transformers don't pretend to do. Filament voltages are stabilized to within  $\pm 1\%$  even with line voltage variations as great as  $\pm 15\%$ . Its current-limiting characteristic protects tubes from cold inrush currents upon starting—as well as from line transients. It is a simple, reliable static-

magnetic regulator with automatic and virtually instantaneous action. Variations in input voltage are usually corrected within 1.5 cycles. There are no tubes or moving parts, and no manual adjustment or maintenance is necessary.

The filament voltage regulator illustrated is only one of a complete line of Sola Constant Voltage Transformers having wide application in electrical and electronic devices. They include such special types as harmonic-free, plate-filament, and adjustable output units—all provide the benefits of regulated input voltage. More than 40 ratings of these compact, economical regulators are available from stock, and Sola manufactures custom-designed units (in production quantities) to meet special needs.

**For complete data write for Bulletin 31D-CVF-269**

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • Offices in principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ont.



CIRCLE 136 ON READER-SERVICE CARD

## NEW PRODUCTS



### Sweeping Oscillator

Has sweep width of 1 kmc

Sweep widths of 1000 mc and wider are possible with the Magna-Sweep sweeping oscillator. The unit is operative in the frequency range of 5 to 1000 mc, and can be modified up to 4000 mc. Sweep width and center frequency are variable through the frequency range, and sweep rate is variable around 30 cps. Sweep output is a regular sawtooth voltage of about 20 v amplitude, and rf output is 0.1 v across 50 ohms. Frequency calibration is obtained by a system of frequency markers and a precision wavemeter. The unit is 21.5 x 28 x 15 in.

Kay Electric Co., Dept. ED, Maple Ave., Pine Brook, N.J.

CIRCLE 137 ON READER-SERVICE CARD

### Servo Motor-Generators

Provide high acceleration



These servo motor-generators have high torque-to-inertia characteristics and provide high acceleration and immediate accurate response to error signals. They are available in sizes 8, 10, 11, 15, 18, and 20. The size 8 generator has an 18 v, 400 cps, 1.65 w input; a 0.27 w voltage gradient per 1000 rpm; a  $-55$  to  $+150$  C temperature range; and a 0.015 v rms null voltage. Phase shift is within 10 deg of reference. The size 8 motor has an input of 18 v, 400 cps, 4.7 w per phase; a torque at stall of 0.42 oz-in.; a no load speed of 6200 rpm; a power factor of 0.875; and a rotor inertia of 0.75 g cm<sup>2</sup>.

Induction Motors Corp., Dept. ED, 570 Main St., Westbury, N.Y.

CIRCLE 138 ON READER-SERVICE CARD

## FLIGHT DATA and CONTROL ENGINEERS

Cross new frontiers in system electronics at The Garrett Corporation.

High-level assignments in the design and development of system electronics are available for engineers in the following specialties:

**1. ELECTRONIC AND FLIGHT DATA SYSTEMS AND CONTROLS** A wide choice of opportunities exists for creative R & D engineers having specialized experience with control devices such as: transducers, flight data computers, Mach sensors, servo-mechanisms, circuit and analog computer designs utilizing transistors, magamps and vacuum tubes.

**2. SERVO-MECHANISMS AND ELECTRO-MAGNETICS** Requires engineers with experience or academic training in the advanced design, development and application of magamp inductors and transformers.

**3. FLIGHT INSTRUMENTS AND TRANSDUCERS**

1) **DESIGN ANALYSIS** Requires engineers capable of performance analysis throughout preliminary design with ability to prepare and coordinate related proposals.

2) **DEVELOPMENT** Requires engineers skilled with the analysis and synthesis of dynamic systems including design of miniature mechanisms in which low friction freedom from vibration effects and compensation of thermo expansion are important.

**4. PROPOSAL AND QUALTEST ENGINEER** For specification review, proposal and qualtest analysis and report writing assignments. Three years electronic, electrical or mechanical experience required.

Forward resume to:  
**Mr. G. D. Bradley**

**THE GARRETT CORPORATION**

9851 S. Sepulveda Blvd.  
Los Angeles 45, Calif.

DIVISIONS:

AiResearch Manufacturing—Los Angeles  
AiResearch Manufacturing—Phoenix  
AiResearch Industrial  
Air Cruisers • Airsupply  
Aero Engineering  
AiResearch Aviation Service

CIRCLE 880 ON READER-SERVICE CARD

# AiResearch creating central air data system for USAF F-108

Also  
latest data  
control concepts  
for missile and  
undersea applications

The AiResearch Centralized Air Data Computing System will sense, measure and automatically correct for air parameters affecting flight of the North American-Air Force F-108 Interceptor and will supply simplified air data to the pilot. Eliminating duplication of components, the system will cut down space and weight requirements over decentralized systems by many times.

The centralized combination of transducers, computers and indicators

represents an integrated system concept combining electrical, electronic, pneumatic, hydraulic, electro-mechanical and mechanical servo capabilities. Technical experience in each of these fields enables AiResearch to achieve optimized systems covering a wide range of functions while meeting the most rigid specifications. Systems management is an integral part of each Central Air Data program enabling AiResearch to assume the overall re-

sponsibility for systems or subsystems.

The first fully optimized central air data system is already operational aboard the Navy's supersonic F4H-1, the first aircraft to fly with such a system. Similar equipment is on the Navy's first weapon system, the A3J "Vigilante." This broad AiResearch systems capability is now being applied in the fields of military aircraft, commercial jet transports, missiles and submarines.

**THE GARRETT CORPORATION**

**AiResearch Manufacturing Divisions**

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

CIRCLE 139 ON READER-SERVICE CARD

## NEW PRODUCTS

### Ferrite Isolators

3.95 to 12.4 kmc range



Covering the 3.95 to 12.4 kmc range in three models, these ferrite isolators have 1 db insertion loss and a 1.2 vswr. Rated at 5 w, they can handle up to 25 w with temporary electrical degradation. Model 1205 covers the entire 2 x 1 in. waveguide range with a minimum isolation of 16 db; model 1204 covers the 1.5 x 0.75 in. waveguide range with a minimum isolation of 20 db; and model 1203 covers the 1 x 0.5 in. waveguide range with a minimum isolation of 30 db.

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

CIRCLE 141 ON READER-SERVICE CARD

### TWT Amplifier

For K band



With a frequency range of 10 to 16 kmc, the model HA-49 twt amplifier provides a minimum small signal gain of 30 db and a minimum power output of 10 mw. Suitable for airborne use, it has a capsule length of 15-7/8 in. and a capsule diameter of 2-1/2 in. It weighs 5 lb. Focusing is accomplished by a periodic array of permanent magnets.

Huggins Labs, Inc., Dept. ED, 999 E. Arques Ave., Sunnyvale, Calif.

CIRCLE 144 ON READER-SERVICE CARD

### Direct Writing Recording Systems

Transistorized

Model 356-5480 and 358-5480 six and eight channel direct writing recording systems are for 5 v full scale use. Input is single-ended with 100 K impedance and attenuator steps are 1, 2, 5, 20, and 50.

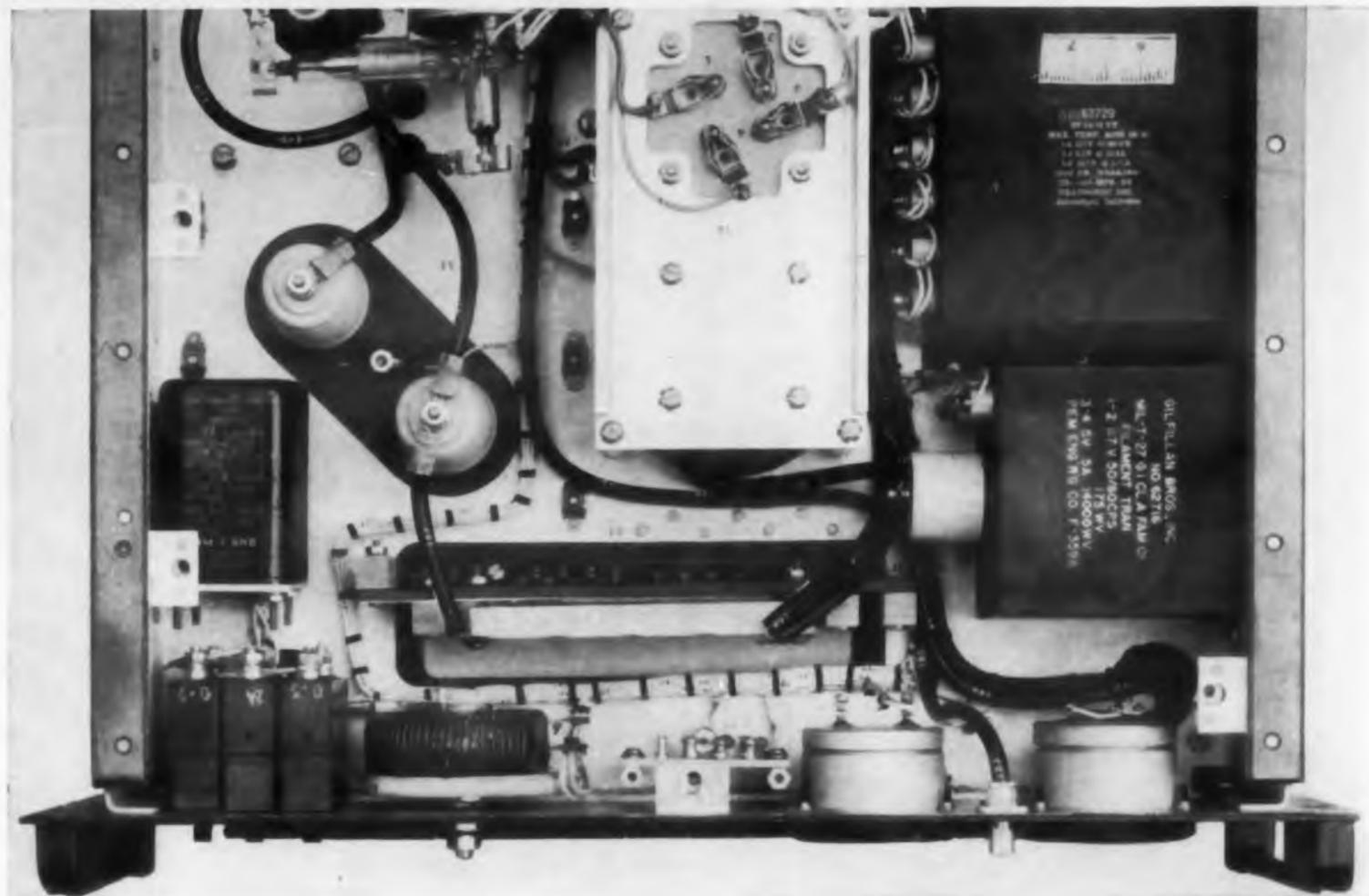
Sanborn Co., Dept. ED, 175 Wyman St., Waltham 54, Mass.

CIRCLE 145 ON READER-SERVICE CARD

## Design better products with

# SILICONE-GLASS LAMINATES

## ... resist arcing under high voltage



This AN/FPN-33 Quadradar Transmitter of Gilfillan Bros., Inc., of Los Angeles, employs silicone-glass laminates to prevent recurrent arcing under high voltage and high humidity conditions. Gilfillan Bros. also use silicone laminates in their Ground Control Approach equipment.

#### TYPICAL PROPERTIES OF SILICONE-GLASS LAMINATES\*

Flexural Strength, psi	
at 25C	24,000
at 260C after 100 hr at 260C	4,600
Water Absorption, percent	0.05
Electrical Strength, volts/mil	
initial	310
after 200 hr at 260C	327
after 5000 hr at 260C	180
Dielectric Constant at 10 <sup>6</sup> cycles	
Condition A <sup>1</sup>	3.67
Condition D <sup>2</sup>	3.68
Dissipation Factor at 10 <sup>6</sup> cycles	
Condition A <sup>1</sup>	.002
Condition D <sup>2</sup>	.004

\* As measured on samples 1/8 inch thick.

<sup>1</sup> As received.

<sup>2</sup> After 24 hr immersion in water at 23C.

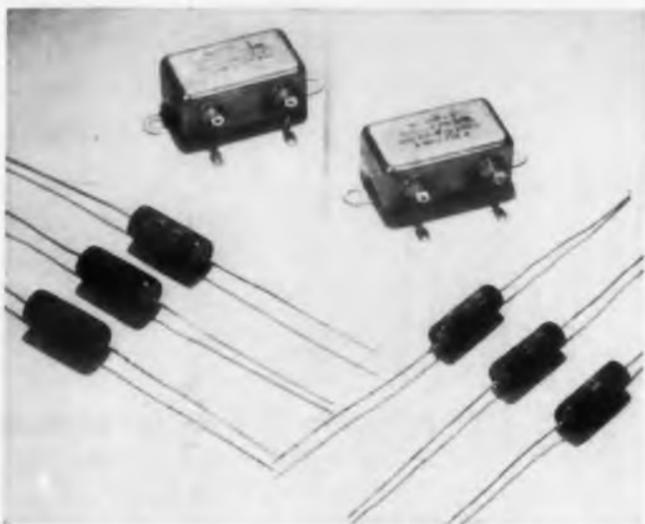
Silicone-glass laminates are ideal dielectrics for high voltage electronic devices operating under extreme humidity conditions. Made of glass cloth bonded with Dow Corning silicone resins, these laminates have high arc resistance, low moisture absorption, low loss factor. At temperatures as high as 250 C, they retain excellent physical and dielectric properties. Lightweight yet strong, silicone-glass laminates are easy to fabricate and machine. Supplied as tubes, sheets, and punched or molded parts by leading laminators. Write for FREE BOOKLET.

CIRCLE 103 READERS SERVICE CARD



**Dow Corning CORPORATION**  
MIDLAND, MICHIGAN

# Dow Corning Silicone Dielectrics



Aerovox capacitors impregnated with silicone dielectric fluid.

## SILICONE DIELECTRIC FLUIDS IMPROVE COMPONENT CHARACTERISTICS

A liquid dielectric, Dow Corning 200 Fluid makes higher operating temperatures possible, increases stability, aids miniaturization and improves characteristics of electronic assemblies and components. Silicone fluid impregnated capacitors, for example, maintain near-constant capacitance at high and low temperatures, show little change in properties over a wide range of frequencies and environmental conditions.

CIRCLE 104 READERS SERVICE CARD



TV tube evacuation with Dow Corning diffusion pump fluid.

## SILICONE DIFFUSION PUMP FLUIDS OFFER GREATER STABILITY, ECONOMY

Because of their great stability, Dow Corning silicone fluids make diffusion pump operation more efficient and economical. They develop vacua in the range of  $10^{-5}$  to  $10^{-7}$  mm of Hg; resist oxidation even when exposed to air at operating temperatures. Dow Corning diffusion pump fluids do not decompose into gums or tars . . . save replacement costs and production time. In addition, they offer rapid recovery and quick pumpdown.

CIRCLE 105 READERS SERVICE CARD

## SILASTIC COVERED WIRE RESISTS CORONA, OZONE

Wire and cable insulated with Silastic®, the Dow Corning silicone rubber, is easy to strip and solder — flexible for quick and convenient hookup of electronic components. Unaffected by moisture, weathering and temperature extremes from  $-90$  to  $250$  C, Silastic insulation remains flexible and retains its dielectric properties despite long exposure to corona and ozone. Wire insulated with Silastic is readily available from leading cable manufacturers.

CIRCLE 106 READERS SERVICE CARD



High voltage transformer for RCA TV receiver.

## Pickup-Storage Tube

For long-storage continuous-readout uses



Type WX-3989 pickup-storage tube has high resolution and was designed for long-storage continuous-readout applications. Required exposure times are less than 1 msec at several hundred ft-c; and about 60 sec at  $10^{12}$  ft-c. The storage time may be varied from less than a second to nearly an hour with continuous electrical readout. Using standard television scan rates, as many as  $2 \times 10^5$  images may be taken from a single exposure. Resolution of 600 television lines and 8 shades of grey are maintained for approximately 5 min. Both optical and electrical images can be stored in the tube.

Westinghouse Electronic Tube Div., Dept. ED, P. O. Box 284, Elmira, N. Y.

CIRCLE 146 ON READER-SERVICE CARD

## Digital Frequency Meters

Direct reading



Manufactured by Sivers Lab, Stockholm, Sweden, these digital frequency meters are available in nine models covering a frequency range of 1100 to 18,000 mc. Frequency is read directly in megacycles by an in-line digital counter. One turn of the knob corresponds to the same frequency change anywhere in the band, permitting the meter to be used with a flexible shaft or servo system for connection to a remote counter or to a chart recorder. The units can serve as laboratory instruments or be incorporated in broadband radar or other systems. Their cavities can be used with waveguide or coaxial lines, with crystal diodes, or as pass filters. For at least one coupling circuit, accuracy is better than  $\pm 0.1\%$ ; for different coupling circuits, calibrations may differ from 0.05% to 0.1% from each other, with correction curves, better than  $\pm 0.05\%$ .

Kay Electric Co., Dept. ED, Maple Ave., Pine Brook, N.J.

CIRCLE 147 ON READER-SERVICE CARD

For further information on these products write Dept. 1616

Commander of a SAC B-52 is shown adjusting controls of the Sperry A-14 Automatic Flight Control System. Teamed with Sperry's advanced K-bombing-navigation-system, this electronic co-pilot provides precision control on long flights to target, assists in instrument landings and automatic programmed control on target runs.



## servo assist for sperry's electronic co-pilot

When the commander of a B-52 gives his Strato-fortress the order to execute this or that maneuver, the control system of his "electronic co-pilot" automatically applies just the right force on the control surfaces to obtain the desired maneuver under the prevailing flight conditions. That's automatic flight control at its finest!

Daystrom Transicoil helps provide the calculated muscle for this flight system in the form of servo controlled pitch, roll, and yaw follow up; coordination integrator; and pitch integrator.

Only the highest level of accuracy, performance, and reliability will do . . . for you, for us.

The engineering and manufacturing assistance you need to turn modern system requirements into optimized working sub-systems and assemblies is the very basis of our business. Contact us direct or through our local representative. Check into our 24 Hour Service on servo motors and generators. Daystrom Transicoil, Division of Daystrom, Inc., Worcester, Montgomery County, Pennsylvania. (Phone: JUNO 4-2421)

**DAYSTROM TRANSICOIL** DIVISION OF DAYSTROM, INC.

*Representatives in Canada and Other Foreign Countries*

CIRCLE 148 ON READER-SERVICE CARD

## NEW PRODUCTS



### Instrumentation Recorder

Has 1 mc frequency response

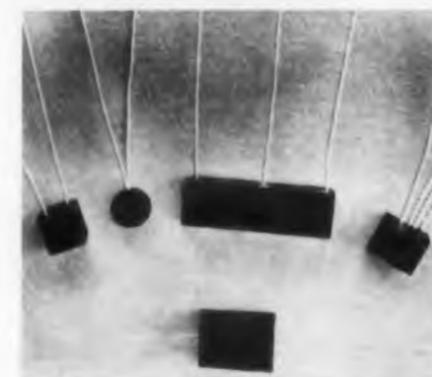
Having a band width of 1 mc per track, the CV-100 series of instrumentation tape recorders/reproducers use 1/2 in. magnetic tape. The unit contains only 12 moving parts. Tape speed of 120 in. per sec allows 12 min of running time, using standard 1-mil tape. Reproducible timing accuracy is 0.005%. Peak flutter and wow specifications are 0.1% or less, measuring all components from 0.1 to 4,000 cps. Starting in 4 sec from rest to full tape speed, the rock-mounted unit has an input impedance of 93 ohms, with 0.1 v peak to peak input voltage required. Output signal level is 2 v at 93 ohms impedance. Power required: 117 v, 60 cps.

Minnesota Mining & Mfg. Co., Mincom Div., Dept. ED, 2049 S. Barrington Ave., Los Angeles 25, Calif.

CIRCLE 149 ON READER-SERVICE CARD

### Selenium Rectifiers

Completely potted



These completely potted selenium rectifiers are designed for half wave, full wave, single or three-phase rectifier circuits. Type ABA is a 130 v rms, 20 ma unit rated for use with a resistive or inductive load. Many different terminal arrangements—axially, radially, etc.—are available to suit application needs, making the units particularly suitable for printed wiring boards.

Radio Receptor Co., Inc., Semiconductor Div., Dept. ED, 240 Wythe Ave., Brooklyn 11, N.Y.

CIRCLE 150 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

## FM Subcarrier Oscillator

Voltage controlled



Model 4500 is an adjustable, voltage controlled fm subcarrier oscillator for ground station telephone, radio, or microwave data transmission use. It plugs into a transmitting multiplexer with conventional 9-pin octal connectors. RDB/IRIG subcarrier channels 1 through 7 are standard, and others are available. Input is  $\pm 2.5$  v into 500 K; output is 3 v at 5 K from a low pass output filter; linearity is  $\pm 0.75\%$  of the bandwidth; and harmonic distortion does not exceed 0.5%. Filament power can be either ac or dc. With tubes mounted externally to dissipate heat, the unit measures  $4\frac{7}{8} \times 3\frac{7}{8} \times 1\frac{5}{8}$  in.

The Geotechnical Corp., Dept. ED, P.O. Box 28277, Dallas 28, Tex.

CIRCLE 151 ON READER-SERVICE CARD

## Dust Proof Relay

Operates on  
2 mw



Available in series 100 types, the sensitivity of this relay may be as low as 2 mw per contact in contact combinations from spst to dpdt. Standard enclosure is a round aluminum protective dust cover available with either a removable bayonet cover or with the cover crimped to the base. Designed for commercial and military use, its operating life is about 25 million operations. The relays can be adjusted with pick-up and drop-out ratios as high as 85% or as low as 10%. Standard coil resistances are up to 30,000 ohms and special windings to 100,000 ohms. Contact capacity ranges from 3 to 5 amp resistive, depending on sensitivity.

General Automatic Corp., Dept. ED, 12 Carlton Ave., Mountain View, Wayne, N.J.

CIRCLE 152 ON READER-SERVICE CARD



This is the actual size of Heinemann's new sub-miniature circuit breaker, the SM3. It is hermetically sealed, magnetically actuated, has been tested to the hilt for reliable operation under all kinds of uncomfortable environmental conditions, terrestrial and celestial. And with all this, it weighs just a scant 2.1 ounces.



This is how the breaker looks inside. As you can see, it has been deftly engineered down to the last pivot pin. What you can't see is how dependably it works, come heat or high water. For example: it will steadfastly hold rated current and set trip points at any ambient temperature, has demonstrated satisfactory operation from a frigid  $-40^{\circ}\text{C}$ . to a steamy  $100^{\circ}\text{C}$ . De-rating is never necessary.



This is the book with the facts and figures you will want to have, if you think the rugged little SM3 will fit in with your portable, airborne or sea-going equipment. Clearly and concisely, it tells you about such things as available time delays (there are two, fast and slow), current ratings (0.050 to 10 amperes, integral or fractional), and voltage ratings (110V, 60 cycles; 110V, 400 cycles; 50V DC). We'll rush a copy to you just as soon as we receive your request for Bulletin 3502.

**HEINEMANN ELECTRIC COMPANY**  **156 PLUM ST., TRENTON 2, N.J.**

S.A. 1941

CIRCLE 153 ON READER-SERVICE CARD

## NEW PRODUCTS

### Deviation Meter

Covers 4 to 1024 mc



This deviation meter covers the 4 to 1024 mc carrier frequency range. The local oscillator can be locked at any frequency within the band by crystals in the 4 to 10 mc range. Deviation ranges of  $\pm 5$ ,  $\pm 25$ ,  $\pm 75$ , and  $\pm 125$  kc full scale are provided, and, using the crystal lock, deviations down to 10 cps can be measured with an external indicator.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N.J.

CIRCLE 154 ON READER-SERVICE CARD

### Servo valve

Operates at 50 to 1000 psi

Model 200 servo valve is a single-stage, four-way, flow-control valve designed for use in electrohydraulic servosystems. It is actuated by a dc torque motor that can exert over 13 lb of force. This motor exerts its full force when particle jamming is encountered, thus enabling the valve to operate in contaminated fluids. The valve can operate at supply pressures from 50 to 1000 psi and at temperatures from  $-65$  to  $+265$  F. It measures  $2-1/4 \times 2-1/2 \times 3-1/2$  in.

American Measurement & Control, Inc., Dept. ED, 240 Calvary St., Waltham 54, Mass.

CIRCLE 155 ON READER-SERVICE CARD

### Standard Frequency Multipliers

Have low phase jitter

Decade multipliers 1112-A and 1112-B operate on the principle of phase locked oscillators to produce 1, 10, 100, and 1000 mc fundamental frequencies from a 100 kc frequency standard. This is accomplished by crystal resonators up to 100 mc and a stable klystron at 1000 mc. The units have a highly stable output and low phase jitter. Accuracy is that of the 100 kc standard.

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 156 ON READER-SERVICE CARD

## for the most efficient production of oxygen-free gas



### NITRONEAL<sup>®</sup> GAS GENERATOR

... provides by far the most economical and efficient method for the production of pure nitrogen—completely free of oxygen—and with hydrogen content precisely controlled at any desired percentage between 0.5% and 25%. Nitrogen is supplied at a fraction of cylinder supply cost.

The Nitroneal Generator is automatic except for startup, with no need for operating personnel. The unit performs instantly, efficiently anywhere in the range of from 25% to 100% of rated capacity. Installation requires only a 110 volt line, water, air, ammonia lines and drain facilities. Units can be supplied in capacities of 100 cfh to 10,000 cfh. . . . The catalyst lasts indefinitely—maintenance costs are practically nil. Write for complete catalog material and data.

CHEMICAL DIVISION • 113 ASTOR STREET  
NEWARK, N. J.

CIRCLE 378 ON READER-SERVICE CARD

CHEMICAL  
DIVISION

WRITE FOR LITERATURE

AMERSIL  
QUARTZ  
DIVISION



## look to Amersil for all high purity fused quartz requirements.



Amersil manufactures and fabricates high purity fused quartz for ultraviolet transmission applications, laboratory ware and production equipment. These products include standard apparatus, plain tubing in many intricate fabrications, crucibles, trays, cylindrical containers and piping in a full range of sizes up to 25" in diameter. Ingots and plates are available in general commercial quality as well as in special optical grades. Amersil engineers are also prepared to assist in developing fused quartz and silica equipment for special requirements. Send for bulletin.

AMERSIL QUARTZ DIVISION • 685 RAMSEY AVENUE  
HILLSIDE, N. J.

CIRCLE 379 ON READER-SERVICE CARD

DOMESTIC DIVISIONS: AMERICAN PLATINUM & SILVER DIVISION, AMERSIL QUARTZ DIVISION, BAKER CONTACT DIVISION, BAKER DENTAL DIVISION, BAKER SETTING DIVISION, BAKER PLATINUM DIVISION, CHEMICAL DIVISION, EAST NEWARK INDUSTRIAL CENTER, HANOVIA LAMP DIVISION, HANOVIA LIQUID GOLD DIVISION, IRVINGTON-BEHR REFINING DIVISION, D. E. MAKEPEACE DIVISION, NATIONAL ELECTRIC INSTRUMENT DIVISION, RESEARCH AND DEVELOPMENT DIVISION, W. A. WILSON DIVISION. COMPANIES ABROAD: ENGELHARD INDUSTRIES OF CANADA, LTD. TORONTO, ENGELHARD INDUSTRIES OF QUEBEC, LTD. MONTREAL, ENGELHARD INDUSTRIES, LTD. LONDON, ENGELHARD INDUSTRIES A. G. ZURICH, ENGELHARD INDUSTRIES PTY., LTD. MELBOURNE, SOCIEDAD SURAMERICANA DE METALES PRECIOSOS S. A. BOGOTA, INDUSTRIE ENGELHARD S. P. A. ROME, ENGELHARD INDUSTRIES OF SOUTHERN AFRICA, LTD. JOHANNESBURG. ASSOCIATED COMPANIES: ACME TIMBER INDUSTRIES LTD., SOUTH AFRICAN FOREST INVESTMENTS LTD., SOUTH AFRICA, AZOPLATE CORPORATION, CHARLES ENGELHARD, INC., NUCLEAR CORP. OF AMERICA, INC., U. S. A.

## a simplified mirror-bright silver plating process



Here is the most efficient, simple procedure to protect electrical electronic and lamp components with a mirror-bright silver finish—through a complete range from flash to heavy deposit. The procedure is easy, economical and non-critical—with little or no polishing required. Silver-Brite is a clear, water-white solution, enabling the operator to observe work as it is being plated. Uniformly good results are attained with current densities ranging from 10 to 40 amperes per square foot. Normal room temperature operation minimizes fumes and tendency toward bath decomposition. Send for descriptive data together with detailed plating procedures.

AMERICAN PLATINUM & SILVER DIVISION  
231 N. J. RAILROAD AVENUE, NEWARK, N. J.

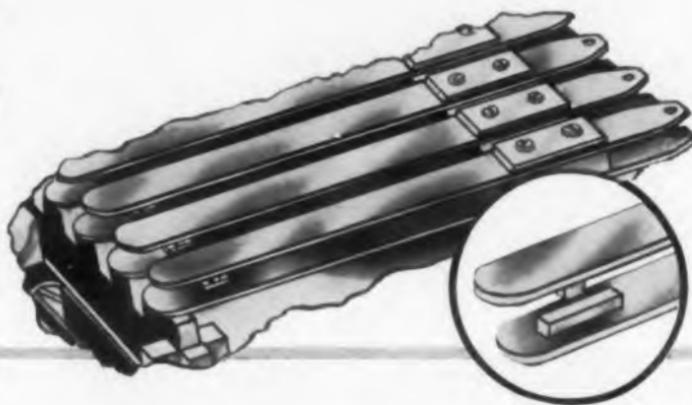
CIRCLE 380 ON READER-SERVICE CARD

AMERICAN  
PLATINUM  
& SILVER  
DIVISION



CIRCLE 381 ON SERVICE CARD

D. E.  
MAKEPEACE  
DIVISION



## ECONOTAPE crossbar contacts are most efficient for electrical relays

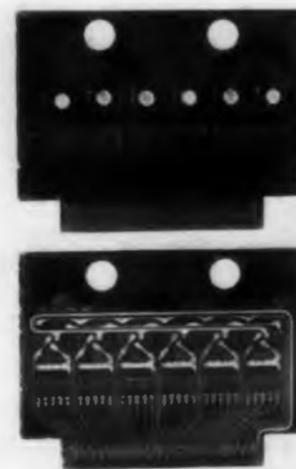
You can now get ideally efficient crossbar contacts for your electrical relays—with as many contacts as you need, where you need them—with positive assurance of full, contact surface. This has been made possible through the development of Makepeace's new ECONOTAPE, a precision-drawn shaped or rectangular contact wire in either solid precious metal or in laminated metal—in your choice of gold, platinum, palladium, silver and their various alloys.

Econotape crossbar contacts are supplied complete, attached to Makepeace blades . . . attached to blades supplied by you . . . or Econotape for your own attaching.

Econotape is cut off and welded to the blade in one operation. It is no longer necessary to handle and attach individual button type contacts. Positioning of Econotape on the blade is done automatically as the tape is cut off and welded. Permanent attachment is assured by a homogenous metallurgical bond that is undisturbed by expansion and contraction caused by temperature changes.

If you are designing a new relay or trying to cut the cost of your present mechanism, send for Econotape Crossbar Contact literature.

D. E. MAKEPEACE DIVISION • PINE & DUNHAM STREET  
ATTLEBORO, MASS.



## Digital Logic Modules Universal

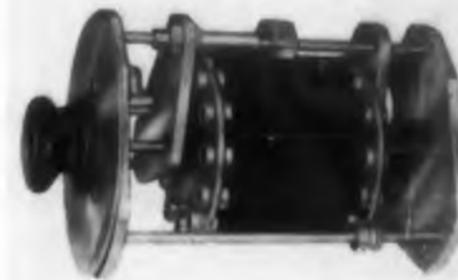
These digital modules replace the complex computer networks of AND gates, OR gates, and flip-flops with gates of a single type, the Sheffer Stroke NOR gate. One gate can drive 11 gates with two inputs each or six gates with six inputs, each. The boards are of epoxy glass and no eyelets or printed circuit plugs are used. The units are constructed so that no calculations are needed to use every gate in every module. Both high and low speed units are available as well as peripheral equipment such as clock sources.

Abacus, Inc., Dept. ED, 3040 Overland Ave., Los Angeles 34, Calif.

CIRCLE 158 ON READER-SERVICE CARD

## Microwave Step Attenuators

Rated at 4 w continuous



Variable step attenuator models AT-108 and AT-109 are rated at 4 w continuous power and 2 kw peak power. With steps of six and 12 positions, respectively, they are intended for incorporation into narrow or broad band devices and systems for accurate attenuation of rf voltage. T-networks of concentric line construction, they have a self-contained coaxial switch for changing insertion loss values. Single units can provide attenuation from under 1 db to 60 db and, if two or more units are connected in series, the range may be extended to 120 db. Standard input and output impedance is 50 ohms, accuracy is  $\pm 0.25$  or  $\pm 0.5$  db depending upon frequency, and vswr is 1.2 to 1.

Empire Devices Products Corp., Dept. ED, 37 Prospect St., Amsterdam, N.Y.

CIRCLE 159 ON READER-SERVICE CARD

## **ANNOUNCING...**

**a major advance in  
electronic insulation**

# **NEW SUPRAMICA® 620 ceramoplastic**

**...the world's most  
nearly perfect  
machinable insulation**

Check This Exclusive Combination of Design Advantages:

- 1550°F maximum operating temperature.
- Fully machinable to one ten-thousandth of an inch tolerances, yet capable of total dimensional stability under the most adverse conditions of thermal cycling.
- Impervious to humidity, water, oil, organic solvents. Resistant to nuclear radiation.
- High dielectric strength—250 volts/mil. ASTM test procedure D-149.
- Excellent arc resistance—300 seconds. ASTM test procedure D-495. Will *not* carbonize.
- Negligible electrical loss—.011 loss factor, 10<sup>6</sup>CPS. ASTM test procedure D-150.
- Thermal expansion coefficient equal to that of stainless steel enabling matched seals using appropriate solder glass.

General Offices and Plant: 121-B Clifton Blvd., Clifton, N. J.  
Executive Offices: 30 Rockefeller Plaza, New York 20, N. Y.

WORLD'S LARGEST MANUFACTURER OF GLASS-BONDED MICA AND CERAMOPLASTIC PRODUCTS  
CIRCLE 160 ON READER-SERVICE CARD

SUPRAMICA 620 is one of a family of versatile materials perfected by Mycalex Corporation of America. Others include:

#### **ceramoplastics**

**SUPRAMICA® 600**—Machinable insulation, for operating temperatures to 850°F.

**SUPRAMICA® 555**—Precision-moldable insulation, for operating temperatures to 700°F.

**SUPRAMICA® 560**—Precision-moldable insulation, for operating temperatures to 932°F. (500°C.)

#### **glass-bonded mica**

**MYCALEX® 400**—Machinable insulation, for operating temperatures to 800°F.

**MYCALEX® 410**—Precision-moldable with or without inserts, temperature range to 600°F.

**MYCALEX® 410X**—Lightweight precision-moldable insulation material.

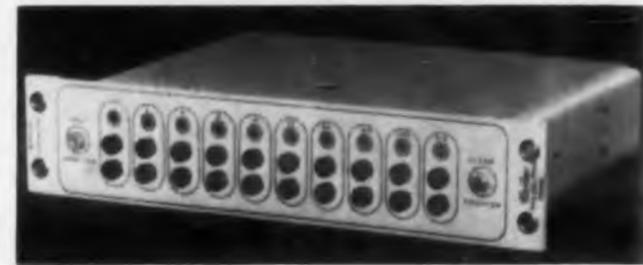
**MYCALEX® 385**—Arc resistant, thermal shock resistant, for continuous service to 700°F.

\* SUPRAMICA, MYCALEX, "400", "410", and "410X" are registered trade-marks of Mycalex Corporation of America. "385", "500", "555", "560" and "620" are trade-marks of Mycalex Corporation of America.



## NEW PRODUCTS

### Binary Counter Reversible



Model 111B counter has completely automatic internal switching. Pulses may be fed into the forward and reverse inputs, and the sum of the two inputs is made visible on neon indicators. On either side of the counter stages are 18 v dc levels that may be directly loaded by other transistor stages. Internal amplifiers may be added to operate relays, low impedance busses, etc. The 10 transistorized units operate up to 200 kc with a single -20 v supply voltage. Both push-button and electrical presetting are available and any number of units may be cascaded.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.

CIRCLE 161 ON READER-SERVICE CARD

### 485 KC to 30 MC Receiver Has crystal lock

This Eddystone receiver covers 485 kc to 30 mc. It features four crystal controlled frequencies in the 2 to 20 mc range, a crystal calibrator, and an equivalent scale length of 34 ft. Bandwidth is variable from 700 cps to 24 kc at 40 db points and the image rejection is 45 db at 18 mc increasing to 90 db at 2 mc.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N.J.

CIRCLE 162 ON READER-SERVICE CARD

### Radar Test Set

Generates 0.05 to 10  $\mu$ sec pulses

The model SSX-2/PAM-2 radar i-f test set provides a pulsed cw output and operates in the 25 to 75 mc range. It consists of the company's PAM-2 variable audio oscillator and pulse generator and the SSX-2, an instrument which combines a sweep oscillator, variable marker, cw generator and crystal controlled markers. The system generates output pulses 0.05 to 10  $\mu$ sec wide with a rise and fall of 0.02  $\mu$ sec. Repetition rate is variable from 50 to 5000 pps.

Telonic Industries, Inc., Dept. ED, 75 N. Second Ave., Beech Grove, Ind.

CIRCLE 163 ON READER-SERVICE CARD

## Rectifiers

For dc meters



Series 80 rectifiers are designed for use with dc meters of 20 to 200  $\mu$ a full scale current. Active cell area is 0.0012 sq in. and dimensions are 0.125 x 0.27 x 0.4 in. exclusive of leads. The units are made for single hole mounting by a no. 2 screw and have nickel silver filiform leads that are easily soldered or formed to fit printed circuits.

Conant Labs., Dept. ED, Box 3997, Bethany Sta., Lincoln 5, Nebr.

CIRCLE 164 ON READER-SERVICE CARD

## Electrometer

3-1/2 in. high

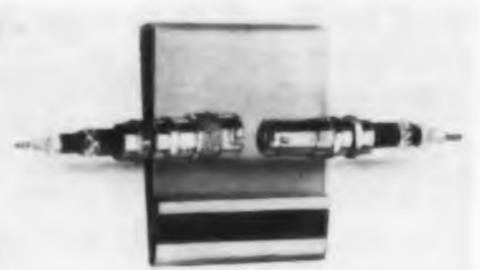
The E-102 electrometer is a rack mounted unit 3-1/2 x 19 x 10 in. It covers  $10^{-12}$  to  $10^{-3}$  amp full scale in 10 ranges and operates from 105 to 125 v, 50 to 60 cps. It has  $\pm 3\%$  accuracy from  $10^{-3}$  to  $10^{-11}$  amp and  $\pm 5\%$  accuracy at  $10^{-12}$  amp. The unit has a 10 mv recorder output and drifts less than 2% per week on  $10^{-11}$  and higher current ranges.

Gyra Electronics Corp., Dept. ED, 518 N. Spring Ave., La Grange Park, Ill.

CIRCLE 165 ON READER-SERVICE CARD

## Cable Connectors

For tri-axial use



Plugs and jacks of these tri-axial connectors measure 1 x 3/8 in., and provide two separate concentric shields. They accommodate cables up to 0.212 in. OD and have a 500 v rated capacity. The connectors are bayonet locking, have Teflon insulation and are available in 4 different polarity groups. The units may also be used with coaxial cable from 0.06 to 0.25 in. OD.

Dage Electric Co., Inc., Dept ED, 67 N. Second St., Beech Grove, Ind.

CIRCLE 166 ON READER-SERVICE CARD



## Meet the Milli-Switch Line

### Sub-Miniature Snap-Action Switches with High Sensitivity



Every Milli-Switch is checked for pre-travel and over-travel. Maximum allowable pre-travel is one-third of that in most other switches.

**You get unequalled performance from more than 40 types: .008" pre-travel, .0015" maximum movement differential.**

If you need precision operation, high electrical capacity, light weight and long life in a sub-miniature snap-action switch, it will pay you to meet the line of Milli-Switches. More than 40 types are available to meet your requirements.

Milli-Switches give you premium performance without premium cost:

- guaranteed minimum life of 1,000,000 mechanical cycles.
- all metal parts are gold plated at no extra cost—extremely important for long shelf life.
- extremely short pre-travel (.008") permitting close tolerances and control.
- exceptionally small movement differential (average .0005"), valuable if you are using pressure switches or bi-metal controls.
- specially designed contact spring with flexing action. Big selection. No dead break occurs when plunger is moved .001" per minute at 6 volts AC 150 milliamps.

Write today for complete information in Technical Data Bulletin.

**MILLI-SWITCH CORPORATION**  
a subsidiary of



Parts distributors in all major cities stock standard Mallory components for your convenience.

CIRCLE 167 ON READER-SERVICE CARD

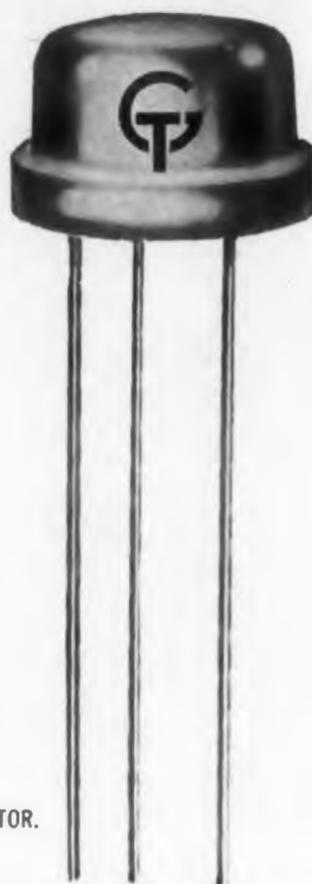
ready to go in

either direction



another

QUALITY PRODUCT FROM GENERAL TRANSISTOR.



**NEW PNP AND NPN  
BILATERAL TRANSISTORS  
HAVE EMITTER  
AND COLLECTOR  
INTERCHANGEABILITY**

General Transistor has developed another new transistor series—the Bilateral PNP 2N592, 2N593 and NPN 2N594, 2N595, 2N596. These germanium alloyed junction transistors have been designed to allow current to flow in either direction—valuable in medium speed switching applications as in computers, communications equipment, multiplexing devices, and for bi-directional switching and phase detection systems.

The characteristics of these transistors are guaranteed in both directions. Their symmetrical design allows extremely low saturation resistances and switching properties. Ordinary uni-directional types lack this advantage. The NPN types have an alpha cutoff frequency range of 1.5 to 10.0 megacycles.

For complete technical specifications write for illustrated brochure G-170.



## GENERAL TRANSISTOR CORPORATION

91-27 138TH PLACE, JAMAICA 35, NEW YORK

In Canada: Desser E-E Ltd., 441 St. Francis Xavier, Montreal 1, Quebec  
FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED  
GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING  
CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. FOR EXPORT: GENERAL  
TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK

CIRCLE 168 ON READER-SERVICE CARD

## NEW PRODUCTS

### Insulation Material

Operates to 1550 F



A machinable ceramoplastic insulation material Supramica 620 will operate at temperatures up to 1550 F with complete dimensional stability. It has a dielectric strength of 250 v per mil and an arc resistance of 300 sec. Loss factor is negligible. The material is resistant to nuclear radiation, will not carbonize, and can be machined to tolerances of 0.0001 in.

Mycalex Corporation of America, Dept. ED, Clifton, N.J.

CIRCLE 169 ON READER-SERVICE CARD

### Decade Oscillator

Has 1 cps to 110 kc range

Covering the 1 cps to 110 kc frequency range, the model D-890-A decade oscillator has a controlled negative feedback which provides waveform purity, constant amplitude, and stable frequency. The unit incorporates a 2 kc crystal, accurate to 0.02%, against which the oscillator frequency can be checked on a panel-mounted 1 in. crt. Outputs are available at 126 v into 8 K or 24 v into 600 ohms over most of the frequency range.

Muirhead Instruments, Inc., Dept. ED, 677 Fifth Ave., New York 22, N.Y.

CIRCLE 170 ON READER-SERVICE CARD

### X-Y Recorder

Transistorized

This transistorized, 11 x 17 in. recorder consists of a basic plotter with separate input modules for general purpose, computer, low-level differential, time base, curve following, and other specialized functions. The unit has 0.03% internal calibration, 10  $\mu$  sensitivity, internal Zener diode reference, improved vacuum hold down system, vernier control between ranges, and remote operation of function modules.

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

CIRCLE 171 ON READER-SERVICE CARD

## Digital Voltmeter

Makes 50 measurements per sec



Designed with fully transistorized logic circuits, the four-digit model 8409 voltmeter can make 50 measurements per sec. It has  $\pm$ digit accuracy; automatic polarity; automatic, manual, and remote ranging; 1000 meg input impedance; BCD and decimal output; direct printer operation; provision for external reference voltage; and modular construction.

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

CIRCLE 172 ON READER-SERVICE CARD

## 19 In. Racks and Cabinets

Modular

These modular electronic racks and cabinets accept standard 19 in. chassis and components. Seven vertical rack sizes are offered in heights from 26-1/2 to 82-7/8 in. plus a 3 in. pedestal. Depths range from 22 to 30 in. Sloping front racks and a variety of side covers, doors, tops, and panel opening components are also available.

Stone & Smith, Inc., Dept. ED, 5965 Alcoa Ave., Los Angeles 58, Calif.

CIRCLE 173 ON READER-SERVICE CARD

## Dual-Gun Storage Tube

Converts radar to TV



Labeled the QK-703, this storage tube was designed for scan conversion of conventional radar scope patterns into composite television signals for viewing on a regular TV receiver. Available in pilot quantities, the unit has a resolution of 1000 lines nominal at 50% modulation. Signals can be stored in less than 1/60 sec, held for many hours, and read out more than 10,000 times. Both writing and reading guns are magnetically deflected, and can be magnetically or electrostatically focused.

Raytheon Mfg. Co., Dept. ED, Microwave and Power Tube Div., Waltham 54, Mass.

CIRCLE 174 ON READER-SERVICE CARD

A Leading Manufacturer of Tubular

Good-All

CAPACITORS

Ceramic Disc and Electrolytic Capacitors

## New, flat shape invites "crowding"

### 663 F.. for Terminal Board assembly

MYLAR WRAP CASE

MYLAR DIELECTRIC



### 663 FR .. for Printed Circuit Boards

EPOXY END SEAL

RADIAL LEADS



These special-purpose versions of popular Good-All Type 663UW offer great flexibility in fitting capacitance into tight spaces. They are conservatively rated and provide the same dependability and electrical ruggedness that has made the 663UW tubular a "standard of quality" for both military and instrument-grade equipment.

\*DuPont's trademark for polyester film.

### SPECIFICATIONS

**TEMPERATURE RANGE**—Full rating to 85°C; to 125°C with 50% de-rating.

**LIFE TEST**—250 hours at 85°C and 125% of rated voltage.

**VOLTAGE RANGES**—100, 200, 400 and 600V DC.

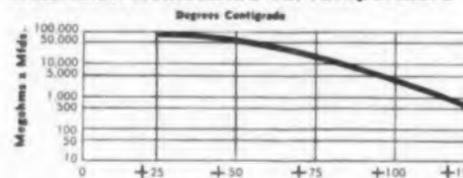
**CLOSE TOLERANCES**—Available in tolerances to  $\pm 5\%$ .

**INSULATION RESISTANCE**—See I.R. versus temperature curve below.

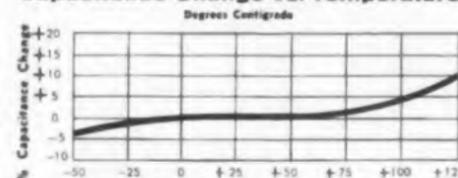
**DIELECTRIC STRENGTH**—Twice rated voltage for 1 minute.

CAPACITANCE IN MFDS.	100 VOLTS			200 VOLTS			400 VOLTS			600 VOLTS			1,000 VOLTS		
	T	W	L	T	W	L	T	W	L	T	W	L	T	W	L
.001	.062	$\frac{3}{16}$	$\frac{1}{8}$	.062	$\frac{3}{16}$	$\frac{1}{8}$	.062	$\frac{3}{16}$	$\frac{1}{8}$	.062	$\frac{3}{16}$	$\frac{1}{8}$	.125	$\frac{1}{4}$	$\frac{3}{16}$
.0047	.062	$\frac{3}{16}$	$\frac{1}{8}$	.062	$\frac{3}{16}$	$\frac{1}{8}$	.093	$\frac{1}{2}$	$\frac{1}{8}$	.125	$\frac{1}{2}$	$\frac{1}{8}$	.156	$\frac{3}{16}$	$\frac{1}{4}$
.01	.062	$\frac{3}{16}$	$\frac{1}{8}$	.062	$\frac{3}{16}$	$\frac{1}{8}$	.140	$\frac{1}{2}$	$\frac{3}{16}$	.203	$\frac{3}{8}$	$\frac{1}{4}$	.234	$\frac{3}{8}$	$\frac{1}{4}$
.022	.093	$\frac{1}{2}$	$\frac{1}{8}$	.140	$\frac{1}{2}$	$\frac{1}{8}$	.203	$\frac{3}{8}$	$\frac{1}{4}$	.234	$\frac{3}{8}$	$\frac{1}{4}$	.218	$\frac{1}{2}$	$\frac{1}{8}$
.047	.125	$\frac{1}{2}$	$\frac{1}{4}$	.156	$\frac{3}{8}$	$\frac{1}{8}$	.218	$\frac{1}{2}$	$\frac{1}{4}$	.281	$\frac{1}{2}$	1	.343	$\frac{1}{2}$	$\frac{1}{4}$
.1	.156	$\frac{3}{8}$	$\frac{1}{4}$	.234	$\frac{3}{8}$	$\frac{1}{4}$	.250	$\frac{1}{2}$	1	.312	$\frac{1}{2}$	$\frac{1}{2}$	.359	$\frac{3}{8}$	$\frac{1}{2}$
.22	.187	$\frac{3}{8}$	1	.250	$\frac{1}{2}$	$\frac{1}{4}$	.343	$\frac{1}{2}$	$\frac{1}{2}$	.468	$\frac{3}{8}$	$\frac{1}{2}$	.500	$\frac{1}{2}$	$\frac{1}{2}$
.47	.281	$\frac{1}{2}$	$\frac{1}{2}$	.340	$\frac{1}{2}$	$\frac{1}{2}$	.437	$\frac{1}{2}$	$\frac{1}{2}$	.531	$\frac{1}{2}$	2	.765	$\frac{1}{2}$	2
1.00	.359	$\frac{1}{2}$	$\frac{1}{2}$	.437	$\frac{1}{2}$	$\frac{1}{2}$	.500	$\frac{1}{2}$	2	.796	$\frac{1}{2}$	$\frac{1}{2}$	.859	$\frac{1}{2}$	$\frac{1}{2}$

Insulation Resistance vs. Temperature



Capacitance Change vs. Temperature



Write for literature on these  
NEW, "space-saving" types

**GOOD-ALL**  
ELECTRIC MFG. CO.

OGALLALA, NEBRASKA

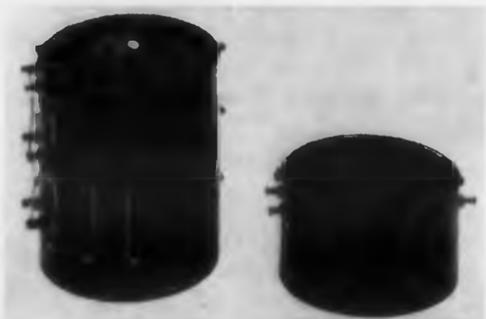
IN CANADA: 700 WESTON ROAD - TORONTO 9, ONTARIO

CIRCLE 175 ON READER-SERVICE CARD

## NEW PRODUCTS

### Transistor Transformers

For power supplies



Series TY transistor transformers provide dc output from mobile supplies of 6, 12, or 28 v dc. Epoxy molded, toroidal type units, they exceed MIL-T-27A Grade 5 Class R requirements. They can be stacked on a single mounting bolt through a centrally located hole, and series parallel connections are easily made to the peripherally located terminal pins. An appropriate splitting of the feedback winding permits operation of most of the units either common emitter or common collector, and operating frequency falls between 2500 cps for the higher power units and 5000 cps for the low power ones. The characteristic square wave output may be converted to sine wave by the use of filtering networks available on special order.

Triad Transformer Corp., Dept. ED, 4055 Redwood Ave., Venice, Calif.

CIRCLE 177 ON READER-SERVICE CARD



### Digital Decoder

20,000,000 code capacity

Type HS-59 decoder can be set to respond to any one of 20,000,000 combinations of coded digital pulses. Electro-mechanical in operation, the code the unit will respond to can be changed without tools in less than 1 min. The unit is designed for use where remote signaling or control is required and where a telephone dial or similar pulse producing device is used for transmission of information. It is also available with additional contacts to extend response to up to 5 different codes.

Secode Corp., Dept. ED, 555 Minnesota St., San Francisco 7, Calif.

CIRCLE 178 ON READER-SERVICE CARD



THE RAW MATERIALS OF PROGRESS



## USING FLUOROCHEMICALS, TRANSFORMER

Our age of miniaturization drops a challenge to the makers of electrical components—size and weight must go down. By using a 3M fluorochemical inert fluid, FC 75, as a dielectric coolant, the Raytheon Manufacturing Company has developed a transformer of improved electrical performance—reduced in volume by 75% and by 50% in weight. The miniaturized transformer is shown above, dwarfed by its old-fashioned counterpart. The reason? FC 75 permits the use of a much smaller transformer core and coils. And it reduces the space needed for insulation.

It has high dielectric strength, high heat transfer capability, is self-healing. It has wide liquid range with a pour point of  $-148^{\circ}\text{F}$  and low viscosity. It is thermally stable in excess of  $800^{\circ}\text{F}$ . As an evaporative coolant it is all these: nonexplosive, nonflammable, nontoxic, odorless, non-corrosive. Check the other properties at the right—then investigate FC 75, as well as the other 3M Chemicals made for the electronics industry: KEL-F<sup>®</sup> Molding Powders, KEL-F<sup>®</sup> Dispersions, KEL-F<sup>®</sup> Elastomers, Cardolite NC 513, KEL-F<sup>®</sup> Oils, Waxes and Greases, Acids and Alkanes.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW

CIRCLE 179 ON READER-SERVICE CARD





**3M FLUORO-CHEMICAL FC 75** pours at  $-148^{\circ}\text{F}$ . It has a wide liquid range of  $-148^{\circ}\text{F}$  to  $212^{\circ}\text{F}$  at atmospheric pressure, with low viscosity. In addition, it offers these useful properties: high dielectric strength of 37KV; self-healing, maintaining dielectric strength after repeated high voltage arcing. Compatible with most materials used in high temperature equipment. Thermally stable in excess of  $800^{\circ}\text{F}$ , it prevents development of hot spots in equipment. Prevents sludge formation due to hydrolysis or oxidation.

## DWARFED 75%

For free literature write on your company letterhead, specifying product interest, to  
**3M Chemical Division, Dept. WD-49, St. Paul 6, Minnesota.**



**3M CHEMICAL DIVISION, MANUFACTURERS OF:**  
 Acids • Resins • Elastomers • Plastics  
 • Oils, Waxes and Greases • Dispersion Coatings • Functional Fluorochemicals  
 • Inert Liquids and Surfactants.

CIRCLE 180 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

### Limit Switch

Stands 2000 ft-lb test



This switch, designated IEN75-R, meets the requirements of MIL-S-901B which call for a 2000 ft-lb shock test. The unit is designed for wide military applications. Its switching chamber is sealed and filled with an inert gas under pressure to insure operation regardless of changes in atmospheric conditions. Electrical rating at sea level or 100,000 ft: 28 v dc, 24 amp, inrush; 4 amp, resistive and 115 v ac, 5 amp, resistive.

Minneapolis-Honeywell Regulator Co., Micro Switch Div., Dept. ED, Freeport, Ill.

CIRCLE 181 ON READER-SERVICE CARD

### Walk-In Test Chamber

For testing missile components

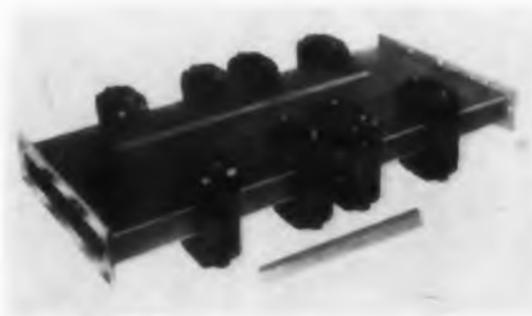
This walk-in test chamber measures 10 x 8 x 12 ft. The 3 ton door, when closed, is sealed by hydraulic closures. Built to test missile components, the chamber has an altitude range from ambient to 100,000 ft, temperature range from  $-100$  to  $+300$  F, and relative humidity range from 20 to 95%.

The American Research Corp., Dept. ED, Farmington, Conn.

CIRCLE 182 ON READER-SERVICE CARD

### UHF Ferrite Isolator

Handles 10 kw average



Designed for the 500 to 700 mc range, the model IUH1 ferrite isolator has an average power handling capacity of 10 kw without cooling, and a peak power of 10 megawatts. Minimum transmit-receive isolation is 9 db and maximum insertion loss is 1 db. The unit measures  $6\frac{3}{4}$  x 19 x 30 in. and weighs 100 lb less transitions.

Raytheon Mfg. Co., Special Microwave Device Group, Dept. ED, River Bldg. 2, Waltham 54, Mass.

CIRCLE 183 ON READER-SERVICE CARD



**POSITIVE MAGNETIC RECORDING!**



Westrex originated the technology of synchronous multi-channel recording. Perforated tape or film permits either optical or magnetic recording, and very precise timing at high speeds. Flutter can become increasingly critical as the speed of the film or the tape is reduced. Our Davis Flutter Suppressor reduces flutter to a value so low that it is no longer of practical importance. Where remote control recording with cameras is necessary, positive electrical interlock is guaranteed. Westrex techniques are now part of several missile programs. May we send you more information on this subject, or on our capability with magnetic heads and film pulling mechanisms? Write to Westrex Corporation, 6601 Romaine Street, Los Angeles 38, California.



**Westrex Corporation**

A DIVISION OF LITTON INDUSTRIES



CIRCLE 184 ON READER-SERVICE CARD

## RMS TO DC CONVERTER

ANOTHER FIRST FROM SYSTRON

NOW...Measure true RMS regardless of waveform with laboratory accuracy and production speed

Most thermocouple units and dynamometer-type RMS meters are limited by slow response, excessive signal current loading and non-linear scale. For RMS measurements, average or peak reading devices are also limited whenever distortion is present. Model 1240 Converter with its *high accuracy, high input impedances, fast response and linear DC output* was designed to circumvent the limitations of existing equipment and provide a *low cost, easy-to-use* instrument for both production and laboratory.

Systron manufactures In-Line Counters for laboratory, military and industrial applications, as well as complete Data Processing and Control Systems tailored to meet individual specifications.

Write today for complete specifications of Model 1240 and your free copy of our new Short Form Catalog.



### SPECIFICATIONS

**Accuracy:**  
Linearity: Less than  $\pm 0.1\%$  (20-100% f.s.)  
Line Voltage: Less than  $\pm 0.1\%$  with  $\pm 10\%$  change  
Frequency: 50 cps to 10 KC. less than  $\pm 0.1\%$

**Input:**  
AC Voltage: 20 millivolts to 300 volts rms  
Full Scales: 1, 3, 1, 3, 10, 30, 100, 300 volts  
Impedance: 100,000 $\Omega$  per volt or 3 megohms

**Output:**  
Full Scales: 10 volts and 3 volts — 10 $\Omega$  impedance

**Stability:** Drift less than  $\pm 0.05\%$   
**Response Time:** Less than 2.75 seconds  
**Power:** 117 volts,  $\pm 10\%$ , 60 cps  
**Price:** \$1150.

SYSTRON CORPORATION

## SYSTRON CORPORATION

950 GALINDO STREET • CONCORD, CALIFORNIA

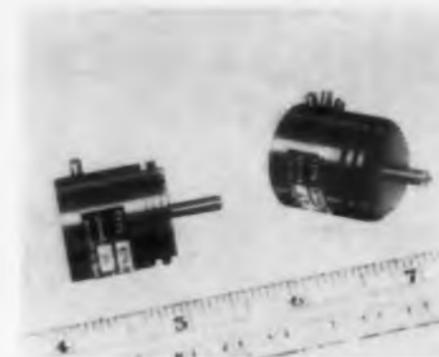
Representatives in Principal Cities

CIRCLE 185 ON READER-SERVICE CARD

## NEW PRODUCTS

### Precision Potentiometer

Has 7/8 in. diameter



Type 87-M30 servo precision potentiometer is 7/8 in. in diameter and has a resistance range of 25 ohms to 50 K. Torque is less than 0.1 oz-in., and independent linearity is  $\pm 5\%$  above 1 K. Except for the shaft end, the unit is completely sealed from moisture and foreign material. The wirewound resistance element has a temperature coefficient of 0.00002 ohm per ohm per deg C. Built for aircraft and missile use, the unit meets MIL-R-19A and MIL-E-5272A requirements.

Maurey Instrument Corp., Dept. ED, 7924 S. Exchange Ave., Chicago 17, Ill.

CIRCLE 187 ON READER-SERVICE CARD

### TV Measuring Oscilloscope

Has bridging inputs

Designed for TV waveform analysis, this oscilloscope has a display for  $\sin^2$  and bar tests, full windowing for black level stability measurements, and built-in TV sync selection circuits. Line clamp circuits are included, and the Y amplifier has a bandwidth of dc to 10 mc. Two bridged inputs are provided, and the signals may be selected either separately or differentially.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N.J.

CIRCLE 188 ON READER-SERVICE CARD

### Panel Meters

Have dc linearity within 1% of full scale

Designed with a scale arc of 5-1/2 in., model 661 panel meters have a standard dc linearity within 1% of full scale. They are equipped with a one piece steel back that shields them from magnetic fields. Measuring 4-1/2 x 6 in., they provide the same sensitivities as the company's smaller meters, beginning with 0 to 5  $\mu$ a or 0 to 5 mv. Minimum practical response time is about 100 msec. Both ac and dc models are available.

Assembly Products, Inc., Dept. ED, Chesterland, Ohio.

CIRCLE 189 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • April 15, 1959

# NEW



## PRECISION DC/AC DIFFERENTIAL VOLTMETER

FAST DELIVERY

Now both DC & AC precision measurements may be made with this all new jf precision instrument. The Model 803 may be used as an AC Differential Voltmeter, DC Potentiometer, or DC/AC VTVM. Actually 3 INSTRUMENTS IN ONE!

### STANDARD CELL REFERENCE

#### DC

Accuracy: Better than .05% from .1v to 500 Volts

Resolution: .005v at 500v to .00005v at .1v

Search Ranges: 500-50-5-.5v

Null Ranges: 10-1-.1-.01v

Input Resistance: Infinite at Null

#### AC

Accuracy: Better than .2% from .5 Volt to 500 Volts from 30 CPS to 5KC

Resolution: .005v at 500v to .00005v at .1v

Search Ranges: 500-50-5-.5v

Null Ranges: 10-1-.1-.01v

Input Impedance: 1 Meg. shunted by approx. 25 mmf.



Cabinet: 9 1/4 x 13 x 17

Price: \$845 f.o.b. Seattle factory

Write for details about this NEW jf instrument or arrange for a demonstration through our manufacturer's representative.

JOHN FLUKE MANUFACTURING CO., INC.

1111 West Nickerson - Seattle 99, Washington



CIRCLE 186 ON READER-SERVICE CARD



## Data Recorder Multichannel

This multichannel data recorder translates frequencies, currents, and voltages into visible records. It is capable of up to 1000 discrete marks on a dry electrosensitive recording paper 19 in. wide. A multistylus scanner, it has a rectilinear scanning system and a channel sampling rate of up to 2 scans per sec. The unit records analog, digital, and alpha numeric data and has a variable scale width for selected channels. It is designed with a single amplifying system for event channels and bridged inputs for analog channels.

Times Facsimile Corp., Dept. ED, 540 W. 58th St., New York 19, N.Y.

CIRCLE 190 ON READER-SERVICE CARD

## Variable Rate Test Turntable

For production testing



The model 031 variable rate test turntable is designed for evaluation and calibration of the response of gyroscopic and other inertial devices to changes in the speed of rotation about a single axis. Simple to operate and ruggedly constructed, it is suited for large-volume production line testing of units weighing up to 50 lb. It is available in low and high speed models, each providing stepless speed control and constant speed performance of the rotating platform with regulation within 0.02% of maximum range. The high speed model has a dynamic range of +1200 deg per sec through zero to -1200 deg per sec; the low speed model, +1 deg per hr through zero to -1 deg per hr.

J. W. Fecker, Inc., Dept. ED, 6592 Hamilton Ave., Pittsburgh 6, Pa.

CIRCLE 191 ON READER-SERVICE CARD



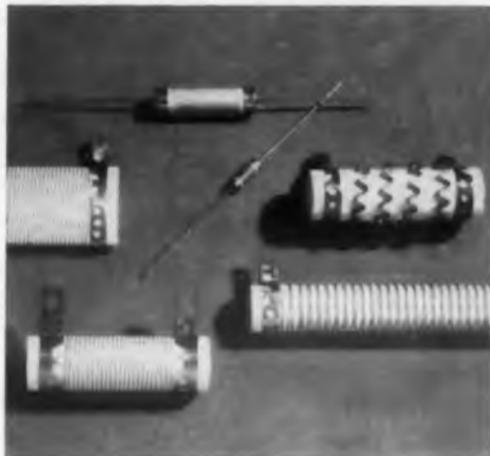
tough tests for incoming material



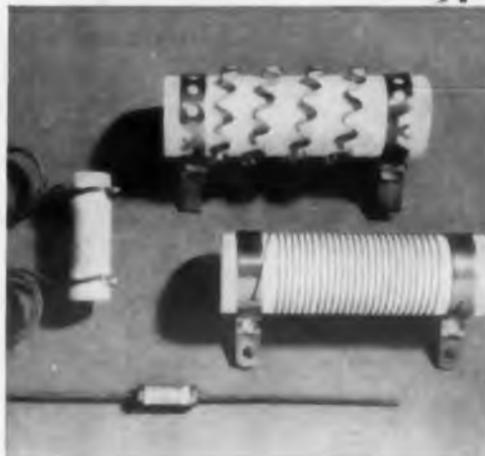
specially selected ceramic core materials



rigid, low resistance terminals



finest alloy resistance wire



spot welded or silver brazed junctions



**THIS IS A  
RESISTOR  
YOU CAN  
STAKE YOUR  
REPUTATION ON**



our own VITROHM enamel, first coat . . . and final coat



### Built-in VITROHM reliability, from core to final vitreous enamel, lets you solder these resistors in and forget 'em

They come in a tremendous variety of sizes, shapes and ratings, but all Ward Leonard VITROHM resistors have one thing in common: They're built for maximum reliability.

Take just one point—ceramic cores, for example: Made by Ward Leonard to exacting specs, the cores feature low-porosity, high-dielectric-strength ceramic for maximum moisture exclusion and good electrical insulation. What's more, the thermal coefficient of linear expansion of ceramic is specially selected to make the core compatible with resistance wire, enamel and terminals . . . to prevent cracking, crazing, peeling, or layer separation.

And there's the same meticulous care with all the other elements that go to make up a finished VITROHM resistor: terminals, spot welded or brazed junctions, resistance wire, and last but not least, W/L VITROHM enamel, formulated and manufactured in our own modern enamel smelting plant . . . provides complete electrical and mechanical protection.

To insure reliability in your product . . . specify VITROHM's. Write for data packed catalog #15, and list of stocking Electronic Distributors: Ward Leonard Electric Co., 77 South Street, Mount Vernon, N. Y. (In Canada: Ward Leonard of Canada Ltd., Toronto.)

CIRCLE 192 ON READER-SERVICE CARD

**WARD  
LEONARD**  
ELECTRIC COMPANY  
MOUNT VERNON, NEW YORK

LIVE BETTER...Electrically

Result-Engineered Controls Since 1892



RESISTORS RHEOSTATS RELAYS CONTROLS DIMMERS



## FANSTEEL HP TYPE TANTALUM CAPACITORS

### For High Temperature (125°C.) Applications

One of the most acute electronics problems today is the failure of components to operate efficiently under severe environmental conditions of temperature extremes and high shock and vibration.

When electrolytic capacitors are called for, Fansteel engineers have licked the problem with the HP Type Tantalum Capacitor. Designed expressly for reliable operation with unexcelled stability over a wide temperature range  $-55^{\circ}\text{C.}$  to  $+125^{\circ}\text{C.}$  The rugged construction of the HP is also especially adaptable for circuitry where exceptional resistance to vibration and shock is required.

Fansteel HP Type Tantalum Capacitors have unlimited storage life . . . are hermetically sealed . . . and still have the most capacitance in the smallest package.



Write for Bulletin 6.111-1

C594A

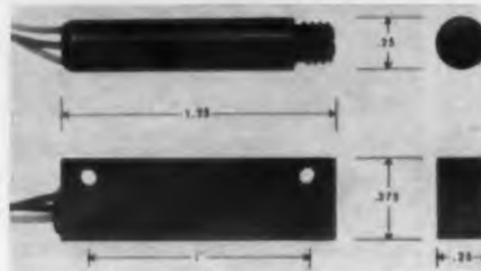
FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

CIRCLE 193 ON READER-SERVICE CARD

## NEW PRODUCTS

### Trimming Potentiometers

Temperature coefficient is 25 ppm



Featuring the ability to withstand severe vibration and shock, these potentiometers have their resistance element embedded in an alkyd resin. The units have a maximum temperature coefficient of 25 ppm per deg C, but can be supplied for transistor circuitry with a high positive temperature coefficient. Exceeding all applicable military specifications, the components have a clutch arrangement which prevents overtravel or jamming of the slider, and a precious metal wiper. Available in both cylindrical and rectangular case styles, ranges of the units is from 200 to 100,000 ohms with zero end resistance and standard tolerances of  $\pm 5\%$ .

Ultronix Inc., Dept. ED, 111 East 20th Ave., San Mateo, Calif.

CIRCLE 194 ON READER-SERVICE CARD

### Coaxial Attenuator Pad

High power



Model AT-75 coaxial attenuator has a continuous power rating of up to 4 w and a peak power rating of 2 kw. Depending on frequency, it has an accuracy of  $\pm 0.25$  or  $\pm 0.5$  db and a vswr of 1.15 to 1 to 1.3 to 1. Attenuation ranging from a fraction of a db up to 60 db can be obtained from a single unit, and standard input and output impedance is 50 ohms. The pad is a T-network of concentric line construction with deposited carbon precision resistors for the series and shunt elements. It can be used as a laboratory standard of attenuation at microwave frequencies, for calibration and periodic checking of instrument attenuators, and as an isolating pad.

Empire Devices Products Corp., Dept. ED, 37 Prospect St., Amsterdam, N.Y.

CIRCLE 195 ON READER-SERVICE CARD



### AMPEX increases signal/noise ratio

A real challenge to magnetic-tape sensitivity comes with frequency - multiplexed data. It is here that the tape's signal-to-noise ratio can mean success or failure. The high levels of occasional combined peaks can build up modulation noise between channels and seriously affect signal output.

Ampex meets this challenge by minimizing tape noise. Painstaking care in coating composition and thickness, plus the exclusive Ferro-Sheen process, gives Ampex Instrumentation Tape a completely uniform, hard, smooth surface that tangibly increases its dynamic range.

Ampex Instrumentation Tape offers other critical improvements, too. A high degree of linearity in its anhysteretic induction output greatly reduces signal distortion, further enhancing the signal-to-noise ratio.

Ampex Instrumentation Tape is available on hubs, NAB-type or die-cast magnesium-alloy Precision Reels. Widths of  $\frac{1}{4}$ ",  $\frac{1}{2}$ " and 1" are standard on either Mylar\* or acetate base, in the following lengths, reel diameters, and base thicknesses:

REEL DIAMETER	AMPEX STANDARD TAPE LENGTHS (feet)	
	BASE THICKNESS (mils) 1.0	1.5
7"	1800	1250
10 $\frac{1}{2}$ "	3600	2500
14"	7200	5000

\*DU PONT TRADEMARK

For complete specifications or additional tape literature, write

### AMPEX MAGNETIC TAPE

934 CHARTER STREET, REDWOOD CITY, CALIF.

CIRCLE 196 ON READER-SERVICE CARD

## WEINSCHEL

### PRECISION FIXED COAXIAL ATTENUATORS

Accuracy and stability assured by  
rigid testing and careful calibration

#### DC TO 12 KMC

with our own Metal Film and Cracked  
Carbon Film Resistors. Connectors:  
N, BNC, TNC, C, SC and 7/8"

#### TYPICAL MODELS



50 ohm impedance  
Type N connectors,  
stainless steel

210

10

50

#### MODEL 10

10 Watt power pads  
Frequency: DC to 1 KMC  
Attenuation: 1 to 10 db  
Maximum input VSWR: 1.15,  
Bilateral

#### MODEL 50

Frequency: DC to 1 KMC,  
Usable to 2 KMC  
Attenuation: 1 to 50 db  
Maximum input VSWR: 1.15,  
Bilateral

#### MODEL 210

Frequency: 1 to 10 KMC  
Attenuation: 1 to 20 db  
Also in ruggedized version  
to meet MIL-A-3933 and  
MIL-T-945A (Model 530)



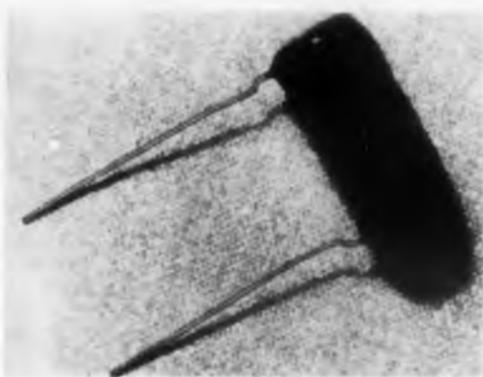
We invite inquiries for  
special applications  
requiring closer tolerances.

*Weinschel Engineering*  
KENSINGTON, MARYLAND

CIRCLE 197 ON READER-SERVICE CARD

## Mylar Paper Dipped Capacitors

Failure proof



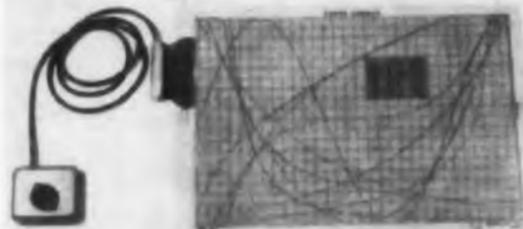
Tested at 100 C with rated voltage applied, these Mylar paper dipped capacitors have yielded a failure rate of 1 per 716,800 unit hours for 1  $\mu$ f. The five case sizes have working voltages and ranges of 200 wvdc and 0.018 to 5  $\mu$ f; 400 wvdc and 0.0082 to 0.33  $\mu$ f; 600 wvdc and 0.0018 to 0.25  $\mu$ f 1000 wvdc and 0.001 to 0.1  $\mu$ f; and 1600 wvdc and 0.001 to 0.05  $\mu$ f. Standard tolerances are 10 and 20% and insulation resistance at 25 C is 100,000 meg for 0.05  $\mu$ f or less and 5000 meg- $\mu$ f for more than 0.05  $\mu$ f. The units exceed MIL-C-91A and MIL-C-25A requirements and EIA specifications RS-164. They come with crimped leads for printed circuit use.

Electro Motive Mfg. Co., Dept. ED, S. Park  
and John Sts., Willimantic, Conn.

CIRCLE 198 ON READER-SERVICE CARD

## Multiple Function Generator

Has up to 10 curves



The "Curve Library," for use with the company's X-Y recorders, is a multiple function generator consisting of up to 10 mathematically derived curves printed on individual plastic sheets which are pressed into a single laminated plate about 3/64 in. thick. The plate is made to fit on the regular recording platen of an Autograf recorder, and a cable connected switch unit provides individual curve selection. Model 34A, now available, contains ten of the most common functions including  $X^2$ ,  $1/X$ ,  $\sin X$ ,  $\tan X$ ,  $\log X$ , and  $e^X$ .

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks  
Ave., Pasadena, Calif.

CIRCLE 199 ON READER-SERVICE CARD

# ...AND ANOTHER Silicon Rectifier

FROM

## FANSTEEL



## 22 AMP. Silicon Power Rectifier

The 6A—just added to Fansteel's expanding line of dependable silicon rectifiers—carries a full 22 amp. load in half-wave circuits; up to 66 amps in bridge circuits. It has rated peak reverse voltages from 50 to 400 V. in 50-volt multiples.

The new 6A Rectifier operates at ambient temperatures up to 165°C. and is unaffected by storage temperatures from -65°C. to 200°C.

This dependable, highly stable unit is especially suited to high temperature operation in all types of power circuits. It will give long, trouble-free performance consistent with other Fansteel electronic components. The 6A unit is hermetically sealed and is of extremely rugged construction. It is the most compact unit of its rating and can be mounted in any position.

Write for Latest Information

**FANSTEEL**

RELIABILITY

E594A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

CIRCLE 200 ON READER-SERVICE CARD

from  
E·H research  
laboratories

## MILLIMICROSECOND PULSE GENERATOR

for fast rise time and high  
repetition rate applications



MODEL 120 A  
F. O. B. Oakland, Calif. \$1275

The E·H Model 120 A is a completely new all-electronic instrument featuring fast rise time, high repetition rate, two high level outputs, and flexible drive and gating features.

### FOR EXAMPLE:

- Rise time (10% to 90%)... less than 2.5 millimicroseconds
- Pulse width — 2.5 to 25 millimicroseconds
- Repetition rate — 10 cps to 10 Mc, continuous below 1 Mc
- Outputs — two independent 0-8 volt outputs
- Flexible — external or internal drive, provision for fast external gating.

Other specifications you will be interested in checking and comparing are:

- ✓ electronic gate input  
gating time — less than 100 millimicroseconds  
amplitude required — +20 volts
- ✓ external or internal drive — 10 cps to 10 Mc
- ✓ 15 volt, 50 millimicrosecond sync. output pulse
- ✓ power requirements — 105-130 volts, 50/60 cps, 200 watts

for additional information, write or wire...



**E·H RESEARCH LABORATORIES**  
1922 PARK BLVD. • GLENCOURT 2-0732 • OAKLAND 6, CALIFORNIA

Electrometer Amplifiers • Millimicrosecond Coincidence Units • Millimicrosecond Pulse Generators

CIRCLE 201 ON READER-SERVICE CARD

## NEW PRODUCTS

### Surface Temperature Meters

Have  $\pm 2\%$  accuracy



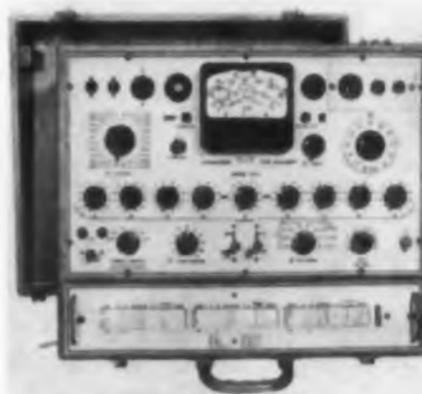
Low cost surface temperature meters with  $\pm 2\%$  full scale accuracy, Pyrotems are available in automatically compensated models for ambient temperature readings and noncompensated types for relative temperature readings. Compensated model DTF comes in 0 to 300, 0 to 450, and 0 to 650 F ranges, and noncompensated model ETF has a range of 0 to 200 C. A special 15 deg side-reading probe permits the checking of hard-to-reach surfaces such as those of resistors and capacitors on parallel mounting boards. All types attain an ultimate temperature response in 3 to 10 sec.

Royco Instruments, Inc., Dept. ED, 874 Fabian Way, Palo Alto, Calif.

CIRCLE 202 ON READER-SERVICE CARD

### Mutual Conductance Tube Analyzer

Covers 0 to 30,000  $\mu$ hos



Dynamic mutual conductance tube analyzer model 3444 measures true  $G_m$  without any extra compensating factors. It uses proper value dc electrode potentials, a 5 kc ac signal source, and a vacuum tube microammeter. Plate impedance is 33 ohms. The unit has four direct reading  $G_m$  ranges: 0 to 1000, 0 to 3000, 0 to 10,000 and 0 to 30,000  $\mu$ hos. It comes in a portable case 15-3/16 x 18-13/16 x 7-3/4 in.

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

CIRCLE 203 ON READER-SERVICE CARD

*Bendix-Pacific*  
needs  
**CIRCUIT  
DESIGN  
ENGINEERS**

TELEMETERING...SONAR...

MISSILE GUIDANCE...AIRBORNE RADAR

If you have had two or more years experience in Circuit Design in Telemetering, Sonar, Missile Guidance or Airborne Radar... and are interested in moving to a permanent, well paying position in Southern California —

Please write W. C. Walker your qualifications or fill in the coupon and mail today.

W. C. Walker, Engineering Employment Manager  
Bendix-Pacific, Bendix Aviation Corporation  
11620 Sherman Way, North Hollywood, Calif.

I am interested in \_\_\_\_\_ Engineering  
I am a graduate engineer with \_\_\_\_\_  
degree and \_\_\_\_\_ years experience.

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City \_\_\_\_\_

Zone \_\_\_\_\_

State \_\_\_\_\_

CIRCLE 870 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959



in microwave design...

## Put PERMANENT MAGNET SPECIALISTS

on your development team

Application of permanent magnets in microwave devices has resulted in vastly improved performance, lower costs and greater stability. Since the early days of microwave research, The Indiana Steel Products Company magnet design engineers have worked closely with leading manufacturers, providing expert help in developing special-purpose permanent magnet assemblies for such applications as radar magnetrons, backward wave oscillators, pm-focus traveling wave tubes and load isolators.

A discussion with permanent magnet specialists at The Indiana Steel Products Company may be just the stimulus your new design efforts need — or perhaps you'll find a way to improve your present products. In any case, you can be sure of this—*nobody knows permanent magnets like Indiana.* And, because Indiana produces all permanent magnet materials, Indiana design engineers are well qualified to recommend the one best material for your design. Why not call in an Indiana man today?

### FREE CATALOG

Write TODAY for important, free, new catalog for microwave design engineers — "Alnico Load Isolator Magnets," which describes shapes, sizes and characteristics of this complete line of Indiana permanent magnets. Ask for Catalog No. 20M-4.

THE INDIANA STEEL PRODUCTS COMPANY  
VALPARAISO, INDIANA  
World's largest manufacturer of permanent magnets

INDIANA PERMANENT MAGNETS

IN CANADA: The Indiana Steel Products Company of Canada Limited, Kitchener, Ontario

CIRCLE 204 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959



## Commutator

Has long life

This thermocouple and strain gage millivolt telemetering commutator has 300 times the life and reliability of circular sampling switches. Having 2 poles and 60 contacts per pole, the unit has a volume of 11.25 cu in and weighs 12 oz. It samples 3 mv signals with 0.5% accuracy and its contact resistance is less than 5 ohms. Operating on 2/3 w, it will take 36 to 2500 cps vibration at 25 g and withstand 150 g for 11 msec. Life at 10 rps is in excess of 1000 hr.

Lind Corp., Dept. ED, Research Park, Princeton, N. J.

CIRCLE 205 ON READER-SERVICE CARD

## Power Amplifier Klystrons

Cover 400 to 985 mc

Models 4KM50,000LA and 4KM50,000LQ are 10 kw power amplifier klystrons that cover the 400 to 985 mc range with a maximum beam voltage of 20 kv and a maximum collector dissipation of 50 kw. External cavity design permits tuning over a wide range with a single set of tuning cavities and allows adjustable loading for broadband operation. The units incorporate a unipotential, indirectly heated cathode and a modulating anode which provides a method of amplitude or pulse modulating the output power without changing the beam voltage. The modulating anode also provides overload protection.

Eitel-McCullough, Inc., Dept. ED, San Carlos, Calif.

CIRCLE 206 ON READER-SERVICE CARD

## Copper Oxide Rectifiers

For instrument use

These copper oxide instrument rectifiers are completely enclosed in a phenolic housing for high moisture, humidity and salt spray resistivity. Operating temperature range is  $-55$  to  $+85$  C. Units A3B4B, A2A4B, A3A2C, A2A2C, A3A2D and A2A2D are rated for 8.5 piv, up to 6 v ac input, and up to 12 ma dc output. A center eyelet permits mounting with a #2 screw.

Edal Industries, Inc., Dept. ED, 64 Franklin St., New Haven 11, Conn.

CIRCLE 207 ON READER-SERVICE CARD



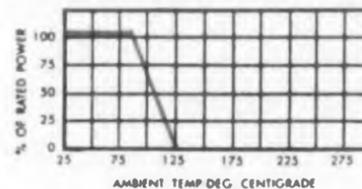
... for Complete Reliability Under Severe Environmental Conditions



## TYPE WW ENCAPSULATED RESISTORS

Wire Wound, Precision, Hi-Value, Non-Inductive

### TYPICAL DERATING CURVE



### JUST ASK US

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

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

Just outline your specific situation.

High resistance value, wire wound resistors designed for non-inductive requirements that demand the closest precision tolerance. Encapsulated in carefully compounded material, selected for matching coefficient of expansion to that of the wire.

- Rated at .1 watt to 2 watts, with a wide selection, depending on type and size.
- Resistance range from 0.6 ohm to 6 Megohms, depending on type.
- Tolerance:  $\pm 0.05\%$ ,  $\pm 0.1\%$ ,  $\pm 0.25\%$ ,  $\pm 0.5\%$ ,  $\pm 1\%$ ,  $\pm 3\%$ .

**TEMPERATURE COEFFICIENT:** Within 0.00002/degree C.

**OPERATING TEMPERATURE RANGE:**  $-55^{\circ}$  C. to  $125^{\circ}$  C.

**SMALLEST IN SIZE:**  $1/8'' \times 3/8''$  to  $2 1/2'' \times 3/8''$ .

**COMPLETE PROTECTION:** Encapsulating material makes them completely impervious to penetrating effects of salt spray, humidity, moisture and corrosive gases and vapors.

**CONFIGURATIONS:** WWA — axial leads; WWP—parallel leads; WWR—radial leads; WWL—lug style terminals; WW-RB—military style with lug terminals; HWA and HW-RB—high temperature applications.

**MILITARY SPECIFICATIONS:** Surpasses MIL-R-93B, characteristic A and B; MIL-R-9444.

Write for Bulletin R-26

CIRCLE 208 ON READER-SERVICE CARD

DALE PRODUCTS INC.

1328 28th AVE.  
COLUMBUS, NEBRASKA



## DECISION MAKER

for simplified monitoring,  
controlling, high-precision switching

Normal/abnormal . . . high/low . . . go/no-go: these are important decisions being made by A.P.I. Very High Sensitivity Measuring Relays.

Direct from sensory elements or circuits, the A.P.I. measuring relay makes a decisive "yes or no" decision on the basis of very close-tolerance voltage or current changes. In typical, critical applications, this measuring relay is saying "yes or no" on a change of  $\pm 1$  microamp; or in a 400- to 500-volt circuit, on a variation of only a few percent.

Moreover, the relay is capable of actuating on very tiny currents: for example, total inputs as small as 0.2 microampere or 0.1 DC millivolt. It does so without signal amplification, amplifier costs or the signal distortion problems that often go along.

Performance stability is inherent; reliability is exceptional due to the A.P.I. locking-coil design. On "make", contact is firm with substantial contact pressure; contact resistance is low. On "break", separation is clean and quick without contact teasing.

10,000,000 perfect operations is not an all-time record; it's a reasonable expectation of service life.

Widely used for precision switching in computer, control and alarm circuits, VHS measuring relays are practically unlimited in scope of application.

For more information, send for Bulletin 104-D.



**ASSEMBLY PRODUCTS, INC.**  
Chesterland 17, Ohio

CIRCLE 209 ON READER-SERVICE CARD

## NEW PRODUCTS

### Solid Tantalum Capacitors

Rated at 6 to 35 v



These solid electrolyte tantalum capacitors are rated at 6, 10, 15, 20, and 35 v and have capacitances from 2.2 to 47  $\mu\text{f}$ . Standard tolerance is  $\pm 20\%$  and units to  $\pm 10\%$  tolerance are available on order. The capacitors are hermetically sealed in 0.175 x 0.438 in. cases and operate from  $-55$  to  $+85$  C. Their dc leakage current does not exceed 0.04  $\mu\text{a}$  per  $\mu\text{f-v}$  or 2  $\mu\text{a}$ , whichever is greater.

The Magnavox Co., Dept. ED, 2131 Bueter Rd., Ft. Wayne, Ind.

CIRCLE 210 ON READER-SERVICE CARD

### Transmitters and Receivers

For telemetry and industrial control

Model T-10 and T-11 transistorized tone and carrier transmitters and receivers are designed for continuous duty industrial control, telemetering, and signalling applications. Of plug-in modular construction, they have output frequencies from 100 cps to 100 kc with 2% minimum spacing between channels. Output level can be adjusted from 0 to +20 dbm. Drift is less than 0.1% from  $-20$  to  $+45$  C, and total operating current drain at 12 v dc is 50 ma for the transmitter, 60 ma for the receiver. Amplitude or phase shift keying is available in all models.

Moore Associates, Inc., Dept. ED, 2600 Spring St., Redwood City, Calif.

CIRCLE 211 ON READER-SERVICE CARD

### Image Orthicon

Low light level unit

With high resolution sensitivity, this image orthicon can pick up usable images with light levels of  $3 \times 10^{-6}$  mL on the scene, or  $3 \times 10^{-7}$  ft-c on the photocathode. Its sensitivity excels that of the human eye aided by night binoculars. In operation, it depends only on the visible spectrum and has a wide range that extends to full sunlight.

General Electric Co., Power Tube Dept., Dept. ED, Schenectady 5, N. Y.

CIRCLE 212 ON READER-SERVICE CARD

# STANPAT SOLVES THE GHOSTING PROBLEM

**NEW resin-base STANPAT  
ELIMINATES GHOSTING,  
offers better adhesion qualities  
on specific drafting papers!**

#### THE PROBLEM

Some of our longtime customers first called our attention to the "ghosting" problem. Certain tracing papers contain an oil which could be leached out by the STANPAT adhesive (green back) causing a ghost.

#### THE SOLUTION

A new STANPAT was developed (red back), utilizing a resin base which did not disturb the oils and eliminates the ghost. However, for many specific drafting papers where there is no ghosting problem, the original (green back) STANPAT is still preferred.

#### WHICH ONE IS BEST FOR YOU?

Send samples of your drawing paper and we will help you specify. Remember, STANPAT is the remarkable tri-acetate pre-printed with your standard and repetitive blueprint items—designed to save you hundreds of hours of expensive drafting time.

#### SO SIMPLE TO USE



**1. PEEL**  
the tri-acetate adhesive from its backing.

**2. PLACE**  
the tri-acetate in position on the tracing.

**3. PRESS**  
into position, will not wrinkle or come off.

#### STANPAT CO.

WHITESTONE 57, N. Y. Dept. 98  
Phone: Flushing 9-1693-1611

- Enclosed are samples of the drafting paper(s) I use (identify manufacturer). Please specify whether Rubber Base or Resin Base STANPAT is most compatible with these samples.
- Send literature and samples of STANPAT
- Please quote price on our enclosed sketches which we are considering to have pre-printed.

NAME \_\_\_\_\_  
FIRM \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_  
ZONE \_\_\_\_\_ STATE \_\_\_\_\_

CIRCLE 213 ON READER-SERVICE CARD



**TEST INSTRUMENTS**

for

**LABORATORY/PRODUCTION**

**FIELD TESTING**

**measure  
microwave power  
directly, quickly,  
accurately**



**TRANSISTORIZED  
POWER BRIDGE**

The AIL Type 50 R-F Power Bridge applies the most advanced transistor circuitry techniques to power measurements in the 10-40,000 MC range. Full scale ranges of 1.0 and 10 milliwatts and plus and minus 10dbm are provided. Accuracy within 0.5 db.

Compact—battery operated—weighs less than 4 pounds—hand held—ideal for field applications.

Each Type 50 is carefully checked and tested under the rigid AIL quality control system assuring highest reliability for a variety of applications in:

*Radar • Communications  
Navigation • Telemetry  
Television • Transmission Lines  
Microwave links • R-F leakage*

Price \$199.00



**AIRBORNE  
INSTRUMENTS  
LABORATORY**

1345 NEW YORK AVENUE  
HUNTINGTON STATION, L. I., N. Y.  
A DIVISION OF CUTLER-HAMMER, INC.

CIRCLE 214 ON READER-SERVICE CARD



**Dielectric Tester**

Incorporates vacuum test chamber

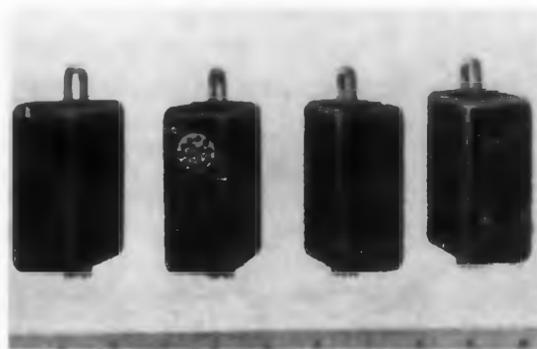
For dielectric testing at simulated high altitudes, in vacuum, or in atmospheres other than air, the model H20 DC-XVP is a one-piece portable unit that combines a dielectric test set and a two-stage vacuum pump with bell jar assembly. It covers a range of 0 to 20 kv dc and can be provided with an additional panel for corona testing. The vacuum pump has a capacity of 58 liters per min and can produce a vacuum of 0.1 micron.

Peschel Electronics, Inc., Dept. ED, RFD 1, Paterson, N.Y.

CIRCLE 215 ON READER-SERVICE CARD

**Transistorized Decimal Counters**

Plug-in



Transistorized N-Series plug-in decades are designed for pulse counting and frequency division application in the 0 to 250 kc and 0 to 5 mc frequency ranges. They are compatible with the company's T-Series germanium plug-in circuits and have standard electrical outputs of N/10 and the N/10 complement for direct use in driving following circuits. All models offer an auxiliary nine-step staircase output for meter display, and a wide selection of visual readout schemes is available. The decades plug into special 13-pin miniature tube sockets, furnished with each unit, and measure 1-5/32 x 2-3/32 x 3-7/8 in.

Engineered Electronics Co., Dept. ED, 506 E. First St., Santa Ana, Calif.

CIRCLE 216 ON READER-SERVICE CARD



**DIEHL\***

**HIGH FREQUENCY PHASE SHIFTER**  
now extends frequency range to 10 Megacycles

The unique characteristics of these newly developed units suggest such interesting fields of application as:

**Color TV Test Equipment    Direction Finding Equipment**  
**Missile Tracking    Standard Time Signal**  
**Communications    Computers (Pulse Generating)**

While accuracies of these Phase Shifters vary with the frequencies, the error at 2 megacycles is less than 30 minutes. Dual channel or single channel units can be provided. Outputs terminate in Cathode Follower circuits, with output impedances of 50 or 500 ohms. Transistorized units can be developed for special requirements.

Write for detailed specifications for the frequency to suit your application.



**DIEHL MANUFACTURING COMPANY**

Electrical Division of THE SINGER MANUFACTURING COMPANY

Finderne Plant, SOMERVILLE, N. J.

other available components

• AC SERVOMOTORS • AC SERVOMOTORS WITH AC TACHOMETERS • DC SERVO SETS  
• AC SERVOMOTORS WITH DC TACHOMETERS • AC AND DC TACHOMETERS • RESOLVERS

\*A Trademark of DIEHL MANUFACTURING COMPANY    †A Trademark of THE SINGER MANUFACTURING COMPANY

CIRCLE 217 ON READER-SERVICE CARD

# Laboratory Power Supply



**MODEL 150**  
features  
**VARIABLE**  
**FREQUENCY**  
**OUTPUT**  
380-2400 cps.

With front panel control of feedback for improved load matching, the Model 150 provides 150 volt-amperes for 1.0 to 0.7 leading or lagging power factors. Consuming about 450 watts from a nominal 115-volt 50/60 cycle line source, its output voltage is adjustable from 105 to 125 volts (0-130 volts as a power amplifier). Output voltage regulation is  $\pm 2\%$  for load or line as an oscillator (as a power amplifier, regulation is dependent on feedback control setting and power factor of the load).

Total output distortion at full load is about 1.5% at 400 cps. At 50 watts, distortion is less than 1% from 100-500 cps.

Output frequency variation due to rated line and resistive load changes is less than 0.1%  $\pm 2$  cycles. Frequency variation due to a change of 100 VA of reactive load is about 0.5%.

Cabinet is 21-1/2" wide x 13" high x 15" deep and is equipped with ventilating fan. Front panel is 19" wide x 10-1/2" high and can be mounted on standard relay rack. Net price \$575.

## For Owners of the RFL Model 829 AC-DC Instrument Calibration Standard

By combining the Model 150 with the Model 829 and the Model 10 Test Equipment Cart, a complete meter calibration facility can be achieved in a small space.

The cart is made of heavy gauge sheet steel and is equipped with free rolling, swivel casters. Usable inside space is 33" wide x 16-1/2" deep x 26" high. One side accommodates standard 19" wide panels to meet RETMA rack standards; the other side has 24" wide opening for equipment mounted in cabinets, such as the Model 150. Interior shelf is adjustable in any position from top to bottom. Accessory, drop-leaf work counter, attachable to either side of the cart, is also available.

Performance is rigidly guaranteed. Price is net, f.o.b. Boonton, N.J. and subject to change without notice.



SEND  
FOR  
TECH.  
DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.



**Radio Frequency**  
LABORATORIES, INC.  
Boonton, New Jersey, U.S.A.

CIRCLE 218 ON READER-SERVICE CARD

## NEW PRODUCTS

### Transistorized DC Amplifier

Operates on 3 to 24 v dc



A transistorized dc amplifier using printed circuitry, the TPC-324 is a high impedance input unit which operates on 3 to 24 v dc power and drives a 3.2 ohm speaker directly without the use of an output transformer. At 6 v, it has an acoustic radio output of 750 mw. Current drain ranges from 10 to 300 ma, and frequency response ranges from 50 cps to 20 kc,  $\pm 2$  db. A typical unit with three 5 w transistors, operating at 12 v, provides 15 w of audio output with 3 v of signal, peak to peak input.

Tri-Phi, Inc., Dept. ED, 141 Albertson Ave., Albertson, N.Y.

CIRCLE 219 ON READER-SERVICE CARD

### Lenticular Displays

Multimessage

Type LD-22 and LD-35 lenticular optical displays handle 16 and 20 messages, respectively. The displays are produced by a process in which all of the messages are stored on a common viewing screen. Any one of the messages can then be selected and displayed by lighting a single miniature incandescent bulb. There is no interference between messages, and switching from one to another is instantaneous. The devices can visually present digits, letters, words, charts, or photographs. They are self-contained and designed for remote operating from any switching system. Respectively, the units are 6-5/8 and 11-3/8 in. deep with 2-1/4 x 2-1/4 in. and 3 x 5 in. common viewing screens.

Burroughs Corp., Electronic Tube Div., Dept. ED, P. O. Box 1226, Plainfield, N. J.

CIRCLE 220 ON READER-SERVICE CARD

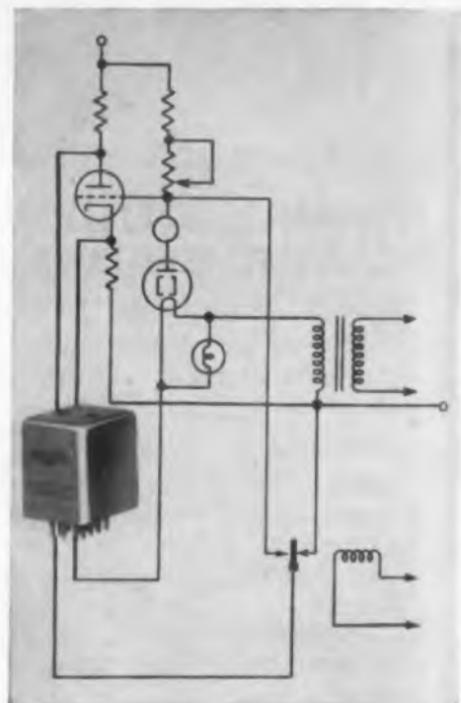
### Multiconductor Cable

Contains 6 to 56 pairs of thermocouple extensions

Polyvinyl insulated "Thermo-Cable" is available with 6, 14, 18, 25, 39, or 56 pairs of thermocouple conductors. It has an outer polyvinyl chloride jacket that resists moisture, abrasion, heat, and chemical action and often eliminates the special



**REGOHM**  
voltage regulation  
down to  $\pm 0.05\%$   
**EXTENDS**  
**TUBE LIFE**



The sensitive yet rugged REGOHM controls input voltage to eliminate the power-source variations which cause premature tube failure. Automatic and precise, this plug-in unit assures constant voltage input.

More and more designers are including REGOHM in circuits, because of its:

- STEPLESS CONTINUOUS CONTROL
- WIDE FREQUENCY RANGE
- PERMANENT ADJUSTMENT
- FREEDOM FROM MAINTENANCE
- RUGGED DESIGN
- LIGHT WEIGHT
- LONG LIFE
- LOW COST

Design data, performance specs and case histories of those applications you wish to explore will be sent on request.

**REGOHM**



**ELECTRIC REGULATOR CORPORATION**  
NORWALK CONNECTICUT

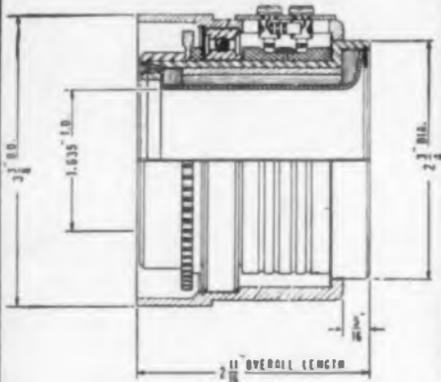
CIRCLE 221 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

# Deflection YOKE specialists

COMPLETE LINE for every Military and Special purpose in PRODUCTION QUANTITIES or CUSTOM DESIGNED to your specific requirement.

## FOR PPI DISPLAYS Compact Rotating Coil Yoke



Stock Type Y25 illustrated



**OTHER ROTATING TYPES** available with fixed off-centering or rotating off-centering. Many mechanical and electrical variations.

**FIXED TYPES** with push-pull windings. Low current coils for slower sweep speeds. Low impedance coils for transistor drives.

Neck diameter, core material, configuration, deflection angle and electrical design to your precise spec. For engineering help, contact Dr. Henry Marcy today.

**syntronic**  
INSTRUMENTS, INC.

100 Industrial Road, Addison, Illinois  
Phone Kingswood 3-6444

CIRCLE 222 ON READER-SERVICE CARD

coatings required to pull extension wires through conduit. Individual conductors are insulated with polyvinyl chloride and can withstand 221 F. Each conductor is color coded according to ISA recommendations, and thermocouple pairs are numbered alike and lie next to each other.

Thermo Electric Co., Inc., Dept. ED, Saddle Brook, N. J.

CIRCLE 223 ON READER-SERVICE CARD

## Transistorized Power Supplies

### Have modular design

The modular construction of these power supplies permits selection from a wide range of specifications. Features that may be specified include 0.01% regulation and adjustable output current with automatic cutoff at a preselected value. All units have a continuously variable output voltage with vernier control; ripple of less than 1 mv rms; and recovery of less than 50  $\mu$ sec without overshoot of less than 1% of voltage setting. They incorporate a magnetic line voltage regulator that causes the voltage across the transistors to drop to zero when the output is shorted.

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

CIRCLE 224 ON READER-SERVICE CARD

## Tri-Axial Accelerometer

### Occupies 5/8 cu. in.

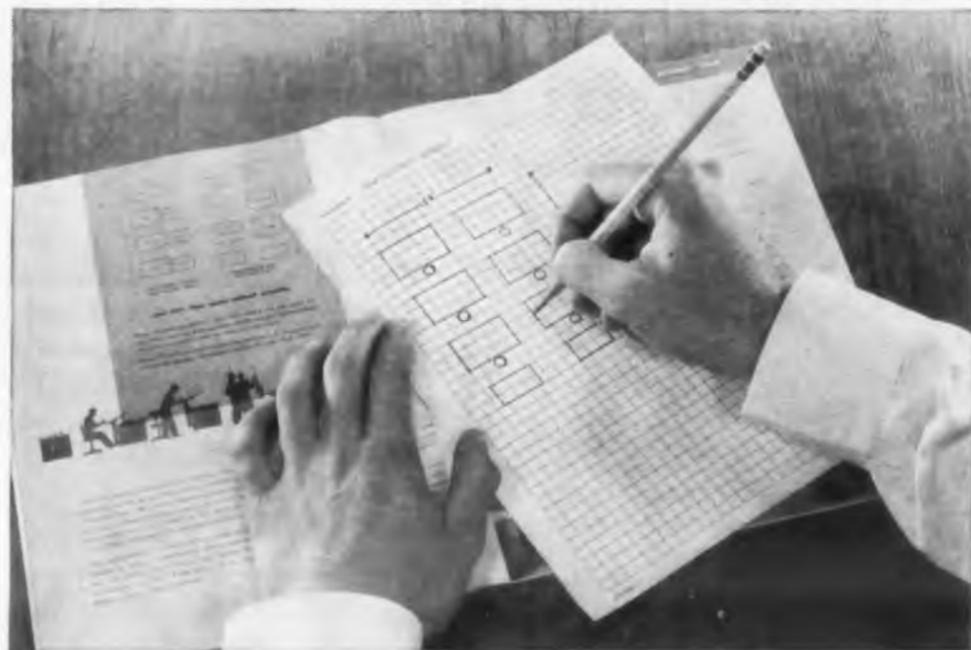


For simultaneous measurement of vibration in three axes, the model 2223 tri-axial accelerometer contains three of the company's Piezite type I sensing elements mounted in mutually perpendicular planes within a 5/8 cu in. block that weighs 1.4 oz. It has a first resonant frequency of 30 kc, a sensitivity of 5 pk-mv/pk-g, and a dynamic range of 1000 g with less than 5% cross-axis sensitivity. It operates over a range of -65 to +220 F with maximum change in sensitivity of +10%. Frequency response is 2 to 2000 cps  $\pm$ 5% with a 1000 meg load. Each axis is individually calibrated from 20 to 4000 cps  $\pm$ 5% before installation.

Endevco Corp., Dept. ED, 161 E. California Blvd., Pasadena, Calif.

CIRCLE 225 ON READER-SERVICE CARD

## DRAFTING TRENDS



Efficient drawing and reference table arrangements are most important. The new Post Hamilton Catalog serves as an excellent guide to more up-to-date drafting room layouts. See special offer below.

## Modern space savers are important time savers

Space saving and more efficient use of manpower are part of a never-ending trend. In drafting rooms, modern space saving techniques are exemplified in Post/Hamilton Auto-Shift Tables.

A 30% saving in floor area is not unusual with proper planning when replacing older tables with Auto-Shifts. And it can be done without crowding. The Auto-Shift is designed for the man-on-the-board. There is ample reference and storage space and the slope of the board is easily controlled through a 0° to 90° range, or the board raised and lowered by fingertip action. This boils down to eliminating unnecessary reaching, cutting clutter, ending back fatigue. The Auto-Shift provides such "extras" as stylized leveling legs, full width foot rest, a triple electrical outlet, integral roll tracing storage bin, foot pedal for vertical board control.

Another space saver is the Post/Hamilton "L" Contour Unit. This combination drawing-reference unit affords complete flexibility of board

movement with a choice of either a right or left hand reference area.

### Space saving filing systems

Efficiency in filing can be a very important work saver, too. Post/Hamilton vertical filing units provide for maximum protection, ease of classification, and efficient use of all storage areas. Specialized cabinets allow for storage of tracings, prints, engineering records, and roll tracings all in one stack of vertical files. This is the UnitSystem, a file control which can be custom-tailored to your needs.

### Send for complete POST/Hamilton Catalog

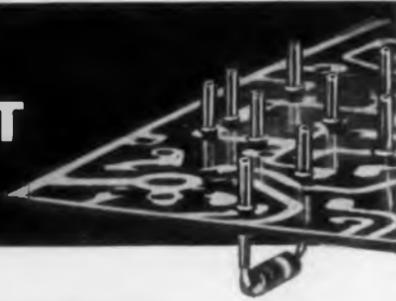
Write for the 1959 Post/Hamilton Drafting Room Equipment Catalog today. It pictures the newest drawing tables and filing systems on the market, and will suggest many new approaches to your drafting room efficiency. Write to Frederick Post Company, 3662 N. Avondale Avenue, Chicago 18, Illinois.



SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES  
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

CIRCLE 226 ON READER-SERVICE CARD

## UPGRADE YOUR PRINTED CIRCUIT PROGRAM



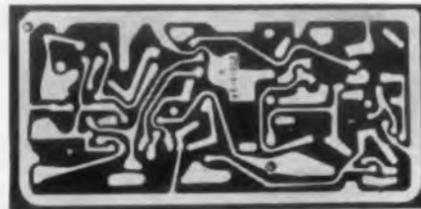
The **LONCO** Problem Solver Way....

### BRIGHTEN



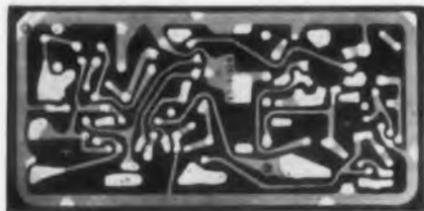
Brighten with LONCO COPPERBRITE #48-HT, the oxide remover that does *not* etch away your copper and cause contamination of your solution and board, but *does* completely clean off surface oxides and hydrates. Lasts longer, too!

### PROTECT



Protect your Copperbrite surface with LONCO SEALBRITE #230-10. Keeps away oxides and dirt and improves ultimate soldering with its unique solder-assist coating. Effectively inhibits oxidation during high temperature cure of solder resists.

### MASK



Mask out solder "take" with LONCO PC#33-R SOLDER RESIST—the hard, tough film that performs excellently over Sealbrite #230-10. Minimizes bridging, improves soldering of uncoated areas, greatly enhances appearance of the finished board.

### FLUX



Flux with one of the new LONCO RESIN-FLUXES that give you greater solderability and less corrosion potential. Now you can satisfy the strictest requirements of both production and quality control departments—and get perfect soldering at safe, low temperatures!

### CLEAN

Clean flux residues from your boards by simple dip with a LONCO FLUX REMOVER. Removers are designed to wash off flux residues at a maximum speed consistent with safety to the delicate components and materials involved.

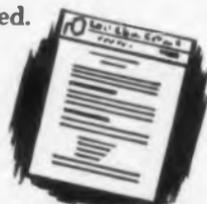
Get the Facts... Ask for full information on any or all of Lonco's printed circuit problem solvers. Request special bulletin, *Soldering of Printed Circuits*.



**LONDON CHEMICAL CO., INC.**

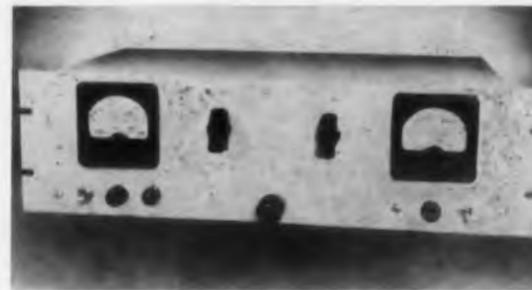
1531 N. 31st AVENUE • MELROSE PARK, ILLINOIS  
MEMBER OF INSTITUTE OF PRINTED CIRCUITS

CIRCLE 227 ON READER-SERVICE CARD



## NEW PRODUCTS

### Regulated DC Power Supply High voltage



Over its entire output range of 500 to 2500 v and 0 to 10 ma dc, the model S-325 power supply has a line regulation of better than  $\pm 50$  ppm, a load regulation below  $\pm 60$  ppm, and a ripple of less than 10 ppm. Polarity is reversible, and both current and voltage meters are standard equipment. The low cost unit is designed around a glass-melamine printed circuit board which constitutes the entire chassis for electronic components. For either bench use or rack mounting, it measures 5-1/4 x 19 x 12-1/4 in.

NJE Corp., Dept. ED, 345 Carnegie Ave., Kenilworth, N.J.

CIRCLE 228 ON READER-SERVICE CARD

### DC Overpotential Testers

Have 50 to 200 kv outputs

Rated at 5 ma, these dc overpotential testers are available with 50, 100, 120, 150, and 200 kv outputs. They may be used to measure leakage current and voltage in the insulation testing of transformers, bushings, and insulating materials, and can also serve as high voltage power supplies. The testers consist of two pieces, a control section and a high voltage tank section, which may be stacked and rolled about or separated for remote control.

Peschel Electronics, Inc., Dept. ED, RFD 1, Patterson, N. Y.

CIRCLE 229 ON READER-SERVICE CARD

### Spectrum Analyzer

Covers 0.1 to 525 kc

Covering 0.1 to 525 kc, the model SB-15 spectrum analyzer can be used for ultrasonic spectrum analyses, harmonic investigations, ultrasonic vibration and noise measurements, telemetering, monitoring, and attenuation measurements of filters and transmission lines. It offers a continuously calibrated sweep width from 200 to 1 kc; 100 cps resolution capability; a choice of independently



by **DIALCO**

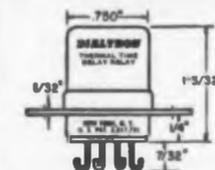


### Hermetically Sealed

Rugged—built to meet conditions of  
**high altitude**  
**high vibration**  
**high temperature**

DIALCO RELAYS exhibit no resonance from 5 to 1,000 CPS at 10 G's; are not damaged by 50 G's shock; are fully compensated for temperatures from  $-65^{\circ}$  C to  $+125^{\circ}$  C.

Available in delays from 1 to 300 seconds; heater voltages up to 150 V. interchangeable on DC or AC of any frequency with a power drain of 4 watts. SPST normally open or normally closed contacts are rated at 6 amps at 115 V. AC or 3 amps at 28 V. DC resistive.



### SUB-MINIATURE

Lightweight  
(3/4 oz.)  
Standard 7-pin  
plug-in or solder  
terminals with  
mounting flange

Dialtron Corp., 203 Harrison Pl., Brooklyn 37, N. Y.

Send data on Thermal Time Delay Relay: to:

Name \_\_\_\_\_

Position \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

**DIALTRON**  
CORP

203 Harrison Pl., Brooklyn 37, N. Y.

HYacinth 7-7600

CIRCLE 230 ON READER-SERVICE CARD

**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 231 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

variable or automatically optimized resolution; and continuously variable sweep rate from 1 to 60 cps. The unit is 8-3/4 in. high.

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

CIRCLE 232 ON READER-SERVICE CARD

### Ferrite Isolator

For KU-band



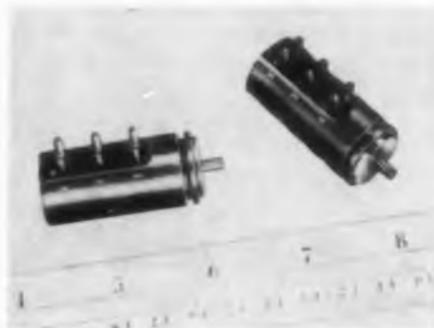
Model W-658-3A-2 transverse field isolator consists of rectangular waveguide with permanent magnetic transverse field and ferrite sections built into the unit. Frequency range of the unit is 12.5 to 18 kmc with isolation at 20 db min and insertion loss is 1 db max. Input vswr is 1.15 max throughout the range with peak power at 100 kw nominal. Ambient temperature operating range is -55 to 150 C. And size is 3 x 1.8 v 2.175 in.

Kearfott Co., Microwave Div., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

CIRCLE 233 ON READER-SERVICE CARD

### Ganged Switch

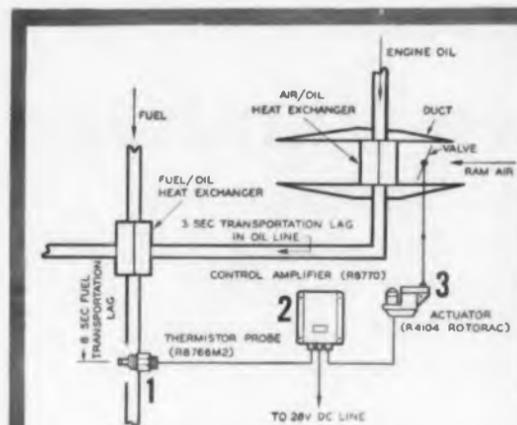
Has less than 0.5 oz-in. torque



Model 75-M49 tandem ganged switch is made to an angular accuracy of  $\pm 2$  deg and has a torque of under 0.5 oz-in. The three cup unit is rated at 100 ma per cup. It is servo mounted, uses miniature precision ball bearings, and is sealed except for the shaft end. It is available in standard and special mounting arrangements, and also in single and dual sections. It has a life of two million revolutions.

Maurey Instrument Corp., Dept. ED, 7924 S. Exchange Ave., Chicago 17, Ill.

CIRCLE 234 ON READER-SERVICE CARD



### AIRBORNE R8010 TEMP. CONTROL SYSTEM

Schematic diagram of temperature control system developed by Airborne for use on Martin P6M-2 Seamaster. System operates on 28 v d-c, maintains fuel temperature at approximately 200°F. by monitoring ram air flow to air/engine oil heat exchanger. Oil is used in turn to heat fuel.



## Airborne electromechanical system regulates jet fuel temperature

Besides offering an extensive line of linear and rotary actuators, Airborne can also meet your requirements for complete electromechanical control systems. An example is the R8010 Temperature Control System designed and developed for Martin and illustrated here. Four of these systems are used on the P6M-2 Seamaster to maintain fuel temperature at 180-220°F. If you have a similar requirement—for an aircraft, missile or ground application—why not contact Airborne. Our capabilities in special actuators, motors and related equipment make it likely that we can meet your needs exactly. Write or phone for further information.

### AIRBORNE R8010 Temperature Control System General Engineering Data

- 1. Probe:** Sensitive thermistor type mounted in MS10057-12 fitting. Resistance—nominally 10,000 ohms at 200°F.—varies with temperature.
- 2. Control Amplifier:** Transistor-relay type. Service temperature range from -65 to +200°F. Vibration and shock per MIL-E-5400A. Acceleration to MIL-E-5272A.
- 3. Actuator:** Partial-revolution, conforming to MIL-A-8064A. Motor—26 v d-c, reversible, continuous duty, conforming to MIL-M-8609. Actuator speed—.12 rpm at normal torque of 84 in./lb. Design incorporates electric clutch, limit switches, positive mechanical stops, radio noise filter.

LINEATOR® • ROTORAC® • TRIM TROL® • ROTORETTE® • ANGLgear® • ROTOLOK

**AIRBORNE**

*Engineered Equipment for Aircraft and Industry*

**AIRBORNE ACCESSORIES CORPORATION**

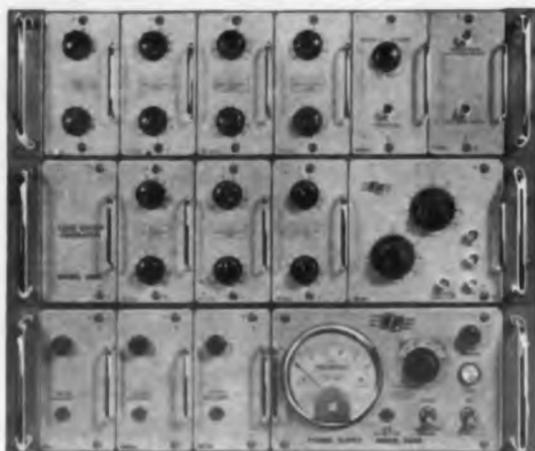
HILLSIDE 5, NEW JERSEY

Represented in Canada by: WINNETT BOYD LIMITED • 745 Mt. Pleasant Rd., Toronto 14, Ont  
CIRCLE 235 ON READER-SERVICE CARD

## DIGITAL PULSE GENERATORS

*for...*

- PCM System Design and Test
- Precision Delays and Pulse Widths
- Code Group Generation
- Digital Frequency Division
- Pulse Train Generation

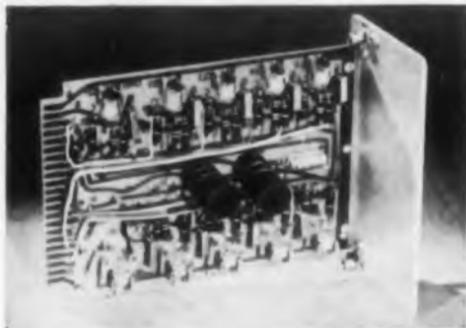


The instrument shown is comprised of a 1 MC crystal oscillator and variable digital frequency divider, one variable digital delay channel, and a three pulse code group generator with digitally variable pulse positions. Other units provide arbitrary length pulse trains and digitally controlled pulse widths.

MODULAR CONSTRUCTION is utilized in several standard instruments available. A broad range of special applications can be covered by other module combinations and use of the 5600 series units with other Electro-Pulse equipment.

PRINTED WIRING PLUG-INS are interconnected in rack frames to make up various units. Modules are easily accessible for maintenance or replacement.

TRANSISTORIZED DESIGN of these Electro-Pulse units draws heavily on computer techniques for high reliability. Accuracy of delays and pulse widths is essentially that of the crystal oscillator.



The 5600 series is the latest addition to the complete Electro-Pulse line of general and special purpose pulse generators, time delay and time mark generators, and electronic counting equipment.

Write for Complete Catalog

Representatives  
in Major Cities



Model 3450B  
MEGACYCLE PULSE GENERATOR

**Electro-Pulse, Inc.**

11861 TEALE ST., CULVER CITY, CALIF. • Phone: TEXas 0-9193 or EXmont 8-6764

CIRCLE 236 ON READER-SERVICE CARD

## NEW PRODUCTS



**Silicon Rectifiers**  
For intermediate power applications

Series SN-60 ac to dc power rectifiers are designed for intermediate power applications. Their maximum forward voltage drop is 1.2 v at 10 amp, 27 C; and the typical difference between case and junction is less than 2 C for each amp of forward current. Hermetically sealed and of rugged, all-weld construction, the units have a life of over 7000 hr. They are available with flat or stud bases and with flexible or rigid positive connections.

Syntron Co., Dept. ED, 1186 Lexington Ave., Homer City, Pa.

CIRCLE 237 ON READER-SERVICE CARD

## Rock Mounted Oscilloscope

Has 3 in. tube

Model 387R, in., oscilloscope has identical vertical and horizontal dc amplifiers with a range of dc to 500 kc. The vertical amplifier has a sensitivity of 10 mv, rms, per in. and the horizontal amplifier has a sensitivity of 15 mv, rms, per. in. Both amplifiers are attenuated in frequency compensated decade steps of 1 to 1 through 1000 to 1, in four ranges, and have non-frequency discriminating 10 to 1 gain control.

The Hickok Electrical Instrument Co., Dept. ED, 10525 Dupont Ave., Cleveland 8, Ohio.

CIRCLE 238 ON READER-SERVICE CARD

## Adhesive

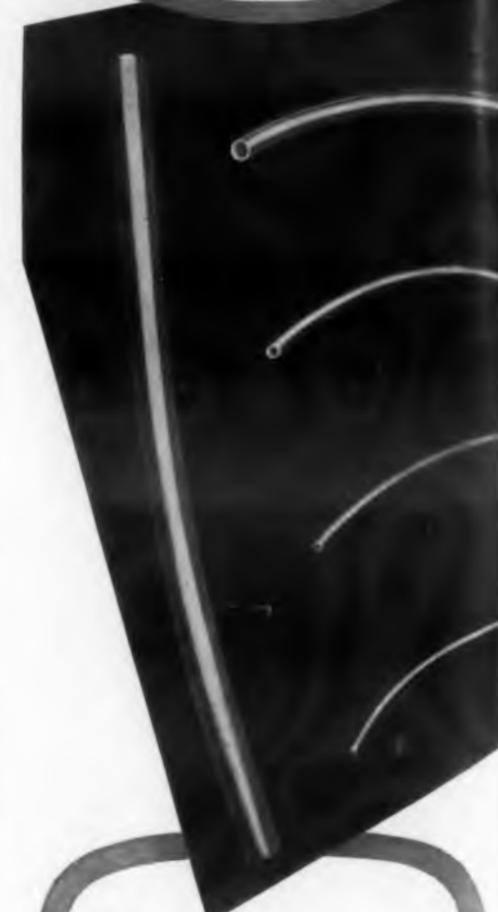
Laminates Mylar to papers

A strong, flexible adhesive, Bondmaster L379 is specially formulated for laminating Mylar to resin-impregnated asbestos papers, Kraft papers, rag papers, varnished fabrics and papers, and similar electrical insulating materials. These laminations are used as phase and layer insulations in electric motors, generators, and transformers. The synthetic, rubber-resin adhesive is resistant to organic solvents, hot oils, and heat aging.

Rubber & Asbestos Corp., Dept. ED, 225 Belleville Ave., Bloomfield, N. J.

CIRCLE 239 ON READER-SERVICE CARD

**INSTRUMENT  
TUBING**  
MADE FROM  
**TEFLON\***



**For  
FLUID LINES, CONTROL WIRE  
GUIDES, THERMOCOUPLE TUBES  
AND SEPARATORS, PROTECTIVE  
BUFFERS, ELECTRICAL INSULATION  
And Similar Applications Where  
Only PF Teflon\* Can Do The Job**

- extreme temperature service range (-450°F to +500°F)
- chemically inert
- zero moisture absorption
- lowest coefficient of friction of any solid material
- rinses clean and does not contaminate

PF instrument tubing is stress relieved for minimum shrinkage and carefully inspected and controlled dimensionally. A full range of sizes and colors are available to meet your specific needs. Write, wire or call for further information, competent engineering assistance and information on special sizes and walls. PF flexible tubing, heavy-walled tubing and rod stock made from Teflon\* is also available.

**PENNSYLVANIA  
FLUOROCARBON CO., INC.**

1115 N. 38th Street, Philadelphia 4, Pa.  
EVergreen 6-0603 TWX PH 252

\*Teflon—Du Pont trade name  
for Tetrafluoroethylene resin

CIRCLE 240 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

# NEW

... in construction  
and performance

## SAGE TYPE "CS"

### Clipper

#### POWER RESISTOR



Here's what  
the SAGE  
Type "CS"  
offers:

- Nickel-plated metal sheathing to prevent damage during clip assembly.
- 100% increase in power rating when clip is mounted in full heat-sink panel.

### PLUS:

- Precision to  $\pm .05\%$  tolerances.
- Stability within .5% for life.
- T.C. of Resistance  $\pm 20$  p.p.m./°C.
- Dielectric Strength of 1000 V-RMS Min.
- Characteristic "G" temperatures 275°C.
- Currently available in 3, 5, 7 and 10 watt ratings.

Write for descriptive literature

## SAGE

### ELECTRONICS CORP.

P. O. BOX 126 • ROCHESTER 10, N. Y.

CIRCLE 241 ON READER-SERVICE CARD

## Power Supplies

Have 0.1% regulation



Models HB2, HB4 and HB6 power supplies deliver 200, 400 and 600 ma respectively. Each unit has a dc incremental four band output voltage range from 125 to 325 v with continuously variable output control within each band. Regulation for line or load is less than 0.1% or 0.2 v, whichever is greater. Ripple is less than 3 mv rms. Recovery time is less than 100  $\mu$ sec. Ambient operating temperature range is from  $-20$  to  $+50$  C and the temperature coefficient is less than 0.05% per C.

Kepeco Laboratories, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 242 ON READER-SERVICE CARD

## Solvent

Reclaims encapsulated parts

The Resinform RF 837 solvent will remove epoxy and polyester resins from an assembly without, in most cases, damaging the components. Developed to reclaim fault-free components from rejected assemblies, the solvent will not corrode, discolor, or otherwise affect copper, aluminum, ferrous metals, or resin-based enamels. It is not inflammable and may be strained and reused.

Resin Formulators, Inc., Dept. ED, 8956 National Blvd., Los Angeles 34, Calif.

CIRCLE 243 ON READER-SERVICE CARD

## Vacuum Gage

Range is  $10^{-3}$  to  $10^{-7}$  mm Hg



Model 100-A vacuum gage consists of the gage tube, shown, a power supply and a front panel housing the 6-position range switch and the meter. The cold cathode gage will operate safely at relatively high pressures. Operating range of the unit is  $10^{-3}$  to  $10^{-7}$  mm of Hg. The cold cathode gage operates by the ionization of gas molecules present in a vacuum system. The unit was designed for such applications as hermetic sealing, vacuum tube pump-down systems and metal evaporation.

Miller Laboratories, Inc., Dept. ED, Box 97, Brea, Calif.

CIRCLE 244 ON READER-SERVICE CARD



Heli-Coil® Screw-Lock Inserts\* lock screws against impact and vibration and permanently protect critical tapped holes in this transducer assembly.

## Critical Electronic Controls Get Internal-Locking, Protective Threads

with

# HELI-COIL

## Screw-Lock Inserts



Principle of Heli-Coil Screw-LOCK Insert. Locking center coil grips internally, holds screw firmly.

Electronic control devices for aircraft and missiles, like this angle of attack vane transducer made by U. S. SCIENCE CORPORATION, LOS ANGELES, CALIF., have to withstand severe vibration, impact, corrosion and temperature change. They must be made of light materials and still have strong threads — able to hold fasteners tightly and stand frequent assembly and disassembly.

U. S. SCIENCE insures rock-solid screw assemblies by protecting vital tapped holes with one-piece

internal-locking Heli-Coil Screw-LOCK Inserts. These precision formed, stainless steel wire inserts eliminate thread wear, lock screws securely — without resort to clumsy, external lock nuts and lock wiring.

### Simple Installation Procedure

U. S. SCIENCE finds it easy to install Heli-Coil Screw-LOCK Inserts. Drilled holes are tapped with a Heli-Coil tap and the Inserts wound in with a prewinder inserting tool. Conventional screws are used in assembling the unit.

### Heli-Coil Screw-LOCK Inserts

- positively lock fasteners against loosening under impact and vibration
- prevent thread wear, stripping, corrosion, galling and seizing
- eliminate lock nuts, lock wiring, other supplementary locking devices
- permit repeated disassembly and reassembly
- can be used in standard proportion bosses without need for redesign
- save assembly time, space, weight and cost
- meet government specs for locking torque and vibration

\*Patented



## HELI-COIL CORPORATION

DANBURY, CONNECTICUT

HELI-COIL CORPORATION, 404 Shelter Rock Lane, Danbury, Connecticut

Send complete design data on Heli-Coil Screw-LOCK Inserts

NAME \_\_\_\_\_ TITLE \_\_\_\_\_

FIRM \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_

IN CANADA: W. R. WATKINS CO., Ltd., 41 Kipling Ave., S., Toronto 18, Ont.

CIRCLE 245 ON READER-SERVICE CARD

Take a  
close look  
at precision...

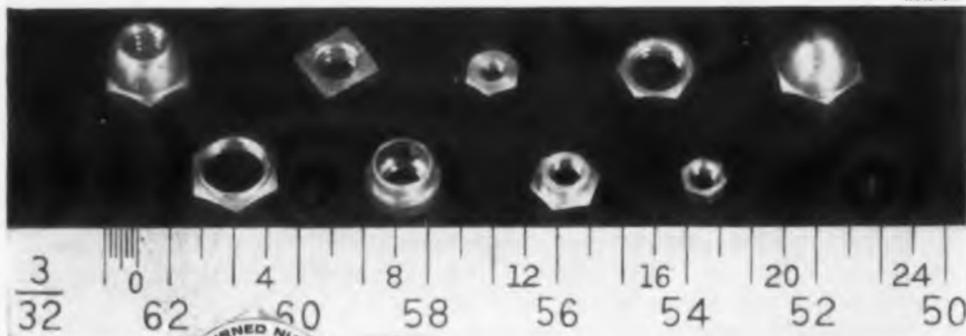


in  
**MINIATURE!**

This is a brass "jewel" nut. A .100-100 shoulder nut used in precision electrical instruments, it is mass produced by FISCHER to Class 3 tolerances, countersunk both sides and supplied deburred, cleaned, ready to install.

FISCHER specializes in turned nuts . . . standards, specials, odd sizes and types . . . having diameters from 1/8" and standard or special threads from No. "0". Each type is made to exacting specifications, delivered promptly, priced competitively. *And these are the reasons FISCHER is your best source for dependable miniature nuts.*

8430-FS



there's no  
premium  
for precision at



**Fischer**  
FISCHER SPECIAL MFG. CO.  
422 MORGAN STREET  
CINCINNATI 6, OHIO

*This enlarged scale photograph illustrates typical miniature nuts being supplied for electrical and electronic products.*

For details and specifications on Fischer brass and aluminum nuts, write for CATALOG FS-1000 and prices.



CIRCLE 246 ON READER-SERVICE CARD

NEW PRODUCTS

Resonant Reel Relays

For remote control applications



Developed for remote control applications, model AR-5 resonant reed relays provide an inexpensive band pass filter of 5-channel operation. Frequency range of the reed is from 200 to 500 cycles. By operating various combinations of the different frequencies, more than 30 distinct control channels can be accurately operated from the same 5-channel unit. Minimum driving power is 1.5 mw, with a stability of 0.25% from 0 to 25 C, and 1% from -20 to +80 C. Standard frequency tolerance is 1%, and reed response is approximately 50 msec.

CG Electronics Corp., Dept. ED, 15000 Central East, Albuquerque, N. M.

CIRCLE 247 ON READER-SERVICE CARD

Audio Oscillator

Has 10 v output

Model 200 oscillator generates a 10 v output into a 500 ohm load and has a power attenuator for lower values. At 5 v output, distortion is less than 0.2%. Frequency response better than  $\pm$ /db over the 30 to 15,000 cps range with a 500 ohm load, with stability exceeding 1%. No zero reset or line calibration is required, and dial calibration is accurate to  $\pm$ 3% scale reading. The oscillator comes in a steel cabinet, 13-3/4 x 7-1/4 x 9-1/2 in. with carrying handle and has a reverse-etched aluminum front panel.

Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

CIRCLE 248 ON READER-SERVICE CARD

Band Elimination Filter

Has 20 cps to 20 kc range



Band elimination filter model BE6 rejects any one frequency between 20 cps and 20 kc and

**D-C  
POWER**

Precisely Regulated for  
Missile Testing and  
General Use



**SILICON  
POWER  
SUPPLIES**

available in 30 standardized and militarized models from 30 to 1500 amps . . . 6 to 135 volts. CHRISTIE'S QUALITY CONTROL is approved by the A.E.C., leading aircraft and missile manufacturers.

Write For Bulletin AC-58-A

**CHRISTIE  
ELECTRIC CORP.**

3410 W. 67th Street  
Los Angeles 43, Calif.

CIRCLE 249 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1969

*New* PRECISION  
FREQUENCY

## STATIC INVERTER SUPPLY

INPUT 28V D.C.  $\pm$  10%

OUTPUT Nom. 115V  $\pm$  2%

400 CPS  $\pm$  0.01%

1  $\phi$  (2- or 3-phase output available)

RATINGS: 30VA 50VA 100VA

Higher ratings available.

### APPLICATION:

For gyro wheel supplies and where precise 400 cycle voltages are required in aircraft, radar and missile computers.



### FEATURES:

PRECISION OUTPUT FREQUENCY

RUGGED

EXCELLENT WAVEFORM

SIMPLICITY OF CIRCUITRY

FAST STARTING TIME

GOOD VOLTAGE REGULATION

throughout an adjustable range

ISOLATED CASE DESIGN

HIGH RELIABILITY

VIBRATION ISOLATED

COMPACT

LIGHTWEIGHT

MILITARY SPECIFICATIONS

(Send for Bulletin S-864)



**MAGNETIC  
AMPLIFIERS, INC.**

652 TINTON AVENUE • NEW YORK 55, N. Y. • CYPRESS 2-6610

West Coast Division

171 WASHINGTON ST. • EL SEGUNDO, CAL. • OREGON 8-2665

CIRCLE 250 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

passes all other frequencies between dc and 100 kc. It has a direct reading dial and is tuned with one knob over the full range. Requiring no power supply, vacuum tubes, or transistors, the unit has a dynamic range of over 120 db and input and output impedances of 600 ohms. Over most of the frequency spectrum it reduces the rejected frequency by more than 40 db. Both portable and rack mounting models are available.

Allison Labs., Inc., Dept. ED, 14185 Skyline Drive, La Puente, Calif.

CIRCLE 251 ON READER-SERVICE CARD

## Digital Calendar

Automatically corrects for leap year

Producing a parallel, decimal representation of the date in months and days, the model 2800 digital calendar is suitable for use in data loggers, computers, data handling systems, and other digital systems. When it is used with the company's digital clock, a digital reading of the date and time is obtained with a resolution to the nearest minute, tenth of a minute, or second. Externally wired common leads for each digit position permit actuation of either parallel or serial devices. For mounting in a standard relay rack, the unit requires 3-1/2 in. of panel height.

Chrono-log Corp., Dept. ED, Box 4587, Philadelphia 31, Pa.

CIRCLE 252 ON READER-SERVICE CARD

## Subcarrier Oscillator

For remote operation



Model RCO-2 reactance controlled sub-carrier oscillator is designed for use with Ultradyne single coil pressure and acceleration transducers where it is desirable that the transducer and the oscillator be separated. The unit is furnished for operation at any of a large number of IRIG bands, as well as at subcarrier frequencies much higher than the highest present IRIG band. When the unit is used with S-60-TG and S-90-TG pressure transducers, or A-60-TG and A-90-TG accelerometers, non-linearity does not exceed  $\pm$ 10%.

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

CIRCLE 253 ON READER-SERVICE CARD

## ALLIED'S NEW ADDITIONS TO THE KH SUBMINIATURE LINE

### Types KHJ and KHY GENERAL FEATURES:

#### Contact Data:

Contact Arrangement—DPDT

Contact Rating—

Low-level up to 2 amps at 29 volts d-c,

1 amp at 115 volts a-c 400 cps

non-inductive or 0.5 amp inductive.

Life—100,000 minimum at 125°C

Also available 3 amps at 29 volts d-c

2 amps at 115 volts a-c 400 cps

non-inductive or 1 amp inductive.

Life—100,000 at 3 amps or 500,000

minimum at 2 amps at 125°C.

#### Initial Contact

Resistance—0.05 ohms maximum

Contact Drop—1 millivolt maximum

at low level rating, initial and during

low level miss test.

#### Operate Data:

D-C Coil Resistance—up to 10,000 ohms

Nominal Power—1.2 watts

Pull-in Power—240 milliwatts (standard)

100 milliwatts (special)

Operate Time—5 milliseconds max.

Release Time—3 milliseconds max.

#### Dielectric Strength:

1000 volts rms at sea level

500 volts rms at 70,000 feet

350 volts rms at 80,000 feet

#### Insulation Resistance:

10,000 megohms minimum at 125°C

### ENVIRONMENTAL FEATURES

#### Vibration:

5 to 10 cps at 0.5 inch double amplitude

10 to 55 cps at 0.25 inch double amplitude

55 to 2000 cps at 20 g

Shock: 100 g's operational • 200 g's mechanical

Ambient Temperature: -65°C to +125°C

### MECHANICAL FEATURES

Weight: 0.5 ounce

Terminals:

Hooked Solder • Plug-in • Printed Circuit

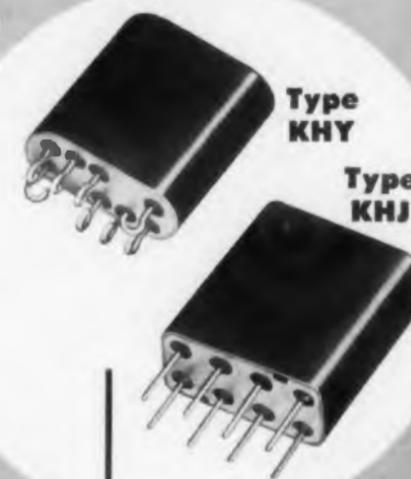
Mountings:

2 or 4 hole brackets at base or center of gravity

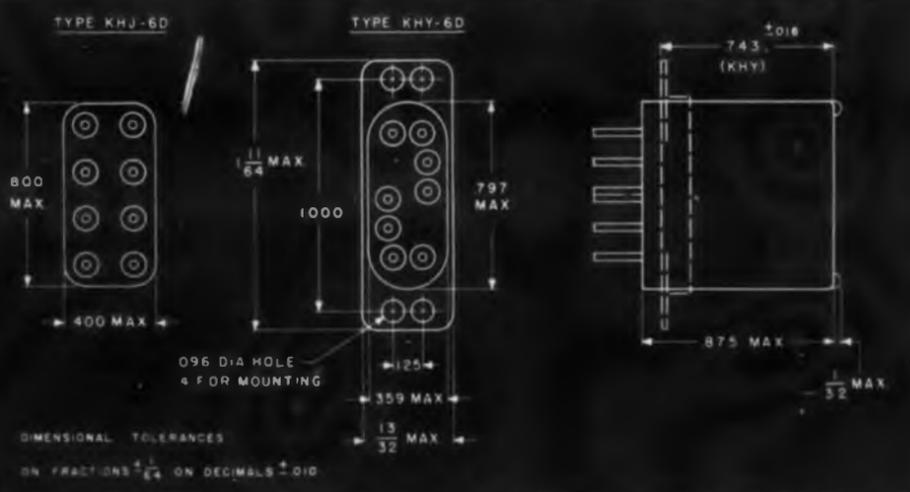
1 or 2 studs on top or side of housing

### MILITARY SPECIFICATIONS

MIL-R-25018 • MIL-R-5757C



Allied's type KHJ and KHY subminiature relays have a higher contact rating than Allied's original subminiature relay and are designed to meet the increased vibration and shock requirements of the latest MIL specs. In addition, the type KHJ relay has incremental grid spaced terminals for application to "Automation" assembly. Both relays are available with brackets for mounting interchangeable with that of Allied's type KH subminiature relay.



**ALLIED CONTROL**  
ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

CIRCLE 254 ON READER-SERVICE CARD

# COUCH

CVE TYPE  
RUGGED  
ROTARY  
RELAYS

Built to  
reach  
outer space . . .

*. . . and work all the way!*

Couch Rugged Rotary Relays were used in the Atlas 10B satellite launched from Cape Canaveral on December 18, 1958.

Couch relays were selected by Convair Astronautics because of their proven ability to perform in the most severe environments. Modern quality control techniques coupled with a simple rugged design provide the reliability needed for missiles.

Couch relays are available in wide variety . . . for switching dry circuits as well as circuits up to 10 amperes . . . for operation with voltages from 6 to 250 VDC . . . all under vibration up to 20 G's with no contact opening.

*May we have the opportunity of discussing your relay requirements?*



**ORDNANCE INC.**

A subsidiary of S. H. Couch, Inc.

3 Arlington Street North Quincy, Mass.

CIRCLE 255 ON READER-SERVICE CARD

## NEW PRODUCTS

**PROGRAMMERS.**—Models LVPR6, LVPR6S, and LVPR13 accommodate punched 35 mm Mylar tape and have interchangeable 6 and 13 channel heads. Tape speed is variable.

Beattie-Coleman, Inc., Dept. ED, 1000 N. Olive St., Anaheim, Calif.

CIRCLE 256 ON READER-SERVICE CARD

**ELASTOMERIC MOUNTINGS.**—For small airborne electronic units, models HTO-1 and HTO-2 weigh 1 oz and have load capacities of 1 and 2 lb, respectively. They operate from -65 to +300 F and provide isolation of frequencies to 2000 cps and high internal damping.

Lord Mfg. Co., Dept. ED, Erie, Pa.

CIRCLE 257 ON READER-SERVICE CARD

**PRECISION CRYSTAL OVEN.**—This unit features low power consumption, constant lead capacity, long term stability, and cavity temperature variation of less than 0.01 C average per degree ambient temperature change.

Robertshaw-Fulton Controls Co., Aeronautical and Instrument Div., Dept. ED, Santa Ana Freeway at Euclid Ave., Anaheim, Calif.

CIRCLE 258 ON READER-SERVICE CARD

**TUBES AND COIL FORMS.**—Low cost, spirally wound Pyrotherm tubing remains physically stable and retains its insulation value at 1100 F. Round, square, or rectangular, it can be supplied in lengths from 1/16 to 48 in., OD's from 1/8 to 6 in., and wall thicknesses from 0.004 to 0.06 in.

Resinite Corp., Div. of Precision Paper Tube Co., Dept. ED, 2035 W. Charleston St., Chicago 44, Ill.

CIRCLE 259 ON READER-SERVICE CARD

**RADAR TEST SET.**—Facilities of this 200 mc set include provision for day to day pulse envelope comparison, spectrum analysis, crystal and variable markers, and delayed pulse or cw output. With this set and the company's 1000 w rf absorption power meter, a radar may be completely checked out without radiating any signal.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N.J.

CIRCLE 260 ON READER-SERVICE CARD

**PRECISION OVEN.**—The ET-M is 1-7/16 x 1-7/8 x 2-1/2 in., houses one MC6, and has  $\pm 0.2$  C stability. It has low inductance windings, an octal base, and a heater voltage of 115 v ac. Other voltages are available. Temperature range is -55 C to 5 C below the specified operating temperature, and warmup time is 7 min.

Monitor Products Co., Dept. ED, 815 Fremont Ave. S., South Pasadena, Calif.

CIRCLE 261 ON READER-SERVICE CARD

## Now! Measure Transistor Parameters Directly



Model 700

## with any GREIBACH PRECISION METER

PORTABLE—BENCH—PANEL MODELS

Greibach Precision Meters, with patented frictionless BIFILAR SUSPENSION and weightless LIGHT-BEAM POINTER, offer the highest meter standards available. Direct measurement—no amplification required.

- Frictionless movement
- Lowest energy use—to  $8 \times 10^{-10}$ W
- Over 100,000% overloads
- Very lowest resistance current meters
- To 0.2 microamp full-scale
- To 23 ranges per meter
- No parallax errors
- Permanently calibrated

Rigorous tests have proved the intrinsic hardness of Greibach Precision Meters. Part of this testing cycle included subjecting meters to a series of transistor punch-through tests—without benefit of any protective circuits.

Greibach produces a wide range of the world's finest meters. For full data on the complete line of microammeters, millivoltmeters, ammeters, voltmeters, multimeters, megohmmeters, plus special custom-order meters, write for your copy of the new Greibach Precision Meter Catalog.

**GREIBACH INSTRUMENTS CORP.**  
315 North Ave., New Rochelle, N.Y., NE 3-7900

CIRCLE 262 ON READER-SERVICE CARD

# STATIC SWITCH

...up to 150 amps  
in 3 micro-seconds  
"with no bounce!"



SILICON semi-conductor devices suitable to circuits up to 400 V that will handle current surges up to 150 amps in continuous 16 amp currents.

- no moving parts
- virtually indestructible
  - ✓ will stand extremely high shock and vibration
  - ✓ surpasses most missile requirements
- operates up to 125C°
- isolated signal and load current
- extremely low signal energy and rapid switching time of 3 micro-seconds with no holding-power required
- weighs only 3½ oz.

## IMMEDIATE DELIVERY "OFF THE SHELF"

other solid state devices, DC-DC converters, DC-AC sine wave inverters, frequency sensors, voltage sensors, time delays and programmers, etc.

for complete information, write:

**JORDAN ELECTRONICS**

A Division of THE VICTOREEN INSTRUMENT COMPANY  
3025 W. Mission Rd., Alhambra, Calif.

CIRCLE 263 ON READER-SERVICE CARD

**DIODES.**—Developed for television use, Ninel-R Dual Diodes are suited for such applications as voltage regulators, balance modulators, and logarithmic converters.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 264 ON READER-SERVICE CARD

**MICROWAVE SIGNAL SOURCES.**—These self-contained sources cover 1050 to 11,500 mc. They have an integral power supply and interchangeable plug-in tuning units.

Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.

CIRCLE 265 ON READER-SERVICE CARD

**SILICON RECTIFIER.**—Rated at 1600 v peak inverse and 500 ma dc, type S-5207 will replace up to five type 6X4 tubes in parallel. Pin connections are identical so that the units are interchangeable.

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

CIRCLE 266 ON READER-SERVICE CARD

**MINIATURE SELENIUM DIODES.**—Applications of Minifer diodes include automatic frequency control, automatic gain control, bias supplies, clamping, clipping, detectors, gating, logic circuitry, phase comparators, and sensitive dc relays.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 267 ON READER-SERVICE CARD

**DUAL WATER LOADS.**—When used with the company's model 290A calorimeter, series 287 loads provide balanced measurements. They are offered in SL, S, and X bands and, with the 290A, comprise a complete power measuring system. To improve accuracy, the thermopile is a part of the load.

Sierra Electronic Corp., Dept. ED, 3885 Bohannon Dr., Menlo Park, Calif.

CIRCLE 268 ON READER-SERVICE CARD

**CAPACITOR LEAD CAPS.**—These preformed caps press fit over tubular capacitor shells and flexible lead wire sleeving, completely protecting lead wire joints from breakdown. They come in a variety of materials including glass silicone, epoxy, polyester, melamine, and phenolic.

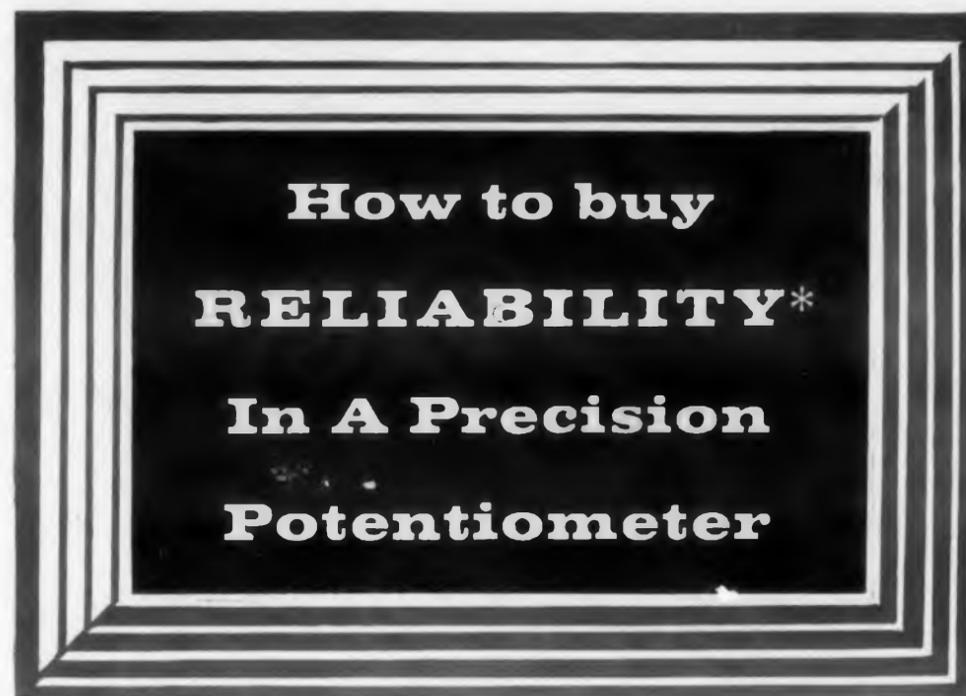
Stevens Products Inc., Dept. ED, 86-88 Main St. East Orange, N.J.

CIRCLE 269 ON READER-SERVICE CARD

**RFI SHIELDING ASSEMBLY.**—Compact and easy to install, this assembly consists of Technit knitted wire strip joined to a Teckstrip solid aluminum extrusion. Technit is available in any length up to 30 ft; and Teckstrip is supplied predrilled or punched, or as gaskets preassembled to specification.

Technical Wire Products, Inc., Dept. ED, 48 Brown Ave., Springfield, N.J.

CIRCLE 270 ON READER-SERVICE CARD



## Answer: SPECIFY ALL THESE RELIABILITY FEATURES

1. Welded terminal and taps. A positive electrical and mechanical bond to withstand high temperatures, shock and vibration.
2. Machined metal case for retention of accuracy, especially under high temperature and/or humidity.
3. Metal inserts in molded wiper hubs for positive wiper positioning, for accuracy under shock, vibration, acceleration.
4. Precious metal resistance wires where needed for extremely low noise values, especially in corrosive atmospheres and for long storage life.
5. Precious metal contacts for low noise and high temperature.
6. One piece wiper construction for life, accuracy, low noise and low torque.
7. Stainless steel clamp bands capable of withstanding high torque, and the stresses and strains of shock, vibration and acceleration.
8. Precision stainless steel ball bearings — for low torque, high temperature, high vibration and shock characteristics.

PLUS 100% inspection AND a separate Quality Control program which puts 1 out of every 100 production units through complete environmental torture tests.

Since the ultimate price of a potentiometer is directly related to the reliability built into it . . . you only get what you pay for in a "pot".

Only Fairchild Linear and Non-Linear High Reliability Pots incorporate *all* of the above features. This High Reliability group can be had in 7/8" to 2" diameters, single and multi-turn, in standard and high temp versions and with accuracies as high as .009%.

For more information write Dept. 11ED.

\*Fairchild's Built-in SAFETY FACTORS Beyond the Specs for Reliability in Performance.



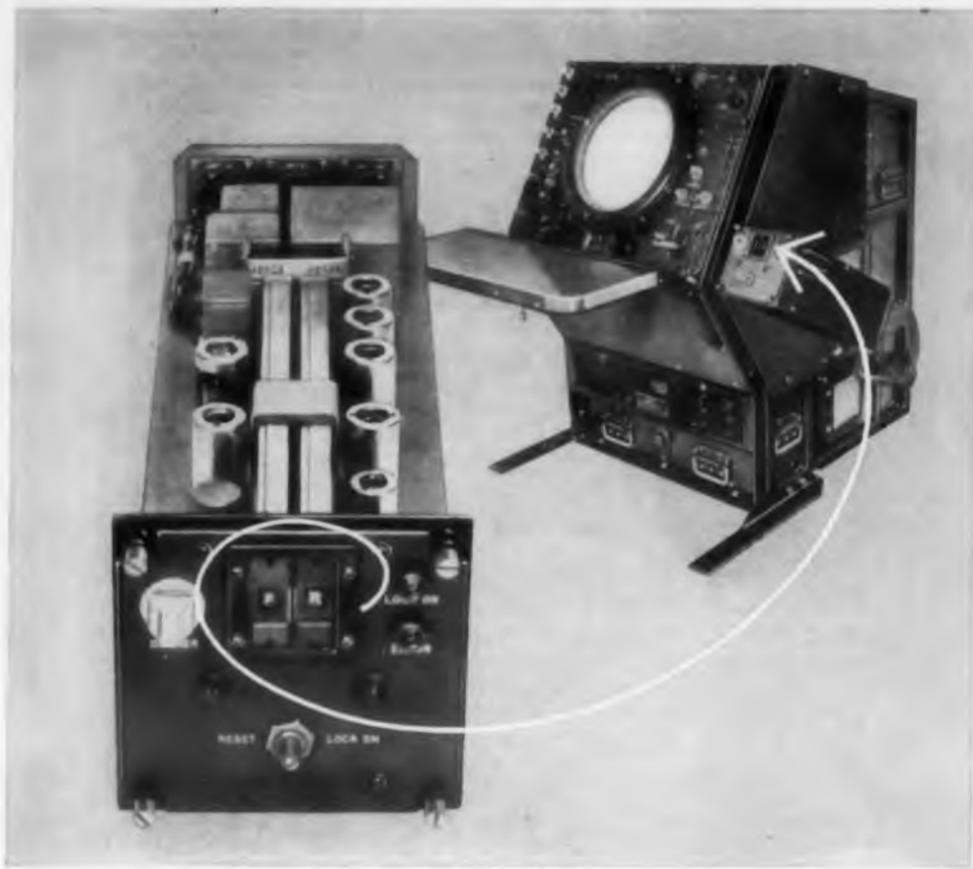
**FAIRCHILD**  
CONTROLS CORPORATION

COMPONENTS DIVISION

225 Park Avenue Hicksville L I N Y. 6111 E Washington Blvd. Los Angeles, Cal

A Subsidiary of Fairchild Camera and Instrument Corporation  
Potentiometers • Gyros • Pressure Transducers • Accelerometers

CIRCLE 271 ON READER-SERVICE CARD



## Union Indicators help Hazeltine radar-display unit identify aircraft

The little box on the right side of the radar-display unit above warns of approaching aircraft. IFF response is displayed by Alpha-Numerical Indicators, made by Union Switch & Signal. Hazeltine Corporation, Little Neck, N. Y., builders of this unit, chose Union Indicators for their supreme reliability, compact design, and for the other features below:

Two types of Data Display Indicators are made by Union Switch & Signal: Digital, displaying 10, 12, or 16 characters, and Alpha-Numerical, displaying up to 64.

*Infinite Retentivity*—Both indicators require power only during response time and retain data visually and electrically until a new code is transmitted.

*Electrical and Visual Read-Out*—Electrical read-out of data is provided in the same form as the input. Data can be read out on a continuous basis without erasing the stored information. Visibility of digital read-out is excellent, even when indicators are mounted in rows. Both indicators operate directly on binary codes on a null-seeking basis, eliminating need for external translation equipment.

Write today for complete information on indicators and other electronic equipment manufactured by Union Switch & Signal.

*"Pioneers in Push-Button Science"*



**UNION SWITCH & SIGNAL**

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

CIRCLE 272 ON READER-SERVICE CARD

## NEW PRODUCTS

**STRIP CHART MARKER.**—Miniature model RI-1-A Identichart is a single digit, ten position marker that prints close to the left hand chart edge on any type strip chart recorder. The single print wheel prints 0 through 9, automatically advancing each time the solenoid is energized and returning to 0 after printing 9.

Royson Engineering Co., Dept. ED, Hatboro, Pa.  
CIRCLE 273 ON READER-SERVICE CARD

**CALORIMETER.**—Model 290A includes liquid flow controls, calibration sources, and metering circuits. Liquid-cooled loads are available in a number of waveguide sizes as well as coaxial. The unit is self-calibrating and permits accuracies up to 1%.

Sierra Electronic Corp., Dept. ED, 3885 Bohannon Dr., Menlo Park, Calif.

CIRCLE 274 ON READER-SERVICE CARD

**PRINTED RESISTOR.**—For weight reduction or where complex shaped resistors can be applied to flat surfaces, this unit can be supplied in most resistance ranges and tolerances, on various substrates, and with many terminal arrangements.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 275 ON READER-SERVICE CARD

**CIRCUMAURAL EARPHONES.**—Each phone has a special liquid filled cushion which provides correct acoustic coupling to the ear and eliminates outside sound from interfering with the reproduced sound. Frequency response is 20 cps to 15 kc; external noise attenuation, 40 db at 1 kc and above.

Sharpe Instruments Ltd., Dept. ED, 965 Maryvale Dr., Cheektowega, N.Y.

CIRCLE 276 ON READER-SERVICE CARD

**HOOKUP WIRE.**—Stranded Plasticote Thrif-T-Bond has overcoated, bonded tinned conductors and is designed for fine wire terminations on miniaturized equipment requiring multi-stranded wire with a single conductor hookup. Rated for use at 80, 90, and 105 C.

Chester Cable Corp., Dept. ED, Chester, N.Y.

CIRCLE 277 ON READER-SERVICE CARD

**MICROWAVE MATERIAL.**—Available in a variety of shapes and sizes, Ferroxcube 5 is for use in rotation, resonance, and field displacement isolators and other unidirectional devices operating in the S, X, K, Q, or V bands.

Ferroxcube Corporation of America, Dept. ED, Saugerties, N.Y.

CIRCLE 278 ON READER-SERVICE CARD

### TUBE PROBLEM:

The Armed Forces needed a new version of the 6J4 reliable tube type which would provide a tube life of almost 1000 hours. Existing tubes of this type had an average life of only 250 hours. In addition, this new tube had to be produced under ultra-high quality control standards.

### SONOTONE SOLVES IT:

By making improvements in the cathode alloy and setting up extremely tight controls in precision manufacture and checking, Sonotone engineers produced a 6J4WA with a *minimum* life of 1000 hours... most running *much longer*.

### RESULTS:

The Sonotone 6J4WA is one of three reliable tubes now being manufactured under U. S. Army Signal Corps RIQAP (Reduced Inspection Quality Assurance Program), monitored by the U. S. Army Signal Supply Agency. And the same rigid quality standards apply to Sonotone's entertainment type tubes as well.

Let Sonotone help solve *your* tube problems, too.

**Sonotone**

Electronic Applications Division, Dept. TGG-49

ELMSFORD, NEW YORK

Leading makers of fine ceramic cartridges, speakers, microphones, tape heads, electron tubes.

In Canada, contact Atlas Radio Corp., Ltd., Toronto

CIRCLE 279 ON READER-SERVICE CARD

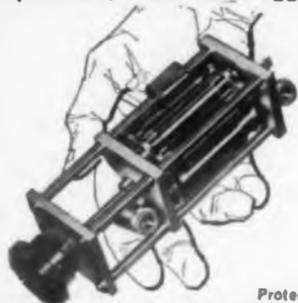
ELECTRONIC DESIGN • April 15, 1959

## STODDART

### COAXIAL ATTENUATORS AND TERMINATIONS

made with exclusive Stoddart Filmistors for highly accurate and stable resistive values from dc to 3000 mc.

2, 6 and 10-position  
**TURRET ATTENUATORS**  
with simple "PULL-TURN-PUSH"  
operation, small and rugged.



Protected under  
Stoddart Patents

### ATTENUATOR PADS



Available in any conceivable combination of male and female Type C and Type N connectors. Maximum length of 3" for any attenuation value.

**GENERAL SPECIFICATIONS**  
VSWR: Less than 1.2 to 3000 mc.  
Characteristic Impedance: 50 ohms.  
Attenuation Value: Any value from 0 db to 60 db including fractional values.  
Accuracy:  $\pm 0.5$  db; values above 50 db have rated accuracy of attenuation through 1000 mc only.  
Power Rating: 1.0 watt sine wave.

### COAXIAL TERMINATIONS



Small-stable-50 or 70 ohms

½-Watt: 50 ohms impedance, TNC or BNC connectors, dc to 1000 mc, VSWR less than 1.2.

1-Watt: 50 ohms impedance, dc to 3000 mc or dc to 7000 mc, Type N or Type C connectors, male or female; VSWR less than 1.2, 70 ohm, Type N, male or female terminations available.

Fast delivery on all items.  
Send for complete literature.

**STODDART**  
AIRCRAFT RADIO CO., INC.  
6644 Santa Monica Blvd., Hollywood 38, Calif.  
Hollywood 4-9292

CIRCLE 280 ON READER-SERVICE CARD  
ELECTRONIC DESIGN • April 15, 1959

**PHOTOVOLTAIC CELLS.**—With response time of a few microseconds, these cells can be used for powering unattended and remote electronic equipment; for the detection and measurement of light and infrared radiation; and in such devices as photometers, temperature controls, photoelectric eyes, and punched paper tape readers. Available in single and multiple units and a variety of shapes and sizes.

Ferranti Electric Inc., Dept. ED, 95 Madison Ave., Hempstead, N.Y.

CIRCLE 281 ON READER-SERVICE CARD

**TRANSDUCER.**—Type 4417 is made especially for the remote indication of sea water depth. It can also be used in fresh water.

Colvin Labs., Inc., Dept. ED, 360 Glenwood Ave., East Orange, N.J.

CIRCLE 282 ON READER-SERVICE CARD

**PLUNGER SWITCH.**—Appliance switch model 6PL41 has a plunger mechanism that provides a minimum of 0.2 in. overtravel without curtailing switch life. Median mechanical life is 2 million operations at full overtravel. The spdt unit may be normally open or normally closed and is rated for 15 amp, 125 or 250 v ac.

Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Dept. ED, Freeport, Ill.

CIRCLE 283 ON READER-SERVICE CARD

**WIRE WRAPPING TOOL.**—For making solderless wrapped wire connections, the Rapid-Wrapit is hand operated, automatic, and self-actuated. No electrical or hydraulic power hookups are needed to operate it.

Kelsey-Hayes Co., Utica Drop Forge & Tool Div., Dept. ED, Utica 4, N.Y.

CIRCLE 284 ON READER-SERVICE CARD

**WIREWOUND RESISTORS.**—These power units are coated with the company's Resisteg and will not crack, craze, or chip from aging, thermal shock, or internal stress.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 285 ON READER-SERVICE CARD

**INDUSTRIAL POWER SOURCES.**—Operating from 60 cps ac power lines, these units provide power for dc motors, relays, solenoids, magnetic chucks, brakes, and separators. Standard models start at 125 w load capacity and deliver 115 or 230 v dc.

Gates Electronic Co., Dept. ED, 2090 Barnes Ave., Bronx 62, N.Y.

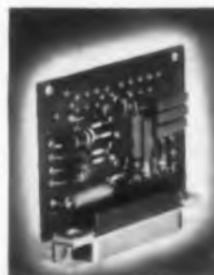
CIRCLE 286 ON READER-SERVICE CARD

Now! A higher reliability factor in printed circuits



# ALTORI

a new and distinctively different  
finish on TAYLOR copper-clad  
laminates that accepts all  
acid resists uniformly



Something new and distinctively different has been added to TAYLOR copper-clad laminates — a finish that accepts all types of acid resists uniformly. High fidelity in printed circuit reproduction is assured. Circuits can be of consistently higher quality and reliability, no matter how critical the design. For complete details about TAYLOR copper-clad laminates and samples, write TAYLOR FIBRE CO., Norristown 48, Pa.

# Taylor

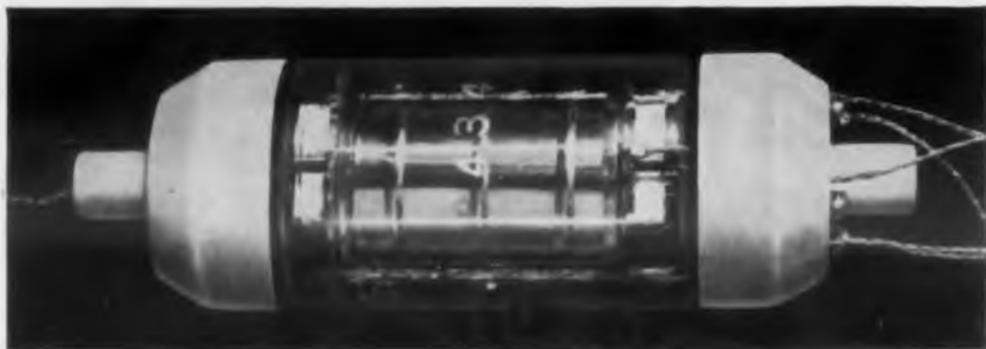
LAMINATED PLASTICS VULCANIZED FIBRE

CIRCLE 287 ON READER-SERVICE CARD

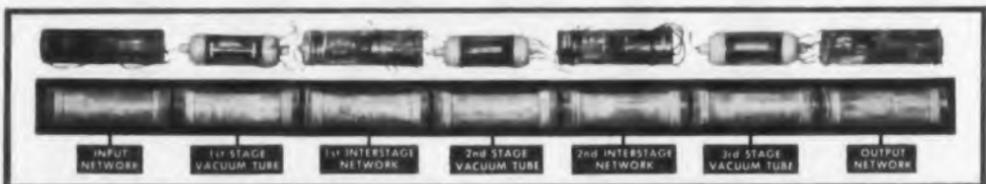
# Nickelonic News

DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS

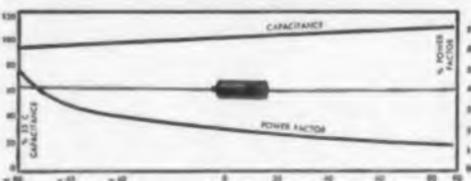
## Underseas two years: Atlantic phone cable amplifier tubes retain full emission, promise 20 years continuous service



175HQ amplifier tube used in underseas phone cable repeaters. There are 306 tubes in the Atlantic cable. All rely on parts made of Nickel.



Nickel parts are essential in the 175HQ tubes, shown in this portion of phone cable repeater unit. Tubes designed and built at Bell Telephone Laboratories, Inc.



New G-E Solid Tantalum Capacitors. Electronic grade "A" Nickel lead wires help make it rugged.

### Small, rugged electrolytic capacitor... Nickel leads boost its strength

HUDSON FALLS, N. Y.: The new Solid Tantalum® capacitor is designed for low voltage circuits — its capacitance changes not more than 20% from +85°C down to -80°C. General Electric designers gave it unusual resistance to mechanical shock with Electronic grade "A" Nickel lead wires. They chose Nickel for three good reasons: (1) welds easily — high thermal coefficient of electrical resistivity aids

quick, strong spot welding. (2) solders easily — speeds hermetic sealing, and assembly into circuits. (3) meets stringent mechanical specifications — leads (0.0201" diameter) withstand 30 second pull test of 3 pounds, four 90° alternate bends.

**Pertinent literature:** Write for "Inco Technical Bulletin 533

©General Electric Co.

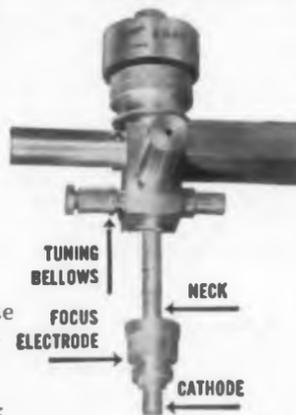
### Non-magnetic Monel "403" alloy aids precise tuning by klystron bellows

SAN BRUNO, CAL.: The low permeability of Monel "403" non-magnetic nickel-copper alloy (1.1 max. at 27°F) in the tuning bellows of this new Eimac X-639 Klystron permits precise frequency adjustment without disturbing the tube's magnetic circuit. And... the good forming and brazing characteristics of Monel "403" alloy make for easy bellows manufacture.

Inco Nickel for the cathode assures stable emission characteristics. Electronic grade "A" Nickel for the focus electrode is readily formed, does not contaminate vacuum. Monel nickel-copper alloy for the neck provides strength at elevated temperatures... withstands oxidation and corrosion.

**Pertinent literature:** Write for Inco Technical Bulletin 535

Nickel and Monel alloys aid manufacture, operation of this Eimac X-639 Klystron by Eitel-McCullough, Inc. Delivers 50 watts in 7100-8500 mc range.



THE INTERNATIONAL NICKEL COMPANY, INC. • 67 Wall Street • New York 5, N. Y.

CIRCLE NOS. 533, 534 OR 535 ON READER-SERVICE CARD



## NEW LITERATURE

### Digital Voltmeter

288

Bulletin 3018 describes the Model 81 digital voltmeter, an all solid-state device using a unique comparison technique for operation. The literature contains detailed information on the operation, circuitry, and specifications of the voltmeter, as well as a list of applications and accessories available. Copies from: R. A. St. Onge, Advertising and Sales Promotion Manager, Beckman Systems Div., Dept. ED, 325 N. Muller Ave., Anaheim, Calif.

### Phase Meter

289

A data sheet on the direct reading phase angle meter and monitor of this company is described. Closely detailed specifications as to accuracy, input impedance, input wave forms and amplitudes accepted, and recorder output are provided. The meter reads 0 to 360 deg with an accuracy ( $\pm$ ) 1 deg through a frequency range of 20 to 20,000 cps. Control Electronics Co., Inc., 10 Stepar Place, Huntington Station, N.Y.

### Silicon Carbide

290

A comprehensive bibliography on silicon carbide is a 108-page listing of scientific literature on the subject. Authors are listed alphabetically and subject keys are listed in the forefront and in the margins by each author listing. Available only in limited quantity from: Advertising Distribution Section, The Carborundum Co., Niagara Falls, N.Y.

### Color Coding

This company will dye plastic parts without affecting their tolerances. Color coding will comply with RETMA standards as specified in GEN 101 A. Valuable in circuit coding, matching housings, and for special effects, this service applies to coloring of nylon, acetate, polyesters and other plastics. Color and quantity choice unlimited. Send samples and request for quotations to Colorite Industrial Dyers, Dept. ED, 244 W. 38 St., New York 18, N.Y.

### Telemetry Data System

291

A 4-page, illustrated brochure describes the new Mark I basic short delivery automatic PDM-to-digital computer format telemetry data system. The entire computer format process is completely automatic and features unparalleled absolute accuracies in excess of 0.1%. Write: John LaFontaine, Advertising Manager, Epso, Incorporated, 588 Commonwealth Avenue, Boston, Mass.

## Technical Writing Study

292

"Technical Writing by Engineers" is an 8-page study which reviews the extent of engineer-authored articles and the policies and opinions of engineering management toward the present situation. Based on a recent survey among engineering executives in 170 companies, the report demonstrates how technical writing by engineers can be encouraged by administrators and includes eight steps for building and maintaining a technical information program. Harry W. Smith Inc., 41 E. 42nd St., New York 17, N.Y.

## Platinum Metals

"Platinum Metals Review" is a 40-page quarterly publication devoted to research of the platinum metals and their applications in industry. Contents of each issue include six or more comprehensive articles on platinum technology, abstracts of current American and European literature on the platinum metals, and a section comprising abstracts of new patents pertinent to the field. *Copy may be obtained by writing on company letterhead stationary directly to: J. Bishop & Co., Platinum Works, Dept. ED, Malvern, Pa.*

## Industrial TV Cameras

293

A 4-page illustrated bulletin describes company's line of industrial television cameras and gives complete specifications for two cameras in the line. The Kin Tel Model 1986C is the standard unit used in most closed-circuit applications. The Model 1986CN is the standard unit used in most closed-circuit applications. The Model 1986CN is specified when extreme noise levels are a hazard. The camera can operate in a 145 db noise environment without danger of microphonics affecting the picture. The bulletin also describes Kin Tel camera accessories, such as remote-control pan-tilt and iris-focus units, an autozoom lens, and acoustical and weatherproof camera housings. Data Sheet 6-100 from Kin Tel Division, Cohu Electronics, Box 623, San Diego, Calif.

## Carbon-Graphite

294

An 8-page brochure is available to designers, engineers, purchasing and management personnel interested in the mechanical, thermal and chemical applications of carbon-graphite, manufactured and machined by Ohio Carbon under the name of Karak. The brochure serves as an idea book for carbon-graphite applications and presents an outline of where, when and how carbon-graphite can be used to advantage. The Ohio Carbon Co., 12508 Berea Road, Dept. 102, Cleveland 11, Ohio.

# FOR REALLY BIG POWER JOBS



## Honeywell Power Transistors

Here's a full line of High Power Honeywell Transistors designed for applications requiring low thermal resistance, low saturation voltage and high current handling capabilities.

- **Highest current carrying capacity**—capable of carrying collector currents up to 30 amperes.
- **Lowest thermal resistance**— $0.7^{\circ}\text{C}/\text{watt}$  maximum,  $0.35^{\circ}\text{C}/\text{watt}$  typical.

These characteristics of the new Honeywell High Power Transistors make them particularly suitable for high ambient temperature applications.

For example, with a mounting base temperature of  $85^{\circ}\text{C}$ , this transistor is capable of dissipating 14 watts without exceeding the  $95^{\circ}\text{C}$  junction temperature limit. Assuming a circuit with a 75% efficiency, 42 watts of useful output power would be attainable.

The low saturation voltage makes these high power transistors ideal high current switches. With a current of 15 amps passing through the device, a typical loss across it will be only 0.3 of a volt.

For information on these or other Honeywell Transistors contact one of Honeywell's 112 sales offices in all major cities. Or, if you wish to discuss transistor applications with a Honeywell transistor specialist, contact one of the five offices at right.

### Now available with both 60- and 80-volt ratings.

	Collector-to-base Voltage Rating	Typical Current Gain at $I_c = 10$ amps
2N574	60	14
2N574A	80	14
2N575	60	25
2N575A	80	25
2N1157	60	48
2N1157A	80	48

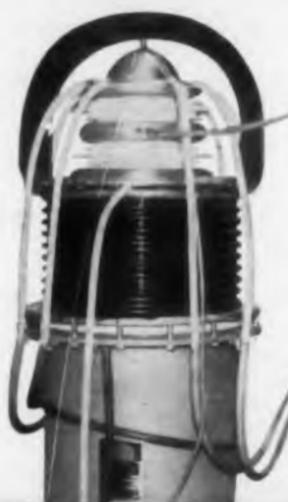
- UNION, N. J., MURdock 8-9000, P. O. Box 161
- BOSTON, ALgonquin 4-8730, 1230 Soldiers Field Rd.
- MINNEAPOLIS, FEderal 2-5225, 2749 4th Ave., So.
- CHICAGO, IRving 8-9266, 7350 N. Lincoln Ave.
- LOS ANGELES, RAmond 3-6611 or  
Parkview 8-7311, 6620 Telegraph Rd.

## Honeywell

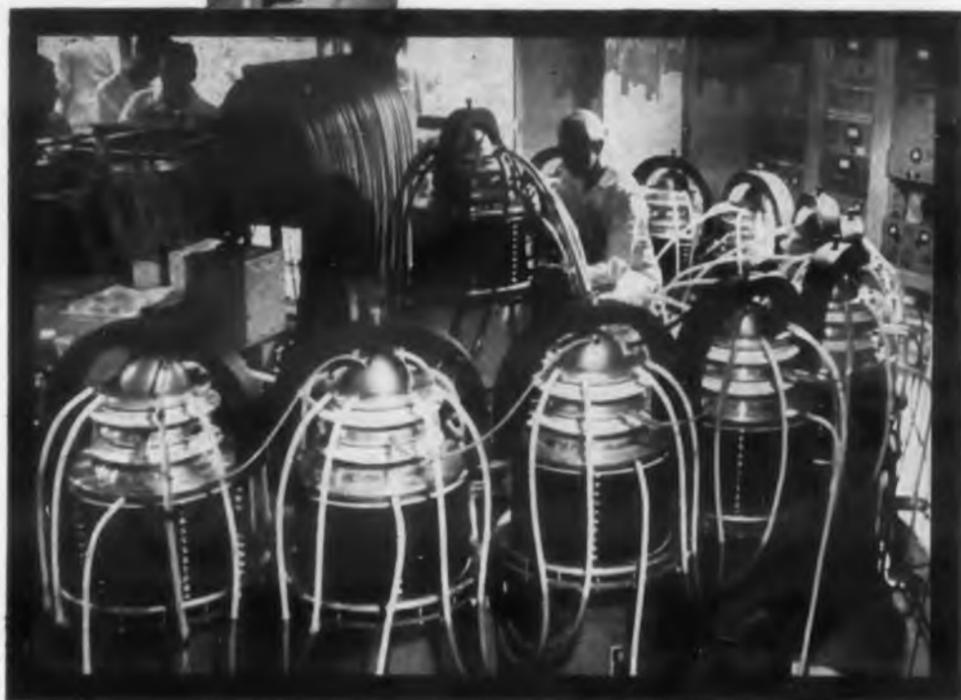
 First in Control

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## LOOK TO TOBE FOR PROGRESS



600,000  
amperes  
help harness  
H-power



At the recent Geneva Atoms-For-Peace Conference, Los Alamos scientists unveiled *Scylla*—a fusion device used to heat a plasma of ionized heavy hydrogen particles millions of degrees by blasting it with a 600,000-ampere thunderbolt.

Surrounding the heart of this thermonuclear machine is a bank of Tobe low-inductance, energy-storage capacitors...each rated at 100,000 volts each capable of a 20,000 megawatt peak surge.

Why *Tobe* capacitors? Because only Tobe, with over 30 years of capacitor manufacturing experience, could meet the rigid design specifications set for the project. Tobe can meet yours too. So, whether you need a bank of thermonuclear energy-storage capacitors or a miniaturized tubular, talk to Tobe. Our engineers speak your language.

For further technical information or engineering aid, write Tobe-Deutschmann Corp. Norwood, Mass.

specify

**TOBE**  
PRODUCTS

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## NEW LITERATURE

### Immersion Heaters 299

This 6-page brochure describes various types of immersion heaters available, including steel, stainless steel and translucent fused quartz. Also presented is a graph which shows the electric heating requirements for liquids. N. J. Thermex Co., Inc., 535-537 Bergen St., Harrison, N.J.

### Art Masterpiece 300

"There's Always Room at the Top!" is the title of latest masterpiece added to Helipot's Art Gallery. Cheerily dusting off an outmoded Algerism, the inspirational credo, appropriately illustrated, is printed on handcrafted vellum in treasury note black-and-green. Helipot Division of Beckman Instruments, Inc., Fullerton, Calif.

### Strain Gage Plotters 301

Two-page Bulletin P-101 contains details and specifications on Models 220 and 221 High Speed Strain Gage Plotters. These instruments scan and record up to 20 channels per second and plot up to 96 channels, on individual graphs, while a load test is in actual progress. Gilmore Ind., Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

### Junction Transistors 302

Brochure G-150A describes high frequency germanium alloyed junction transistor types 2N444A through 2N447A and 2N519A through 2N523A. These improved "A" versions provide higher voltage ratings and generally tighter specifications than were previously found in types 2N444-2N447 and 2N519-2N523. General Transistor Corp., 91-27 138 Pl., Jamaica 35, N. Y.

### Printed Panel Circuit Pads 303

Describing a new type of pressure sensitive die cut used on printed panel circuit work, this brochure consists of four pages. It covers the various types of pads that permit master layouts to be made without ink and reduce drafting time. M & C Products Co., 6918 State Road, Philadelphia 35, Pa.

### Wire and Cable 304

Detailed descriptions, specifications, electrical characteristics of BIW products together with charts, graphs and other helpful information are given in a series of 4-page bulletins. Subjects include flexible 1000 F wire and cable, multiconductor MIL-C-3432A cable, small diameter high voltage, high temperature conductors, silicone rubber insulated single and multi-conductor cable, coaxial and other cables. Boston Insulated Wire & Cable Co., 25 Bay Street, Boston 25, Mass.

### Waveguides 305

This four-page bulletin reviews briefly a wide variety of waveguide equipment—size WR 770 and up—for military and commercial applications. Report No. 5 describes and illustrates products ranging from simple sections of straight waveguide through plane-turners and transitions, and such waveguide test equipment as simulated loads, slide-slug tuners and slotted lines. I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.

### Microwave Components 306

Specially designed waveguide and coaxial components for advanced systems use are featured in this components catalog entitled "A Complete Source of Microwave Instruments, Special Components and Standard Components." Included in the catalog are approximately 100 standard waveguide and coaxial components and test instruments. High power and low power microwave absorbing material is also covered. Radar Design Corp., Pickard Drive, Syracuse 11, N. Y.

### Antennas and Accessories 307

This catalog contains data sheets on parabolic antennas and accessories, passive reflectors, commercial communication antennas, other unclassified military antennas, and waveguide and transmission lines. The catalog also includes data on communication antennas. Ward Products Corp., Division of the Gabriel Co., Cleveland, Ohio.

### Wires Catalog

308

The 1959 Electronic Wire Catalog No. 859 offers 382 new stock items. This detailed publication has been redesigned to include wires grouped by type and application for easier use. All essential electrical characteristics and construction details are shown for each item with each type of wire clearly illustrated. Typical listings include microphone and shielded power supply cables, TV camera cables, hi-fi stereo, and phonograph cables, intercom and sound cables, transmission line cables, plus a complete conduit capacity table to simplify intercom wire installations. Belden Manufacturing Co., Chicago 80, Ill.

### Shock-Resistant Switches

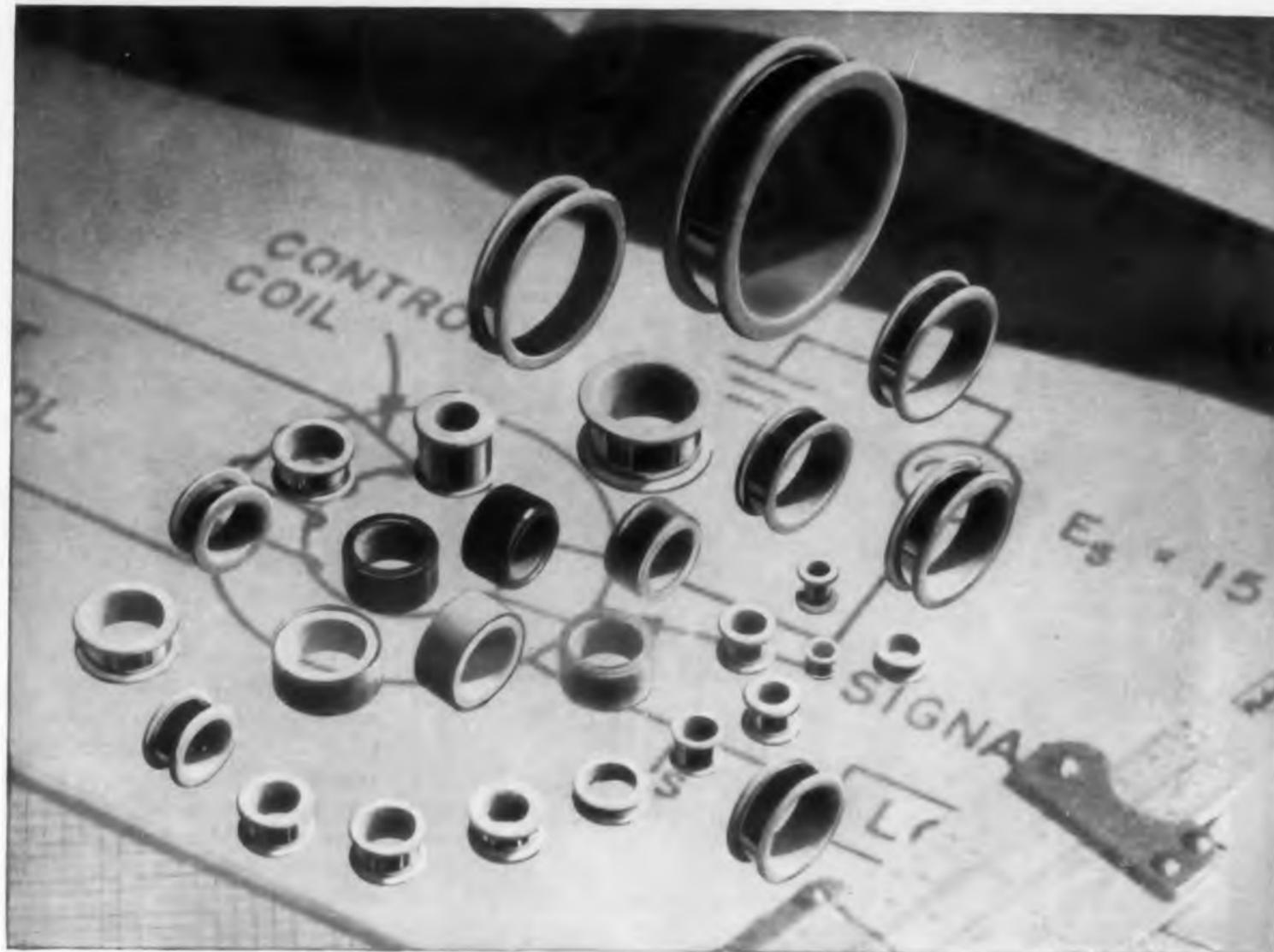
309

This 2-page data sheet describes two new precision sealed limit switches that meet the high-shock requirements of MIL-S-901 B (Navy). Designed for use on gun mounts and missile launching platforms, both switches have an in-line plunger actuator. Switches are electrically rated for: 5 amps, 115 vac at sea level and 100,000 ft, inductive load. Complete electrical rating, photos, dimension drawings, characteristics and application information included. Micro Switch, Freeport, Ill.

### Magnetic Instrumentation

310

A new treatise discussing the fundamentals and chief applications of magnetic instrumentation recording is available from Ampex Corporation. The booklet, entitled "The Tape Recorder as an Instrumentation Device," begins with the introduction of magnetic recording devices in this country some 16 years ago. The author briefly traces the burgeoning need for more precise measurement, and points out how magnetic-tape devices are uniquely suited to meet it. Several of the booklet's 74 pages are a comprehensive discussion of the principles of magnetic recording, the physical elements of instrumentation recorders, and the four major recording processes—direct, frequency modulation, pulse-duration modulation, and digital. It deals at length with the crucial role of magnetic record and reproduce heads, and suggests typical physical and electronic tolerances for the heads. Remaining sections are devoted to the design and function of tape transports and their components, and to selected significant application areas for instrumentation recorders. Profusely illustrated with photographs, line drawings, and circuitry and performance graphs. Copies of the treatise may be had by writing Ampex Corp., Instrumentation Div., 934 Charter St., Redwood City, Calif.



## In Computer Applications, you need PRECISION ...and that's the word for ARNOLD BOBBIN CORES

For use in shift registers, coincident current matrix systems, pulse transformers, static magnetic memory elements, harmonic generators and similar equipment, Arnold Bobbin Cores meet the most exacting requirements.

Quality and uniformity? *You'll find them no problem*—because, as a fully integrated producer with highly modern facilities, we're able to maintain close control over every step.

Arnold Bobbin Cores are available in a wide range of sizes, tape thicknesses, widths and number of wraps. Magnetic materials usually employed are Deltamax and Permalloy, in standard gauges of 1, 1/2, 1/4 and 1/8 mil, in widths from 1/32" through 1/4". Core properties include quite rectangular hysteresis loops, relatively

low coercive values and high saturation densities, plus the ability to shift in a few micro-seconds from negative remanence to positive saturation, and vice versa, under conditions of pulse excitation.

Let Arnold supply your requirements for Bobbin Cores—or other tape-wound cores, powder cores, permanent magnets, etc.—from the most complete line of magnetic materials in the industry. • Just address *The Arnold Engineering Company, Main Office and Plant, Marengo, Ill.*

#### ASK FOR BULLETIN TC-108A

Includes essential data on applications and properties, fabrication and testing of Arnold Bobbin Cores; lists standard sizes, etc.

ADDRESS DEPT. ED-94

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Ultra-thin tape for bobbin cores is rolled to high precision standards for thickness and finish on our own 20-high Sendzimir cold reducing mill, beta-ray controlled.

NEW 1480A



# ARNOLD

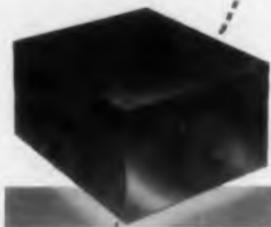
SPECIALISTS in MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES  
Find them FAST in the YELLOW PAGES

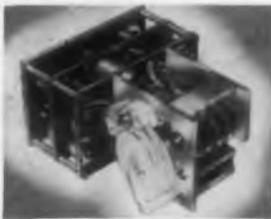
The NEW Series BH100

# MILLI-V-METER

**DIGITAL  
READOUT**



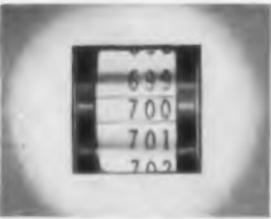
**SMALL SIZE** — This compact, transistorized, servo-driven instrument measures only 3 x 5 x 5/4".



**ALL INCLUSIVE** — With Zener reference, power supply, amplifier, servo motor, 144" tape-slidewire.



**TAPE-SLIDEWIRE** — Mounted on side-by-side spools, slidewire is embedded in edge of tape, punched for sprocket drive.



**PRINTED READOUT** — Calibration printed on tape available to measure steady-state conditions or where input deviates more than 13%.

TRADE MARK



**ACCURACY  
0.1%**

## THE INSTRUMENT with the TAPE-SLIDEWIRE

Highly accurate digital display of

## VOLTAGE · CURRENT FREQUENCY · POWER RESISTANCE · R.P.M.

Every discrete scale unit is a calibrated point.

100 calibrated points per foot of slidewire length.

Slidewire up to 12 feet long.

LINEAR, PARABOLIC, LOGARITHMIC  
FUNCTIONS DISPLAYED IN DIRECT DIG-  
ITAL RELATION... COMPOUND RANGES,  
PLUS & MINUS SCALES FROM ZERO,  
SUPPRESSED RANGES

Full information is available for the asking:

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CO., INC.**

3479 West Vickery Blvd. • Fort Worth 7, Texas

Sales-Engineering Offices: COMPTON, CAL., VALLEY STREAM, L. I., N. Y., DAYTON, OHIO

CIRCLE 312 ON READER-SERVICE CARD

## NEW LITERATURE

### Range, Balance Unit 313

Bulletin BR 111.1, two-pages, and in color, describes in detail a new Range and Balance Unit now available. The new unit, Model BR 111, balances out small inequalities in bridge resistances. Its features include gold contact relays that minimize "dry circuit" problems. Computer Eng. Assoc. Inc., 350 N. Halstead, Pasadena, Calif.

### Aluminum 314

In this brochure are complete specifications for the hundreds of alloys and forms of aluminum. The brochure enables designers to pinpoint specific properties and apply them accurately to the desired end use. Providing a description of the metal's advantages over the other materials, the 18-page brochure includes alloy and temper designations, fatigue and shearing strengths, and various alloys available in foil, sheet and plate, wire, rod and bar, and tubing and pipe. Reynolds Metals Co., Dept. PRD-1, Box 2346, Richmond, Va.

### Servo Components 317

This twelve page booklet was prepared for engineers who use servo components. It covers standard Mil type synchros, resolvers, servo motors, and tachometer generators. Complete explanations of the symbols which identify units are included as well as definitions of all important characteristics of units. Merchandising Ketay Dept., Norden Div., United Aircraft Corp., Commack, N. Y.

### Missile Plug Catalog 318

This 48-page catalog titled "Guided Missile Umbilical Connectors," describes and illustrates a representative cross section of the latest developments in umbilical plugs designed for the specialized demands of missile launching. These plugs serve the function of connecting electrical circuits within the missile to testing and control systems on the ground. Four basic types of release disconnect mechanisms are fully described and illustrated to show the principles that effect the remote release of plug and receptacle. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

From the manufacturer of the widely used and well known FM-3 Frequency Meter and the later FM-6 Frequency Meter comes the newest addition to a growing family of fine instruments. The newest, the FM-7 provides in a small package all of the essentials for the maintenance of mobile communications systems.

## NEW FREQ METER

**MEASURES AND GENERATES: 20 mc to 1000 mc**  
**ACCURACY: 0.0001% exceeding FCC requirements 5 times**  
**MODULATION: AM, 30% at 1000 cps; FM, 1 kc at 30 mc**  
**5 kc at 150 mc, or 15 kc at 450 mc max.**

### MODEL FM-7

As optional equipment the FM-7 may be combined with the new DM-2 Deviation Meter as illustrated. The DM-2 is a new Dual-Range Deviation Meter with 15 kc and 7.5 kc full scales.



GERTSCH PRODUCTS, Inc.

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WRITE OR CONTACT YOUR GERTSCH REPRESENTATIVE FOR FULL DETAILS

**Gertsch**

CIRCLE 315 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

### Magnetic Amplifiers

This six-page bulletin called "Techni-Topics," contains a brief technical discussion of basic magnetic amplifier theory, circuitry and applications. The publication is illustrated by 12 diagrams and graphs. Copies of the publication are available by writing to Magnetic Controls Co., Dept. ED, 6405 Cambridge St., Minneapolis 16, Minn.

### Switches, Actuators 321

Catalog ES-59, 52-pages, contains a comprehensive definition of terminology used in the switch industry, as well as photos, specifications, dimensional drawings, and modification information on the following switches and their actuators: sub-sub-miniature peanut switches; Sub-miniature snap action switches; Single pole, double pole, triple pole, and multi-pole types; and special actuators. There is also basic information on these switches: lighted pushbutton panel; environment-free; hermetically-sealed; die cast enclosed. Electrosnap Corp., Switch Div., 4218 W. Lake St., Chicago 24, Ill.

### Wire, Cable Insulation 322

Properties of Butyl rubber for insulating and jacketing electric wire and cable are presented in this 12-page booklet. It compares the physical, electrical, and chemical properties of Butyl with other elastomers. Thiokol Chemical Corp., 780 North Clinton Ave., Trenton 7, N. J.

### Navigation Module 323

Navigation module, model 2374, for operation of VOR/LOC and marker beacon is described in this two-color brochure. It contains installation drawings, engineering and performance specifications. Lear, Inc., Learcal Div., 3171 South Bundy Drive, Santa Monica, Calif.

### Frequency Meters 324

Specifications and descriptive material are provided on types 532 through 538 direct frequency meters in this one-page data sheet. Polytechnic Research and Development Co., Inc., 202 Tillary St., Brooklyn, 1, N. Y.



HIGH-Q

## KELVIN TOROID INDUCTORS

rapid delivery on prototype and production quantities

High Q factors, excellent stability vs. temperature and current, and self-shielding effects are the main features of Kelvin toroid inductors wound on molybdenum permalloy dust cores.

The coils are supplied to the exact inductance required at no extra charge. Standard inductance tolerance is  $\pm 1\%$ .

Available in three forms:

UNCASED, with protective wax coating.

HERMETICALLY SEALED in steel cases to MIL-T-27A specifications.

ENCAPSULATED in hi-temp plastic to withstand extreme humidity and severe mechanical shock.

Send for bulletin KT-1



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ELECTRIC COMPANY

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CIRCLE 325 ON READER-SERVICE CARD

Kennedy Introduces  
a new  
dual  
polarized feed  
with 2  
waveguide inputs



#### FEATURES:

- 2 inputs for maximum power transmission at both polarizations (10kw. on each).
- More than 30 db. decoupling.
- Same center of radiation.
- Presently installed and operating at these frequencies: 1700-2400 mc; 755-985 mc and 400-450 mc. Also available in other frequencies.

**T**HIS latest development in feed design greatly steps up versatility and flexibility in quadruple diversity tropospheric scatter systems.

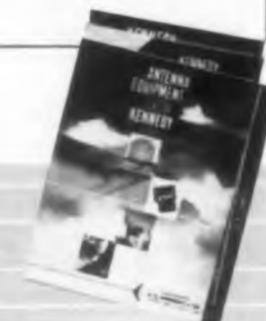
For the most efficient use of your antenna, let Kennedy engineers design your feed system. Complete pattern data available for this dual polarized feed system applied to a 60-ft. dish.



ANTENNA EQUIPMENT

**D. S. KENNEDY & CO.**

155 King Street, Cohasset, Mass.



CIRCLE 326 ON READER-SERVICE CARD



## When low noise level is vital...

Microwave Associates - developers of the famous low noise  
"E" series silicon diodes - now brings you

### COAXIAL DIODES

with noise figure improvement of:

- 1.5 db at 16 KMC with the 1N 788
- 3 db at 25 KMC with the 1N 25A
- 3 db at 35 KMC with the 1N 53B

Simple substitution of these new coaxial diodes for existing types should improve your overall receiver noise figures as shown. No holder or IF amplifier redesign is required to realize system improvements with these improved versions of the standard coaxial mixer diodes.

Microwave Associates is now delivering these diodes as well as the new tripolar types. Typical of these breadboard types is the 1N630 which covers the frequency range of 1 KMC to 12.4 KMC.

Our factory or the sales representative nearest you will gladly handle your specific requests by wire, phone, or mail.



**MICROWAVE ASSOCIATES, INC.**

BURLINGTON, MASSACHUSETTS • BRowning 2-3000  
CIRCLE 327 ON READER-SERVICE CARD

## NEW LITERATURE

### Silicon Rectifiers

328

Descriptions, data, and specifications on recently introduced silicon power rectifiers are given in this data sheet. Complete information on electrical and mechanical characteristics, and data on performance for diodes with capacities of 6, 20, and 40 amp per cell and with piv ratings of from 50 to 500 v are provided. Syntron Co., 1186 Lexington Ave., Homer City, Pa.

### Computer Brochure

329

Brochure S-526R1 gives specifications, basic features, illustrates major components, and lists applications of the LGP-30 General Purpose Computer. Operation of control panel and simple 16-part Command Table are described. The new optional photo-electric punched tape Reader (200 characters per second), and combination high-speed Reader and Punch unit are illustrated. Royal McBee Corp., Data Processing Division, Port Chester, N.Y.

### Tantalum Capacitors

330

This booklet tells what to expect from tantalum capacitors of the wet electrolytic type. The 16-page booklet discusses their capabilities and limitations under various electrical and electronic service conditions and shows representative applications. The publication includes tables, charts, and curves and a description on temperature, frequency, surge voltage, shock and vibration conditions, results of life tests both in use and on the shelf. Fansteel Metallurgical Corp., North Chicago, Ill.

### Toroid Inductors

331

Bulletin KT-1, 4-pages, describes a complete line of uncased, hermetically sealed and plastic encapsulated toroid coils. Description, specifications, charts, and curves are presented. Kelvin Electric Co., 5907 Noble Ave., Van Nuys, Calif.

**CHART-PAK** precision tapes and die-cut symbols made these conductor paths and terminal pads for a printed circuit layout in 9 minutes 40 seconds!

HOW LONG WOULD IT TAKE  
YOU TO DRAW THEM?

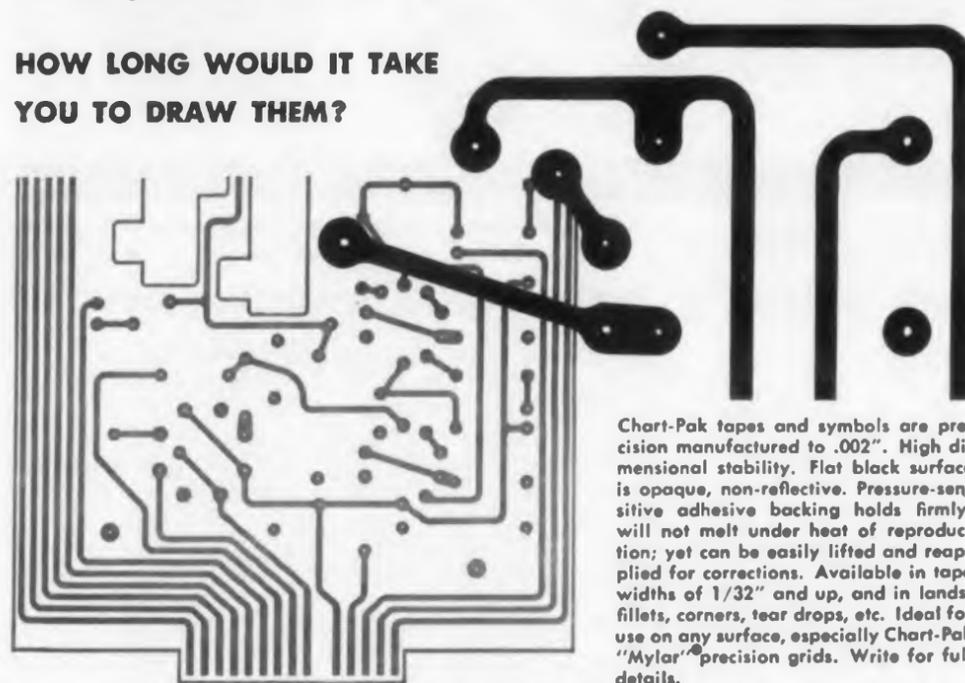


Chart-Pak tapes and symbols are precision manufactured to .002". High dimensional stability. Flat black surface is opaque, non-reflective. Pressure-sensitive adhesive backing holds firmly, will not melt under heat of reproduction; yet can be easily lifted and reapplied for corrections. Available in tape widths of 1/32" and up, and in lands, fillets, corners, tear drops, etc. Ideal for use on any surface, especially Chart-Pak "Mylar" precision grids. Write for full details.

**CHART-PAK**  
Saves time...  
Saves money!



**CHART-PAK, INC.**

ORIGINATOR OF THE TAPE METHOD OF DRAFTING

144 River Road, Leeds, Mass.

CIRCLE 332 ON READER-SERVICE CARD

ELECTRONIC DESIGN • April 15, 1959

### Shaft Angle Encoders 333

Five, 4-page bulletins (0858, 0958, 1058, 1258) describe each of five Analog-to-Digital Shaft Angle Encoders (13, 16 and 18-digit). Operation and construction features, plus electrical and mechanical specifications are given, along with illustrations and schematic operation diagrams of each unit. Industrial Products Div., The Baldwin Piano Co., 1801 Gilbert Ave., Cincinnati 2, Ohio.

### Electronic Counters 334

A general description, electrical specifications, photographs and application notes on models 14-20A and 14-20AT electronic counters are provided in this 16-page, two-color brochure. Northeastern Engineering, 25 South Bedford St., Manchester, N. J.

### Capacitors 335

Capacitors in five different designs and values from 0.5 to 6800  $\mu\text{f}$  are described in catalog 59-1, eight pages. It is illustrated and provides information on the manufacture, electrical characteristics

and design applications of these monolithic, porcelain and silver capacitors. Vitramon, Inc., P. O. Box 544, Bridgeport 1, Conn.

### Selsyns and Synchros 336

Sixteen-page bulletin, GEA-6675, discusses a complete line of Selsyn and Synchro generators, motors, control transformers, differential generators, differential motors, tandem Selsyns, and system operation. Bulletin includes schematic and line drawings, figures, tables, charts, and dimensions. General Electric Co., Schenectady 5, N. Y.

### Meters and Accessories 337

Bulletin 81100, eight-pages, provides specifications and pictures on ruggedized electrical meters and accessories for military and commercial applications. Among the uses of the meters are: communications equipment; aircraft applications; electrical test sets; and industrial devices. WacLine, Inc., 35 So. St. Clair St., Dayton 2, Ohio.

here is the world's smallest and simplest strip chart recorder!



- **AMPLE STORAGE:** Contains 63-ft. chart roll, or 31 days' recording at one inch per hour. Useful chart width 2 3/4".
- **ACCURATE:** Galvanometer pointer swings free for maximum accuracy, being clamped briefly for marking.
- **INKLESS:** Recording process is completely dry, utilizing special pressure sensitive paper. Method provides remarkable definition.
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\* Subject to change without notice.

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—these construction features assure exceptional reliability:

**Positive sealing.** Advance's use of induction heating cuts rejects from faulty soldering to a negligible figure. Soldering is accomplished at high speed, hence damage to the relay due to heat transfer is eliminated.

**RADIFLO testing for leakage** is used to detect leaks as small as  $10^{-6}$  cc/sec. All relays that pass this test will function after long shelf life.

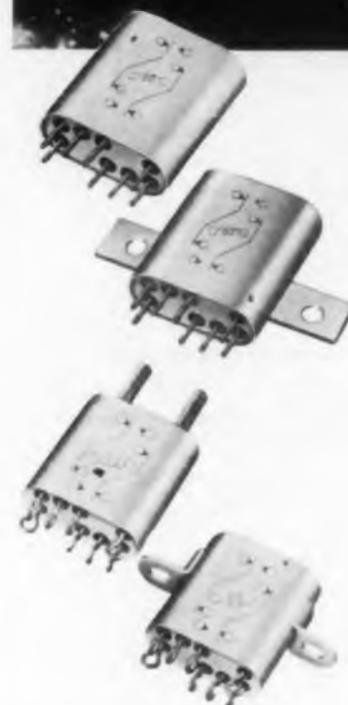
**RIQAP\* program approval.** Under RIQAP, the Signal Corps constantly checks Advance's quality control and inspection, to insure military standards of reliability for all Advance customers, both military and industrial.

\*Reduced Inspection Quality Assurance Plan of the U. S. Army Signal Corps.

#### SPECIFICATIONS

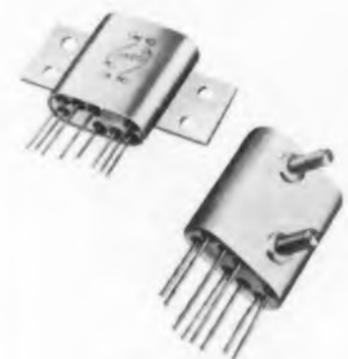
<b>Coil resistance:</b>	Available in 7 values, from 30 to 10,000 ohms.
<b>Shock:</b>	50 G's for 11 milliseconds.
<b>Vibration:</b>	10 to 34 cycles per second at maximum excursions of .4". 34 to 2000 cps 20 G's acceleration.
<b>Operating power:</b>	Pull in power 250 milliwatts at 25°C.
<b>Contact rating:</b>	2 amps resistive at 32 VDC or 115 VAC.
<b>Life:</b>	100,000 operations minimum at rated current.
<b>Weight:</b>	0.45 ounce.
<b>Size:</b>	7/8" high x 5 1/4" wide x 2 3/4" deep.

Our Applications Engineering Dept. will be pleased to work with you on your special application problems.



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But the easy way is to come to Ace! Our shockless pots incorporate, through exclusive precision production methods, fantastically close bearing fit. And our own specially balanced contacts place extremely low mass at the edge-wipe end, under low brush pressure, for steady contact under shock. Tempered precious metals and low contact resistance mean long, corrosion-free wear. Tested to 50 G's at 2000 cycles.



Our complete pot line incorporates all these anti-shock design features. Under extreme servo applications, this 1/2" servo-mount Series 500 Acepot delivers 0.3% linearity.

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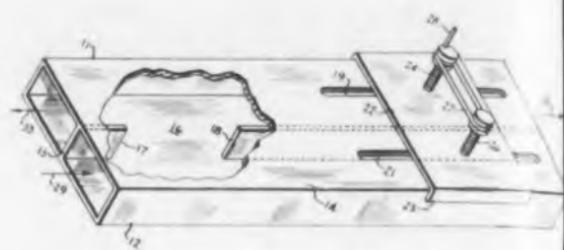
# PATENTS

## Microwave Power Divider

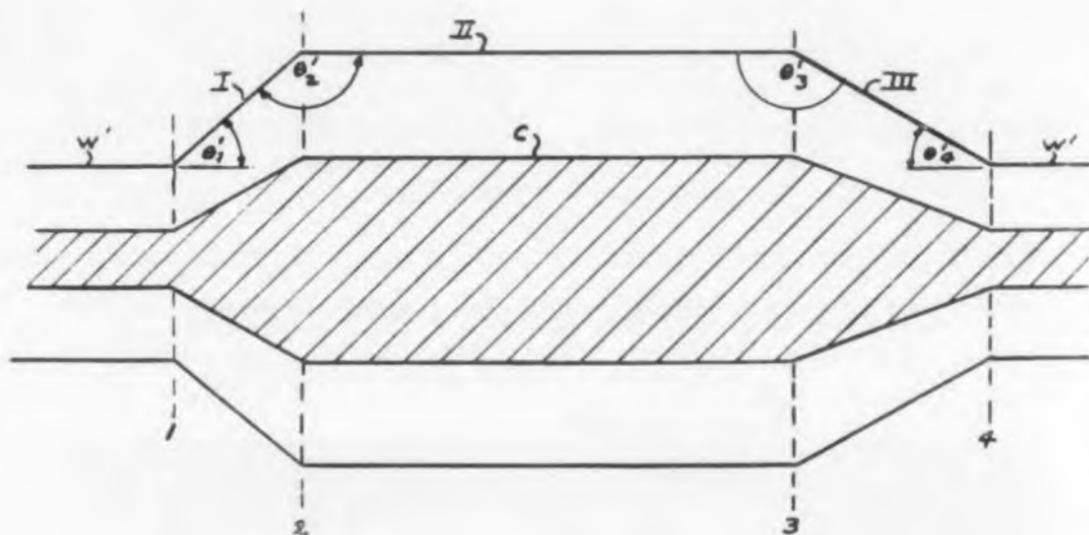
Patent No. 2,866,166. John F. Zaleski. (Assigned to General Precision Laboratory)

Directional coupler principles are used to divide microwave power to three output branches with no energy reflected back to the input.

At port 16, power input 16 divides equally with the component in guide 11 leading by 90 deg. Reflection occurs at screw posts 24 and 26, equidistant within slots 19 and 21 respectively, and equal energy exits as 31 and 32. The reflected portion returns to the left and equally divides at port 16 again with 90 deg.



phase shift. As a result, phase cancellation of the reflected components occurs in guide 12 whereas equiphase addition in guide 11 exits as component 33. The percentage of energy 33 relative to outputs 31 and 32 depends upon the adjustment of the reflecting posts by handle 28.



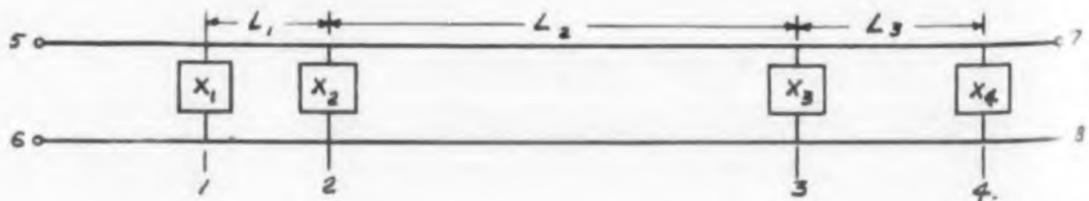
## High Power Transmission Line Filters

Patent No. 2,859,418. Joseph H. Vogelmann. (Granted under Title 35 U.S. Code (1952), sec 266.)

High power filters are obtained by inserting tapered coaxial or waveguide sections along the length of a uniform transmission line. The discontinuities produced at the junctions essentially are shunt reactances which may be synthesized to produce the specified pass band. The tapered cross-section must exceed the cross-section of the uniform line and

proper filtering requires that the length of the filter section shall be equivalent to the wavelength at the center of the pass band.

A tapered coaxial line and its equivalent network are shown. The geometry of the line is obtained by first measuring experimentally the relationship of the shunt reactance  $X$  to taper angle  $\theta$ . The filter is synthesized by calculating the location of the discontinuities by synthesis of reactances having preselected resonance and anti-resonance characteristics.



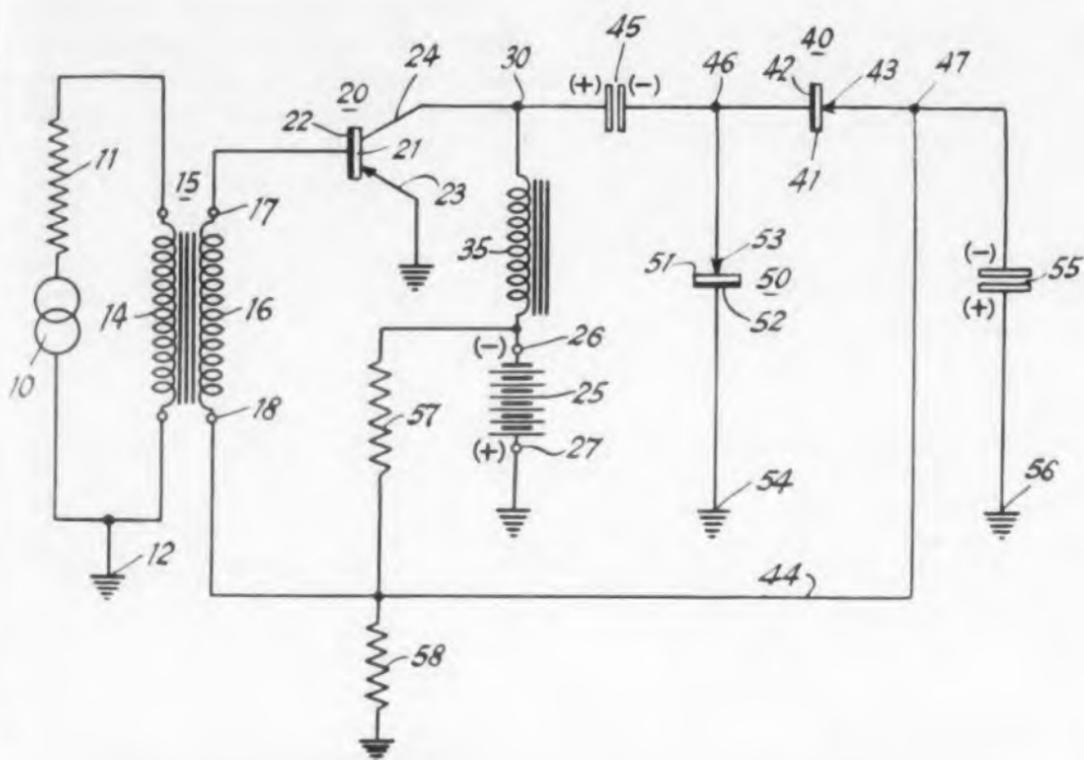
### Reflex Circuit System

Patent No. 2,863,065. David DeWitt, Harold Sandler, Roland C. Wittenberg. (Assigned to Radio Receptor Co., Inc.)

Reflex amplification achieves, in a single transistor amplifier stage, sufficient ac and dc amplification to control the required current in a load.

The ac signal from generator 10 is

transformer coupled to transistor 20 which produced an amplified signal in relay 35. In addition, the amplified ac signal is voltage doubled by the combination of capacitors 45 and 55 and diodes 50 and 40. The resultant dc signal adjusts the base-emitter voltage in transistor 20 to further change the current in relay 35.



### Universal Phonograph Pickup Head

Patent No. 2,864,897. Ira J. Kaar. (Assigned to Hoffman Electronics Corp.)

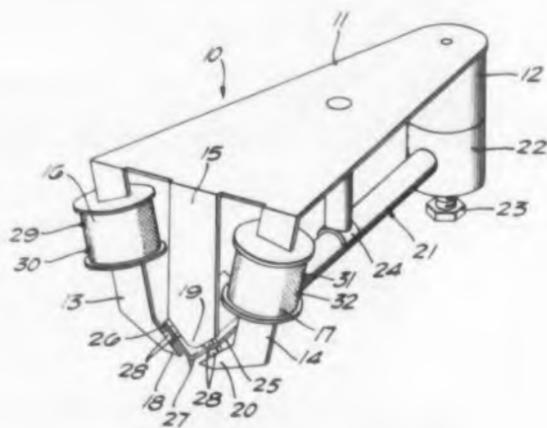
A single stylus dual-variable reluctance pickup reproduces Westrex stereo as well as lateral and vertical recordings.

The magnetic circuit consists of magnet 12, connecting bar 15, stylus 27 with winged elements 25 and 26 and cantilever 21. Output coils 16 and 17 are mounted on orthogonal pole pieces 18 and 20.

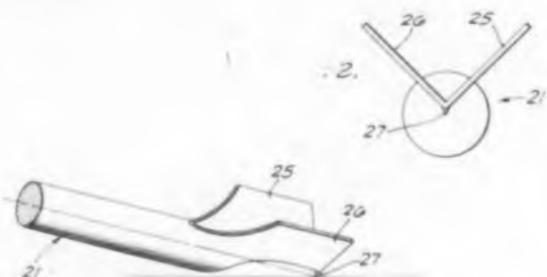
For vertical recording, displacement of stylus 27 causes an equivalent change in the air gap at each pole tip. The variable reluctances change the flux in the two coils which are connected series aiding at the output.

In tracking a lateral impression, an increase in one air gap will cause a simultaneous decrease in the other air gap. The output coils can be reconnected for maximum output.

Stereo records are faithfully reproduced except for possible crosstalk due to twisting of cantilever 21. As the stylus



travels in the track, the orthogonal recordings are followed independently by changes in each air gap and the voltages induced in the two coils are connected to the separate inputs of a dual amplifier chain.



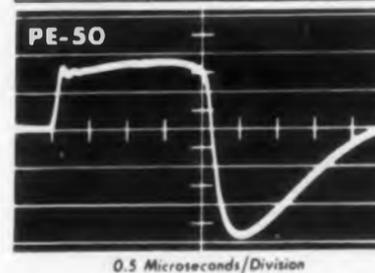
## CHICAGO STOCK PULSE TRANSFORMERS

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Designed for Navy Preferred Circuits and other blocking oscillator applications

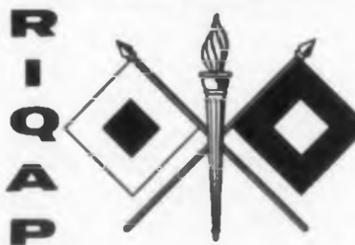
These CHICAGO ultra-miniature wound core pulse transformers are hermetically encapsulated 3 winding units. They are designed and built in accordance with MIL-T-27A and are characterized by extremely fast rise time, minimum droop, and high temperature stability. The leads are arranged so that they can be soldered directly in to the circuit or clipped and plugged into a standard 7-pin miniature tube socket. Each unit in the "PE" series weighs approximately .16 ounce.

CHICAGO Part No.	Nominal Pulse Width Microseconds	Rise Time Microseconds	Height	Width	Depth
PE-50	0.5	.07	1/16"	1/16"	1/16"
PE-75	0.75	.07	1/16"	1/16"	1/16"
PE-100	1	.06	1/16"	1/16"	1/16"
PE-200	2	.05	1 1/16"	1 1/16"	3/4"
PE-500	2	.07	1 1/16"	1 1/16"	3/4"
PE-700	7	.1	1 1/16"	1 1/16"	3/4"



Data obtained through use of N.B.S. Preferred Circuit #46 as found in Navy Aeronautical Preferred Circuits Handbook.

Oscillograph pictures of pulses for all units and other technical data are available in Chicago Bulletin CT-45. Write for your free copy.



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### TYPICAL VALUES FOR 2 KC UNIT\*

Frequency range	1 to 15 kc
Holder	T5 1/2 glass bulb —Noval Base
Temperature range	—55 to +100°C
Frequency tolerance	±.015%
Effective resistance	75,000 ohms max.
Aging 8 hours—100°C	±.001% max.
Meets MIL specifications for vibration stability	

\*Reeves-Hoffman manufactures a broad line of crystals in the range from 1 to 1000 kc.

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WRITE FOR BULLETIN RHG-DP  
DIVISION OF  
DYNAMICS CORPORATION OF AMERICA  
CARLISLE, PENNSYLVANIA

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## PATENTS

### Apparatus for Producing Electric Anesthesia

Patent No. 2,866,461. Kensaku Suguki.

Constant current dc is applied to the body by electrodes to decrease the conductivity of nerves near the positive electrode such that the area becomes insensitive to pain. The positive electrode is the surgical instrument and the negative electrode covers a proportionately larger surface at a remote position of the human body. Typical values of current to produce proper anesthesia are given.

### Semiconductor Apparatus

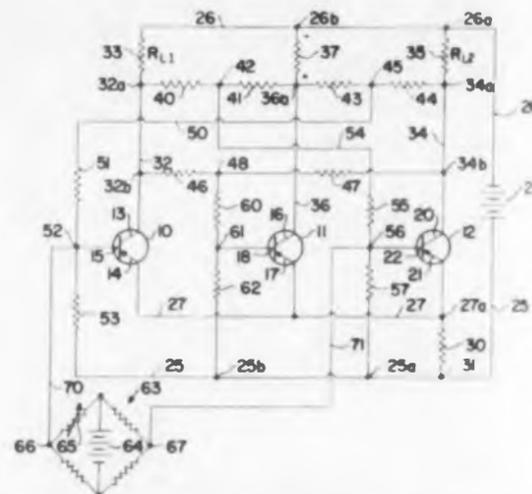
Patent No. 2,864,962. James L. Jensen. (Assigned to Minneapolis-Honeywell Regulator Co.)

Unique selection of a single load device, in response to an electrical signal, is available with a multiposition transistor switch.

For the quiescent condition, transistor 11 is made conducting and the bias developed across load resistor 37 holds transistors 10 and 12 at cut off due to the

electrodes at junctions 45 and 42. A change in voltage across bridge terminals 66 and 67 will cause transistor 10 to conduct and, regeneratively, the bias at the base electrode of transistor 11 will exceed cut off. Transistor 10 is now conducting and transistors 11 and 12 cut off. A reversal in the voltage across terminals 66 and 67 will make transistor 12 conducting and the other transistors cut off.

Similar circuitry may be added to include a large number of switching channels. Simplicity is achieved by using zener diodes to bias the base electrodes.



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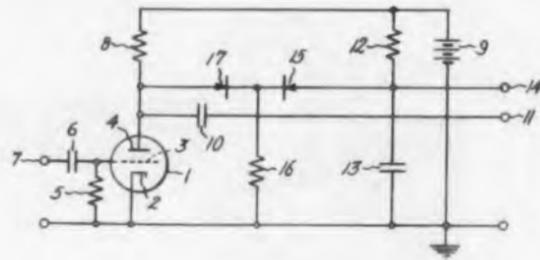
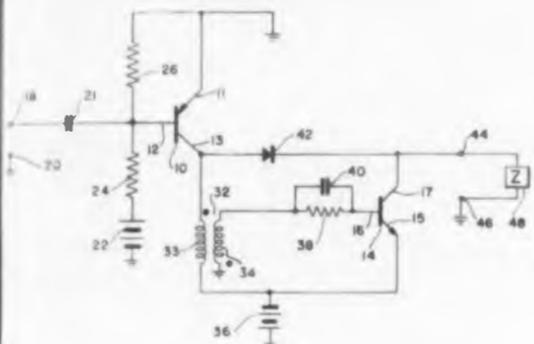
ELECTRONIC DESIGN • April 15, 1959

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#### Low Output Impedance Semiconductor Amplifier

Patent No. 2,868,897. Douglas J. Hamilton. (Assigned to Hughes Aircraft Co.)

Complementary transistors in shunt maintain low impedance across the load for both the "off" and "on" periods of successive clock pulses. With no applied input pulse, the "off" period, load current is delivered to load Z by pnp transistor 14 since npn transistor 10 and diode 42 are cut off. A negative going "on" pulse at terminals 18-20 causes transistor 10 to conduct, triggering transistor 14 to cut off, and the load current passes through diode 42 to the output impedance.



#### Wave Amplifying and Generating Circuit

Patent No. 2,868,972. Peter G. Smee. (Assigned to General Electric Co.)

Amplification of an input pulse and independent generation of a separate sawtooth voltage are performed by the network shown. Quiescent, triode 1 is conducting hard and capacitor 13 is charged to the voltage set by resistors 12 and 16 in series with diode 15 since diode 17 is cut off.

A negative-going impulse applied to input 7 is amplified and coupled out through capacitor 10. Simultaneously, during the pulse interval, diode 17 conducts to cut off diode 15 and capacitor 13 charges through resistor 12 to produce a sawtooth waveform at output terminal 14.

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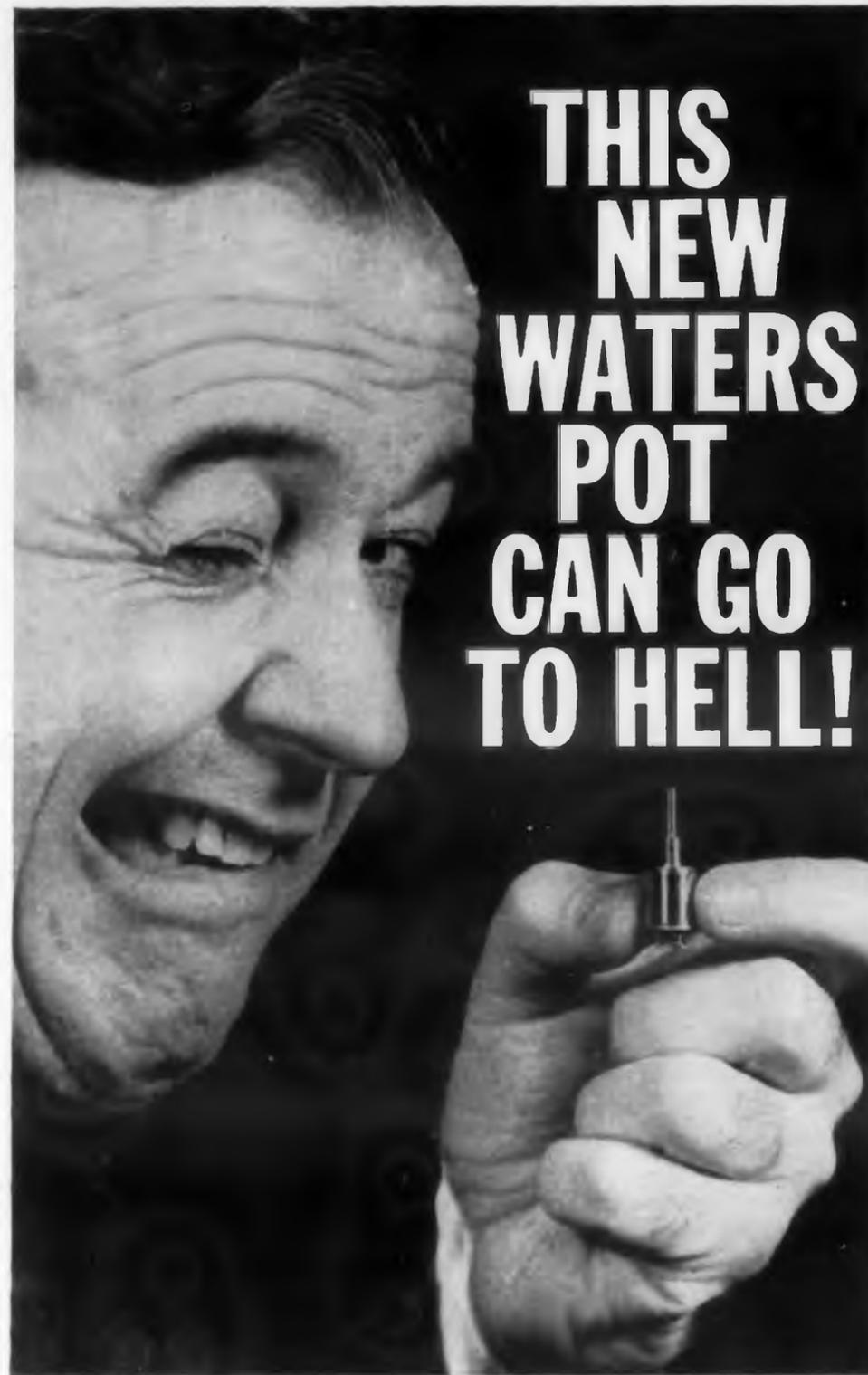
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## BOOKS

### Topics in Electromagnetic Theory

Dean A. Watkins, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 118 pp, \$6.50.

Presents for the first time in book form a series of related topics in the field of electromagnetic theory and microwave electron tubes. Developed from a set of lecture notes organized for a one-semester course in electrical engineering, the selected topics in electromagnetic theory compile a text for the student on the advanced level.

The first chapter is devoted to periodic transmission systems and creates an operating framework for the material which

follows. It clarifies common misconceptions concerning microwave transmission systems acquired by those who have studied only uniform systems. The field approach and the equivalent circuit approach are employed. Propagation on a wire helix is the basis of the second chapter and the subsequent chapter discusses concepts concerning coupling of modes of propagation. A quick view of the world of anisotropic media and the waves that propagate therein concludes this unified series of topics.

Concepts are illustrated throughout the volume, and a series of problems for the reader are suggested for each chapter.

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### The Atom and the Energy Revolution

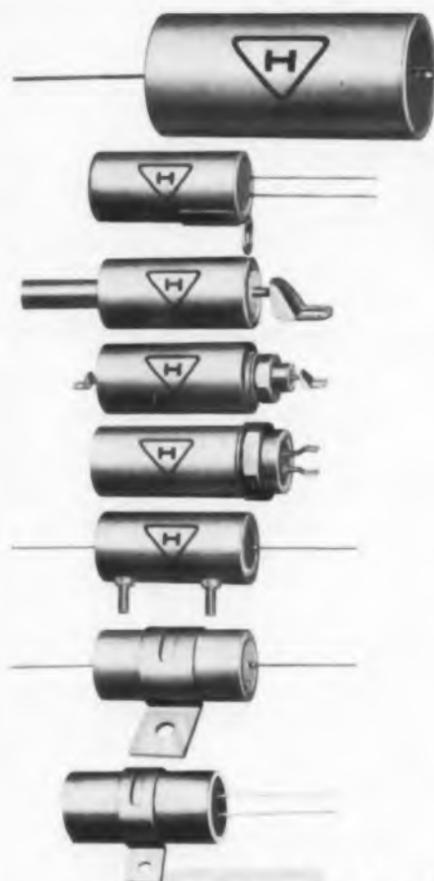
Norman Lansdell, *Philosophical Library*, 15 E. 40th St., New York 16, N.Y., 200 pp. \$6.00.

The social and political implications of the revolution in the methods of energy production are discussed for the general reader, who seeks insight into the new era of scientific techniques; for the businessman, who must accommodate himself to the new industrial and commercial factors introduced by atomic energy; and to the specialists in any related field of inquiry. A balanced and broad introduction to the atom, its energy and methods of releasing it; material sources of atomic energy; its exploitation by separate countries and by international bodies; and its impact upon the world as a whole. This work stimulates the layman to seek answers to world-wide problems caused by the impact of atomic energy.

### Introduction to the Theory of Transistor Circuits

Dr. J. J. Hupert, *Communications and Electronics Foundation*, c/o A. R. F. Products, Inc., 7627 Lake St., River Forest, Ill., \$3.00, 48 pp.

An outgrowth of a lecture given by the author at the IRE Transistor Lecture Series in Chicago, this brochure is limited to small signal analysis and is intended to emphasize topics which are peculiar to transistor circuits or which gain in importance when applied to transistor circuits. It is intended as an orientation publication for persons on the B. S. level in engineering and science, whose syllabus of college study did not include courses on transistors. A certain degree of familiarity with such topics as matrices, Laplacian transformation, theory of linear electric circuits, etc. is taken for granted. Numerous references are provided however which can serve to refresh the reader's background.



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**HOPKINS Engineering COMPANY**

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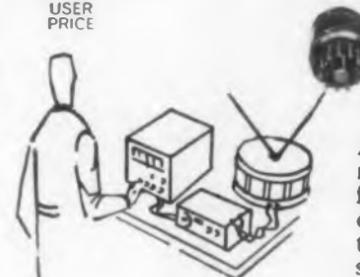
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# JAMES TRANSISTOR TRANSFORMER REFERENCE KIT

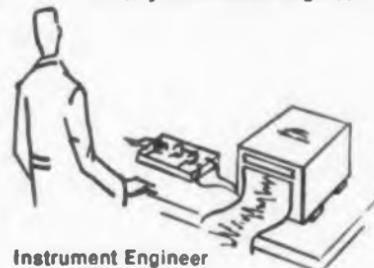
### A KIT TO GIVE THE DESIGNER TRANSFORMERS FOR 93% OF ALL APPLICATIONS

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- PHASE SHIFT
- PERMISSIBLE POWER LEVEL
- DISTORTION
- IMPEDANCE RATIO
- EFFECT OF UNBALANCED DC

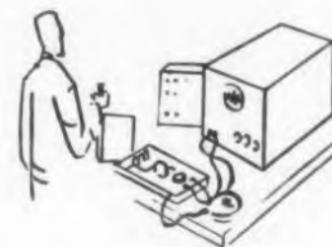
With these transformers and their complete specifications the design engineer will know the "when... why... and how" of transformer application in his circuitry.

Transformers immediately and permanently available for prototype work and with all the information necessary to generate a final production specification.

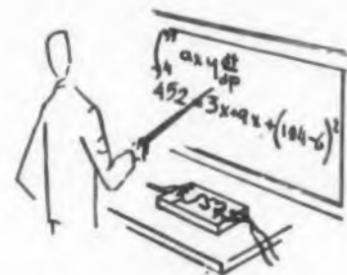
See your Industrial Distributor or write.

A time saver; elimination of multiple purchase of stock transformers with inadequate data, or costly procurement of custom transformers at the breadboard stage.

These high quality transformers conveniently packaged in a working engineers kit are bifilar wound with a complete four winding eight terminal configuration.



Radio and Communications Engineer



Educational Institutions

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PHOTOS • DRAWINGS • CAPACITIES • ENCLOSURES

## GUARDIAN® General Purpose RELAYS



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CIRCLE 351 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

Get \$10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication.

# Megawatt Transient Protection In Small Space

**R**ECENTLY we had to trace a nasty transient problem which caused many breakdowns in a piece of electronic equipment. The circuitry involved a modulator for a 1 kw, grid-controlled traveling wave tube. All the circuitry was constructed to operate at the high cathode potential, to minimize space and weight by eliminating huge coupling elements.

Unfortunately, the twt did not behave well when it was installed in a minimum weight-space modulator system. The grid would often arc to ground, shorting the tremendous energy stored in C2 through the decoupling resistor  $R_d$ , the bias filter C2, and the pulse transformer T.

The weakest of the three (usually C3 or  $R_d$ ) would vaporize upon impact of the 20 joules stored in C2.

Still bound by the space-weight consideration, we had to select one of the three components to withstand this burst of energy, while protecting the other components in the series chain.

We found that a resistor was available to take this jolt. The one resistor we found, of reasonable size (1-1/4 in. long by 5/16 in. diam) was the

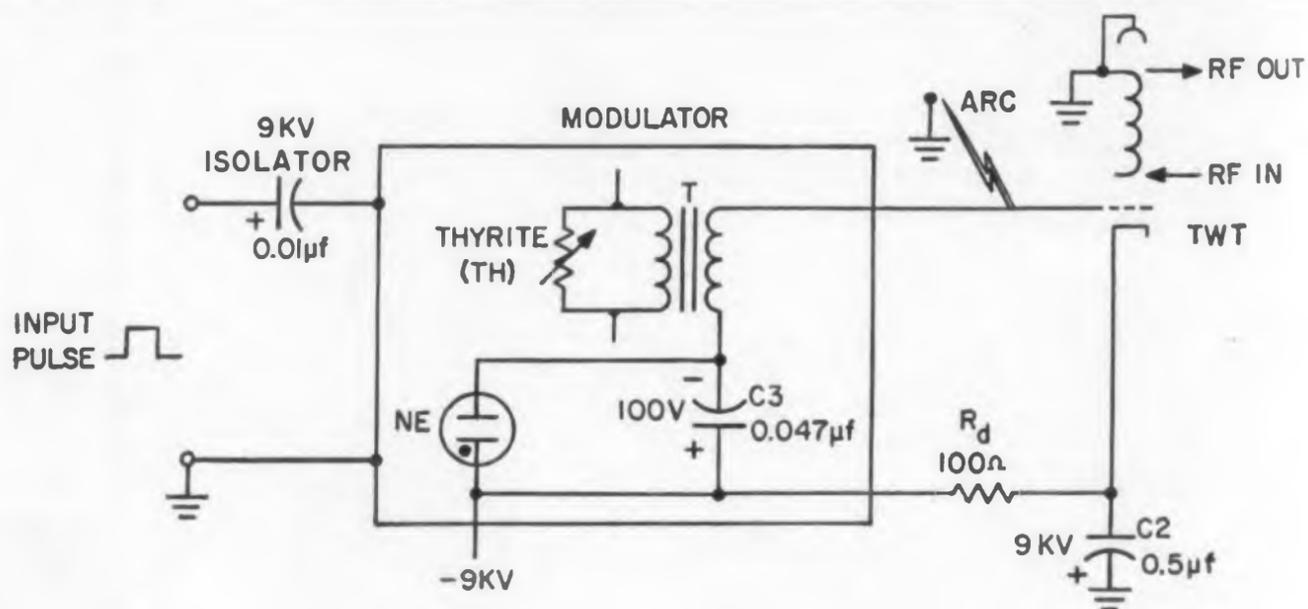
new ceramic type manufactured by the Global Plant of the Carborundum Co. This resistor can withstand the 2/3 to 1 megawatt discharge for several microseconds and can take an ambient temperature of 1000 F. This makes it excellent for withstanding extremely large, short-time overloads.

Since this resistor is non-inductive, it works well as a decoupling element during normal pulse operation. If the twt should arc from grid to ground, the resistor would withstand the impact and dissipate the energy of C2, while the thyrite Th and neon bulbs NE would protect T and C3.

After C2 would discharge and the arc would be extinguished, C2 would recharge and normal operation would continue.

The philosophy in this solution can be applied in other equipment and can obviate heavy protective devices so prevalent in ground or commercial modulation equipment—especially when no one is present to reset circuit breakers or replace fuses.

J. A. Develet, Jr., Ramo-Wooldridge, Div. of Thompson Ramo Wooldridge Inc., Los Angeles, Calif.



One tough resistor saves space and obviates heavy transient protection in this twt modulator.

# Stabilized Transistor Power Supply

This power supply uses transistors and is designed to provide a stabilized voltage to transistorized equipment. The required voltage is of the order of a few volts, but the current may well reach several amperes. This rules out the possibility of using ordinary tubes, but nothing precludes the use of power transistors in a circuit similar to the arrangement common with vacuum tubes.

The accompanying diagram is due to the German firm Valvo. A power transformer provides 2 x 15 v to two junction rectifiers. The positive side of the *B plus* is grounded. The high current prevents the use of an efficient choke of high inductance value, and the filtering is mainly provided by two high capacitance, low voltage capacitors.

The regulating element is a series transistor *Q4*, a power type able to deliver up to 2 amperes. The stabilized voltage appears on its emitter.

As usual, a resistance divider, across the output, feeds an adjustable fraction of the output voltage to the base of an amplifying transistor *Q1*. The emitter of this transistor is kept at a con-

stant voltage with the help of the two bias-stabilizing cells *C1* and *C2*, fed by a 2200 ohm resistor. These cells effectively replace a battery.

The collector output voltage is applied to two cascaded additional stages of amplification *T2* and *T3*. Note that the common collector circuit provides for no phase reversal.

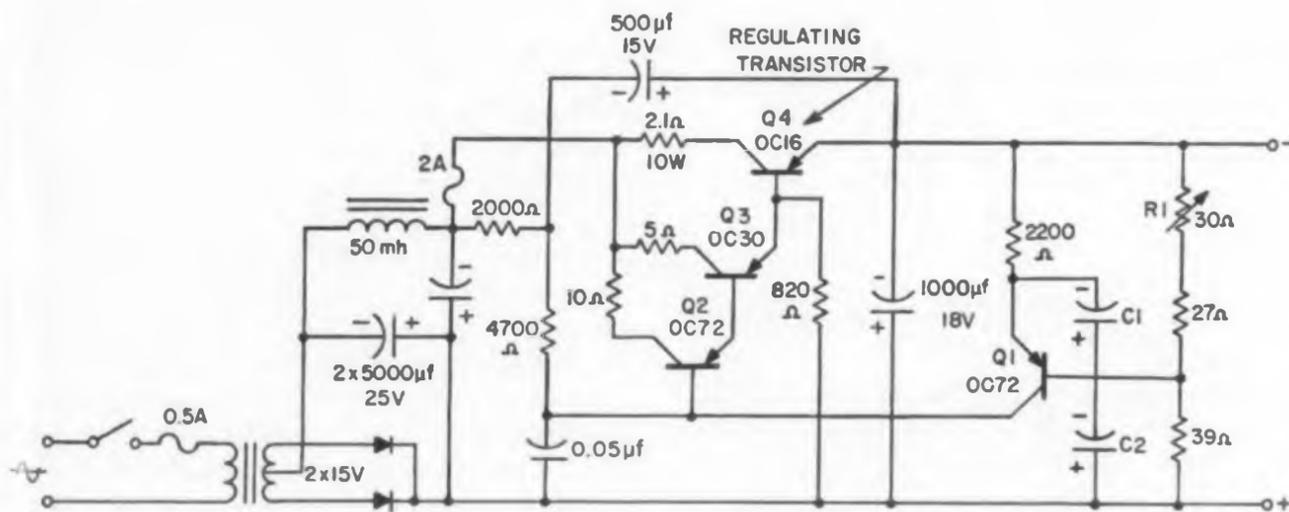
The second stage of the pair is a medium power transistor *Q3*, which drives the base of the regulating power transistor *Q4* and modifies its internal resistance according to the output voltage variations.

The similarity with the controlled series tube stabilizer is evident.

The 2.1 ohm resistor, in series with the power transistor collector, creates a feedback which improves the stabilization and provides some measure of temperature compensation. The output voltage can be adjusted to any value between 5.4 and 7.5 v by potentiometer *R1*.

A 10 per cent line voltage variation causes an output change of less than 0.3 per cent.

*Dr. A. V. J. Martin, Carnegie Institute of Technology, Pittsburgh, Pa.*



German power supply similar to vacuum tube version.

"go"/"no-go"  
voltage measurements

— specify VOLTRON  
for high accuracy, high  
reliability, and low cost.



## VOLTRON VOLTAGE INDICATOR

— tells the operator whether or not the monitored voltages are within predetermined limits. Indicator has an expanded scale, with each scale marked in arbitrary units. Meter can be programmed to represent a wide range of voltages.

Accuracy: DC — 0.25%, AC — 0.5%

Temperature Range: —55 to 71°C for Military meters; 0 to 50°C for Industrial meters.

Vibration, Humidity, Shock: Military meters meet MIL-M-10304A



## VOLTRIP VOLTAGE COMPARATOR

— built with an amplifier and relay instead of the indicating meter. The relay operates when the voltage falls outside of predetermined limits. Unit can be programmed by either analog or digital methods.

Signal Voltage Range: DC: —500 to —1.0, and +1 to +500 volts. AC: 5 to 500 volts.

Accuracy of Trip Point: MILITARY VOLTRIPS: DC: 0.25% of voltage programmed AC: 0.5% of voltage programmed from —55°C to +71°C. INDUSTRIAL VOLTRIPS: DC: 0.5% of voltage programmed AC: 1.0% of voltage programmed from 0 to 40°C.

Repeatability: Approx. 1/4 of the specified error.

Construction: MIL-T-27 Size FA can.

Complete data will be sent on request.  
Write for Bulletin 34.

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# DELCO POWER TRANSISTORS

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EIA	2N297A*	2N297A	2N665**	2N553
Collector Diode Voltage (Max.)	60	60	80	80 volts
HFE ( $I_c = 0.5A$ ) (Range)	40-100	40-100	40-80	40-80
HFE ( $I_c = 2A$ ) (Min.)	20	20	20	20
$I_{CO}$ (2 volts, 25°C) (Max.)	200	200	50	50 $\mu a$
$I_{CO}$ (30 volts, 71°C) (Max.)	6	6	2	2 ma
$F_{ae}$ (Min.)	5	5	20	20 kc
T (Max.)	95	95	95	95°C
Therm Res. (Max.)	2	2	2	2° C/W

\*Mil. T 19500/36 (Sig. C.)

\*\*Mil. T 19500/58 (Sig. C.)

NOTE: Military Types pass comprehensive electrical tests with a combined acceptance level of 1%.

Delco Radio announces new PNP germanium transistors in 2N553 series — the 2N297A and 2N665, designed to meet military specifications. These transistors are ideal as voltage and current regulators because of their extremely low leakage current characteristics. All are highly efficient in switching circuits and in servo amplifier applications, and all are in *volume* production! Write today for complete engineering data.

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Division of General Motors • Kokomo, Indiana

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CIRCLE 353 ON READER-SERVICE CARD

## IDEAS FOR DESIGN



Magnetic control linkage applied to a hermetically sealed rotary switch (above) and a variable capacitor (below).



### New Control Device for Hermetically Sealed Equipment

Electronic equipment must often be sealed hermetically. In all cases, the weak point has been the gasket arrangement for a control shaft.

A French invention by A. Delaporte solves this difficulty elegantly. It allows control of any internal component such as switch, potentiometer, or variable capacitor by an external knob without any mechanical linkage whatsoever.

Basically, the device is made of two parts: one hermetically sealed enclosure containing the driven component, and one outside driving control in the environment medium, which can even be a liquid such as water.

A purely magnetic link ensures the coupling

between driving and driven components, through a nonmagnetic part of the wall of the hermetic container. On each side of this wall, and near its surface, a disk carries on its periphery a number of pellets of a magnetic material such as Ferrodur, duly magnetized. The outside disk is carried by the control knob shaft; the inside disk is fixed on the driven component.

When turning the control knob, the magnetic torque acting on the inside disk ensures a very precise positioning of the driven element. The mechanical design is such that the parallax effect is negligible, and the manual "feeling" is practically indistinguishable from the usual feeling of a mechanical direct link.

When the driven component belongs to the discontinuous type, such as a rotary switch, it can advantageously have the standard spring-loaded positioning mechanism. Then positive positioning of the control knob is also obtained.

An automatic safety is embodied in the device. If excessive torque is applied, the magnetic link simply slips. This may prevent damage to the component, say for example at one of the maximum rotation positions for a potentiometer.

An interesting application of the magnetic drive is worth mentioning. The driven component is a hemispherical capacitor transducer, made of four stators and one rotor. With this transducer, having two degrees of freedom, the spatial position of a shaft can be translated into two electric signals. Such a two-dimensional transducer has a host of applications. However, the required stability can not be obtained in a varying environment, hence the advantage of sealing the capacitor in an inert atmosphere and eventually stabilizing the temperature, while the magnetic drive is used to control the transducer.

The accompanying photographs show two applications of the magnetic drive to a variable capacitor and a rotary switch.

Dr. A. V. J. Martin, Carnegie Institute of Technology, Pittsburgh, Pa.

### Blow Out Old Solder

To remove old solder from solder terminals, heat the terminal with a soldering iron. When the solder is fluid, place one end of a short length of Teflon tubing at the terminal and blow through the other. Teflon is necessary for this job because it won't melt at soldering temperatures.

Jack Koff, Engineer, Farrand Optical Co., New York, N.Y.



### DUAL HIGH DIRECTIVITY COUPLERS

Narda Dual High Directivity Directional Couplers are designed for reflectometer measurements in waveguide systems, and exhibit the same flat response ( $\pm 0.4$ ) and high directivity (40 db min.) as Narda's single units. Primary line VSWR: 1.05 max. (1.10 for M1027); secondary line VSWR: 1.15 max. coupling factor: 20 db

Coupling structures are on opposite broad walls of the primary line; secondary output arms are on the same side to facilitate connecting detector mounts.

BAND	FREQUENCY (kmc)	WAVEGUIDE G.D. (in.)	NARDA Model	PRICE
S	2.60-3.95	3 x 1 1/2	1034	\$650.
C	3.95-5.85	2 x 1	1033	400.
XN	5.40-8.20	1 1/2 x 3/4	1032	255.
XB	7.05-10.0	1 1/4 x 3/4	1031	220.
X	8.20-12.4	1 x 3/4	1030	175.
KU	12.4-18.0	7/2 x 3/4	1029	180.
K	18.0-26.5	3/2 x 3/4	1028	295.
V	26.5-40.0	3/2 x 2/2	V1027	330.
M	50.0-75.0	2 1/2 x 1 1/4	M1027	900.



3, 6, 10 and 20 DB

40 DB HIGH POWER

### HIGH DIRECTIVITY COUPLERS

The 40 db High Power Coupler is another exclusive Narda product. Similar to standard types, except that coupling irises are in the narrow wall, it may be used at full rated power of the waveguide size. Nominal coupling value is 40 db; directivity 40 db. Directivity for 3, 6, 10 and 20 db couplers is also 40 db. Standard cover flanges on primary line; low VSWR termination and standard cover flange on secondary. All bands—2600 to 90,000 mc.



### STANDARD REFLECTIONS

Narda offers five values of reflections for each of six different waveguide sizes—the most complete choice we know of! Provides calibrated reflections or VSWR's for use in standardizing reflectometers or calibrating slotted line impedance meters.

#### SPECIFICATIONS

Reflection Coefficient	0.00	0.05	0.10	0.15	0.20
Accuracy	0.002	0.0025	0.0035	0.0045	0.007
VSWR Equivalent	1.00	1.105	1.222	1.353	1.50

Models for 2.60 to 18.0 kmc, from \$125 to \$300

Complete Coaxial and Waveguide Instrumentation for Microwave and UHF — including:

DIRECTIONAL COUPLERS  
TERMINATIONS  
FREQUENCY METERS  
HORNS  
VSWR AMPLIFIERS

200 to 90,000 mc.  
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COAXIAL HYBRIDS

ATTENUATORS  
STANDARD REFLECTIONS  
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**Microwave engineers—**

**Where can you use these exclusive features offered by NARDA?**



### BOLOMETER & THERMISTOR BROADBAND MOUNTS

• Exclusive plug-in elements

This new series of Narda matched Bolometer-Thermistor Mounts offers the optimum in accuracy and flexibility. At the same time, they permit instant replacement of the element. Bolometers and Thermistors, available from stock, simply plug in, without the use of tools, without the need of adjustments.

In addition, these mounts offer an extremely low VSWR over the full waveguide band, and require no tuning. Using bolometers, these units are designed for highest accuracy square law detection and power measurements. The thermistors are particularly recommended for accurate pulse power measurement.

BAND	FREQ. (KMC.)	WAVE GUIDE (IN.)	NARDA MODEL	DETECTOR TYPE AND MODEL	MAX. VSWR	CRYSTALS*	LENGTH (IN.)	PRICE
L	1.12-1.70	6.66x3.41	536	BOLOMETER N 605 THERMISTOR N 333D	1.35 1.5	IN21 or IN23	14	\$210.
LS	1.70-2.60	4.46x2.31	535	BOLOMETER N 605 THERMISTOR N 333D	1.35 1.5	IN21 or IN23	9	210.
S	2.60-3.95	3x1 1/2	534	BOLOMETER N 605 THERMISTOR N 333D	1.35 1.5	IN21 or IN23	7 1/4	110.
C	3.95-5.85	2x1	533	BOLOMETER N 605 THERMISTOR N 333D	1.5 1.5	IN21 or IN23	5 1/4	80.
XN	5.40-8.20	1 1/2 x 3/4	532	BOLOMETER N 605	1.5	IN23	4 1/4	90.
			542	THERMISTOR N 333D	1.5	IN23	4 1/4	75.
XB	7.05-10.0	1 1/4 x 3/4	531	BOLOMETER N 605	1.5	IN23	3 1/4	85.
			541	THERMISTOR N 333D	1.5	IN23	3 1/4	65.
X	8.20-12.4	1 x 3/4	530	BOLOMETER N 604	1.5		2 1/4	65.
			540	THERMISTOR N 336	1.5		2 1/4	60.
KU	12.4-18.0	7/2 x 3/4	529	BOLOMETER N 604	1.5		2	65.
			539	BUILT-IN THERMISTOR	1.5		2 1/4	95.
K	18.0-26.5	3/2 x 3/4	538	BUILT-IN THERMISTOR	1.85		1 1/4	150.

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CIRCLE 354 ON READER-SERVICE CARD

## Microwave Component News



from SYLVANIA



# NEW Space Saving Ferrite Devices



Three-port Circulator,  
Model FD-TC 522



Coaxial Ferrite Isolator,  
Model FD-155

## Sylvania introduces new ferrite devices covering UHF through K band

Sylvania scientists and engineers have developed advanced ferrite devices with new utility and reliability. They are the results of pure research and product development by the Microwave Physics Laboratory, now a part of Special Tube Operations.

Now, new Tee circulators are available that perform the same electrical function as standard phase shift circulators, yet occupy only 25% of the space and cost much less. The devices can also be used as isolators and as fast-acting switches.

New isolators, available in coaxial and standard design, incorporate exclusive space-saving features in addition to outstanding electrical performance. The 8½-inch FD-151, for example, provides 15-db isolation across the band from 2-4 kmc. Whatever the degree of isolation required, you'll get a smaller package and top reliability from Sylvania.

Data on Sylvania ferrite devices available from stock may be obtained from your Sylvania representative or by writing to the address below. Devices can also be custom designed to meet your specific requirements.



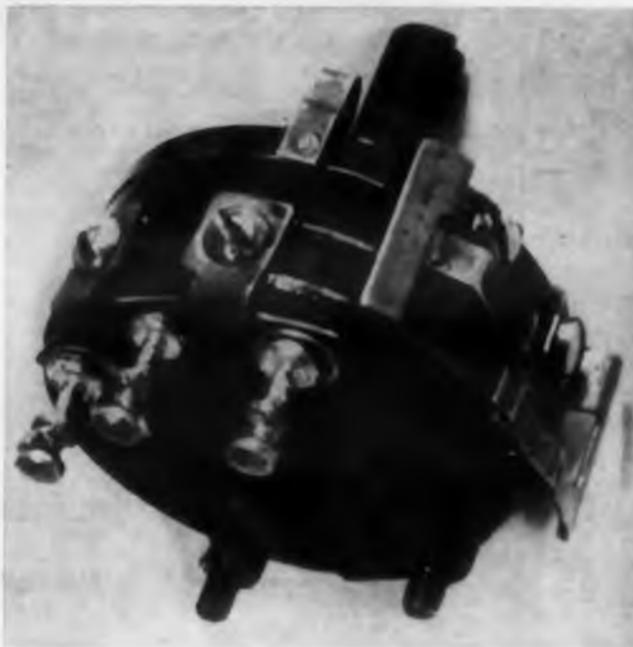
# SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.  
Special Tube Operations

500 Evelyn Avenue, Mountain View, California

CIRCLE 355 ON READER-SERVICE CARD

## IDEAS FOR DESIGN



Unique pot design includes a low resistance vernier to improve resolution.

### Slide Wire Pot With Very High Resolution

Conventional slide wire potentiometers rarely have adequate resolution. As the slider is moved, one turn of the resistance winding gives a value too small, and the next turn a value too large.

The solution can be provided by a vernier which eliminates the turn-by-turn steps. Such a vernier might be across a small portion of the major resistance element as in Fig. 1 or between two similar resistance elements as in Fig. 2.

In one particular design, shown in the photograph, a hollow cylinder has two similar resistance mandrels around the periphery. This is the coarse resistance support which remains fixed in position.

The vernier consists of a single wire around the periphery of a second cylinder of the same outside diameter. Contact springs from the ends of this wire are mounted so as to engage the two coarse mandrels. This vernier support fits cleanly in the large hole through the support for the coarse resistance elements.

The two parts may be easily rotated relative to one another about their common axis.

A vernier contact is mounted on an arm extending from the control shaft. This shaft passes through the insulating supports which hold the resistance elements. Rotation of the shaft causes smooth vernier variation through an angle of about 300 deg.

When a vernier limit is reached, the vernier contact arm engages a stop. Further rotation requires greater torque which causes the vernier



**TODAY-**  
he can escape

## Rheumatic Heart Disease

Tommy had an attack of rheumatic fever, frequent forerunner of rheumatic heart disease. Fortunately for him, his heart was not damaged.

Rheumatic fever, usually preceded by a "strep" infection, often strikes the same victim more than once. With each attack comes a new danger of heart damage.

Tommy's parents no longer live in fear of rheumatic heart disease, however. Through research, medical science has developed new methods of controlling "strep" infection and preventing recurrences of rheumatic fever.

For more facts about prevention, see your physician or ask your Heart Association.

For more research progress against the heart diseases . . .

Give



HEART FUND

**TEST INSTRUMENTS**  
for  
**LABORATORY/PRODUCTION**

**Sensitive Detection of  
Microwave Energy**



**PRECISION  
TEST  
RECEIVER**

The AIL Type 130 Precision Test Receiver (30 and 60 Mc standard units available) is a versatile instrument combining a high gain, low-noise figure receiver and a secondary standard of attenuation. It can be used wherever accurate measurements of the differences of r-f and i-f power levels are required. A few typical applications are: noise - figure measurement, measuring characteristics of directional couplers, calibration of r-f attenuators and measurement of selectivity characteristics.

Detailed literature is available on request.

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345 NEW YORK AVENUE  
HUNTINGTON STATION, L. I., N. Y.  
A DIVISION OF CUTLER-HAMMER, INC.

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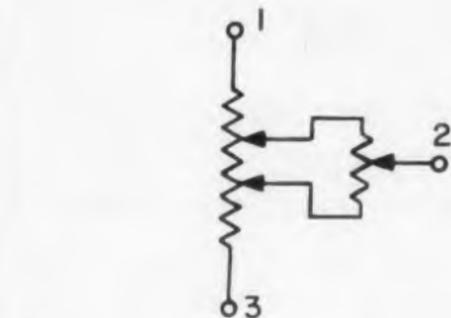


Fig. 1. In one type of vernier arrangement, the vernier bridges a small portion of the major resistance element.

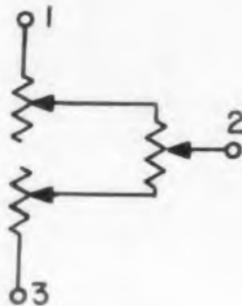


Fig. 2. In another arrangement, the vernier is between two similar resistance elements.

support to rotate relative to the fixed coarse resistance supports.

In production units, each of the coarse mandrels have approximately 700 turns of resistance wire with a resistance of 200 ohms. The vernier is a single wire with a resistance of about one ohm. With cylindrical supports 1-1/2 in. in diameter, the resolution is better than 2 ppm.

*Elliott Barr, Taylor Instrument Co., Rochester, N.Y.*

**Simulating Transistor Beta Changes**

Checking circuit performance with changes of transistor beta is tedious and time consuming.

Here is a method which simulates changes of beta, so circuits can be tested without changing transistors each time.

If a variable resistor  $R_{EB}$ , is connected between the base and emitter terminals of a transistor, the base to collector current gain, *i.e.* the effective beta, can be changed from its normal value, by varying  $R_{EB}$ .

A transistor having a beta equal to the highest beta to be used in the circuit is chosen and tested in a beta tester. A resistance decade box is connected between the base and emitter, and beta readings are taken as a function of the resistance  $R_{EB}$ .

Now, when the transistor is used in the circuit, any beta can be chosen by adjusting  $R_{EB}$ , and the circuit performance can be evaluated.

*Sergio Bernstein-Berverly, Tarrytown, N. Y.*

**Microwave Component News**



from **SYLVANIA**



**NEW Subminiature  
Microwave Diodes**

Sylvania opens the way to advanced miniaturization concepts in microwave and radar design with new smaller Silicon Microwave Diodes



Major step in the trend to ever smaller radar and microwave equipment to meet today's military and commercial demands is represented by Sylvania's new line of subminiature microwave diodes. The new diodes meet the electrical performance of their larger counterparts and are equivalent in ruggedness and reliability. They combine in one unit Sylvania's unmatched experience in diode packaging and proven technical excellence in microwave diode design.

The subminiature metal-to-glass package opens the way to new possibilities in strip-line and slab-line transmission designs. Included among the new types are Detector Diodes ranging in frequencies from 100 mc to 9,000 mc and Mixer Diodes in frequencies from 3,000 mc to 9,000 mc. Contact your Sylvania representative for full information on the new subminiature microwave diodes—or write Sylvania directly.

**NEW SYLVANIA MICROWAVE DIODES**

D 4050—UHF Detector  
D 4063—X Band Video Detector

D 4064—S Band Mixer  
D 4065—X Band Mixer



**SYLVANIA**

SYLVANIA ELECTRIC PRODUCTS INC.  
Semiconductor Division  
100 Sylvan Road, Woburn, Mass.  
CIRCLE 358 ON READER-SERVICE CARD



NEW!

## KAY Magna-Sweep

ALL-ELECTRONIC SWEEPING OSCILLATOR

Displays Sweep Widths of 1000 mc and Wider

LOW BAND: 5-1000 MC — HIGH BAND: 2200-3800 MC

The *Magna-Sweep*, the new Kay sweeping oscillator employing the latest in high frequency techniques, incorporates a precision wavemeter of  $\pm 0.1\%$  accuracy for the measurement of output frequency on its direct-reading in-line digital counters. It is extremely useful in standard frequency alignment procedures for television, radar, or communications systems where very wide band coverage is needed. It may also be used as a wide-band spectrum analyzer or as a transistor alpha tester, as well as in wide-band filter and traveling wave tube investigations. With a suitable cable and detector, a wide-band Mega-Match for the measurement of standing waves may be made.

### SPECIFICATIONS

**Frequency Range:** Low band, 5-1000 mc; high band, approximately 2200-3800 mc.  
**Sweep Width:** 25 mc minimum to at least 1000 mc, continuously variable.  
**RF Output:** Low band, 0.1 volt rms into 50 ohms, flat within  $\pm 0.75$  db; high band, 1.5 volts rms into 50 ohms, flat within  $\pm 1.0$  db; AGC controlled. Powers up to 0.5 watt available on S-band by internal modification.  
**Spurious Output:** Up to 500 mc, more than 40 db down; above 500 mc, more than 30 db down.  
**Frequency Indicators:** Precision wavemeter,  $\pm 0.1\%$  accuracy, with direct-reading in-line digital counters for each band.  
**Built-in Detector:** Facilitates wide-band studies.  
**Sweep Output:** Regular sawtooth synchronized with sweeping oscillator. Amplitude 7 V approx.  
**Power Supply:** Input approx. 300 watts, 117-V ( $\pm 10\%$ ), 50-60 cps ac. B+ electronically regulated.  
**Dimensions:** 22" x 22" x 15" in cabinet; standard 19" rack panels.  
**Weight:** 150 lbs.  
**Price:** \$4950.00, f.o.b. factory.

Write for  
Kay Catalog 1959-A

**KAY ELECTRIC COMPANY**

Dept. ED-4 Maple Avenue

Pine Brook, N. J.

CApital 6-4000

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relays designed especially for

**VIBRATION  
and SHOCK**

The rotary-balanced armature design of Hi-G relays assures efficient operation of these important components even under severe vibration and shock — up to 20 or 30G out to 2000 cps. By design, very little momentum is built up in moving parts. For more complete information on the complete line of Hi-G relays, send for New 1959 Hi-G CATALOG.



HI-G THE ONLY COMPLETE LINE OF ROTARY BALANCED RELAYS

Hi-G offers complete engineering and production facilities to manufacture relays for specific applications. Your inquiries are invited.



S & R TYPES



SL TYPES



SM TYPES

BALANCED  
HI-G  
ROTARY

**HI-G INC.,**

BRADLEY FIELD/WINDSOR LOCKS, CONN.

CIRCLE 360 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

### Poly Bags Save Encapsulation Time, Money

One is often faced with the problem of trial encapsulation of small assemblies. The usual method involves weighing potting compounds in paper cups and transferring the compounds to disposable syringes. This leads to waste, contamination, and loss of time.

One solution of this problem is a simple one. The paper cup is retained as a support for a small polyethylene bag in which the potting compound is weighed. The poly bag is then twisted shut at the top. A hand-squeezing action thoroughly mixes the potting compound and hardener or catalyst. When the compound is suitably mixed, a corner of the bag is snipped off with scissors, and the proper amount can be squeezed out.

Small quantities of long gell-time compounds can be premixed and stored, under refrigeration, for several hours before use without danger of contamination.

The transparent bag technique facilitates inspection of the resin prior to injection, and is particularly effective with the RTV silicones.

*Herman A. Goetz, Chief Engineer, Impresario Distinguished Sound, New York, N. Y.*

### Reliable Shift Register With Fewer Components

Using a transistor analog of a gas tube, a reliable shift register can be built with fewer components. The analog consists of the two-transistor configurations shown in Fig. 1. The characteristic of the combination is shown in Fig. 2.

When  $E1$  is less than  $E2$ ,  $I1$  equals zero. When  $E1$  is greater than  $E2$ , the current  $I1$  flows when transistor  $Q2$  is momentarily pulsed into conduction. Conduction is maintained as long as  $E1$  exceeds  $E2$ . If  $E1$  is made less than  $E2$ , then  $I1$  drops to zero. Also, for  $E1$  greater than  $E2$ , the circuit may be extinguished by a momentary pulse applied to the base of  $Q2$ .

The circuit has an additional advantage in that it can be extinguished by a pulse applied to the base of  $Q2$ . Also, by adjusting  $E2$ , the firing voltage can be accurately controlled.

A four stage shift register, employing this basic circuit, is shown in Fig. 3. The load resistor  $R_L$  is common to all stages, so it can be designed to allow only one stage to be on at a time.

*T. T. Salih, Project Engineer, Lenkurt Electric Co., Inc., San Carlos, Calif.*

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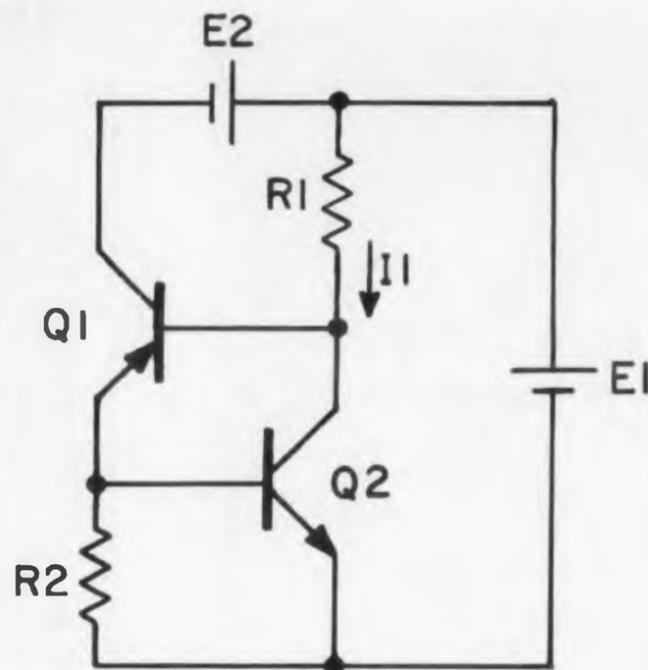


Fig. 1. Basic shift register using transistor analog of a gas tube.

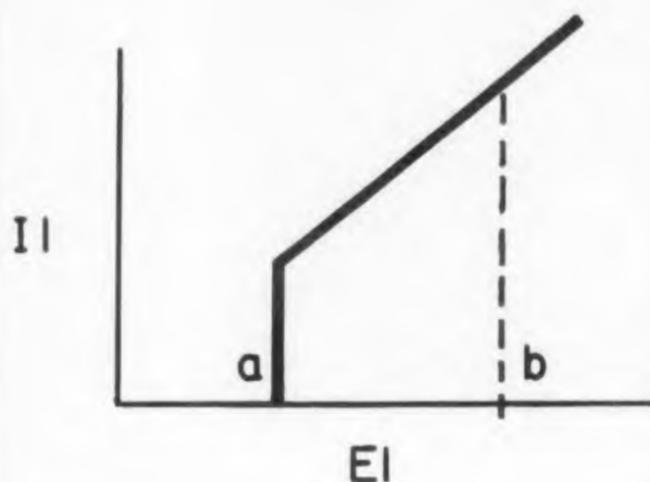


Fig. 2. Characteristic of the shift register of Fig. 1.

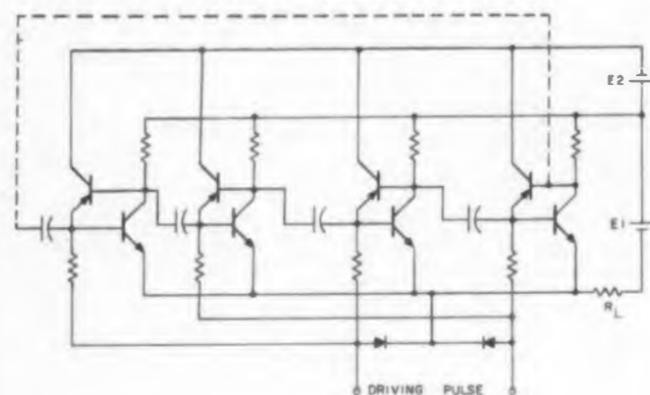


Fig. 3. A four stage transistorized shift register.

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## REPORT BRIEFS

### 2- to 4-KMC Band-Pass Stripline Filter

A 2- to 4-kmc stripline band-pass filter is described that has less than 1-db insertion loss throughout its pass band. A brief experimental treatment lists design pitfalls and how to avoid them. Drawings of the case and stripline details are provided. *Improved 2- to 4-KMC Band-Pass Stripline Filter*, Everett E. Guthrie, *Electronic Defense Laboratory, Mountain View, Calif.*, Apr. 1957, 9 pp, microfilm \$1.80, photocopy \$1.80. Order PB 134583 from Library of Congress, Washington 25, D. C.

### High Power Traveling Wave and Hybrid Tubes

Summarizes progress under three projects; Cloverleaf traveling-wave tube project, gridded electron gun project, and study of multicavity klystrons. *Development of High Power Traveling Wave and Hybrid Tubes*, Marvin Chodorow, E. L. Ginzton, *Microwave Laboratory, Stanford University, Calif.*, quarterly scientific report no. 2, Oct. 15, 1956-Jan. 15, 1957. May 1957, 19 pp, microfilm \$2.40, photocopy \$3.30. Order PB 132205 from Library of Congress, Washington 25, D.C.

### Solidified Wound Capacitors

A loaded resinous system, epoxy-titanium dioxide, was successfully applied as a high dielectric constant material for solid wound capacitors. The capacitors were shown capable of long-time performance at high temperatures under operational voltage, with the high dielectric constant supplying a substantial volume reduction for a given capacitance. The epoxy-titanium dioxide material applied in films of one mil or less on aluminum foil yielded dielectric constants of 15 to 19. Flat plate capacitors of coated aluminum foil tested at 150 C and applied voltages of 105 and 210 v dc operated successfully over 1000 hours. They maintained capacitance, dissipation factor, and insulation resistance. Highest microfarads product at 150 C was 54. Wound capacitors of coated aluminum foil with the dielectric material also operated 1000 hours at 210 v dc. The report includes descriptions of the dielectric, its application to aluminum foil and porous glass paper, measurement facilities, and sample capacitors. *Solidified Wound Capacitors*, J. A. Caputo, Emerson & Cuming, Inc. for Wright Air Development Center, U. S. Air Force, May 1958, 112 pp, \$2.50. Order PB 151203 from OTS, U. S. Department of Commerce, Washington 25, D. C.

### Barium Titanate Accelerometers

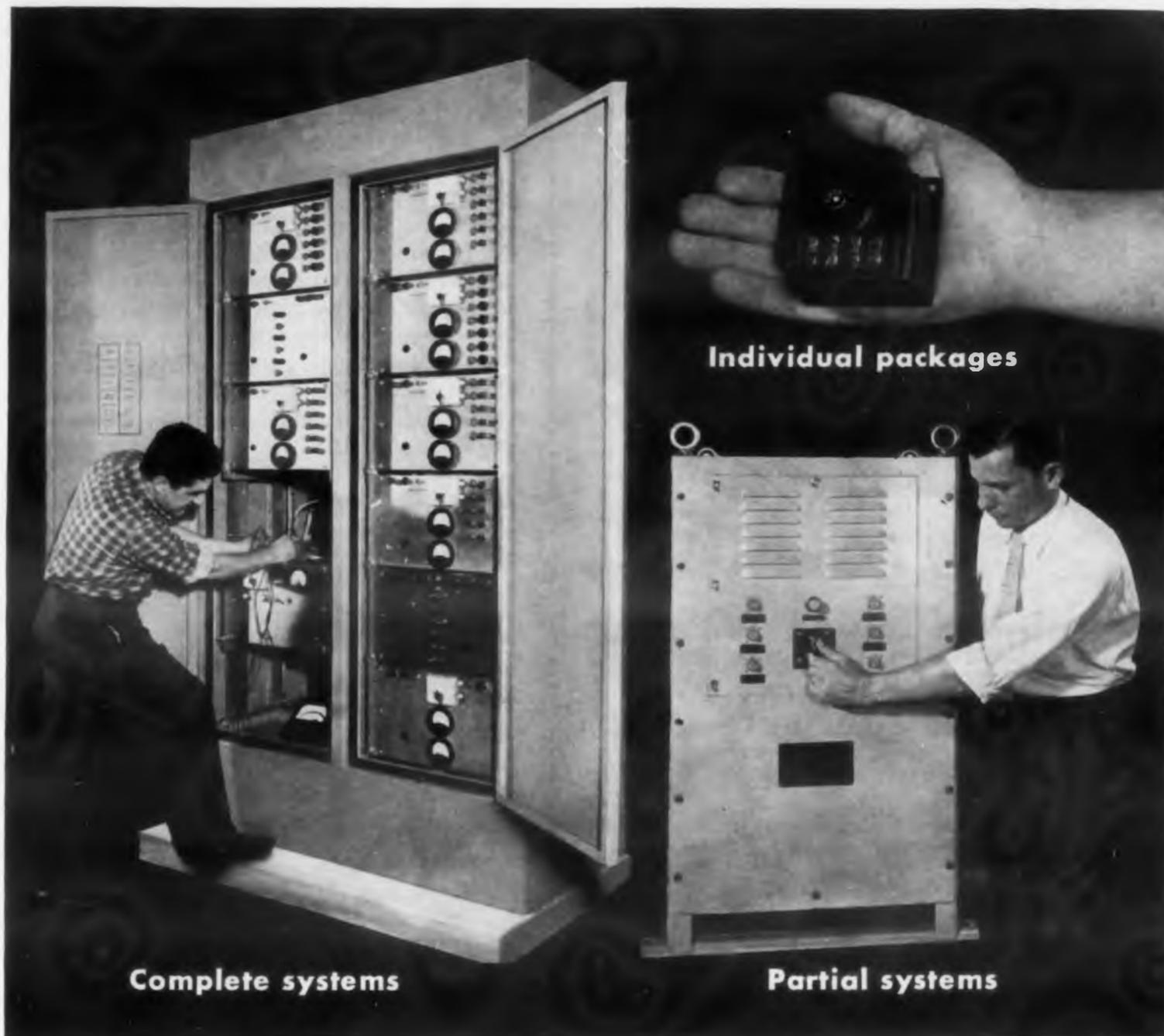
A summary of the proceedings of the Symposium of Barium Titanate Accelerometers held in Washington in 1953 contains papers and discussion sessions held at the four-day meeting of some 250 scientists and engineers from industry, universities, and U.S. and foreign agencies. The symposium was conducted as part of the Basic Instrumentation Program at the National Bureau of Standards under sponsorship of the Air Research and Development Command, the Office of Naval Research, and the Atomic Energy Commission. General subjects covered during the sessions were: the properties of barium titanate and titanate mixtures; design factors and performance tests of barium titanate accelerometers; and instrumentation associated with the accelerometers. *Proceedings of Symposium on Barium Titanate Accelerometers, T. A. Perls, National Bureau of Standards, U.S. Department of Commerce, Aug. 1953, 246 pp, \$4.00. Order PB 151161 from OTS, U. S. Department of Commerce, Washington 25, D.C.*

### Use of Delay Lines as Network Elements

Development of analysis and synthesis techniques for networks containing idealized distributed-constant elements, in addition to the usual set of lumped-constant elements having parameters, R, L, and C. Analysis procedures are directed toward finding transfer functions for a network containing an arbitrary interconnection of delay lines and lumped elements. A method for transient analysis based on the time-series representation is presented. *Use of Delay Lines as Network Elements, L. E. Franks, Stanford University, Stanford, Calif. July 1957, 131pp, microfilm \$6.90, photocopy \$21.30. Order PB 134795 from Library of Congress, Washington 25, D.C.*

### High-Frequency Silicon Switching Transistor

Development of the emitter contact of a gold-antimony doped npn silicon transistor is covered. Methods were found to deposit gold onto the emitter region that improved the wetting of the silicon by the gold during alloying. Studies of solubility of antimony in silicon versus temperature of alloying and resistivity versus temperature of alloying were undertaken. Studies of doping effects of arsenic and phosphorous on silicon were undertaken. A method to decrease base resistance employs a low-resistance skin surrounding the emitter. *High-Frequency Silicon Switching Transistor, R. A. Williams, Philco Corp., Philadelphia, Pa. Aug. 1957, 29pp, microfilm \$2.70, photocopy \$4.80. Order PB 132583 from Library of Congress, Washington 25, D.C.*



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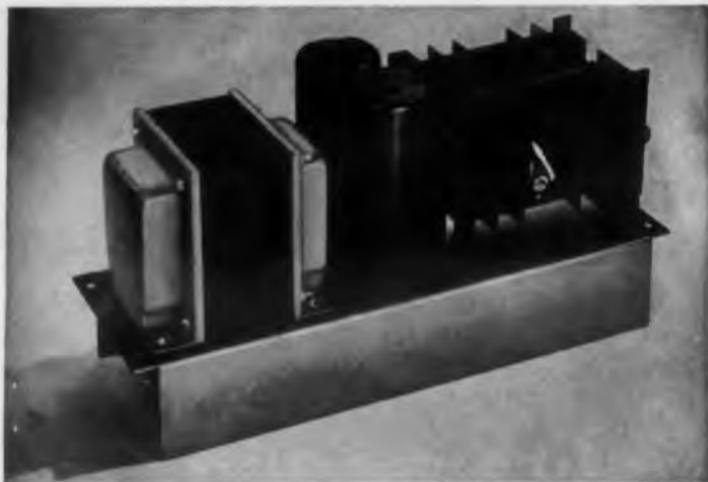
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22-115	17-22 VDC @ 0-1.5 amp.
22-116	22-27 VDC @ 0-1 amp.
22-117	27-32 VDC @ 0-1 amp.

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## REPORT BRIEFS

### In-flight Comparison of Pilot Performance

This report concerns an in-flight comparison of pilot performance using the standard Air Force instrument panel with performance employing an experimental panel. The ID-249 cross-pointer type instrument and the Zero Reader instrument were used on the experimental panels. Although the pilots expressed a preference for the standard panel, with most favorable scores were made with the experimental panel employing the Zero Reader. It was found that experienced pilots could transfer from one panel to the other without difficulty and that no special training was necessary to fly acceptable ILS approaches with the experimental panel. *In-Flight Comparison of Pilot Performance On A Standard ASAF and An Experimental Instrument Panel*, J. F. Gardner, R. J. Lacey, C. M. Seeger, and J. E. Wade, Wright Air Development Center, U. S. Air Force, Sept. 1957, 23 pp, \$0.75. Order PB 131652 from OTS, U. S. Department of Commerce, Washington 25, D. C.

### Image Line Coupler

At about 20 kmc and higher frequencies, the dimensional tolerances of metal waveguide and the various components associated with it become quite critical. Furthermore, as the dimensions decrease in size, resistive losses increase. Metals with high conductivity, such as silver, must be used. If, however, a dielectric guide is used, an economical and easily manufactured means for guiding electromagnetic energy is achieved. *Image Line Coupler*, B. S. Packer and D. J. Angelakos, California University, Division of Electrical Engineering, Berkeley, Calif. July 1957, 35pp, microfilm \$3.00, photocopy \$6.30. Order PB 134729 from Library of Congress, Washington 25, D. C.

### Radiation and Reception of Electromagnetic Energy from Aircraft and Guided Missiles

The present contract is the third in support of a basic research program. The aim of this program has been to provide the aircraft industry with new or improved measuring techniques, new concepts and increased understanding of radiating systems, with an ever-increasing fund of basic design data. *Radiation and Reception of Electromagnetic Energy from Aircraft and Guided Missiles*, R. L. Tanner, Stanford Research Institute, Menlo Park, Calif. Jan. 1958, 22pp, microfilm \$2.70, photocopy \$4.80. Order PB 133957 from Library of Congress, Washington 25, D. C.

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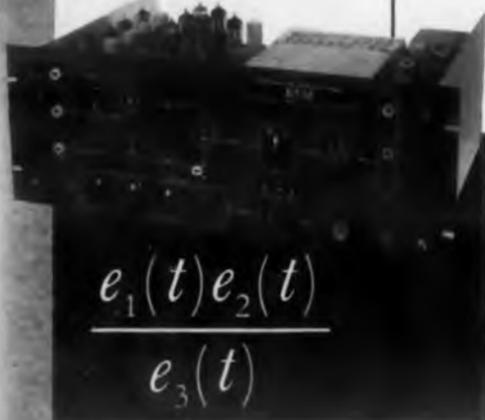
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### Component Evaluation and Specification Engineering. Final Report

Throughout the investigation, damages and failures were evaluated by visual inspection and observed resistance changes both during and after the force applications. The report contains data in appropriate tabular form, descriptions of procedures, equipment instrumentation, and specimen mounting fixtures as well as summary comments concerning each operation on each type of component. *Component Evaluation and Specification Engineering*, P. G. Perry and E. G. Lebre, Jr., Battelle Memorial Institute, Columbus, Ohio, Jan. 1955, 97pp, microfilm \$5.40, photocopy \$15.30. Order PB 134535 from Library of Congress, Washington 25, D.C.

### Ferrite Rod Wave-Guide

Electro-magnetic properties of a ferrite rod wave-guide at microwave frequencies are investigated. The rod was uniformly magnetized in the longitudinal direction and excited from the end of a circular wave-guide propagating a circularly polarized  $TE_{11}$  mode. The general behavior of ferrites at microwave frequencies is reviewed and the determinantal equation for the propagation constant of the characteristic modes of the ferrite rod is derived. *Ferrite Rod wave-Guide*, Byron N. Edwards, Electronics Research Laboratory, Berkeley, Calif. Mar. 1957, 35pp, microfilm \$3.00, photocopy \$6.30. Order from Library of Congress, Washington 25, D.C. PB 133537.

*Products, Inc., Mountain View, Calif. Mar. 1956,*

### Project Vanguard Report No. 36

The time standard described is a basic part of the Minitrack satellite tracking system. If adjusted properly it can maintain a time reference at each satellite tracking station of plus or minus 1.0 millisecond. With the exception of the local-oscillator frequencies, all measurement frequencies used in the Minitrack system are derived from the basic time standard and are phase-coherent. The time of day is read in a serial code during the first 5 seconds of each 6-second interval. This code is available as relay contact closures or as voltage pulses from a low-impedance source. The serial time code and the various standard frequencies (100 kc, 10 kc, 1 kc, 100 cps, 10 cps, 1 cps) are available from transformer outputs suitable for feeding 50-ohm or 500-ohm lines. *Project Vanguard Report No. 36: Minitrack Report No. 8—Time Standard*, C. A. Schroeder, E. J. Habib, and W. R. Silvester, Naval Research Laboratory, Oct. 1958, 44 pp, \$1.25, Order PB 151169 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

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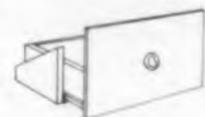
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## REPORT BRIEFS

### Component Failure Rate and Weighting

This report provides a basis for the assignment of reliability numbers suitable for use in the assessment of the relative reliability of each of several possible system mechanizational solutions. The accuracy of the method is sufficient for the preliminary design stage of system development. To obtain basic component data, a reliability literature search was conducted and a large number of industrial and governmental agencies were visited. The results of this survey are summarized in the form of failure rate tables for electronic, electromechanical, mechanical, and hydraulic components. *Component Failure Rate and Weighting*, Donald E. Johnston and Duane T. McRuer, Kelsey-Hayes, Inglewood, Calif. Dec. 1957, 53pp, microfilm \$3.60, photocopy \$9.30. Order PB 135050 from Library of Congress, Washington 25, D.C.

### Increasing Facsimile Transmission Speed

Description of a method of improving short-wave facsimile transmission by the automatic removal of multi-path echoes. The equalizer operates on narrow pilot pulses that are added to the transmitted video signal. The pilot pulses are cancelled before the video signal reaches the receiving facsimile unit. The pilot pulses can also be used to synchronize the receiving facsimile unit drum so that distortion caused by changes in effective transmission time is minimized. *Increasing Facsimile Transmission Speed*, A. E. Laemmel and S. Deutsch, Microwave Research Institute, Brooklyn, N.Y. Apr. 1957, 45pp, microfilm \$3.30, photocopy \$7.80. Order PB 134724 from Library of Congress, Washington 25, D.C.

### Nuclear Radiation Effects on Semiconductor Materials and Devices

Discussion on some of the presently available information on the effects of radiation (primarily neutron and gamma radiation) on semiconductor materials and devices. Discrepancies in some of the results obtained are indicated, and suggestions are made for further experimentation. *Nuclear Radiation Effects on Semiconductor Materials and Devices*, Bernard Reich and G. Edward Pavlik, U.S. Signal Corp Engineering Laboratories, Fort Monmouth, N.J., June 1957, 18pp, microfilm \$2.40, photocopy \$3.30. Order PB 134783 from Library of Congress, Washington 25, D.C.



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TYPICAL OPERATION	D-C Plate Voltage (Volts)	Power Input (Watts)	Driving Power (Watts)	Power Output (Watts)
Class-C Amplifier				
Telegraphy or FM	2000	500	3	390
Plate Modulated	1500	300	2	235
Class-AB <sub>1</sub> Amplifier				
Audio (Two tubes)	2000	1000	0	600
SSB (One tube)	2000	500	0	300



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- Dual, self-checking turns counting system
- Loading (wire length) counter
- Core range:  $\frac{1}{4}$ " I.D. to 4" O.D. to  $1\frac{1}{2}$ " high

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- Change wire and core in 45 sec.

#### PRODUCTION USE

- 1500 turns per minute
- Insert core and load in 20 sec.

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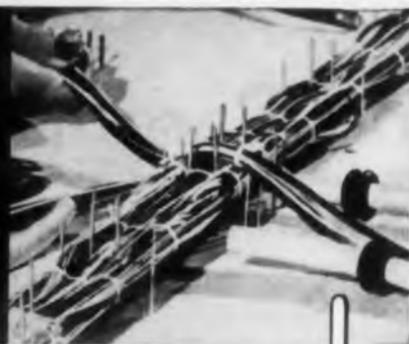
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## Photoelectric Function Generator

A photoelectric function generator has been designed and implemented which permits the generation of an electrical signal varying in time proportional to the amplitude of any desired single-valued function. It will be used to generate the antenna beam pattern in the Single Target Search Radar Simulator developed at the Columbia University Electronics Research Laboratories. This and previous methods of function generation are discussed in this paper, and the relative advantages of the present system are described. *Photoelectric Function Generator, Barbara Silverberg, Columbia University, New York, N. Y. Oct. 1957, 25pp, microfilm \$2.70, photocopy \$4.80. Order PB 134952 from Library of Congress, Washington 25, D.C.*

## 200-Megacycle Transistorized Oscillator

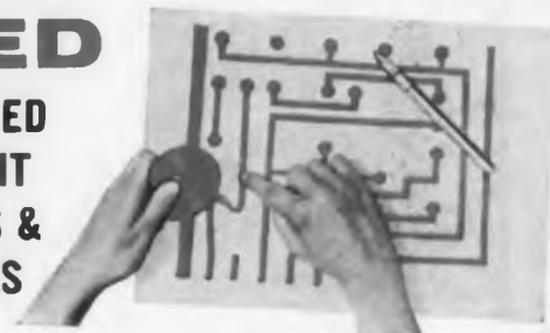
A test oscillator was built, using a trial-and-error method of construction, after design attempts using four-pole parameters failed. Measurements were made on this oscillator with three different transistors used as the active element. From a comparison of the power equations and the measurements obtained, it is concluded that some correlation exists between collector capacitance and bias, and the maximum possible power output for any one transistor. *200-Megacycle Transistorized Oscillator, Edward B. Richter, U.S. Air Force, Dayton, Ohio, Mar. 1958, 53pp, microfilm \$3.60, photocopy \$9.30. Order PB 134689 from Library of Congress, Washington 25, D.C.*

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## RUSSIAN TRANSLATIONS

# Nonlinear and Parametric Phenomena in Radio Engineering

Part 16

(Translated by J. George Adashko)

A. A. Kharkevich

Chapter 2

## Generation of Oscillations

### 25. Graphic Methods

Phase diagrams make it possible to represent simply and clearly, in graphic form, various oscillatory phenomena and also properties of various systems (passive networks, self-oscillating systems).

However, this is not the only purpose of phase diagrams. Plots in the phase plane serve not merely as illustrations, but as the basis for graphic methods of solving nonlinear equations. What is important is that the graphic solution requires no simplifying assumptions such as the assumption that the nonlinearity is small or that the solution is sinusoidal.

When we speak of solving a nonlinear problem by means of a graphic construction in the phase plane, we mean that the solution is obtained in the form of a phase portrait. The phase portrait furnishes us with all the necessary information on the behavior of a system described by the given nonlinear equation. The phase portrait shows all possible modes under all initial conditions. In particular, it shows the limit cycles if they exist. The phase portrait makes it possible to evaluate the stability of the limit cycles, for the shape of the limit cycle determines the waveform of the oscillations.

One of the most universal graphic methods is the method of isoclines. This method makes it possible to plot the phase portrait of a system described by a nonlinear second-order differential equation of the following form.

$$Q'' + \phi(Q') + \psi(Q) = 0 \quad (1)$$

We introduce

$$I = \frac{dQ}{dt}$$

Equation (1) is then rewritten

$$\frac{dI}{dt} = -\frac{\phi(I) + \psi(Q)}{I} \quad (2)$$

Dividing (2) by  $I$  we get

$$\frac{dI}{dQ} = -\frac{\phi(I) + \psi(Q)}{I} \quad (3)$$

In this equation  $dI/dQ$  is the slope of the tangent to the phase trajectory at a given point, i.e. at a point with coordinates  $Q$  and  $I$ . Choosing any point, we can determine its coordinates by calculating the right half of (2), and thus determine the direction of the phase trajectory at the given point.

Having calculated the values of  $dI/dQ$  from any points, we can plot in the phase plane a direction field as shown in Fig. 82. From the arrows that indicate the slope of the phase trajectory at the given points, it is possible to plot a family of trajectories, i.e., a phase portrait, with any desired degree of accuracy. This accuracy obviously increases with increasing number of points. It is convenient to plot lines along which the direction of the trajectory (i.e., the slope of the tangent to the trajectory) remains constant. These lines are called isoclines (lines of equal inclinations). The equation of the isocline is of the form

$$\frac{\phi(I) + \psi(Q)}{I} = \text{constant}$$

Let us illustrate this with a simple example of the linear system, described by the equation

$$\frac{dI}{dt} + \omega_0^2 Q = 0$$

In this case

$$\phi(I) = 0, \quad \psi(Q) = \omega_0^2 Q$$

and the equation of the isoclines is

$$\frac{Q}{I} = \text{constant}$$

which represents a family of straight lines passing through the origin. The plotting of the corresponding phase portrait is shown in Fig. 83. This is the portrait of a lossless tank circuit.

In many cases we can restrict ourselves to an equation less general than (1), namely

$$Q'' + \phi(Q') + Q = 0 \quad (4)$$

This is the form to which it is possible to reduce the equations of most oscillators used in radio engineering. The graphic solution of eq (4) can be obtained without auxiliary calculations by a purely graphic method, known as the Lienard construction. This construction is based on the following. We have instead of (3)

$$\frac{dI}{dQ} = -\frac{\phi(I) + Q}{I} \quad (5)$$

We plot in the phase plane the curve

$$Q = -\phi(I) \quad (6)$$

(Fig. 84). From an arbitrary point A with coordinates  $(Q, I)$  we draw, parallel to the  $Q$  axis, a straight line which intersects the curve (6). From the point of intersection B we drop a perpendicular to the  $Q$  axis. The base of the perpendicular

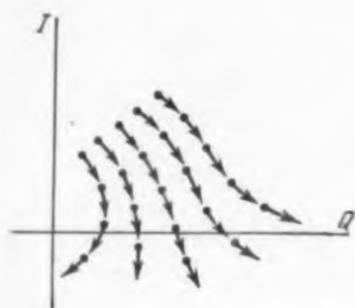


Fig. 82. A direction field plotted in the phase plane.

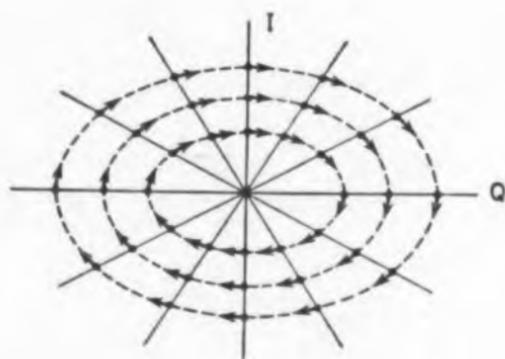


Fig. 83. This family of straight lines passing through the origin is the phase portrait of a lossless tank circuit.

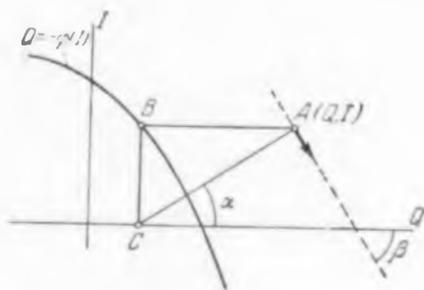


Fig. 84. The Leonard construction starts as a plot of charge vs current in the phase plane.



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**RUSSIAN TRANSLATIONS**

is denoted  $C$ . We then have

$$\overline{BA} = Q + \phi(I), \quad \overline{BC} = I$$

$$\frac{\overline{BC}}{\overline{BA}} = \frac{I}{Q + \phi(I)}$$

The second expression is merely the expression for the tangent of  $\alpha$ , the angle between the line  $CA$  and the  $Q$  axis. On the other hand to draw the line whose slope relative to the  $Q$  axis is

$$\tan \beta = \frac{dI}{dQ} = - \frac{\phi(I) + Q}{I} = - \cot \alpha$$

it is necessary to draw a line perpendicular to  $CA$  at the point  $A$ . This perpendicular is indeed in the direction of the phase trajectory at the point  $A$ . Thus the procedure for the Lienard construction is: 1. reduce the equation to form (4) and plot the characteristic curve (6); 2. draw the right triangle  $ABC$ ; 3. draw a perpendicular to the hypotenuse  $AC$ . This perpendicular gives the sought direction of the trajectory at the point  $A$ .

Let us illustrate the Lienard construction, using as an example a vacuum tube oscillator, whose nonlinear equation is (see Sec. 21)

$$U'' + \frac{1}{L} \left( R - \frac{MS}{C} \right) U' + \omega_0^2 U = 0 \quad (7)$$

or

$$U'' + f(U) U' + \omega_0^2 U = 0 \quad (8)$$

(since the transconductance  $S$  depends on the voltage  $U$ ). To reduce eq (8) to the same form as eq (4), we first introduce the dimensionless ("proper") time

$$\tau = \omega_0 t$$

Then

$$\frac{dU}{dt} = \frac{dU}{d\tau} \frac{d\tau}{dt} = \omega_0 \frac{dU}{d\tau}; \quad \frac{d^2U}{dt^2} = \omega_0^2 \frac{d^2U}{d\tau^2}$$

and we get

$$U'' + \frac{1}{\omega_0} f(U) U' + U = 0 \quad (9)$$

The primes now denote differentiation with respect to  $\tau$ . We now introduce a new variable

$$x = \int U d\tau \quad (10)$$

and define a certain function  $F(x') = F(U)$  by means of the relation

$$F(x') = \frac{1}{\omega_0} \int f(U) dU \quad (11)$$

Let us integrate eq (9) with respect to  $\tau$ :

$$\int U' d\tau + \frac{1}{\omega_0} \int f(U) U' d\tau + \int U d\tau$$

$$= U' + \frac{1}{\omega_0} \int f(U) dU + \int U d\tau$$

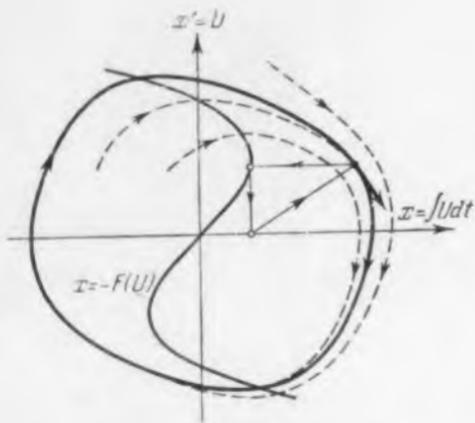


Fig. 85. The phase portrait of a soft oscillator, shown as a cubic parabola.

Substituting  $x$  for  $U$  on the basis of eq (10), we get

$$x'' + F(x') + x = 0 \quad (12)$$

i.e. an equation identical with (4). The coordinates of the phase plane will now be  $x$  and  $x' = U$ , i.e., the voltage and the integral of the voltage. We must first plot the characteristic curve

$$x = -F(U)$$

We have

$$\begin{aligned} \pi(U) &= \frac{1}{\omega_0 L} \int f(U) dU = \frac{1}{\omega_0 L} \int \left( R - \frac{MS}{C} \right) dU \\ &= \frac{1}{\omega_0 L} \left[ RU - \frac{M}{C} \int S(U) dU \right] \end{aligned} \quad (13)$$

us consider the case of soft excitation, for which

$$S(U) = a_1 + 3a_3 U^2 = S_0 + 3a_3 U^2 \quad (14)$$

(See Sec. 21). Inserting (14) into (13) we find

$$F(U) = \frac{1}{\omega_0 L} \left[ \left( R - \frac{MS_0}{C} \right) U - \frac{M}{C} a_3 U^3 \right] \quad (15)$$

The curve

$$x = -F(U)$$

is thus a cubic parabola, as shown in Fig. 85. The procedure becomes graphic, as shown in the same diagram. The result is the phase portrait of a soft oscillator, which is already known to us.

It must be noted, however, that we learned more than what the quasi-linear theory taught us, for we obtained the waveform of the oscillations, which, in a nonlinear system, must naturally differ from sinusoidal. This is reflected in the plot of Fig. 85 by the fact that the limit cycle is not an ellipse.

## 26. Several Oscillator Circuits

So far when we spoke of vacuum-tube oscillators we used only one classical circuit with a tuned grid circuit and inductive feedback. This



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## RUSSIAN TRANSLATIONS

was done to demonstrate various approaches and methods as applied to the same object of investigation.

Let us now consider several other oscillator circuits and take the opportunity to clarify one basic problem pertaining to feedback. The tuned-grid oscillator circuit is repeated in Fig. 86. Fig. 87 shows an oscillator with a tuned plate circuit. The circuit with auto-transformer coupling of Fig. 88 does not differ in principle from the other two; it is frequently called the three-point circuit.\*

Feedback can be capacitive as well as inductive. The feedback signal can be applied to the grid by using the grid-to-plate capacitance. If this is not sufficient, a supplementary feedback capacitor is connected between the grid and the plate as shown in Fig. 89.

A feature common to the circuits of Figs. 86 to 89 is that all have a distinct (external) feedback circuit and that the feedback can be adjusted by varying a certain parameter of this circuit, such as the coupling coefficient in the circuits of Figs. 86 and 87, the transformer ratio in Fig. 88, and the grid-to-plate capacitance in Fig. 89.

In many oscillators, however, the feedback proceeds via hidden channels, which cannot be displayed in the diagram in the form of a separate feedback loop. The feedback exists in such oscillators, inasmuch as we have shown in Sec. 15 that feed back is an essential element of any self oscillating system. To understand fully the performance of oscillators with intrinsic feedback, the mechanism of this feedback must be clarified.

We shall examine briefly the dynatron and transitron oscillators as examples of oscillators with intrinsic feedback. The action of the dynatron oscillator is based on the secondary electron emission from the anode when it is bombarded by the incident electrons from the cathode.

If several secondary electrons are produced by a single primary electron the current component due to the secondary electrons exceeds the primary-emission current. This may cause the plate current to diminish or even reverse. Obviously, the higher the velocity of the primary electron the more secondary electrons it can produce. The electron velocity depends on the accelerating voltage. Any suitable triode can be used as a dynatron.

It must be noted that if the triode is used as a dynatron, its plate is no longer the anode. The purpose of this electrode is now to emit second-

\* Often called the Hartley oscillator.



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ary electrons. To emphasize this circumstance, the plate of a triode operating in the dynatron mode is frequently called the dynode. As to the grid of the triode, a high positive potential is applied to it in the dynatron mode, so that it acts as the anode.

The characteristics of the dynatron, i.e., the dependence of the current  $I_d$  in the dynode circuit on the dynode voltage  $U_d$  are shown in Fig. 90.

The three curves of Fig. 90 pertain to three different anode voltages; the higher the plate voltage, the further to the right does the characteristic extend.

(Continued on following page)

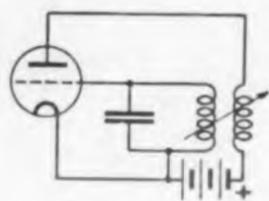


Fig. 86. A basic tuned-grid oscillator.

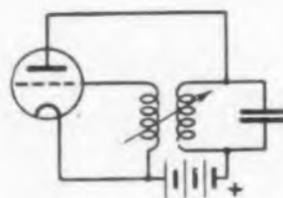


Fig. 87. A tuned-plate oscillator.

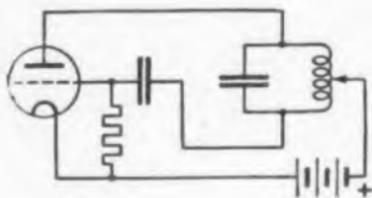


Fig. 88. A Hartley oscillator.

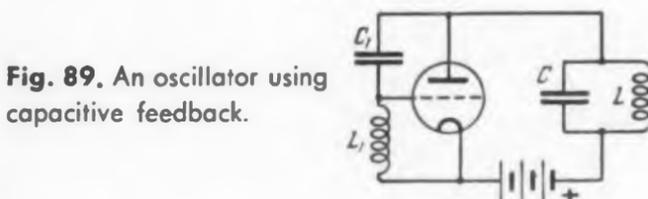


Fig. 89. An oscillator using capacitive feedback.

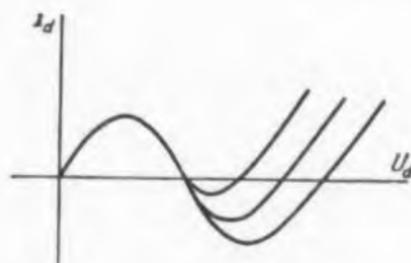


Fig. 90. Plate current vs plate voltage in a dynatron oscillator for three different plate voltages.

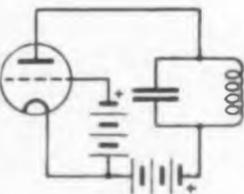
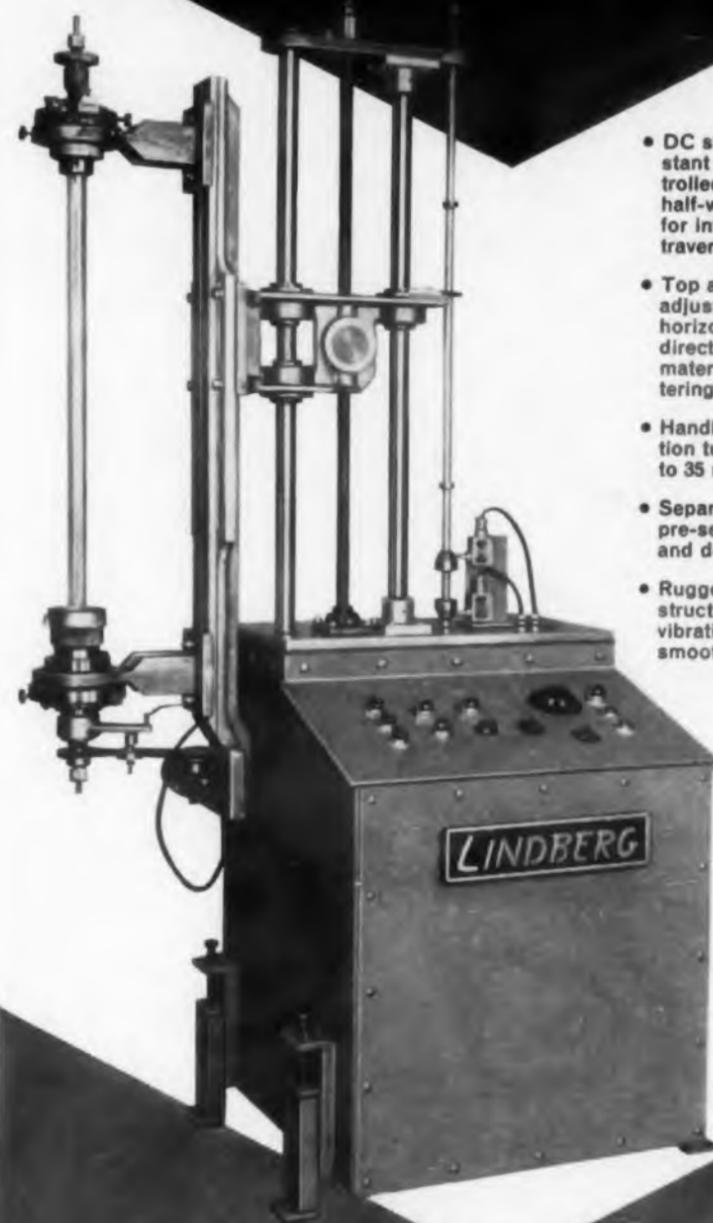


Fig. 91. A dynatron oscillator.

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## RUSSIAN TRANSLATIONS

We see that the volt-ampere characteristic of the dynatron has a descending portion, where the dynatron acts as a negative resistance and can therefore be used as an oscillator. A dynatron-oscillator triode circuit is shown in Fig. 91.

The slope of the decreasing portion of the volt-ampere characteristic, and consequently the magnitude of the negative resistance, depends on the emission current. The emission of the triode can be varied only by changing the filament current. It is therefore preferable to use tetrodes for dynatron circuits, in which the tetrode emission current can be controlled by varying the voltage on the first grid.

The feedback mechanism in a dynatron oscillator is exceedingly simple: the tank circuit voltage is applied directly to the dynode, so that it controls the dynode current. The feedback thus acts via the same circuit from which the tank circuit is fed. By suitably establishing the phase relationship, the operation is on the diminishing portion of the characteristic.

We turn now to the transitron oscillator. We take a tetrode with limited total emission (i.e., with a tungsten cathode) and connect it as shown in Fig. 92. A negative voltage is applied to the second grid so that no current flows in its circuit.

As to the current of the first grid  $I_1$ , its value, together with that of the anode current  $I_a$ , should equal the emission current. Thus any variation in  $I_1$  can occur only by redistribution of the emission current among the first grid and the anode.

Under certain conditions, an increase in the positive voltage on the first grid, and consequently also on the second grid (the two grids are interconnected through a battery), can cause an increase in the plate current and consequently a reduction in  $I_1$ . Thus the curve of the current of the first grid vs the voltage of the first grid may have a section with a negative slope, i.e., a negative resistance may exist between the first grid and the cathode.

The feedback in the transitron oscillator manifests itself in the fact that the tank circuit voltage controls the redistribution of the currents. The feedback acts simultaneously through two loops, namely the two grid circuits.

Practical transitron oscillator circuits employ tetrodes or hexodes, in which the first grid serves

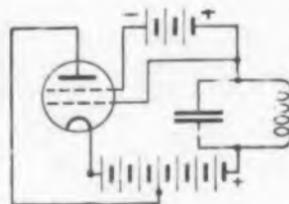


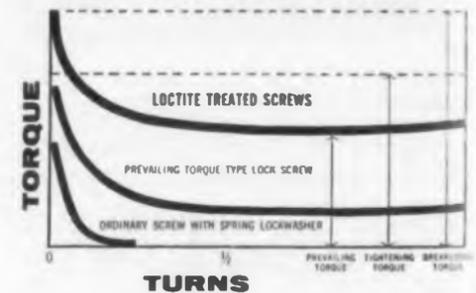
Fig. 92. The transitron oscillator.

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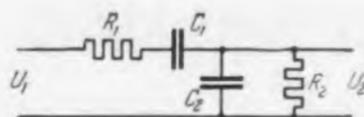


Fig. 93. A simple RC network can become the basis of an RC oscillator.

to limit the total emission current. By varying the voltage of the first grid it is possible to control the value of the negative resistance.

## 27. RC Generators of Sinusoidal Oscillations

In the oscillators discussed so far the generated frequency was determined by an LC tank circuit, which comprised the oscillating system of the generator. The question arises, under what conditions can the same result be obtained by using circuits made up of only resistances and capacitances.

We already know that the oscillator equation is a second-order equation in which, through the effect of feedback, the multiplier of the first derivative term vanishes. Consequently if we build up a circuit comprising resistances and capacitances, describable by the same equation, our circuit will have the same properties as an ordinary oscillator. (Such a conclusion is based on the assumption that the differential equations correctly represent the real properties of the circuit.)

Consequently, to construct an RC oscillator we must first build up an RC network that can be described by a second-order differential equation, analogous to that of an ordinary tank circuit. But, we know that a simple network containing only R and C is described by a first order equation. We must therefore change from a simple network to a more complex one, with at least two degrees of freedom.\*

Let us examine the circuit of Fig. 93. The equation relating the voltages at the input and at the output is of the form

$$U'_2 + 2\alpha U_2 + \omega_0^2 \int U_2 dt = \frac{1}{R_1 C_2} U_1 \quad (1)$$

where

$$\omega_0^2 = \frac{1}{R_1 R_2 C_1 C_2} \quad (2)$$

$$2\alpha = \frac{1}{R_1 C_1} + \frac{1}{R_2 C_2} + \frac{1}{R_1 C_2} \quad (3)$$

\* The number of degrees of freedom in an electric network is determined by the number of independent currents that can flow through the network. The number of degrees of freedom may depend also on the minimum number of discontinuities capable of blocking the flow of current in the network.

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## RUSSIAN TRANSLATIONS

Equation (1) is quite analogous to that of an *RCL* series circuit. If we now add an amplifier to the circuit and provide a feedback connection from the output to the input, we obtain a circuit capable of generating sinusoidal (more exactly, nearly sinusoidal) oscillations. (Fig. 94.)

Let us set up the equation for the circuit of Fig. 94. Let the gain of the amplifier be

$$K = U_1/U_2 \quad (4)$$

(We note that we have retained the symbols of Fig. 93, so that  $U_1$  is the output voltage of the amplifier and  $U_2$  its input voltage). Using (4) to express  $U_1$  in terms of  $U_2$  in the right half of eq (1), and rearranging, we get

$$U''_1 + \left( \frac{1}{R_1C_1} + \frac{1}{R_2C_2} + \frac{1-K}{R_1C_2} \right) U'_1 + \frac{1}{R_1R_2C_1C_2} U_1 = 0 \quad (5)$$

which is the usual oscillator equation. The self-excitation condition is obtained by subjecting the coefficient of the first derivative to the following condition

$$\frac{1}{R_1C_1} + \frac{1}{R_2C_2} + \frac{1-K}{R_1C_2} < 0 \quad (6)$$

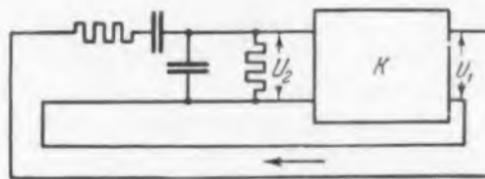


Fig. 94. With amplification added and proper feedback, the RC network of Fig. 93 becomes an oscillator.

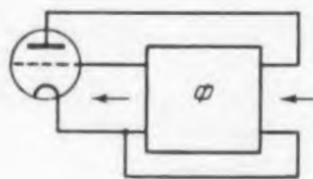


Fig. 95. In this type of oscillator, feedback is applied to the triode grid through a phase-shifting two-port network.

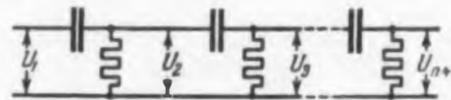


Fig. 96. A ladder type phase shift network.

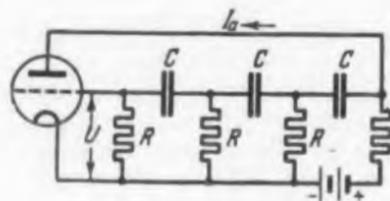


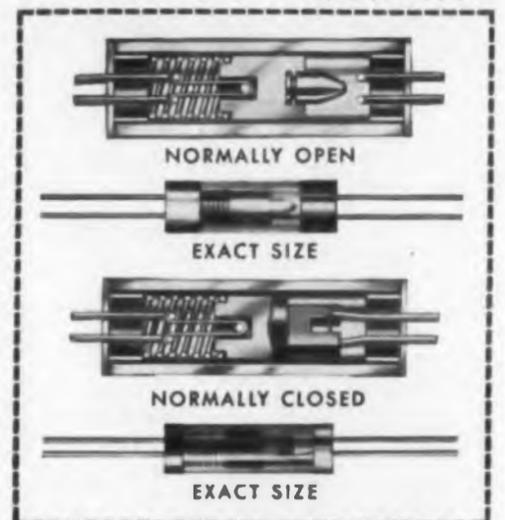
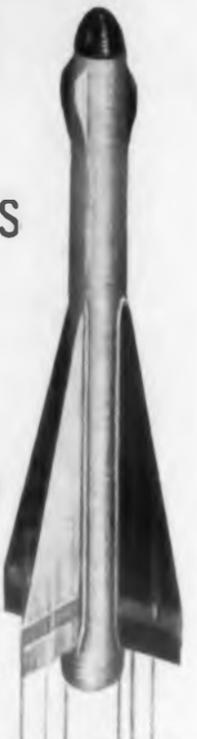
Fig. 97. The single tube phase-shift oscillator.

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Obviously, to satisfy the self-excitation condition it is necessary to have a sufficiently large gain  $K$ .

Concerning the circuit of Fig. 94, we must furthermore remark that relation (4) is satisfied only if there is an even number of amplification stages, since each stage produces a phase shift of 180 deg. Therefore, if the number of stages is odd we obtain negative feedback instead of the required positive feedback. Consequently the number of tubes in the amplifier of Fig. 94 must not be less than two and this circuit is frequently called the two-tube RC oscillator circuit.

We can also proceed to construct an RC oscillator circuit in a different manner. Any circuit that can be reduced to the block diagram of a self-oscillating system as shown in Fig. 53 will generate oscillations of steady frequency and of steady amplitude, provided the amplitude and phase balance condition are satisfied in a stable manner. The first condition determines the amplitude and the second the frequency of the steady-state oscillations.

The amplitude-balance condition is satisfied by choosing a suitable gain. On the other hand, to satisfy the phase-balance condition it is essential that the feedback be positive at a given frequency (i.e. at that frequency which the oscillator generates or should generate). Thus, the circuit of Fig. 95, in which the feedback is applied to the triode grid through a phase-shifting two-port network  $\Phi$ , can oscillate at a frequency for which the phase of the voltage is shifted by the two-port network by exactly 180 deg. (since the tube itself produces a phase shift of 180 deg).

These arguments point the way towards constructing a single-tube RC oscillator. The phase-shifting network can be of the ladder type, consisting of several RC elements as shown in Fig. 96. Each element produces a phase shift which is less than 90 deg. Thus, to obtain a phase shift of exactly 180 deg one must have not less than 3 elements. The resultant single-tube RC oscillator circuit is shown in Fig. 97. Putting  $I_a = SU$  and setting up the equation of the circuit we can derive the self excitation condition

$$R_a S > 29 + 23 \frac{R_a}{R} + 4 \frac{R_a^2}{R^2}$$

and the expression for the frequency

$$\omega_0 = \frac{1}{RC} \sqrt{\frac{R}{6R + 4R_a}}$$

We must indicate that the equation of a three-element circuit is of third order. Of the three roots of the characteristic equation, one is negative and real and the other two are complex; these are the roots that determine the frequency and the attenuation.

(To be continued)

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# East German Special Conference On Noise

**Abstractor's Note.** The December 1958 issue of the (East) German magazine *Nachrichtentechnik* is devoted to the papers which were presented at a special conference on Noise held at Gera on August 20-21, 1958. The technical papers of that issue are briefly described below:

- "Mathematical Methods in Noise Calculations" by K. Lunze, pp 530-537. Calculation of spectrum on effective value of stochastic function. Calculation of noise figures in networks.
- "Noise in Semiconductor Diodes" by W. Drechsel pp 538-541. Abstract follows.
- "Equivalent Circuits for Noise Calculations of Transistors" by C. Winkler pp 542-547. Abstract follows.
- "Contribution to the Theory of Noisy Quadripoles" by R. Paul pp 548-568. General equivalent circuits of noisy quadripoles. Noise figures for important elements. Noisy components in systems. Examples of series, parallel and cascade connections.
- "Noise in Oxide Semiconductors under load at Low Frequencies" by K. Leberwurst pp 568-579.
- "Noise of Resistors and Resistor Combinations with and without Load" by K. Lunze pp 580-584. Abstract follows.
- "Flicker Noise of Tubes at Low Frequencies" by H. Mutschke, pp 585-590.

## GERMAN ABSTRACTS

E. Brenner

# Transistor Noise

**T**RANSISTOR noise can be represented by means of two basically different circuit descriptions. If the representation is to be based on noise measurements, then the three terminal circuit of Fig. 1 (noise sources  $v$  and  $i$  are external to the network) may be used. In the second representation, the noise sources are represented as the calculated internal sources shown in Fig. 3.

The noise sources in Fig. 1 are given by

$$\overline{v^2} = 4kTR_n \Delta f \quad (1)$$

$$\overline{i^2} = 4kTg_n \Delta f \quad (2)$$

and are not incoherent. They are correlated through the complex correlation factor  $K$  where

$$K = (\overline{v i^*}) / (\overline{v v_p^*} \overline{i i^*})^{1/2} \quad (3)$$

which defines the correlating impedance  $Z_{cor}$

$$Z_{cor} = R_{cor} + jX_{cor} = K (R_n/g_n)^{1/2} \quad (4)$$

When a voltage source, in series with its output

impedance  $Z_s$ , is applied to the transistor the noise factor,  $F_z$ , is:

$$F_z = \overline{v_{tr}^2} / \overline{v_n^2} \quad (5)$$

where  $v_{tr}$  is the equivalent noise source due to the two sources shown in Fig. 1. For real source impedance,  $Z_s = R_s$ , Eq. 5 reduces to

$$F_z = R_n/R_s + g_n (R_s + 2R_{cor}) \quad (6)$$

and, defining  $Y_{cor} = G_{cor} + jB_{cor} = K^*(g_n/R_n)$ , the dual form is obtained as

$$F_z = g_n/G_s + R_n (G_s + 2G_{cor}) \quad (7)$$

For a given operating condition,  $F_z$  is measured

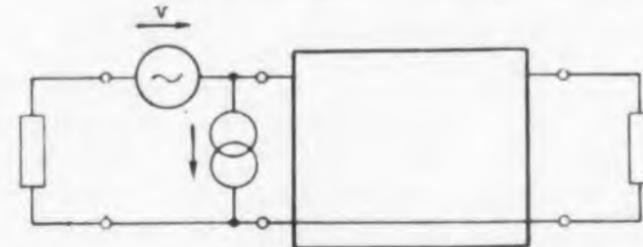


Fig. 1. Equivalent circuit of noisy three terminal network.

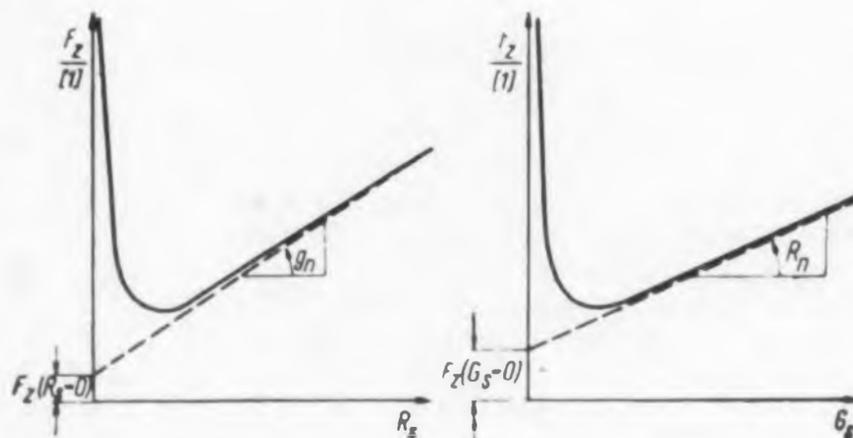


Fig. 2. Graphical determination of noise parameters from measurements.

\*means conjugate

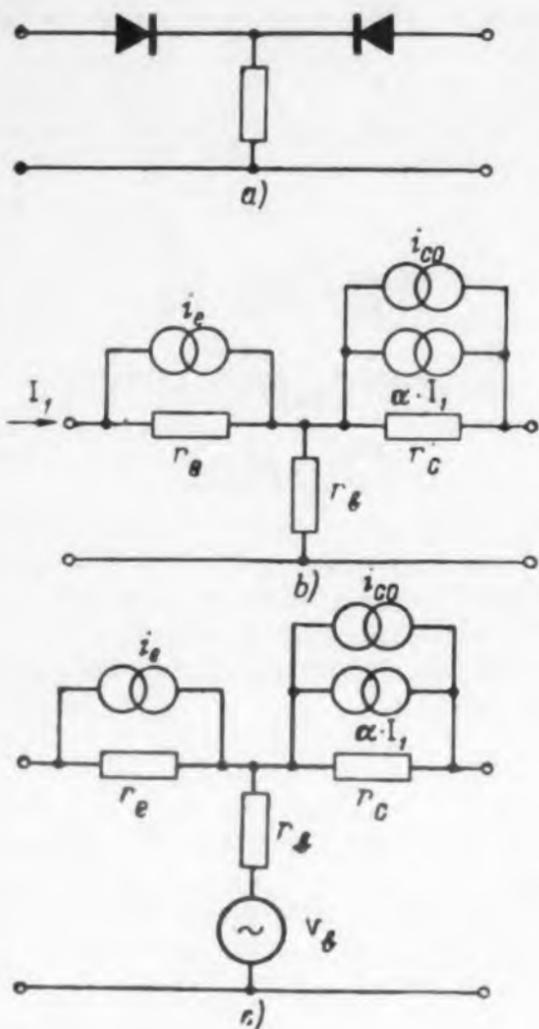


Fig. 3. Internal noise sources in a transistor.

as a function of  $R_s$  and plotted as a function of  $R_s$  and  $G_s$  as shown in Fig. 2. From the asymptotic behavior,  $g_n$  and  $R_n$  are determined. The intercepts of the asymptotes determine  $R_{cor}$  and  $G_{cor}$ :

$$R_{cor} = F_s(R_s = 0)/2g_n; G_{cor} = F_s(G_s = 0)/2R_n \quad (8)$$

and the relationship  $R_n/g_n = R_{cor}/G_{cor}$  may be used as a check. The value of the correlating reactance is obtained by adjusting  $Im(Z_s)$  until a match is obtained.

The internal sources shown in Fig. 3 are calculated by representing the transistor as two coupled diodes. The circuit applies at frequencies above about 5 kc where the flicker effect may be neglected. The noise sources shown are all independent and are related to the operating conditions through

$$\overline{v_b^2} = 4kTR_b \Delta f \quad (9)$$

$$\overline{i_e^2} \cong 2eI_e \Delta f \quad (10)$$

$$i_c^2 \cong 2eI_{c0} \Delta f \quad (11)$$

$$i_v = 2eI_c I_b \Delta f / I_e = 2eI_c (1 - \alpha) \Delta f \quad (12)$$

where  $\alpha = I_c/I_e$ .

In the original paper it is shown that the two representations are consistent. Experimental results as well as a discussion of the frequency

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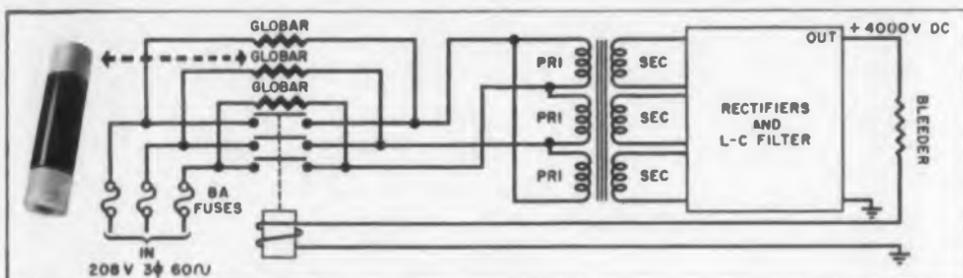
## High Energy Resistor Delays Fuse Opening— Collins Radio uses GLOBAR® resistor to handle short-time overload

A unique application of a GLOBAR high energy resistor is made in a radio power supply unit manufactured by Collins Radio, Cedar Rapids, Iowa. The resistor is used for delaying the opening of a fuse under a short-time overload current condition.

Requirements are rigorous. The resistor has to be capable of handling 21 amps for 3 seconds (140 times rated load) and 10 amps for 5 seconds and must not arc, burn, char or change in resistance by more than  $\pm 5\%$  when subjected to 5 seconds of the specified overload currents for 5 cycles on with 5 minutes off. It must operate con-

tinuously under 35 watts loading for 1,000 hours in a room temperature ambient, the resistance change being not more than 10%.

A GLOBAR Type SP resistor,  $3\frac{1}{4}$ " long,  $\frac{3}{4}$ " O.D. and  $\frac{5}{8}$ " I.D. is used. This resistor will operate continuously in ambients up to 1,000° F. It is supplied with metalized ferrule type ends for fuse clip mounting. For information on GLOBAR resistors for similar high temperature, high energy applications, write to GLOBAR Plant, Refractories Division, Dept. EDR 49, The Carborundum Company, Niagara Falls, N. Y.



4000 VOLT SUPPLY FOR AN/FRW-2 SHOWING STEP-START CIRCUITRY

## CERAMIC IGNITER for oil and gas burners A development of high temperature resistors

The versatility of silicon carbide for high temperature resistors is further demonstrated by its application as a ceramic igniter for fuel oil and gas furnaces.

Conventional igniters utilize either a hot wire, which has a relatively short life, or a spark discharge system, necessitating a high potential transformer.

Requirements for the ceramic igniter were that it should operate directly from 12, 24 and 115 volt

sources, have high stability, be inexpensive and effective for up to 25,000 cycles of operation. A composition similar to that of the GLOBAR Type SP resistor proved to be the answer. By varying resistivity, operation is possible on any of the desired voltages.

To alert electronics engineers, the success of this application may suggest the many possibilities of utilizing similar resistors in high temperature circuits with ambients up to 1,000° F. Terminals which can be spot-welded or brazed into circuits have been developed. Prototypes of such resistors are now actually being evaluated by several customers as potential components for missiles and other critical applications.

Technical assistance and information can be secured by writing to GLOBAR Plant, Refractories Division, Dept. ED1R-49, The Carborundum Company, Niagara Falls, N. Y.



## Matched or Compression Seals?

Which metal-to-glass combination should you choose for packaging rectifiers and other housings?



Two types are available. The first type is represented by KOVAR® matched seals in which the identical thermal expansion characteristics of KOVAR Alloy and borosilicate hard glasses result in a fused hermetic bond. Since KOVAR has about the same expansivity as silicon and germanium, stability in operation is assured. The second type is represented by the compression seal which relies on differences in contraction between glass and metals, like mild steel, to provide a tight joint.

Both types give excellent service depending upon the design and application of the unit. Compression seal applications are often those where the use of heavier metal parts is advantageous.

Among other advantages, KOVAR "to hats" have special value as high voltage seals. The insulating glass does not need to be contained within a compression band and thus can be extended for higher flash-over voltage ratings.

For help in your choice of seals, write Latrobe Plant, Refractories Division, Dept. EDK 49, The Carborundum Company, Latrobe, Pa.

### NEW BULLETIN DESCRIBES FIXED NON-INDUCTIVE CERAMIC RESISTORS



Gives data on Types A, B, and CX resistors recommended for general-purpose applications in electronic and electric power circuits. A wide range of sizes, shapes and compositions provide desired resistivities and watt ratings. For a copy, write: GLOBAR Plant, Refractories Division, Dept. ED 49, The Carborundum Company, Niagara Falls, N. Y.

dependence of the noise parameters are also included.

Abstracted from an article by C. Winkler, Nachrichtentechnik, Vol. 8, No. 12, December 1958, pp 542-547.

## Noise in Semiconductor Diodes

IN A SEMICONDUCTOR, three different sources of noise can be identified. In the absence of current, the only noise source is given by the mean squared Nyquist noise current (thermal resistor noise)

$$\overline{i_{th}^2} = 4kT \Delta f / R \quad (1)$$

When current flows, there occurs, in addition, the shot noise and flicker noise. Of these three components only the flicker noise is frequency dependent; its variation is inverse with frequency.

At frequencies where the noise sources have uniform spectrum, the Schottky formula for saturated vacuum diodes applies, i. e.

$$\overline{i^2} = 2eI \Delta f \quad (2)$$

provided that the carrier transit time through the blocking layer is much less than either the period of the signal or the mean life time of the charge carriers. The noise power of the diode is then given by

$$P_v = \overline{i^2} R_i / 4 = [(1 + I_o / I_1 k T \Delta f)] / 2$$

where  $R_i$  is the differential resistance  $dv/di$ , and

$$I = I_1 - I_o = I_o [\exp(V/V_T) - 1] \quad (3)$$

and  $V_T = kT/e$ .

To calculate the diode noise under dynamic conditions at high frequencies, the total noise (source) current is written as:

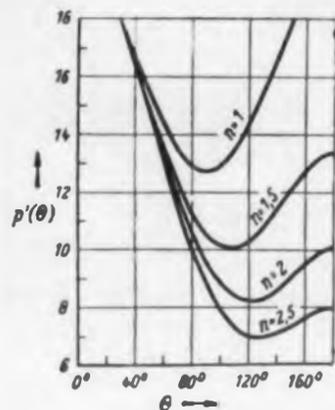
$$i^2 = [4k p T_o \int df] / R_d \quad (4)$$

where  $R_d$  is the parallel combination of the back resistance  $R_o$  and  $R_i$  and  $p$  is the noise temperature factor of  $R_d$ .

In the neighborhood of the operating point the diode curve is assumed in the form  $i = kv^n + qv$ . Assuming a voltage of the form  $v = V_1 + V_1 \cos \omega t$ , factor  $p$  is calculated as a function of the angle of current flow  $\theta$  with  $n$  as a parameter. The result, assuming that the maximum diode voltage does not exceed 1.0 v is shown in the Figure.

In the original paper, similar calculations are carried out with the diode used as a mixer. It





Reduced, dynamic noise temperature factor  $p'$  ( $\theta$ ) as a function of the angle of current flow with  $n$  as a parameter.

is concluded that, of the diodes tested, the Sylvania diode 1N210 was most suitable for mixing from the viewpoint of noise and conversion loss.

Abstracted from an article by W. Drechsel, Nachrichtentechnik, Vol. 8, No. 12, December 1958, pp 538-541.

## Resistor Noise

WHEN no current flows in a resistor, the noise is thermal noise which is represented by the source  $v$  where

$$\overline{v_{th}^2} = 4kTR \Delta f \quad (1)$$

For a series combination of resistances at different temperatures, the value of  $R$  is the sum of the individual values and the noise temperature  $T$  is given as

$$T = \frac{\sum T_k R_k}{\sum R_k} \quad (2)$$

with a dual formula for parallel arrangements. For a terminal pair network,  $R$  is the real part of the complex impedance at every frequency.

When a current flows, the factor  $p$  may be introduced in Eq. 1 so that the total mean squared noise voltage is

$$\overline{v^2} = p \overline{v_{th}^2} = (p_i + 1) \overline{v_{th}^2} \quad (3)$$

The current flow factor  $p_i$  depends on the current, the resistance, the frequency and the length of the resistor,  $l$ . The equation is where  $c$  and  $c'$  are

$$p_i = cI^2R^2/l^2 f = c'J^2/f \quad (4)$$

proportionality constants which depend on the material and  $J$  is the current density.

Abstracted from an article by K. Lunze, Nachrichtentechnik, Vol. 8, No. 12, December 1958, pp 580-584.



## NEW FROM CORNING C-42 low-power, low-cost film-type resistor

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

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

In every characteristic, this new C-

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

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

Humidity: 1% max. resistance change

Shelf life: 0.2% per year, maximum.

Noise output: .1 microvolt per volt

Nominal length of the C-42 is  $\frac{1}{16}$ "

$\pm \frac{1}{32}$ ". Power rating is 2 W at 70°C.

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

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



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**ROLLPIN** is easy to install, easy to drive out with a drift pin or punch, yet will "stay put" indefinitely.

**ROLLPIN** is available for immediate off-the-shelf delivery—comes in sizes from .062" diameter to .500" in carbon steel, corrosion resistant steel or beryllium copper.

For a free bulletin detailing Rollpin applications and installation methods, write to Dept. R53-457.



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# MEETINGS

## Calendar of Events

### April

- 1-30 9th Plenary Session of the International Radio Consultative Committee, Hotel Biltmore, Los Angeles, Calif.
- 14-16 3rd Signal Maintenance Symposium, Fort Monmouth, N.J.
- 20-21 Techniques in Electronics Instrumentation (IRE), Philadelphia, Pa.
- 20-22 1st Annual Southeastern Regional ISA Conference & Exhibit, Gatlinburg, Tenn.
- 21-22 Technical Conference on Electronic Data Processing (IRE), Cincinnati, Ohio\*
- 22-24 AIEE East-Central District Meeting, Akron, Ohio\*
- 28-30 13th Annual Power Sources Conference, Atlantic City, N.J.\*
- 29-1 AIEE Empire District Meeting, Syracuse, N.Y.

### May

- 3-7 Symposium on Electrode Processes, Philadelphia, Pa.
- 4-5 Conference on Industrial Control Systems Components, Memorial Center, Purdue University, West Lafayette, Ind.
- 4-6 11th National Aeronautical Electronics Conference (IRE), Dayton, Ohio
- 4-8 85th Society of Motion Picture and Television Engineers Convention, Fontainebleau Hotel, Miami Beach, Fla.
- 5-7 URSI Spring Meeting (PGI, PGIT, PGGT), Washington D.C.
- 5-7 7th National Conference on Electro-Magnetic Relays, Stillwater, Okla.
- 6-8 1959 Electronics Components Conference (IRE, AIEE, EIA, WCEMA), Philadelphia, Pa.\*
- 6-8 7th Regional Technical Conference and Trade Show (IRE), Albuquerque, N. Mex.
- 11-12 Symposium on Industrial Uses of Radioisotopes, Atlanta, Ga.
- 11-13 National Power Instrumentation Symposium, Kansas City, Kan.
- 11-13 National Symposium (PGMT, IRE), Boston, Mass.
- 11-13 2nd Annual Joint Conference on Automatic Techniques, Chicago, Ill.
- 11-13 Radio Technical Commission for Marine Services Assembly Meeting, Mt. Royal Hotel, Montreal, Canada
- 12-14 Annual Frequency Control Symposium, Signal Research and Development Laboratory, Fort Monmouth, Berkeley-Carteret Hotel, Asbury Park, N.J.
- 18-20 5th Annual National Symposium on Instrumental Methods of Analysis, Houston, Tex.
- 18-20 Electronics Parts Distributors Show, Chicago, Ill.
- 18-20 Fifth National Symposium on Instrumental Methods of Analysis, Instrument Society of America, Hotel Shamrock Hilton, Houston, Tex.
- 19-21 AIEE Middle Eastern District Meeting, Baltimore, Md.
- 20-22 National Spring Meeting, Society for Stress Analysis, Sheraton Park Hotel, Washington D.C.
- 25-27 National Telemetry Conference (IAS, ISA, AIEE, ARS), Denver, Colo.
- 25-29 International Convention on Transistors and Associated Semi-Conductor Devices, London, England

### June

- 1-3 National Symposium on Microwave Theory and Techniques (IRE), Cambridge, Mass.
- 3-5 Armed Forces Communications and Electronics Assoc. Annual Meeting, Washington D.C.
- 4-5 3rd National Conference on Production Techniques (IRE), San Mateo, Calif.



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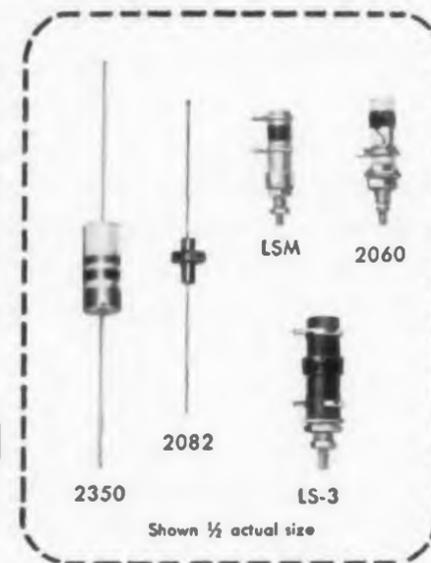
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- 8-11 Semi-annual Meeting, American Rocket Society, San Diego, Calif.
- 10-12 2nd International Symposium on Gas Chromatography (ISA), East Lansing, Mich.
- 15-18 Summer Meeting, Institute of Aeronautical Sciences, Los Angeles, Calif.
- 15-20 1st International Conference on Information Processing, Paris, France
- 15-20 Symposium on Electromagnetic Theory, Univ. of Toronto, PGAP, URSI, University of Toronto, Ont., Canada
- 16-18 International Symposium on Circuit and Information Theory (IRE), Los Angeles, Calif.
- 17-27 International Plastics Exhibition, London, England
- 21-26 Summer and Pacific General Meeting AIEE, Seattle, Wash.
- 22-26 ASEE-ASTM Symposium on Education in Materials, Atlantic City, N.J.
- 24-26 2nd Nuclear Instrumentation Symposium, Idaho Falls, Idaho
- 24-28 International Conference on Medical Electronics, UNESCO, Rockefeller Institute, IRE-PGME, Paris, France
- 29-1 National Convention on Military Electronics (IRE), Washington D.C.

\*Indicates meetings described herewith.

### Technical Conference on Electronic Data Processing, April 21-22

Engineering Society Bldg., Cincinnati, Ohio. Conference Theme: Electronic Data Processing. Papers to be presented on applications of data processing to such fields as communications, radar, computers, missile technology, chemical engineering, machine tools, and nucleonics.

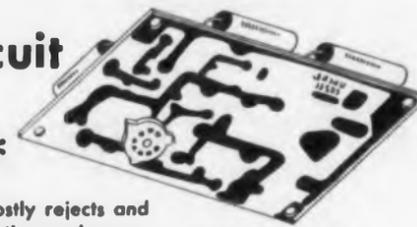
### AIEE East-Central District Meeting, April 22-24

Sheraton Hotel, Akron, Ohio. To be held in conjunction with the 11th Annual AIEE Rubber and Plastics Technical Conference, there will be a program of more than 50 technical papers and discussions. A special symposium on "Heating for Plastics Extrusion" has been scheduled together with such topics as: industrial heating and lighting; automation; computers; communications; high voltage cables and transmission; electric drive equipment; relaying and distribution; static components; nylon tire cord processing; rubber processing; standards for the rubber and plastics industry; its atmospheric contamination problems; and its use of new machines and processes; magnetic amplifiers, transistors, and semiconductors.

### 13th Annual Power Sources Conference, April 28-30

Shelburne Hotel, Atlantic City, N.J. Held annually to present the results of the military battery research and development program and to discuss this program with the battery and battery-using industries. Attendance at the Conference is by invitation only. Persons who wish to attend may make the necessary arrangements by writing direct to *Power Sources Div., U.S. Army Signal Research & Development Laboratory, Fort Monmouth, N.J.*

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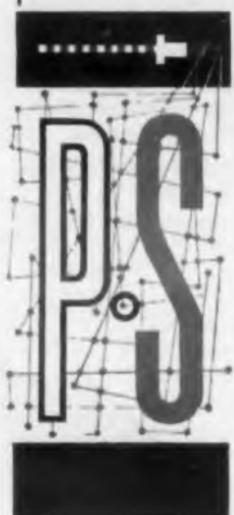
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## MEETINGS

**1959 Electronic Components Conference, May 6-8**

Benjamin Franklin Hotel, Philadelphia, Pa. Sponsors: IRE, EIA, AIEE, WCEMA. Theme: New Concept for Space Age. The eight sessions will cover such subjects as: High Speed Data Processing; Transmission Devices; Extreme Environments; Space Electronics; Electronic Materials; Microminiaturization; and Semiconductors. For additional information contact: *John E. Hickey, Jr., The Chilton Co., 56th & Chestnut Sts., Philadelphia 39, Pa.*

### Paper Deadlines

**May 1:** Deadline for papers to be presented at WESCON, Aug. 18-21 to be held in San Francisco, Calif. Required are 100-200 word abstracts, together with complete texts or detailed summaries which should be sent to *Dr. Karl R. Spangenberg, WESCON, 60 West 41st Ave., San Mateo, Calif.*

**May 1:** Abstracts not exceeding 200 words are due for papers to be submitted for the 15th Annual National Electronics Conference, scheduled for October 12-14, 1959 at the Hotel Sherman, Chicago. Title, author and author affiliation should be included. Send ten copies of the abstract to *M. E. Van Valkenburg, Electrical-Engineering Dept., University of Illinois, Urbana, Ill.*

### Courses and Seminars

From May 19 to 22, 1959, Dunlap and Associates, Inc., will present at Stamford, Conn., its **Seventh Annual Human Engineering Institute**. The four-day program will deal with human capabilities and limitations as they relate to the design of complex man-machine systems, specific equipment items, consumer products, and workplaces. Lectures and discussions concentrate on basic concepts and newest techniques. Particular attention is given to practical aspects of the application of human engineering principles to development and design projects for industry and the military. The compact course, to be given by skilled instructors of Dunlap and Associates, Inc., includes: methodology and scientific background pertinent to the field of human engineering, systems concepts and planning, measurement and experimental techniques, designing for human inputs and outputs, implementing human engineering design recommendations, and establishing groups responsible for human engineering. Contact: *Robert T. Eckenrode, Director, Seventh Annual Human Engineering Institute, Dunlap and Associates, Inc., 429 Atlantic Street, Stamford, Conn.*

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The scope of original design effort ranges from the design of low power pulse and RF circuits to the design of super power hard-tube pulsers and RF cavity type amplifiers.

Experience in the development and design of communications, TV, radio and radar transmitters or their components is required. A knowledge of high power tube design and the application of klystron and magnetron tubes would be beneficial.

Salary to \$16,000.

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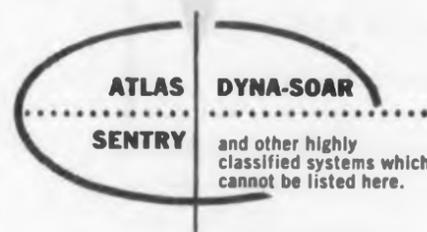
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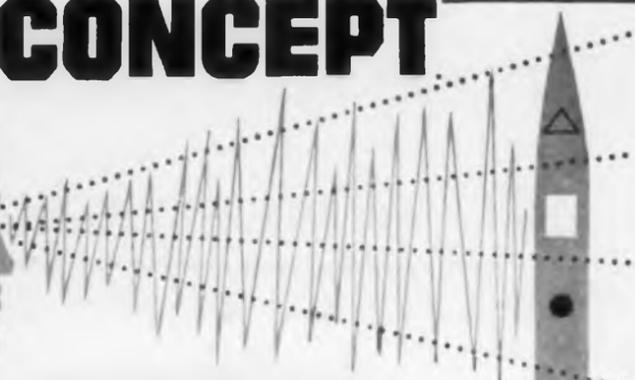
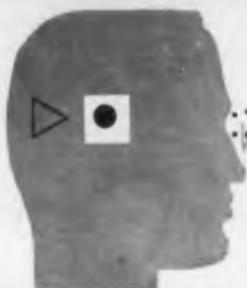
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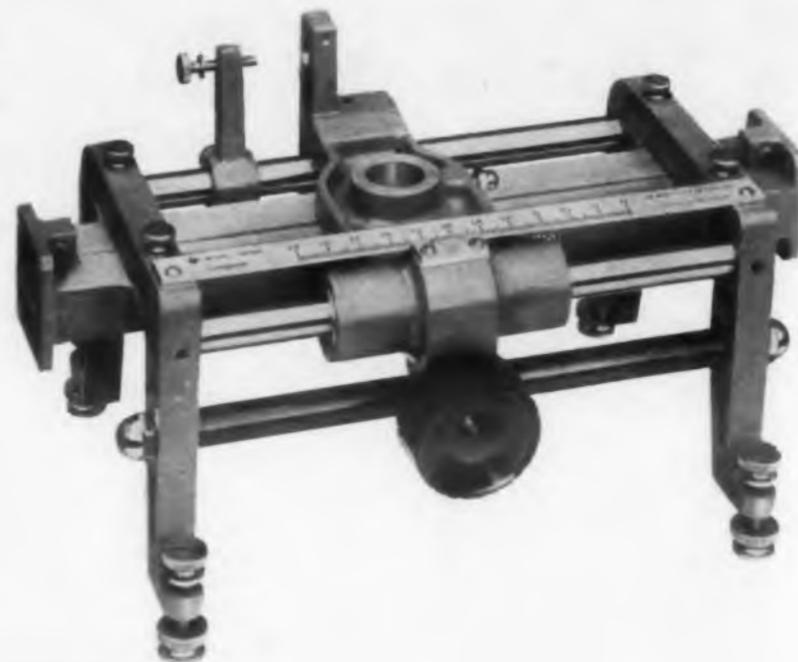
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### Specifications

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<b>Carriage:</b>	Mounts $\Phi$ 810B Slotted Sections and $\Phi$ 806B Coaxial Slotted Section (not shown: 3 to 12 KMC, 50 ohms impedance, Type N connectors).
<b>Probe Required:</b>	$\Phi$ 442B Broadband Probe plus $\Phi$ 440A Detector or $\Phi$ 444A Untuned Probe.
<b>Probe Travel:</b>	10 centimeters.

**Accuracy:** With waveguide sections, 1.02 SWR easily read. Slope error eliminated by adjustment.

**Price:** \$160.00.

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S810A Waveguide Slotted Section—  
2.6 to 3.95 KMC.

This instrument is a conventional slotted waveguide complete with a probe carriage mounted directly on the section. It is available in the S-band only and will operate with 442B or 444A probes. SWR less than 1.01. \$450.00.



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Table 1—810B/815B Slotted Sections.

Model	Frequency Range KMC	Fits Waveguide Size (in.)	Overall Length (in.)	Price
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J810B	5.20 - 8.20	1 1/2 x 3/4	10 1/4	110.00
H810B	7.05 - 10.0	1 1/4 x 5/8	10 1/4	110.00
X810B	8.20 - 12.4	1 x 1/2	10 1/4	90.00
P810B	12.4 - 18.0	.702 x .391	10 1/4	110.00
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