

# ELECT D

NOV 27 1959

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## DESIGNING FOR SHORT- RUN PRODUCTION



An ELECTRONIC  
DESIGN  
Staff Report

... page 32

**R O N I C**  
**E S I G N**

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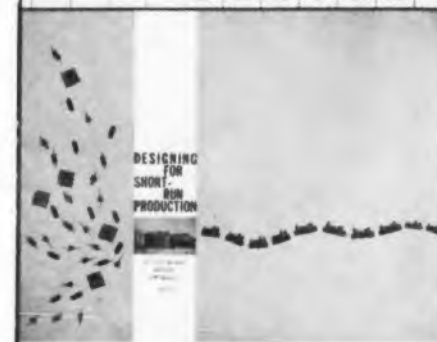
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P. A.

### HIGHLIGHT OF THIS ISSUE

## ELECTRONIC DESIGN



### Designing for Short-Run Production (Cover) . . . . . 32

Designing for low-quantity production poses many unique problems. In this 30-page report, dozens of illustrations show hundreds of design techniques culled from the "bags-of-tricks" of scores of engineers.

Though there is no single solution to the problems in designing for short-run production, these pages show many approaches, many "nuts-and-bolts" techniques, and many broader philosophical measures which can be used to smooth the way.

(Plant photo used in cover design is courtesy of Rivins & Caldwell, Inc., High Point, N. C.)

### SIDELIGHT OF THIS ISSUE

#### Let's Go, George!

In his Editorial in this issue, page 31, associate editor George Rostky wisely advises engineers to learn when to stop engineering and start getting a design into production. Rostky learned this lesson the hard way: he didn't take his own advice.

For months he gathered material for his report on short-run production. (It appears in this issue.) He visited dozens of plants, spoke to hundreds of people—he wouldn't stop.

A week late getting his copy to the printer, Rostky was still calling the coast for more information. The printer was screaming at editorial production manager Dollie Viebig. Viebig was screaming at managing editor Jim Lippke. Lippke was screaming at what was left of Rostky. And Rostky was screaming "But there's more out there."

And there is. Rostky promises to deliver it in future issues.

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**SHORT-RUN PRODUCTION**

An ELECTRONIC DESIGN Staff Report

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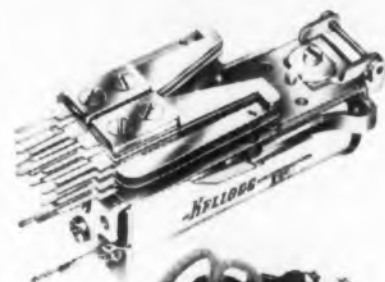
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# Industrial Relays by KELLOGG



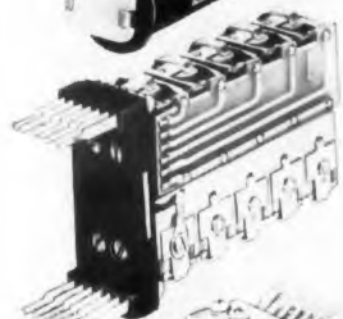
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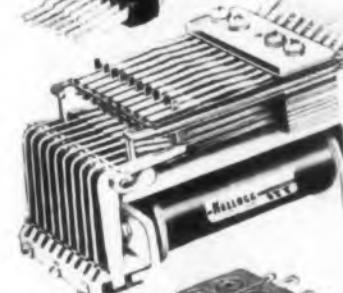
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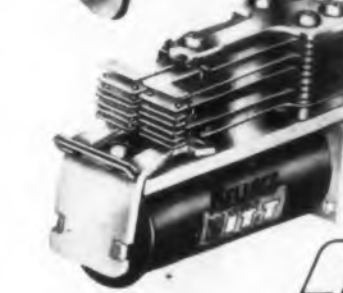
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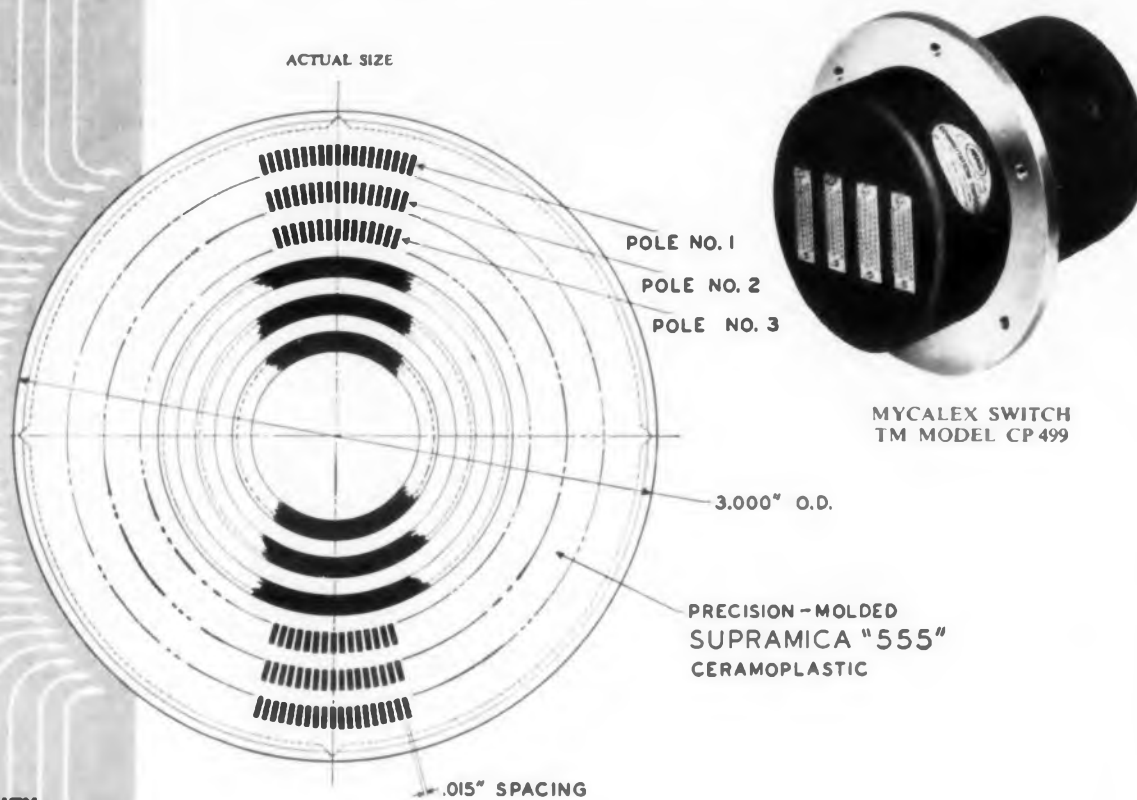
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*ELECTRONIC DESIGN* is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N. Y., T. Richard Gascoigne President, James S. Mulholland, Jr., Vice-President & Treasurer. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation at Bristol, Conn. Additional entry, New York, N. Y. Copyright 1959 Hayden Publishing Company, Inc., 37,000 copies this issue.



## New Navy Report Raises Possibility:

# Can Research Be Organized Mathematically?

**A** NEW REPORT prepared for the Navy to determine the nature and value of basic research raises an intriguing possibility. Could a mathematical model be constructed to guide the distribution of effort in research?

Such a model would simplify the organization of a research program. It would also aid in ensuring optimum distribution of money and effort between basic and applied research. At some point its effects would reach the design function, where it could help clarify many problems.

The theory of the model is outlined in a report, "Basic Research in the Navy," prepared by Arthur D. Little, Inc. This study examines the nature of basic research, its growth in Navy programs, and its importance to the country. The study's major conclusion: Navy basic-research spending, once adequate, is no longer enough. Successful industrial companies are spending for basic research twice the Navy's percentage of its R & D budget—16 per cent versus 6-8 per cent.

In investigating the nature of research, the Arthur D. Little team developed a preliminary model for study and application of knowledge. The model is based on the idea that research can be considered the discovery of individual facts in a body of facts; at any moment in the research process some of the facts have been uncovered, and the rest are awaiting discovery. Certain facts are "key facts"—the last ones that must be found before a useful invention can be developed.

The process of discovering the key facts is compared in the study to a two-stage chemical reaction,  $A \rightarrow B \rightarrow C$ , where  $A$  represents the key facts not yet discovered,  $B$  the key facts that have been discovered, and  $C$  the final applications.

The first major step in the research process is finding the key facts. The second step is the process of invention.

"The development of a field proceeds as a step function, with a breakthrough opening a new body of knowledge, which is then explored and

applied," the investigators reported. "Within the region of a single step, the development follows the familiar S-shaped growth, or logistic, curve."

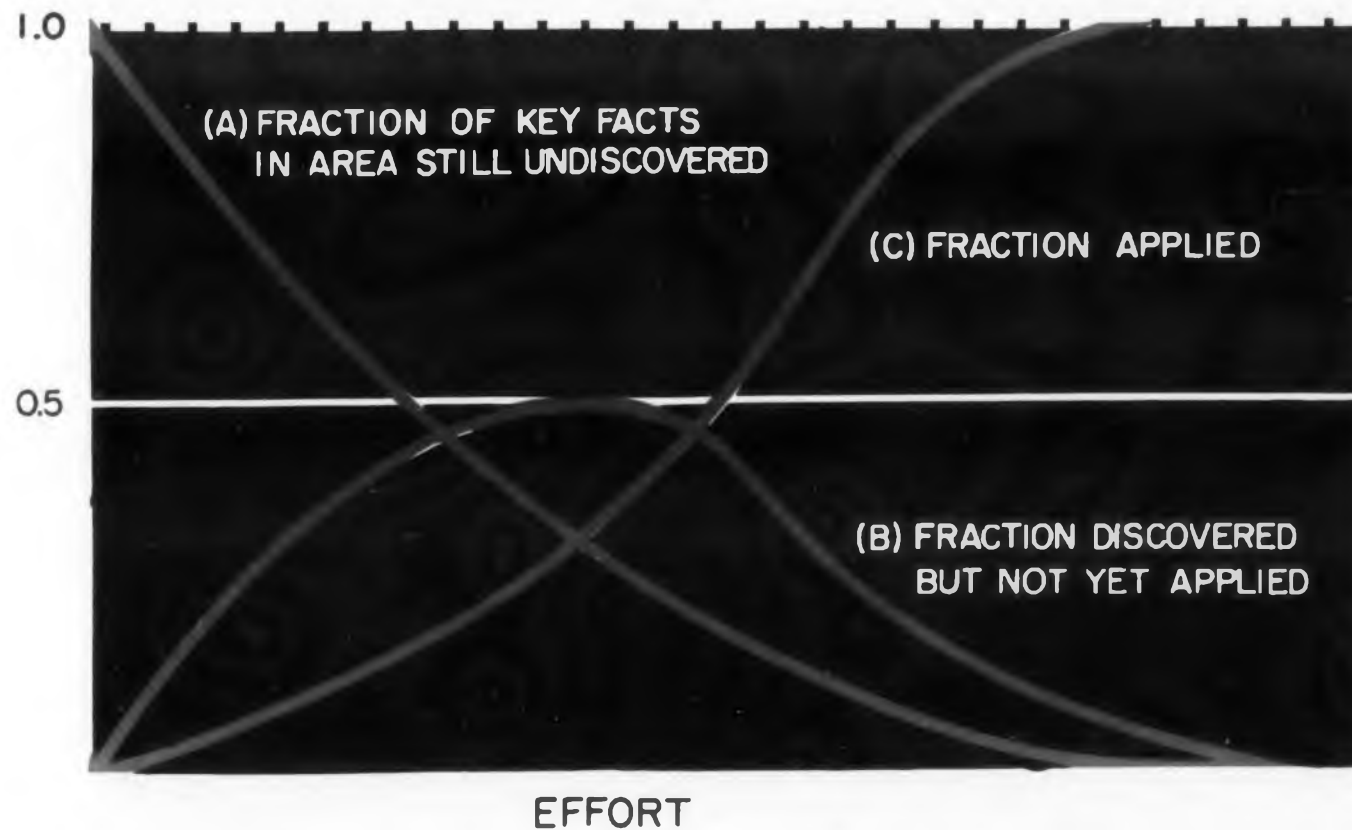
According to the researchers: "The chemical analogy suggests, and the theory of search developed during World War II reinforces, the idea that the rate of the first step is proportional to the effort put into the process and to the number of undiscovered facts. Similarly the rate of the second step should be proportional to the effort put into it and to the number of discovered but unapplied facts."

Thus the first rate should be of the form  $k_1 E_1 A$ , and the second,  $k_2 E_2 B$ , where  $E_1$  and  $E_2$  are the respective efforts, and  $k_1$  and  $k_2$  are the two constants of proportionality, with the dimensions of reciprocal time.

The constants  $k_1$  and  $k_2$  are measures of the relative ease with which the two processes can be carried out. If  $k_1$  and  $k_2$  are equal, the two processes are equally easy. If  $k_1 = 10 k_2$ , it is 10 times as easy to find a fact as to apply it, and so on.

"To find the proper balance of effort between

### FRACTION OF KEY FACTS IN AREA



**A typical history** of a research process aimed at exploiting an area. At any stage of research, the facts to be discovered and applied are distributed as shown. The curves were developed in studies for a mathematical model that would lead to optimum research efforts.

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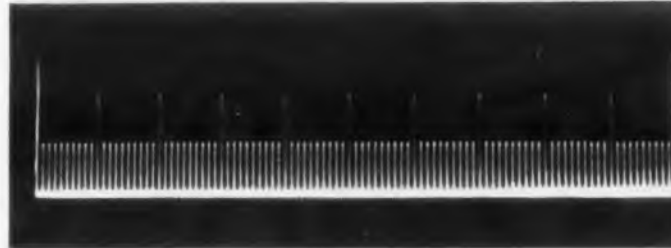


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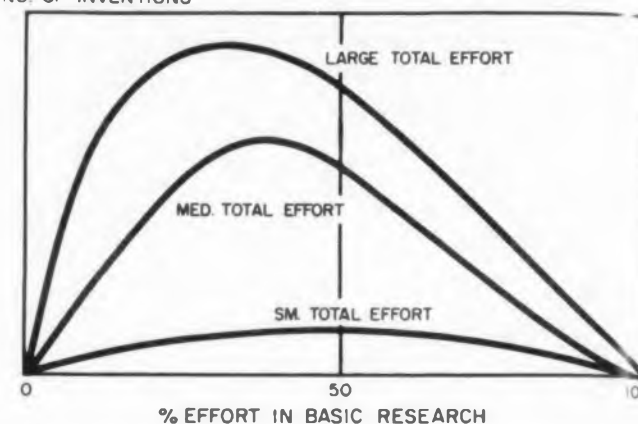
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## NEWS

NO. OF INVENTIONS



How should research effort be applied for best results? Each curve here shows how the total result of the effort, as measured by the number of inventions, changes as the distribution of the effort between basic research and applied R & D is varied. The curves happen to be plotted for an effort in which it is easier to find a fact than to apply it.

the two steps, it is clearly necessary to find a way of determining these 'ease factors,' the investigators said. "One approach to this is by the analysis of past experience."

### Plotting the Research Process

If during the development of a field, the effort put into each of these two processes is held at a constant ratio, the system can be formulated and solved as follows:

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

$$\left. \begin{aligned} \frac{dA}{dt} &= -k_1 A \\ \frac{dB}{dt} &= k_1 A - k_2 B \\ \frac{dC}{dt} &= k_2 B \end{aligned} \right\} \text{at } t=0 \begin{aligned} A &= 1 \\ B &= C = 0 \end{aligned}$$

for the intermediate step, B

$$B = a_1 e^{b_1 t} + a_2 e^{b_2 t}$$

$$a_1 = -a_2 = k_1 / (k_2 - k_1)$$

$$b_1 = -k_1 \quad b_2 = -k_2$$

for the final step, C

$$C = a_0 + a_3 e^{b_3 t} + a_4 e^{b_4 t}$$

$$a_0 = 1 \quad a_3 = k_2 / (k_1 - k_2) \quad a_4 = k_1 / (k_2 - k_1)$$

$$b_3 = -k_1 \quad b_4 = -k_2$$

This solution gives the set of curves for A, B and C, (see Typical History graph), where the C-curve corresponds to what is empirically ob-

served; the curves taken together show the facts in each category and how they move with time.

But this is a simplified picture, which presents a distorted picture of the *B* state. It implies that the unit of knowledge once applied, cannot be reapplied with experience. The facts are not applied in units but in combination. The  $k_2$  process, in yielding to application of knowledge, does not generally apply to a unit of knowledge, but to a conclusion drawn from a number of units of knowledge.

Thus a fact may be applied many times, in different combinations with other facts. This, the researchers report, leads to two difficulties in the model outlined:

- The number of combinations available from a number of facts increases extremely rapidly as the number of facts increase, so that neither the *B* nor the *C* curves will approach a limit, much less decrease.

- If combinations of *A*-state units are assumed to be *B*-state units, the dimensionality of the equation for  $dB/dt$  is wrong.

To remove these flaws, the study team proposes a more complicated model based on continued syllogisms that reduce to Boolean algebra.

The simpler system shows the promise of the basic idea, however, and gives an insight into the operation of the ease factors. If it were possible to observe all three of the curves, the analysis of the research process would be relatively simple. But data are hard to get, the team reports. The only data obtainable were for a few cases, which gave only the *C* curve.

"These few cases, however, are in excellent agreement with the prediction of this theory," the researchers said. "Furthermore they indicate a ratio of  $k_1/k_2$  in the neighborhood of 2"—which means it is twice as easy to discover a fact as to apply it.

#### Handle With Care

But, the researchers warn: "It would be risky in the extreme to draw the conclusion that this ratio is universal. It may very well be that this ratio varies widely from one field of research to another."

If the theory could be accepted, it would be possible to study the problem of the correct distribution of effort between the two steps. Both kinds of effort are necessary; the question is: how should a given total effort be divided?

"If too much effort is put into the first step, and too little into the second," the investigators reported, "the result will be the discovery of a large fraction of the key facts but the application of only a small fraction of those discovered. If too much effort is put into the second step, and too little into the first, only a small fraction of the key facts will be found. While a large frac-

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tion of the discovered facts will be applied, the number of applications will be small, because the number of discovered facts is small."

Generally if the total effort is small, the best result is obtained when the two efforts are equal. As the total effort is increased, the position of the maximum shifts. How this shift takes place depends on the ease factors,  $k_1$  and  $k_2$ .

If, as studies so far indicate, the actual ratio of  $k_1$  to  $k_2$  is about 2, the optimum fraction of basic research in a large program to develop a field should be in the neighborhood of 30 per cent, the team reports. "This suggests that a larger effort should be placed in basic research than is now the case," the researchers said.

What's next? The team concludes that its program "has shown enough basic promise to warrant consideration for further development."

This would take the form of:

- More elaboration of the mathematics, probably involving computers for numerical integrations. Numerical rather than analytical solutions seem indicated.

- Elaboration of the relationship between time, manpower, and other factors in the effort function.

- Development of independent criteria to measure the model's effectiveness. ■ ■

## World's Largest Traffic Control System Being Installed

Installation of the first phase of the world's largest radio traffic-control system has been completed in Washington, D. C. The new system, being installed by Motorola, will provide for synchronization and coordination all of Washington's 1000 traffic lights and for the automatic change of their cycles.

At the master control station will be the master clock and programmer, a coder, two master dial cabinets, and a control display panel. The clock and programmer is a high-speed, high-capacity punched-tape readout device. The signal cycle variation, determined by traffic study, is coded on punched paper tape.

As the tape is fed through the readout device, the cycles for specific intersections for specific periods of time are selected. This information is translated into audio tone codes, which are generated by the central-station coder. These tone codes are transmitted by the radio base station to the various intersections. The time cycles, in effect, are shown on the display panel, which also includes manual control buttons for emergency use.

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CIRCLE 6 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 25, 1959



VTP 3ABP



VTP 5XP-11



VTP 5ACP4



VTP 12GP



VTP P1XP-11



VTP 16 AFP-19



VTP 5BC



VTP 928006-2E

## VTP's FAMILY OF SPECIALIZED CRTs

World's finest special-purpose tubes in production quantities!

Do you need tube characteristics which will enable you to tighten your "specs"? Or, have you a particular tube application demanding high operating performance with extreme reliability under difficult environmental conditions? If so, Vacuum Tube Products can supply you with specialized CRTs in production quantities to fill your most exacting requirements.

VTP's broad experience, unmatched "know how" and excellent facilities guarantee you custom-designed tubes in the quantity needed ... tailored to your environmental specifications:

- Shielded or unshielded,
- with or without special mountings,
  - potted or unpotted,
- with the exact phosphor you require.

### TUBE CHARACTERISTICS

VTP 3ABP Screen diameter: 2.68" Deflection: Electrostatic Overall length: 10.75"	VTP 5XP-11 Screen diameter: 5 1/4" Deflection: Electrostatic Overall length: 17 3/8"
VTP 5ACP4 Screen diameter: 4.25" Deflection: Electromagnetic Overall length: 11 1/8"	VTP 12GP Screen diameter: 12" Deflection: Electrostatic Overall length: 22"
VTP P1XP-11 Screen diameter: 1.0"+ Deflection: Electrostatic Overall length: 7.5"	VTP 16AFP-19 Screen diameter: 14.738" Deflection: Electromagnetic Overall length: 19.146"
VTP 5BC Screen diameter: 4.95" Deflection: Electromagnetic Overall length: 7 7/16"	VTP 928006-2E Screen diameter: 4.5" Deflection: Electrostatic Overall length: 18.38"

For detailed specifications and data sheets on VTP's specialized CRTs as well as specific application information, write: VACUUM TUBE PRODUCTS, P.O. Box 90427, International Airport Station, Los Angeles 45, California.

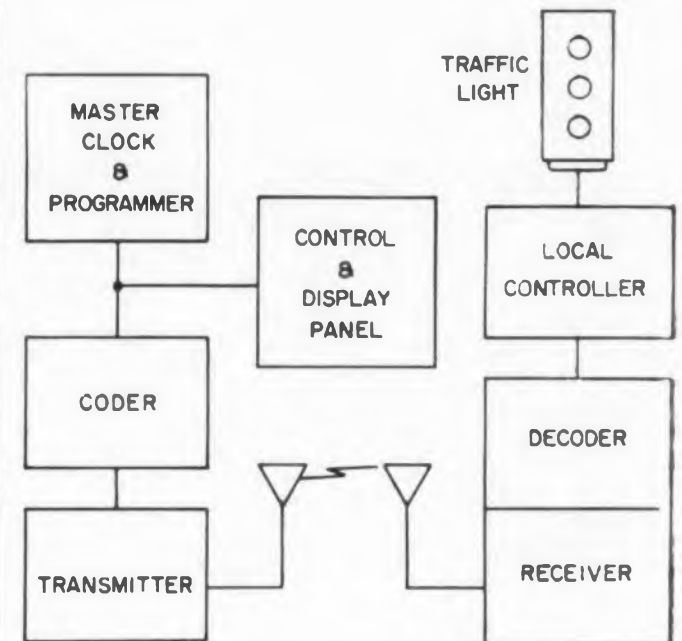
For export information, write: HUGHES INTERNATIONAL, Culver City, California.



**VACUUM TUBE PRODUCTS**

a division of HUGHES AIRCRAFT COMPANY

CIRCLE 7 ON READER-SERVICE CARD



Radio control system now being installed will ultimately synchronize all of Washington's traffic. Economics determined use of radio in place of usual cable.

Independent of the function change tone codes and the working of the master programmer are the generation of the synchronization codes by the master time-cycle units. These tone codes are decoded and applied to the regular local signal controller, causing the desired effect—time-cycle change and synchronization.

### Improved Airborne Sonar Due For Submarine Detection

A Navy method for detecting submarines from helicopters is scheduled for formidable improvement with a Sonar system of "greatly increased range."

The system uses a transducer, dunked periodically by a long cable from a helicopter, to spot enemy submarines by Sonar echo ranging. The 'copter then unleashes homing torpedoes to destroy the undersea craft.

The Pacific Division of Bendix Aviation Corp. is producing the improved Sonar, which is reported in limited production. Fleet evaluation tests are scheduled for January, to be followed by volume production.

The transducer in the system is similar to a direction-sensitive microphone. But it not only picks up reflected water-borne vibrations, as a microphone picks up airborne sound waves, but shows visually in the 'copter cockpit the position and nature of the reflection.

The airborne Sonar scans 360 degrees with range comparable to shipboard equipment, Bendix reports. Hundreds of square miles of ocean can be searched in an hour with it, the company adds.



**CRYSTALS**

Available for any frequency from 2 KC thru 100 mc. to meet and exceed all military specifications.

**CRYSTAL FILTERS**

Center frequencies from 10 KC thru 20 mc. band widths of 0.1% to 8% of center frequency.

**OVENS**

Complete from multi purpose AM 100 to the specific BHC series. Temperature stabilization to 1°C.

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30 cps thru 70 mc. frequencies available as tube type or transistorized oscillators.



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in frequency control—components and systems

Today, an increasing number of electronic systems demand a degree of reliability heretofore unobtainable. That is why more and more manufacturers are specifying Bulova.

Bulova crystals, filters, ovens, packaged oscillators, and Bulova frequency control systems, custom-designed for either limited or mass production, meet and exceed military and industrial specifications.

Bulova's experience in mastering many of the most difficult problems involving component and system reliability has made it the *number one source* for frequency control devices. This experience can prove of immense value in your particular program. For more information write Dept. A-1183, today.



**ELECTRONICS DIVISION • WOODSIDE 77, NEW YORK**  
CIRCLE 8 ON READER-SERVICE CARD

## NEWS

### Space Communications Net In 5-10 Years Is U.S. Goal

Ambitious plans for a world-wide communications network in space in the next 5 to 10 years have been disclosed by the Army.

Relay satellites "hovering" over the equator would constitute the heart of the network. The system envisions the transmission and reception of both voice and pulse signals from point to point on the earth via the satellites.

Announcement of the plans last month preceded by two weeks a decision by President Eisenhower to transfer the Army Ballistic Missile Agency to the civilian National Aeronautics and Space Administration (NASA). The transfer order is subject to Congressional amendment or rejection.

In telling of the space communications plans, Brig. Gen. Earle F. Cook, Deputy Chief Signal Officer of the Army, reminded the Radio and Television Executives Society at a New York meeting that the military had already taken the first step toward space communications. He referred to Project SCORE (Signal Communications by Orbiting Relay Equipment), an Army-developed communications package placed in orbit by an Air Force Atlas missile in December, 1958.

SCORE demonstrated, General Cook noted, that voice, teletypewriter and even multiple teletypewriter signals could be received, stored and retransmitted by a satellite.

#### Series of 'Tasks' Slated

Further advances, the general said, will be grouped as "tasks" under Project Notus.

In a three-year period beginning the middle of next year, he continued, several new communications satellites will be launched at relatively low altitudes of about 650 miles minimum. These will act as couriers of messages (Task Courier). As a satellite whirls over a ground station, it will receive a message, store it on magnetic tape and feed the communication to another ground station to which it is addressed.

"The trick, of course," General Cook explained, "is to transmit and receive all of this traffic at exceptionally high rates of speed during the short period that the satellite is passing over each ground station. Our system has a traffic-handling capacity equivalent to 20 teletypewriter channels each operating continuously at a rate of 100 words a minute."

Real-time or instantaneous satellite repeaters are a further goal of Project Notus. Two-way communications in the polar regions, the general said, will be covered by satellites to be launched by the Air Force (Task Steer) and the Army (Task Tackle).

For world coverage—aside from the polar regions—a real-time communications relay station (Task Decree) will be placed in a 24-hour equatorial orbit, General Cook related.

“Operating at about 23,300 statute miles above the earth’s surface,” he said, “a Decree satellite will travel at such a speed that the rotation of the earth will keep the space vehicle in a fixed position with respect to the earth. It will effectively ‘hover’ over a given location along the equator.

“At this great distance, a large portion of the earth is visible to the microwave transmissions of the satellite, which acts as a relay between points on the earth separated by several thousand miles.”

Many voice channels, including one for aircraft communications, are planned for the equatorial satellites. General Cook estimated that three or four of the stations, “properly placed in space, would be sufficient to literally cover the world—except for the small polar areas.”

He cautioned, however, that before the communications network could be set up, engineers and scientists must solve such key problems of transmission and reception as propagation. “Atmospheric interference, cosmic influence, fading, distortion and other effects,” he noted, contribute to the sometimes “tantalizing and unpredictable behavior” of kilomegacycle waves.

#### President Orders Transfer

A fortnight after General Cook’s speech, the President, acting under the Government Reorganization Act, ordered the Army relieved of its space activities. The move was explained as in no sense a cutback of space explorations but rather an attempt to accommodate and accelerate the work under a central control.

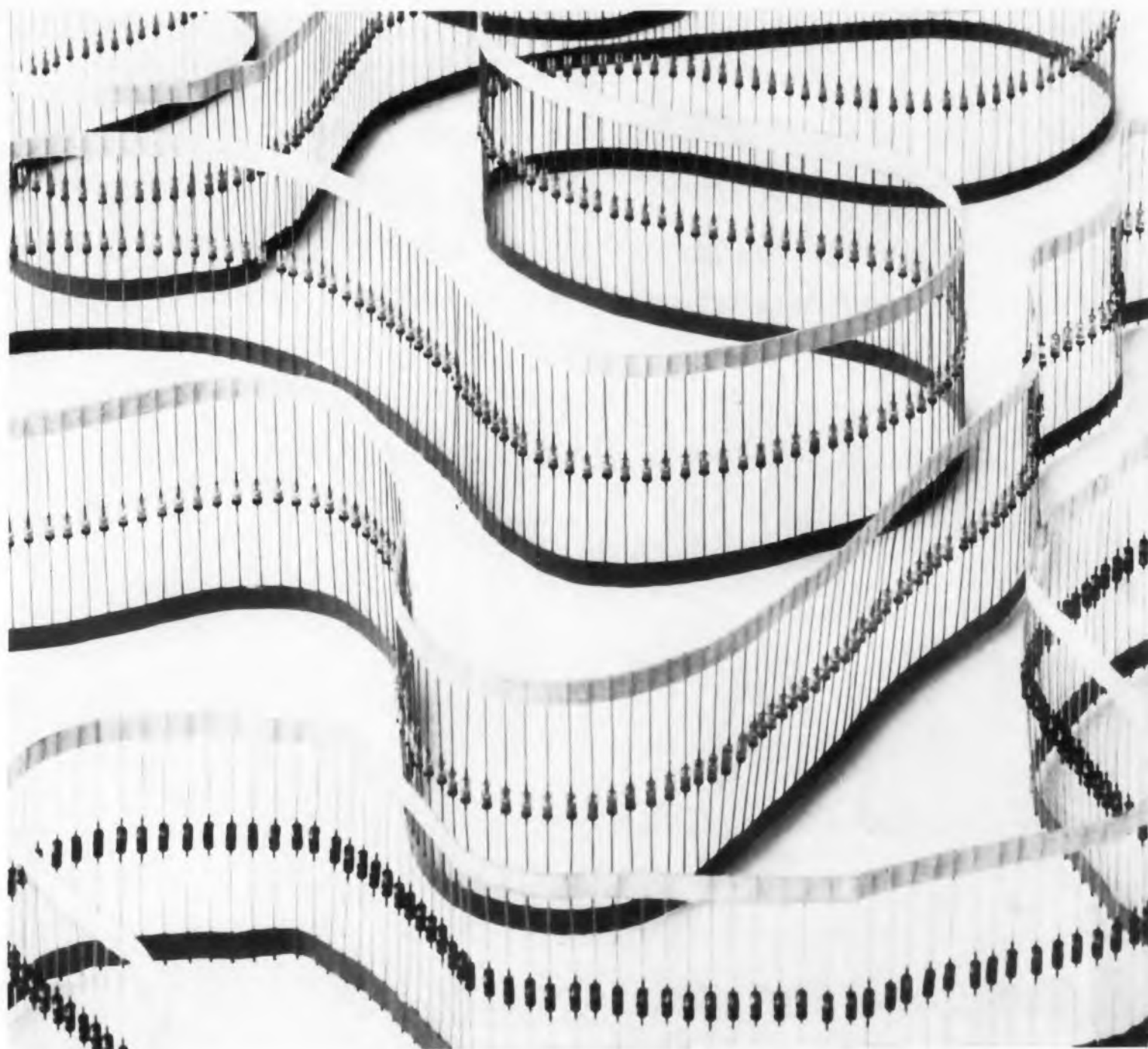
Two kinds of activities were recognized by the White House in its explanation: super-booster space vehicles with 1,500,000 pounds thrust, “not looked upon as having any military significance,” and ICBMs of some 300,000 pounds thrust, which have a military purpose.

About 90 per cent of the effort of the Army Ballistic Missile Agency, headed by Dr. Wernher von Braun, has been concentrated on the Saturn rocket engine, designed to provide 1,500,000 pounds of thrust. This work would be transferred to NASA.

The President’s order included “provision”—not otherwise specified—for continuation of the Army’s military missile programs. It was believed the Air Force would inherit this work.

Congress has until Dec. 20 (sixty days under the reorganization law) to amend or reject the transfer order. If neither the House nor the Senate votes against it, the switch will become effective.

The transfer has been recommended by the Defense Dept. and NASA.



## 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.

Standard types 1N702 through 1N720 available for immediate delivery from stock.

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.

SEMICONDUCTOR DIVISION

Creating a new world with *ELECTRONICS*

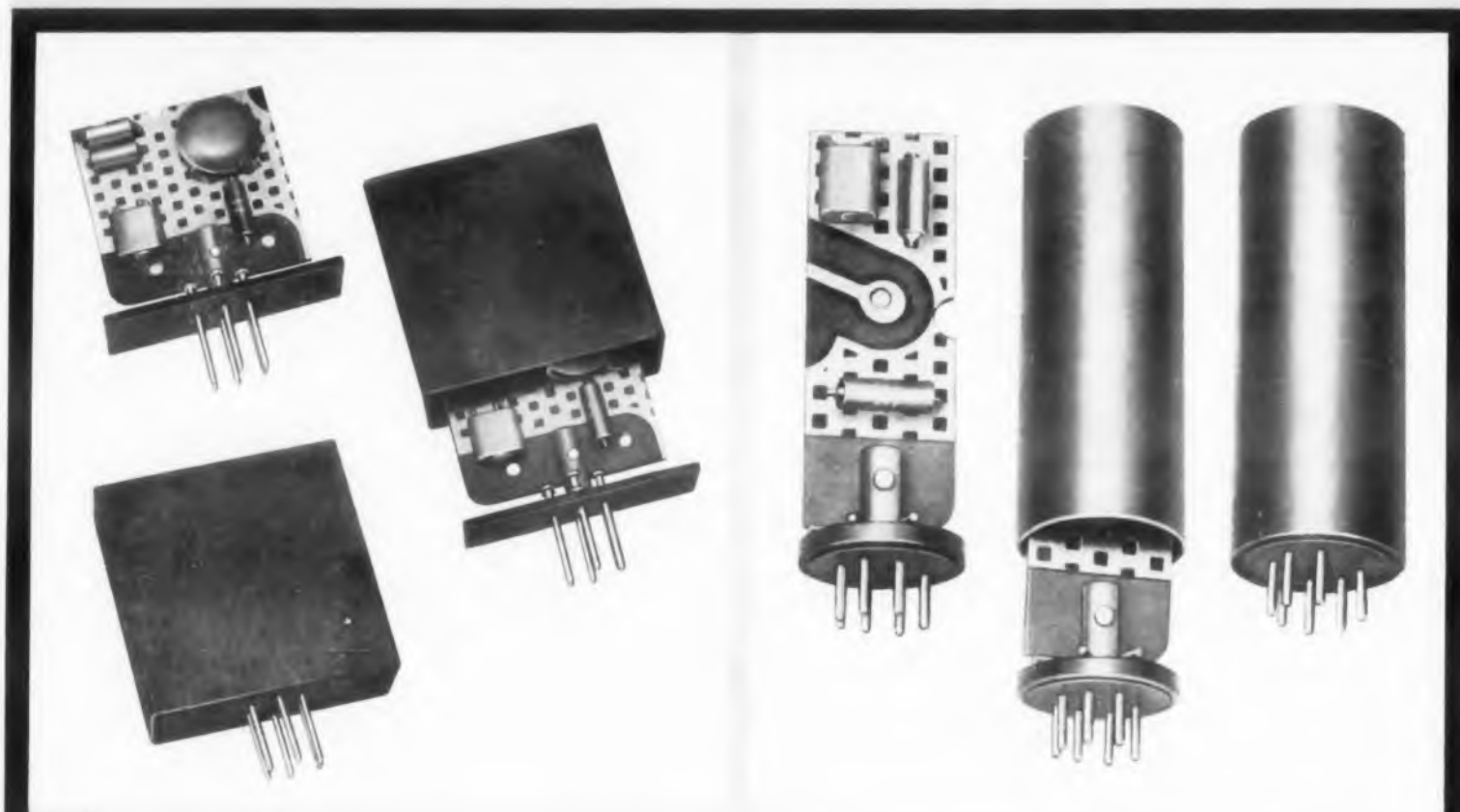
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CIRCLE 9 ON READER-SERVICE CARD

# NEW ALL-EPOXY MODULE PACKAGE



## designed for your specific application!

Despite the many advantages of modules, their greatest virtue—the proximity of components—makes them vulnerable to shorting and failures caused by vibration, low insulation resistance, humidity and other environmental effects.

Now, thanks to the all-epoxy E-Pak encapsulation system\* you can eliminate these failures completely — and do it faster, cheaper and better! This simple, mass production system contains three parts: (1) an all-epoxy header, complete with embedded leads and attached mounting board, (2) a molded, all-epoxy shell (round or rectangular) and (3) pre-metered, all-epoxy pellets. You simply attach the module's components to the mounting board, then insert the module and preformed pellet into the molded shell

and heat. The pellet melts and cures, embedding the module and forming a single, epoxy-encapsulated unit of infinite insulation resistance and great mechanical stability.

There's no glass-to-metal seal, no cracked glass, no weld contamination. Any type of metal may be used for leads; dissimilar leads may be welded together; threaded inserts and studs can be furnished in the headers; shells are also available with female plug tops. The entire system has met temperature cycling of  $-55^{\circ}\text{C}$  to  $+200^{\circ}\text{C}$ , altitudes of 50,000 feet, and the salt spray, vibration, fungus and humidity requirements of Mil Std. 202A and Mil E-5272A.

\* Patents applied for.

**Write today for complete information.**

# EPOXY

A DIVISION OF JOSEPH WALDMAN & SONS

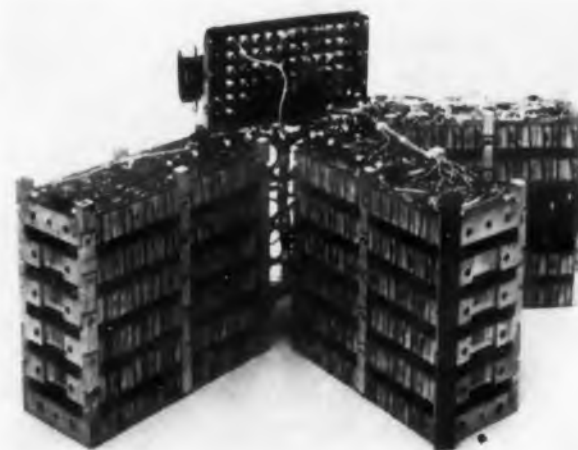
## PRODUCTS, INC.

137 Coit Street, Irvington, New Jersey  
ESsex 5-6000

CIRCLE 10 ON READER-SERVICE CARD

## NEWS

### Telebit System Shown Unpackaged



Telebit telemetering system now circling earth in Vanguard VI accepts analog and digital inputs from various experiments and converts data to a binary coded, 1024-cps subcarrier that modulates a 5-watt transmitter signal. System is serving in satellite primarily as test for use in space probes. Transmitter of 150 watts is expected to provide 64 pulse-per-second data transmission from distance of 55 million miles.

### RF Head Fits On Antenna In Radars Designed for Weather Tracking

An antenna designed specifically for meteorological use incorporates a piggy-back radio-frequency head to supply r-f energy to the antenna. This unit fits directly behind the antenna reflector and is said to eliminate changing the complete waveguide run for changeover.

The S-band storm finder can be converted for



Weather Bureau S-band radar can be switched to X or C band without changing complete waveguide run.

operation at X- or C-band frequencies by changing the rf head. A servo system remotely controls antenna position and mode of operation. It provides the normal slewing, tracking, azimuth and elevation scanning functions.

Currently, the Weather Bureau is operating 75 low-power, short range radars originally designed for tracking aircraft. The storm-finding radar network now being installed will blanket the country with an electronic warning system. The radars are being produced for both the Bureau and the Navy by Raytheon Manufacturing Co., Waltham, Mass. ITE's Special Products Div. is building the antenna systems under subcontract from Raytheon.

## SIGNIFICANT CONTRACTS . . .

. . . To Stromberg-Carlson, Rochester, N.Y., \$1,200,000 from the U. S. Navy Bureau of Ships for the design and development of an advanced, completely transistorized single-sideband communication system.

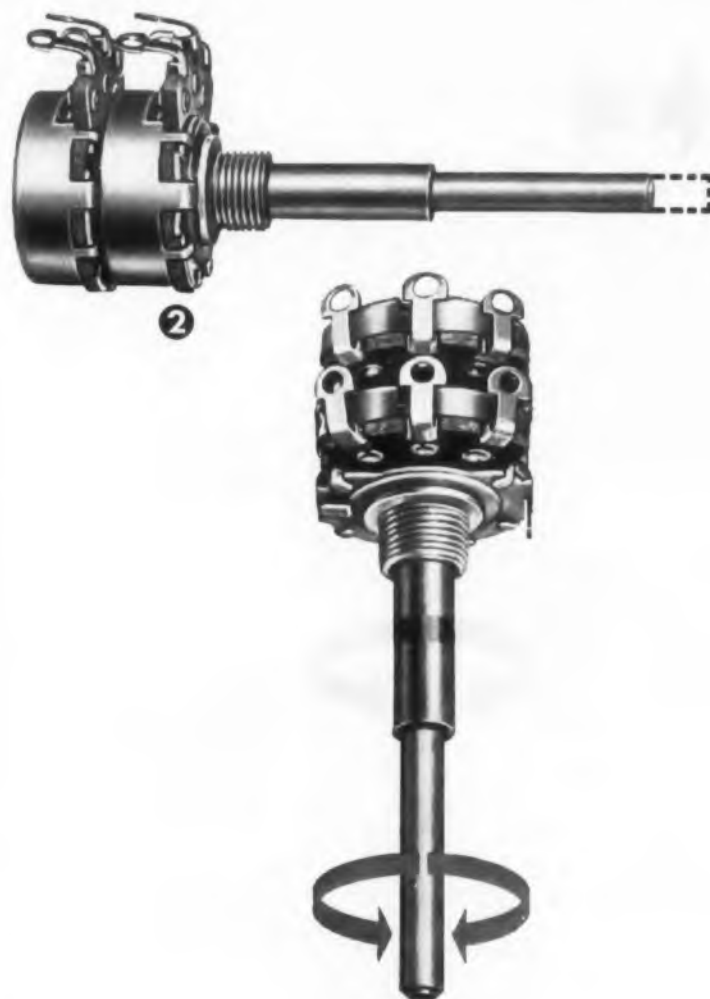
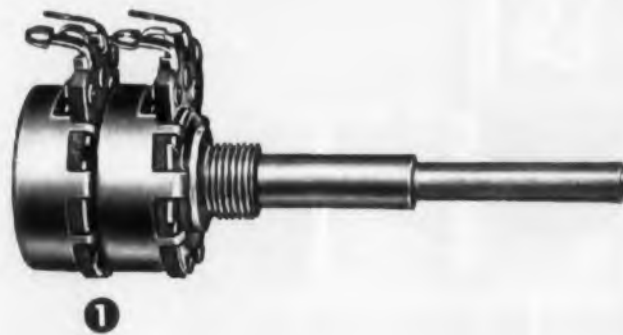
. . . To Melpar, Inc., Falls Church, Va., \$550,800 from Wright Air Development Center for a two-phase study and development for a speech compression system.

. . . To Electronic Engineering Co., Santa Ana, Calif., \$358,000 from the F.A.A.'s National Aviation Facilities Experimental Center for range instrumentation work. The contract covers the engineering study of the over-all range instrumentation system and recommendation for a complete system to meet NAFEC requirements.

. . . To Electronic Systems Development Corp., Ventura, Calif., \$200,000 from the Navy for the development, manufacture and installation of a precision radar synchronization system linking all the tracking surveillance radar facilities of the Pacific Missile Range.

. . . To Polarad Electronics Corp., Long Island City, N.Y., \$300,000 from the Western Development Laboratories of Philco Corp. for special microwave receivers with extremely precise calibration.

. . . To Daystrom Instrument Div., Murray Hill, N.J., from ITT Laboratories for the development and manufacture of two militarized random-access memory systems for use with data-processing equipment servicing the Strategic Air Command's Control set up. The value of the contract was not disclosed.

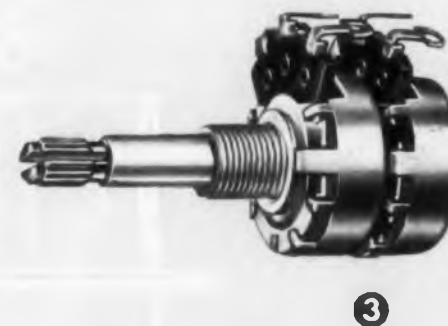


## STACKPOLE

Coldite 70+® fixed composition Resistors • Slide & Snap Switches • Ceramag® Ferrite Cores • Fixed composition Capacitors • Ceramagnet® Ceramic Magnets • Electrical Contacts • Brushes for all rotating electrical equipment • Hundreds of related carbon, graphite, and metal powder products.



CIRCLE 11 ON READER-SERVICE CARD



# NEW CONTROLS FOR STEREO

## Flexibility without Complexity

Even a wife can appreciate the major points of these special dual-element controls for 2-channel stereo equipment! No longer is it necessary to fiddle with 2 bass controls, 2 treble controls, and 2 volume controls to obtain proper stereo balance—then re-adjust everything when listening to monophonic material. No longer, that is, unless you're an ardent audiophile who would have it no other way.

For these new Stackpole controls "clean-up" the panels of stereo equipment, make them easier to operate and understand . . . yet retain all the flexibility of individual adjustments required on the most elaborate equipment.

- ① **FRICION SHAFT DUAL**—Type LS3: A friction fit between shafts causes both elements of this dual concentric shaft control to operate in tandem when either shaft is turned. Either element can also be adjusted independently by holding one shaft while rotating the other. Once set, either knob can be turned while maintaining stereo balance through a wide range of adjustment.
- ② **CLUTCH SHAFT DUAL**—Type LS1: This wonderfully convenient control allows either simultaneous or individual adjustment of its two elements. A push on the inner shaft engages a clutch which connects both elements together for tandem operation by either shaft. Pulling the inner shaft permits each element to be individually adjusted without disturbing the other.
- ③ **MATCHED ELEMENT TANDEM**—Type L-Tandem: Through precise electrical matching and careful mechanical alignment, this stereo tandem control allows convenient, single-knob adjustment of both channels. It's ideal for adjustment of master volume or of bass or treble in systems where an absolute minimum of panel complexity is desired.

*Mechanical and electrical specifications on these dependable 0.75-watt variable composition resistors are available on request. Electronic Components Division, Stackpole Carbon Company, St. Marys, Pa.*



## Get rack-mounting VERSATILITY with Chassis-Trak Slides

Ease of installation . . . space-saving design . . . smooth, trouble-free operation—these are sound reasons for specifying Chassis-Trak Slides. Still another reason is *versatility*.

Suppose you want to transfer a piece of equipment from one cabinet or rack to another. Nothing to it with Chassis-Trak. Simply press a push button spring and the entire chassis comes out. Then slip it into another rack equipped with Chassis-Trak Slides and the changeover is complete. Because Chassis-Trak parts are interchangeable (even on different models and sizes), equipment fitted with slides in one work area can be mounted without modi-

fication in Chassis-Trak-equipped cabinets *anywhere*.

Chassis-Trak Slides come in nine stock lengths and support loads up to 275 lbs. More than 200 standard models meet every installation need. Approved for military use.

Chassis-Trak "Detent" slide, shown in one of seven different tilting positions.



For further information contact:

**525 South Webster, Indianapolis 19, Indiana**

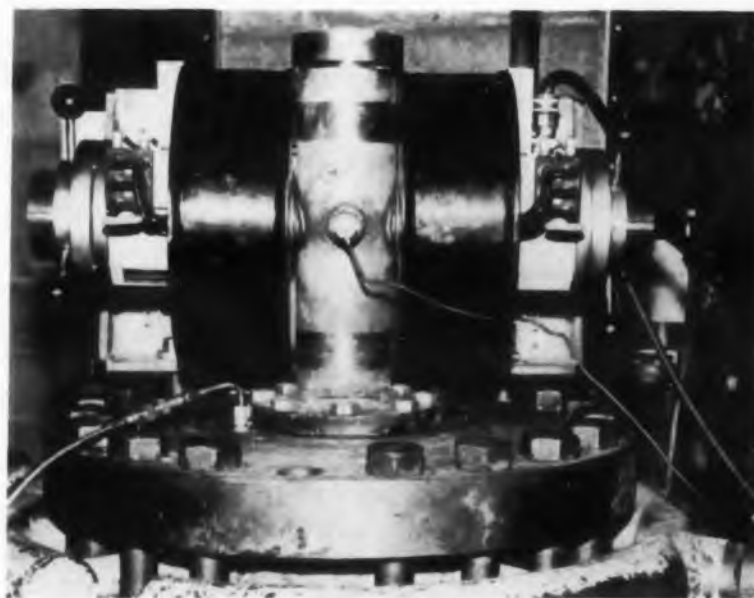
CIRCLE 12 ON READER-SERVICE CARD

## NEWS

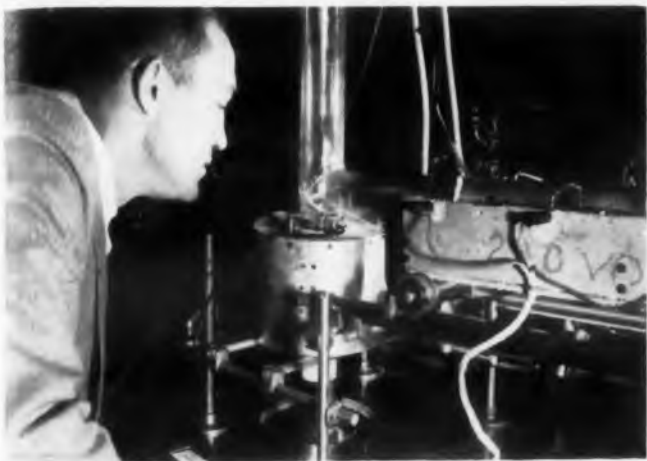
# Design News in Photos



The Army's latest master aircraft navigation system, developed by Sperry Gyroscope, is now undergoing prototype flight tests in a Douglas R4D. Map display on pilot's knee is pierced by a moving light to continuously show exact position of plane. Other instruments enable pilot to fly a pre-test flightpath without resorting to outside navigational aids. By flipping overhead switches, pilot can navigate automatically with respect to grid north, true north, magnetic north or inertial gyro.



First photos of General Electric's magneto-hydrodynamic energy converter show configuration (left photo) and the heart of the converter (right photo). The vertical cylinder flanked by electro-magnet pole pieces houses the molded-quartz generator shown in the photo at right. Hot ionized gases directed up through the vertical cylinder cut the magnetic flux and create a voltage. Energy is extracted through two electrodes, one of which is shown in the smaller photo.



"The purest crystal ever made of any compound" is being produced in this apparatus at Battelle Memorial Institute. Indium antimonide with less than 1 ppm impurity is being made for low-temperature detectors.



**Countermeasure simulator**, developed by Sylvania Electric Products Inc. and being installed at air-defense stations, simulates four types of marking jamming for radar training.



**Second Generation** data processing system developed by IBM for American Airlines will keep track of a million or more reservations, inform any of 1,100 ticket offices of the availability of seats, record data on new reservations retrieve data on an electric typewriter, automatically indicate an omitted detail, search files to confirm reservations, and make spelling corrections. The system is expected to be installed in 1962.



TYPE 33M

utmost  
in  
performance

MOLDED  
mylar\*  
CAPACITOR

*applications* | *computers • instrumentation • test equipment*  
*filter networks • transistor circuitry • amplifiers*

Sangamo Type 33M molded mylar\* capacitors combine the excellent electrical performance characteristics of mylar\* dielectric material with a molded case of high moisture resistant thermosetting plastic.

**Temperature Range:** "The Type 33M is designed to operate over the temperature range of  $-55^{\circ}\text{C}$ . to  $+85^{\circ}\text{C}$ . Satisfactory performance at  $125^{\circ}\text{C}$ . can be obtained by derating the voltage to 50% of the  $85^{\circ}\text{C}$ . value."

**Dissipation Factor:** The dissipation factor of the Type 33M capacitor does not exceed 1% at normal equipment operating temperature over the complete audio frequency range.

**Tolerances:** Available in capacitance tolerance values of  $\pm 5\%$ ,  $\pm 10\%$ ,  $\pm 20\%$ .

**Life Test:** These units will withstand a life test of 250 hours at 125% of rated voltage at  $85^{\circ}\text{C}$ . Life tests at  $125^{\circ}\text{C}$ . should be made at 125% of the derated voltage.

**Dielectric Absorption:** Dielectric absorption of Type 33M capacitors is less than half that of oil impregnated paper capacitors.

**Moisture Resistance:** Type 33M capacitors will successfully withstand the moisture resistance tests specified in Spec. MIL-C-91A.

**Insulation Resistance:** The insulation resistance of these capacitors will exceed 5,000 meg/mfd. over the normal operating temperature range.

• Write for engineering bulletin TSC-206A

\*DuPont's trademark for polyester film.



SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

CIRCLE 13 ON READER-SERVICE CARD

SC-59-6



## NEWS

### New Components Featured At Devices Meeting

State-of-the-art reports on tunnel diodes, new tubes, low-noise amplifiers and functional devices highlighted the 1959 Electron Devices Meeting in Washington, D. C. In addition, design improvements were described in traveling-wave and backward-wave devices, cathode ray tubes and semiconductors.

Dr. R. N. Hall, of GE's Research Laboratory, presented the basic characteristics of tunnel diodes and outlined their future use with transistors and tubes. He predicted that several years development time would be necessary to fulfill the applications predicted for the device.

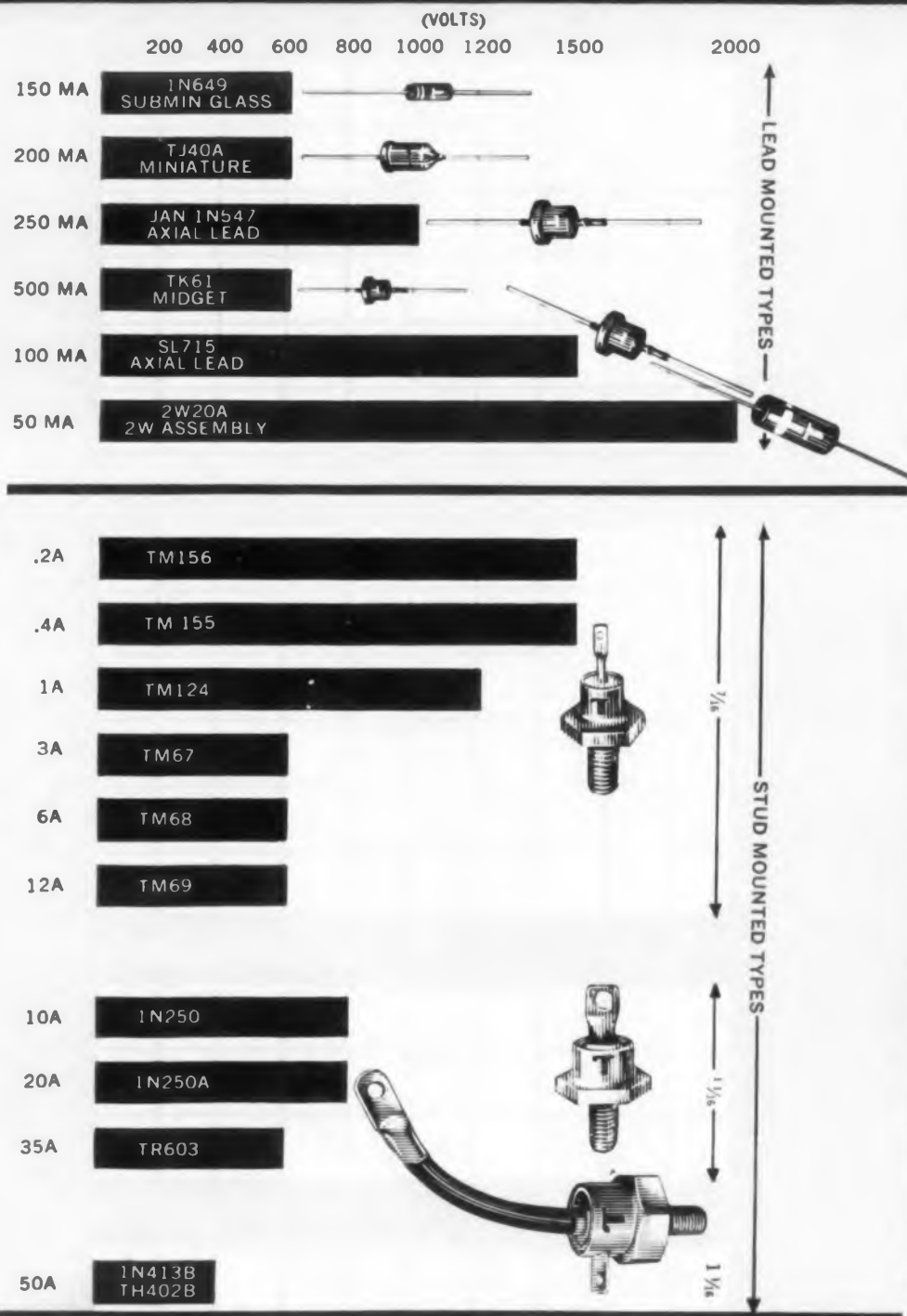
H. Heffner, of Stanford Electronics Laboratories, discussed the comparative merits of traveling wave tubes, parametric amplifiers, masers and tunnel diodes as low-noise amplifiers. He cautioned the audience to examine noise contributions offered to microwave systems by antennas, transmission lines, and other noise contributors preceding the amplifier; further reduction of amplifier noise might be of no avail if other noise sources override the input signal.

Multifunctional devices, specifically designed to perform a system function, are being developed by Bell Telephone Laboratories, revealed Dr. I. M. Ross. Conventional circuit design and interconnecting



**Advanced cathode ray tube** being described by Sylvania's H. E. Smithgall has a heater-cathode assembly said to be 25 times smaller than comparable standard assemblies.

# T<sup>®</sup> INDUSTRY'S MOST COMPLETE SILICON RECTIFIER LINE



### SILICON CERAMIC BASE RECTIFIERS



Fig. 1

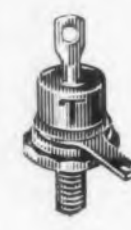


Fig. 2

Ceramic base rectifiers of compact design now eliminate the need for insulating hardware and "reverse polarity" units. These rugged stud-mounted silicon power rectifiers achieve their versatility by virtue of an alumina ceramic disc mounted between the top hat assembly and the hex base. The ceramic disc offers low thermal resistance and high electrical insulation properties. Further, bridge assemblies are now simplified and standardization of components is subsequently advanced.

The ceramic base rectifiers are available in  $\frac{1}{4}$ " hex base configuration up to 12 amperes @ 150°C case, and in  $\frac{1}{16}$ " hex base configuration up to 20 amperes @ 150°C case.

For example:

Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current @ 150°C Case (amps)	Figure
1N 341/C	400	400	1
1N 250 A/C	200	20	2

For further information write in for bulletin TE-1351R.

Number 12, 13, 14 and 15 in a series of 37 new Transistron Products to be announced before 1960!

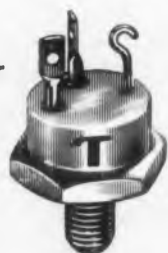
... designed to meet ALL your circuit requirements: current, voltage, temperature, size ... now available from Transitron.

A complete description of the lead and stud mounted types, which are summarized below, is in bulletin TE-1351.

We welcome your inquiries concerning special requirements such as high frequency, fast recovery and high voltage applications.

## SILICON CONTROLLED RECTIFIER

Handling 10 KW Power



Transitron's Silicon Controlled Rectifier is a PNP High power bistable controlled switching device. It is analogous to a thyatron or ignitron, with far smaller triggering requirements and microsecond switching. The low forward voltage drop permits high current ratings and provides high efficiency with low cooling requirements. The PNP design permits higher voltage ratings and lower saturation resistance than power transistors. This permits the smallest packaging for high power control yet made possible.

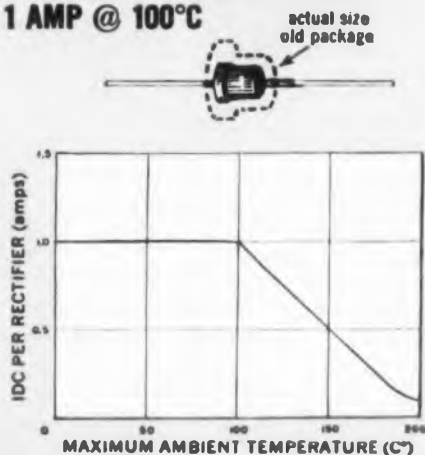
NOW AVAILABLE IN  
TRANSITRON'S NEW PACKAGE

Type	Minimum Peak Reverse Voltage (Volts)	Minimum Forward Breakdown Voltage (Volts)	Maximum Average Forward Current (amps)	
			at T case = 100°C	at T case = 25°C
TCR102	100	100	10	20
TCR202	200	200	10	20
TCR302	300	300	10	20
TCR402	400	400	10	20

Maximum Storage Temperature Range -65°C to +150°C  
Maximum Operating Temperature Range -65°C to +125°C

Send for Bulletin TE-1356A

## MIDGET RECTIFIER 1 AMP @ 100°C

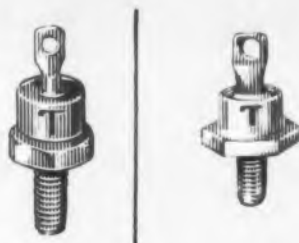


Transitron announces, higher ratings and smaller size in a lifestested lead mounted silicon rectifier. By establishing a high level of designed quality, these rectifiers feature reliable 200°C operation. Remember, the size is SMALLER, the flange is GONE! These units will meet all electrical and environmental requirements of the JAN-1N 547 series.

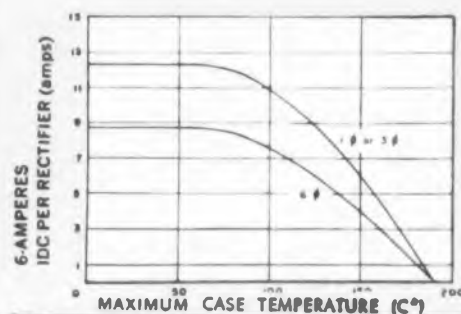
Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current (Milliamps) (Amps)		Maximum Forward Voltage @ 25°C (Volts) (Milliamps)
TK61	600	100	1.0	1.0 @ 750
TK41	400	100	1.0	1.0 @ 750
TK21	200	100	1.0	1.0 @ 750

Write for bulletin PB-58

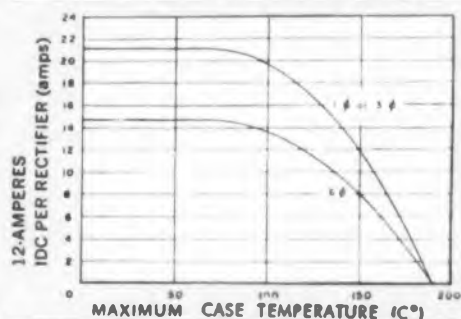
## HIGH CURRENT RECTIFIERS



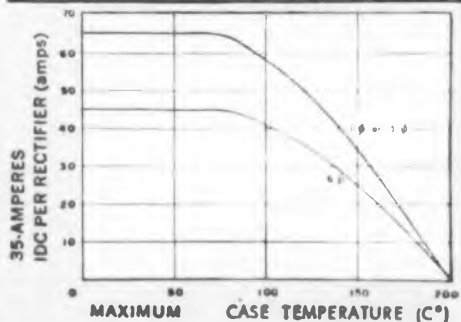
Now, from Transitron, stud-mounted silicon power rectifiers which combine high power handling ability with a minimum of size and weight ... The extremely low forward resistance and thermal impedance of these units allow operation up to 12 amperes @ 150°C case temperature in the 1/16" hex base configuration, and similarly up to 35 amperes @ 150°C case temperature in the 1/8" hex base configuration. Still further, the inherently low leakage currents and high peak inverse voltage ratings allow flexibility in the design of both power supply and magnetic amplifier circuits.



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TM68	600	1.1 @ 6	2
TM58	500	1.1 @ 6	2
TM48	400	1.1 @ 6	2
TM38	300	1.1 @ 6	2
TM28	200	1.1 @ 6	2
TM18	100	1.1 @ 6	2
TM8	50	1.1 @ 6	2



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TM69	600	1.2 @ 12	2
TM59	500	1.2 @ 12	2
TM49	400	1.2 @ 12	2
TM39	300	1.2 @ 12	2
TM29	200	1.2 @ 12	2
TM19	100	1.2 @ 12	2
TM9	50	1.2 @ 12	2



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TR603	600	1.5 @ 100	5
TR503	500	1.5 @ 100	5
TR403	400	1.5 @ 100	5
TR303	300	1.5 @ 100	5
TR203	200	1.5 @ 100	5
TR153	150	1.5 @ 100	5
TR103	100	1.5 @ 100	5
TR53	50	1.5 @ 100	5

\*Averaged over one cycle with rectifier operating at full rated current and voltage into a resistance load.

wiring are dismissed in favor of a new approach in system concept. Outstanding examples of simplification giving increased reliability in telephone equipment were shown.

A 220-mc negative-resistance parametric amplifier, described by Dr. G. Schaffner of Motorola, Inc., uses only 0.1 mw pump power and provides 13 db gain.

A heater-cathode assembly, requiring only a 1.5-v, 140-ma heater supply, has been developed by Sylvania Electric Products. Requiring only six per cent of the heater power normally needed for 6.3-v, 600-ma tubes, the new design centers around a cathode-radiating surface of 0.0054 sq in., (see photo). Conventional structures have 0.136 sq. in. surfaces.

Among the other tubes described at the technical sessions was a "thin" picture tube called a reflected-beam kinescope, which displays its image on a screen 20 in. or more in diameter, and is only 10 in. deep. RCA reports that its recessed area is large enough to hold most of the receiving circuitry.

In this tube, the phosphor screen is mounted on the rear inner surface, near the gun. The electron beam is sent to the front of the tube, where it is reflected back from the transparent tubeface to the phosphor screen.

## TWT Delivers 10 kw

RCA also reported on a developmental X-band traveling wave tube capable of delivering a peak rf power output of 10 kw. The electrostatically focussed tube uses different types of slow-wave rf structures rather than a bifilar helix to increase its power and frequency capabilities.

Papers from Europe and Asia described a silver-bonded diode for parametric amplification (Japan), a series of pulsed, high-perveance, high-power klystrons for linear accelerators (France), and a beam-power multiplier tube (Egypt).

About 1300 engineers attended the Oct. 29-30 meeting in Washington, D. C., sponsored by the IRE Professional group of Electron Devices.

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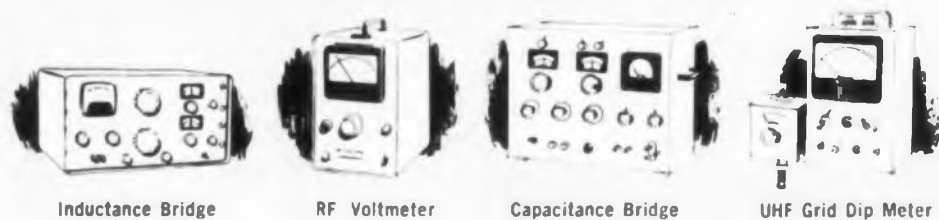


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CIRCLE 15 ON READER-SERVICE CARD

## NEWS

**Pigeon** in secondary trainer has passed his first flight tests and is now learning how to track targets that will be shown on display screen in front of "missile." For pecking the image on the nose the pigeon will be awarded with corn. Wire leading from pigeon's beak closes control loop when beak touches electrically conducting glass of display screen. Project was a wartime idea for a jamproof control system for homing missiles.



## Navy Declassifies Details of Pigeon Guidance Project

**A** STUDY of missile guidance by pigeon pecking has been taken out from under wraps by the Navy. At the same time, perhaps to calm fears of guidance designers, the Navy made clear that the project has been discontinued (*ED*, Sept. 30, 1959, p. 11.)

Started during World War II, Project Orion (for organic control), was a try-anything approach to solution of some then-current problems. Guidance systems for homing missiles were being easily countermeasured and the Navy thought animals might have potential as a jam-proof control element.

Pigeons were selected for trial because they were light, easily obtainable and adaptable. Their job was to ride inside a missile and peck at an image of a target picked up by a lens in the missile's nose. The pigeon's pecking of the target image was translated into an error signal that corrected the simulated missile's simulated flight.

The project was revived in 1948 and carried further. In simulated rocket tests the pigeons produced "surprisingly good results." The researchers were convinced that a pigeon could successfully guide a speeding missile under optimum conditions, compensating for his own and the missile's errors.

But after three years of equipment development and testing, the project was

abandoned because range of the Orion system could be no greater than the range of any optical system and the system could be used only in the daytime.

The study was divided into two phases. The first, involving a primary trainer, tested the capability of pigeons. Could they peck fast enough? Could they distinguish between images of targets and backgrounds? How much training would they need?

Both the trainer and the pigeons passed their tests and a secondary trainer was developed. It used target images specially photographed in color by a jet



**Pigeon in tracking** position waits for image to appear.

plane, which made picture-taking dives at a destroyer and a freighter in the open sea. Highly original electronics provided a realistic situation for the birds.

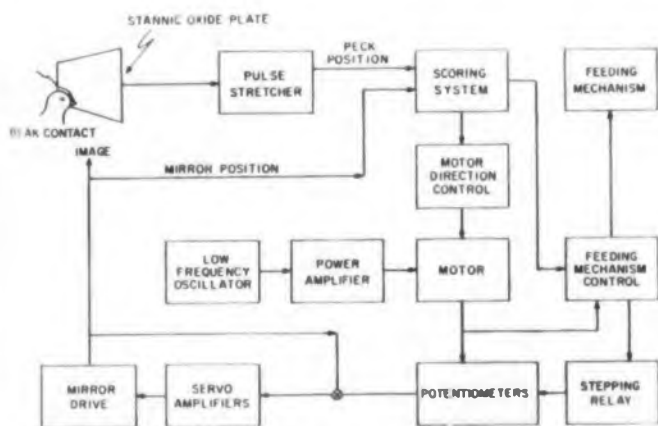
Trainee pigeons were started out in the primary trainer pecking at slowly moving targets. They were rewarded with corn for each hit and quickly learned that good pecking meant good food. Eventually pigeons were able to track a target jumping back and forth at five inches per second for 80 seconds without a break. Peck frequency turned out to be four per second. More than 80 per cent of the pecks were within a quarter-inch of the target.

In guidance terms, the bandpass frequency of the pigeons was seven radians per second.

In the secondary trainer, the pigeon rode in a harness and actually changed the course of the target image by his pecking. The image was shown under a glass screen coated with stannic oxide to make it electrically conducting. Through circuitry based on the Wheatstone Bridge principle, pecks on the glass were translated into distance right and left and up and down from the center lines.

The target was moved by a small mirror controlled by a servo. The control circuits were such that if the pigeon stopped tracking, the target image would drift rapidly away from the center of the screen. This forced the pigeon to correct not only his own pecking errors, but those introduced by the yawing of the "missile."

A complete recording system provided data for analysis. It turned out that 55.3 per cent of the "runs" made were successful—that is, the pigeons were able to keep the target image on their screens for the duration more than half their flights. Four pigeons, however, were about 80-per-cent successful, raising the possibility that picking better tracers would result in still greater accuracies. The training conditions simulated  
(continued on following page)



Highly original electronic design went into the circuitry for this secondary trainer, which permitted pigeon pecks to control movement of a target image on a screen.

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CIRCLE 16 ON READER-SERVICE CARD

## NEWS

missile-flight speeds of about 400 miles per hour.

If pigeon guidance did not get very far in the Navy, it did have one valuable offshoot. The electricity-conducting glass later used in many radar displays was developed originally for project Orcon.

## NEWS BRIEFS . . .

. . . **MAGNETIC-DOMAIN** computer progress has reached the working-element stage at Servomechanisms, Inc., (*ED*, 10/14/59, p25). Goal is logic element of iron-nickel sheet made bistable by domain-domain interaction. Switching speed will reach 0.3 microsec.

. . . **THE TUNNEL DIODE COMPUTER** being designed by Leo Esaki and a Tokyo University group will incorporate a basic circuit using 30 tunnel diodes. Each diode will have a 30-mc switching speed. The first model is scheduled to be ready early next year about the same time that Sony is expected to start commercial production of tunnel diodes. The university computing group is also working on early designs for a computer with the same switching capacity as the human brain—100,000 diodes with a 100-mc switching speed will be required.

. . . **EXPERIMENTAL TV** colorcasts are being made with a low light-level image orthicon developed by GE originally for military use. The Z-5351 is said to produce acceptable pictures with 40 foot-candles of light, roughly the amount available at night baseball games and auditorium events.

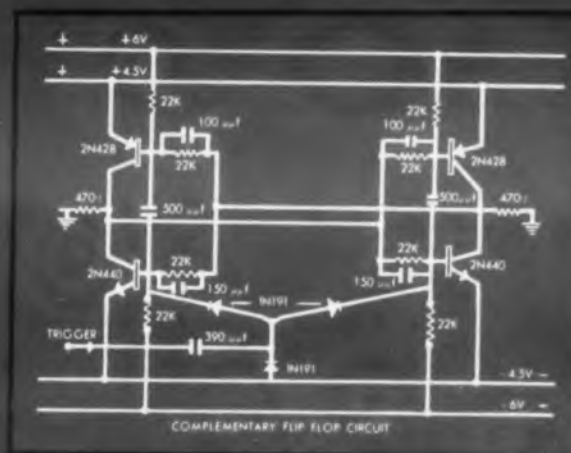
UNIVAC solid-state computers will be available with this magnetic tape attachment, now being adapted for use with the Remington Rand units. Presently only punched-card capability is available with Univac solid-state computers.



## for switches

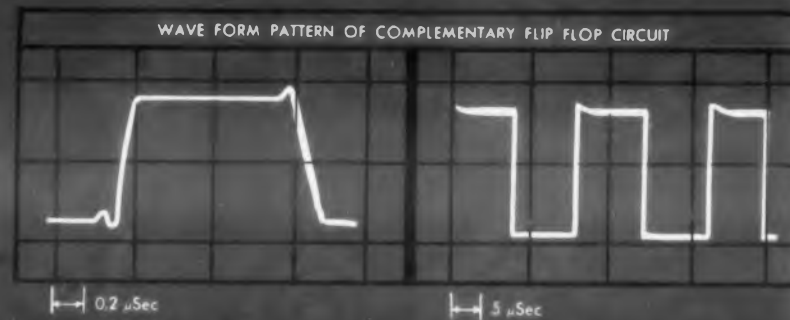


### COMPLEMENTARY FLIP FLOP CIRCUIT

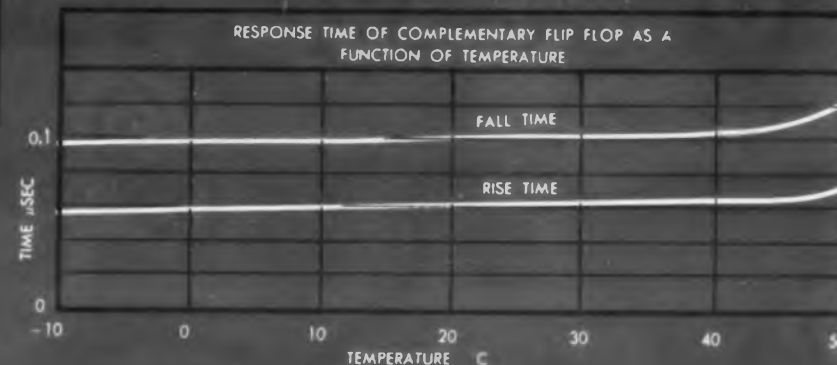


higher efficiency  
symmetrical wave shape  
lower output impedance  
shorter rise and fall times

WAVE FORM PATTERN OF COMPLEMENTARY FLIP FLOP CIRCUIT

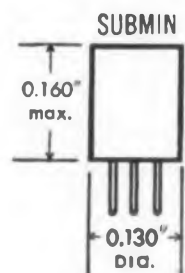
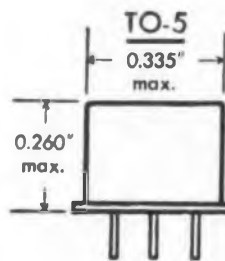


RESPONSE TIME OF COMPLEMENTARY FLIP FLOP AS A FUNCTION OF TEMPERATURE



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### Medium Current Switches



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Type	V <sub>CE</sub> Volts	I <sub>av1</sub> Avg. Mc	HFE <sub>1</sub> I <sub>B</sub> = 1MA V <sub>CE</sub> = 0.25V	HFE <sub>2</sub> Min. I <sub>B</sub> = 10MA V <sub>CE</sub> = 0.25V	Rise* Time Max.
2N404	-24	12	—	—	—
2N425	-20	4	20-40	10	1.0
2N426	-18	6	30-60	10	0.55
2N427	-15	11	40-80	15	0.44
2N428	-12	17	60	20	0.33
2N1017	-10	22	80	20	0.27

\*I<sub>C</sub> = 50MA; I<sub>B1</sub> = 5MA; R<sub>L</sub> = 200Ω I<sub>B2</sub> = 5MA

#### GERMANIUM NPN ALLOY — TO-5 CASE

Type	V <sub>CE</sub> Volts	I <sub>av1</sub> Avg. Mc	HFE Min. I <sub>C</sub> = 50MA V <sub>CE</sub> = 1.0V	Rise* Time Avg. μsec
2N438	25	6	20	0.7
2N439	20	11	30	0.5
2N440	15	17	40	0.3

\*I<sub>B1</sub> = I<sub>B2</sub> = 1MA; I<sub>C</sub> = 10MA; R<sub>L</sub> = 1KΩ

Contact the nearest Raytheon office for data on

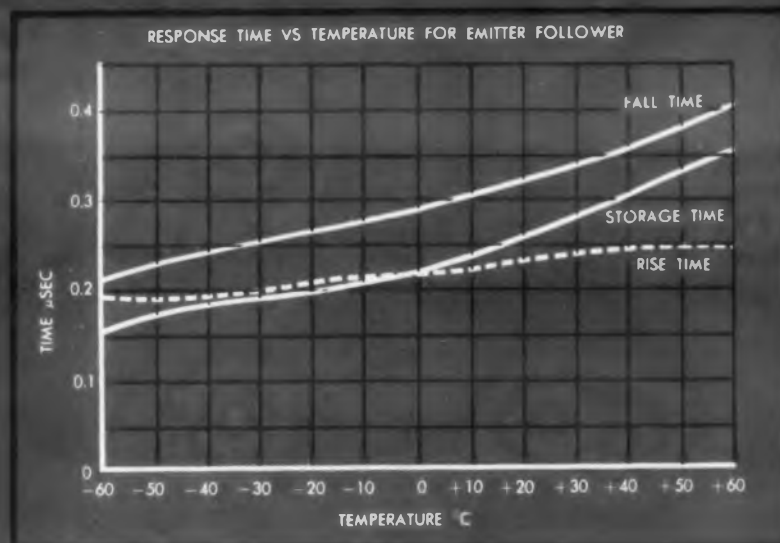
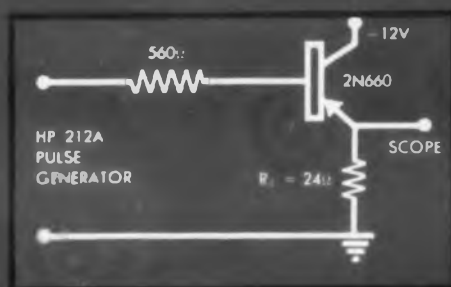
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High Current Switches

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Type	V <sub>CE</sub> Volts	I <sub>sat</sub> Ave. Mc	H <sub>FE</sub>	
			I <sub>B</sub> = 1MA V <sub>CE</sub> = 0.25V	H <sub>FE</sub> Min. I <sub>B</sub> = 10MA V <sub>CE</sub> = 0.35V
2N658	-24	5	25-80	15
2N659	-20	10	40-110	25
2N660	-16	15	60-150	40
2N661	-12	20	80	55
2N662	-16	8	30	18

Subminiature Switches

GERMANIUM PNP ALLOY — SUBMIN CASE

Type	V <sub>CE</sub> Volts	I <sub>sat</sub> Ave. Mc	H <sub>FE</sub>		Rise <sup>o</sup> Time Max.
			I <sub>B</sub> = 1MA V <sub>CE</sub> = 0.25V	H <sub>FE</sub> Min. I <sub>B</sub> = 10MA V <sub>CE</sub> = 0.35V	
CK25	-20	4	20-40	10	1.0
CK26	-18	6	30-60	10	0.55
CK27	-15	11	40-80	15	0.44
CK28	-12	17	60	20	0.33

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... TUNNEL DIODES now being offered as samples by General Electric have resistive cutoff frequency of over 1100 mc, with peak tunnel current and voltage of 1 amp and 55 v.

... COMPONENT SHIPMENTS during the first half of 1959 were definitely up more than 30 per cent over those of the comparable 1958 period. According to the Dept. of Commerce, this is the greatest rise in component output since the Korean War, and confirms estimates based on earlier, less complete data.

... COMPUTER that would use solid-circuit modules has been proposed to the Air Force by Texas Instrument's Apparatus Div. Advantages of the computer over one of standard miniaturized-component design would line up this way, according to the company: Component density—5,000,000 parts/cu in. vs. 50,000; manufacturing steps per flip flop—14 vs. 188; components per flip flop—1 vs. 20; computer volume—12 cu in. vs. 864 cu in.; computer weight—1.2 lb vs. 10 lb.

SILENCER for Explorer VII satellite is a 2-in. cube designed to turn off the satellite's transmitter after one year. The Bulova unit draws 0.000000001 watts, has 9000 hour capacity.



... THE AMERICAN STANDARDS ASSOCIATION has approved the IRE's standard for television luminance signal levels. Designated C16.31-1959, "American Standard Method of Measurement of Television Luminance Signal Levels," the standard describes methods of measuring the significant amplitude levels of a monochrome or color TV signal, either composite or noncomposite.

... THE AUDIO ENGINEERING SOCIETY has honored Dr. Harold S. Black of Bell Labs, for "outstanding achievement in the field of audio engineering" and "in recognition of his original enunciation of the feedback principle." Dr. John G. Frayne, Westrex Corp., was honored by the AES for "outstanding development in the field of audio engineering" and "in recognition of his contributions to the development of photographic and magnetic motion picture sound recording devices, and of feedback cutters for monophonic and stereophonic disc recording."

CIRCLE 17 ON READER-SERVICE CARD

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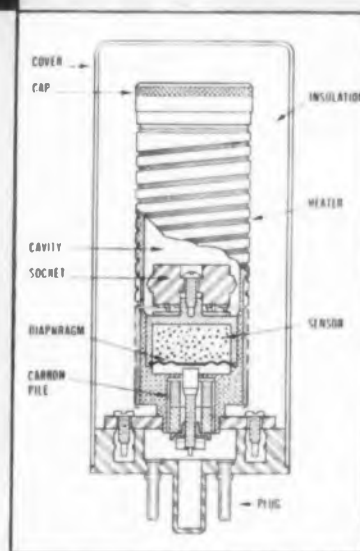
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CIRCLE 18 ON READER-SERVICE CARD

## NEWS BRIEFS . . .

. . . **PASSIVE** communication satellites are nearer because of successful launching last month of NASA's 100-foot aluminized balloon, shot into space from Virginia and effectively inflated.

. . . **THE INSTRUMENT SOCIETY OF AMERICA**, aided by an NSF grant will continue publishing translations of the 1959 issues of four Soviet technical journals: *Measurement Techniques, Instruments and Experimental Techniques, Automation and Remote Control*, and *Industrial Laboratory*.

. . . **THE SOVIETS** have ordered a medium-size transistorized British computer, the Elliott 802. The computer, which has a memory of about 1000 33-bit words, will probably be used for scientific work.

. . . A **THERMOELECTRIC** water purification apparatus developed by the Whirlpool Corp. uses thermoelements simultaneously for evaporating and condensing. Idea is to eliminate the large quantities of cooling water normally required in purification devices.

. . . **AN ELECTRONICS CENTER** at Hanscom Field, Bedford, Mass. will be established within the next eight months. Main objective is to establish a one-location organization for acquisition and delivery of large complex ground electronic systems.

. . . A **DIGITAL TELEVISION** transmission system, for long-range transmissions, jointly developed by the Colorado Research Corp. and the Signal Corps, is reported to give clear pictures under high-noise conditions.

## PRICE CHANGES . . .

. . . Germanium scrap processing charges have been reduced up to 25 per cent by Sylvania Electric Products, Inc. . . . Single crystal Germanium prices have been cut from \$296 to \$285 per pound by Semimetals, Inc., Richmond Hill, N.Y. . . . Hyperpure-silicon, single-crystal prices have been cut by up to \$150 per pound by the Du Pont Co. . . . Zener diode price cuts by Motorola Semiconductors, Phoenix, Ariz., have resulted in basic prices of \$4.00, \$2.90, and \$2.90 for the company's 1N620, 3/4M7.5Z-through-56Z, and 1M7.5Z-through 56Z diodes.

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## New Metallized Mylar\* (Type TWMM) and Mylar-Paper (Type MTWK) Capacitors by Cornell-Dubilier.

Whether you specify miniature metallized capacitors for military or industrial electronic equipment—for critical power-supply filter circuits or bypass applications—Cornell-Dubilier's new MYCON metallized capacitors assure top performance and dependability. Backed by over 47 years of capacitor engineering and manufacturing leadership, MYCONS combine better high-temperature operation and better insulation resistance with low dissipation factor and fault count. Available in a wide choice of mounting styles, MYCONS meet the requirements of applicable military specifications. For complete specifications, write for Engineering Bulletins 190 and 185 to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

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CAPACITORS

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## WASHINGTON REPORT



Ephraim Kahn

### New Defense Dept. Cost Principles Mean Aid, Trouble for Electronics

Uniform contract cost principles, set by the Defense Department after years of discussion—and dispute—with industry, promise both help and hindrance to the electronics industry. Use of the new regulation, formally titled Revision No. 50, Armed Services Procurement Regulation, may start at once. It is mandatory for contracts made after July 1, 1960. Existing contracts need not be amended to reflect the new cost principles, but they will apply in the negotiation of contract terminations.

Preliminary judgments by industry men indicate that these cost principles may slightly liberalize terms of cost-reimbursement contracts while possibly tightening the squeeze on holders of fixed-price pacts. Though the new regulations are considered "guidelines" by the military, it is generally believed that government officials will try to adhere to them as closely as possible. This could easily result in a decreased recovery of costs for firms working on fixed-price contracts.

This is acknowledged in the regulation itself, which notes that since the military "have not provided specific guidance in the past, these new principles will, at least in some instances, result in reduced recovery by contractors for certain particular items of expense."

Electronics firms that do independent research in addition to working on government contracts stand to gain from the cost rules change. Under the new rules, "a contractor's costs of independent research . . . shall be allowable as indirect costs . . . provided they are allocated to all work of the contractor." In other words, the government will pick up its share of the tab for basic research that is not sponsored by a contract, grant, or other arrangement if the company's other customers make a proportionate contribution.

#### Some Independent Development Chargeable

Costs of independent development directly aimed at specific products are chargeable to the government to the extent that it is related to the product lines for which the government has contracts. But such costs must be reasonable and be allocated to all work of the contractor on these product lines. Contractors who do not engage

#### MYCONS

TYPE TWMM—  
Metallized Mylar

TYPE MTWK—  
Metallized Mylar and Paper Film

#### Specifications and Features

- Ratings from .01 mfd. to 12.0 mfd. Voltages of 200, 400, or 600 volts DC Working.
- Wide useful temperature characteristics within range of -55°C to +125°C.
- Hermetically sealed in miniature tubular metal cases with metal-to-metal end-seals.
- Wire lead or solder lug terminals.
- Various bracket-mounting or threaded-neck mounting styles.

in production work may charge the government for development to the extent that it is "related and allocated as an indirect cost to the field of effort" of government R & D contracts.

No blank check will be written for independent R & D. The Defense Department will assume a share of a reasonable amount of current R & D "in line with the national policy of encouraging independent research." But company expenditures must be consistent with "a broad planned program, which is reasonable in scope and well managed." Spending, especially for development, will be scrutinized with great care in connection with contractors whose work is "predominantly or substantially" with the government. Recognizing that cost-sharing may provide "motivation for more efficient accomplishment" of R & D, the new rules say that "it is desirable in some cases that the government bear less than an allocable share of the total cost of the program."

Incentive pay, cash bonuses, and other compensation are considered allowable costs by the government, except for stock options. These, as well as fringe benefits, must be reasonable and consonant with the company's past practice.

Contract termination costs are also subject to the new principles. In general, the government will not allow a charge for items that can reasonably be used on the company's other work, unless the contractor can show he would suffer a loss by retaining the items. The government will, however, pay for costs that can not be discontinued immediately after contract termination. In figuring termination costs, certain initial expenditures may be included, as are settlement expenses.

"Reasonableness" is probably the key word in the application of the new cost principles, and the one that will provoke the most debate. The regulation says that a cost is reasonable if it "does not exceed that which would be incurred by an ordinarily prudent person in the conduct of competitive business." But it is made clear that "what is reasonable depends upon a variety of considerations and circumstances involving both the nature and amount of the cost in question."

#### Not All Costs Covered

Not all cost items are treated in the regulation. This "is not intended to imply that it is either allowable or unallowable." Sample allowable costs include advertising in trade or technical journals (the ads can not offer specific products for sale); help wanted ads; cost of participation in exhibits under certain conditions; bonding costs; Civil Defense costs; wages, salaries, and other compensation; training and education expenses; depreciation; manufacturing and production engineering costs; and other normal business expenses.

Most interest will not be considered a charge

# voltage controlled transistorized subcarrier oscillator less than 2 milliwatts of power consumption



ACTUAL SIZE



Power requirements 1.25 volts dc at approximately 1.5ma

Linearity less than  $\pm 1\%$  of design bandwidth

Distortion less than 0.75%

Output voltage approximately 0.5 volts rms

It is recommended only for application where extremely low power consumption is required.

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Static components eliminate tubes, brushes, and other moving parts.

Sta-Vo-Trol regulators assure you reliable, constant voltage—regardless of line or load fluctuation—giving optimum performance of critical military and commercial electronic equipment.

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- Rating: 1 Kva output, 0 to 8.5 amperes, single phase, 60 cycles  $\pm 5\%$
- Input range: 95 to 135 volts
- Output range: 115 volts normal, 110 to 120 adjustable
- Accuracy:  $\pm 0.25\%$  bandwidth†
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- Load power factor range: 0.5 lagging to unity
- Wave-form distortion: 3%

†  $\pm 0.25\%$  bandwidth for any line and load changes at constant power factor;  $\pm 0.5\%$  bandwidth for changing load power factor.

‡ 6 to 12 cycles for 63% correction after ordinary line and/or load changes; up to 30 cycles for complete correction.

**NET PRICE—\$475**

(type SLR-1000)

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**GENERAL ELECTRIC**

## WASHINGTON REPORT

allowable by the government. In the past, interest costs were not allowed when contracts were completed, but the government considered rental paid for money in negotiating contract terminations. This is no longer the case. In addition, many other financial costs—bond discounts, costs of financing and refinancing, certain legal and professional fees paid in connection with stock issues—can not be passed on to the government. Interest levied by state or local government may, under specified conditions, be an allowable cost to the government.

The final word on cost principles has not been said in the new regulation. It is believed that some industries feel that the new rules do not meet their needs. They are expected to press for revisions.

## Government Studies Computer Economics

Computer economics—whether to buy or rent automatic data processing machinery—is being studied by the Government. More and more agencies that handle substantial quantities of information are turning to computers to speed their work. So far, the inter-agency group that has been studying the question has not been able to come up with a single hard and fast rule for all agencies. It is indicated, however, that most agencies will, for the time being, rent rather than buy. After developments in the costly machines begin to be less rapid, there may be a swing to buying. (One of the government's largest users of computers, the Census Bureau, already buys its machines.)

Biggest problem that faces government officials who have to decide whether to rent or buy computers is obsolescence. This is reflected in the government's tendency to rent machines with an option to buy. The government is also trying to figure out, well in advance, what to do with old computers.

It seems to regard trading-in obsolescent computers with misgivings, feeling, apparently, that predicting values in used equipment is at best an uncertain game. Besides, from the point of view of an agency processing cut-and-dried data (income tax returns, for example), technological obsolescence is not a real factor if there is no real need for equipment that embodies major improvements. In order to justify replacement of a data-processing system, such an agency would have to find a new one that promised savings large enough to offset the undepreciated part of the old system.

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**TYPICAL LOAD AND VOLTAGE CORRECTION**—output setting, 115 v—load change, 0 to 8.5 a, unity power factor—input change, 115 to 95 v.

**TYPICAL VOLTAGE CORRECTION**—output setting, 115 v—load, 8.5 amps, unity power factor—input voltage change, 115 to 135 v.

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DIFFUSED SILICON MESA TRANSISTORS MAKE THIS POSSIBLE. THEY RETAIN THEIR HIGH PERFORMANCE OVER A VERY WIDE RANGE OF TEMPERATURE, FREQUENCY AND COLLECTOR CURRENT.

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# MEETINGS

## Calendar of Events

### December

- \*1-3 1959 Eastern Joint Computer Conference, AIEE, ACM, PGEC, Statler Hilton Hotel, Boston, Mass.
- \*1-2 4th Midwest Symposium on Circuit Theory, Marquette University, Milwaukee, Wis.
- 3-4 Professional Group Vehicular Communications, Colonial Inn & Desert Ranch, St. Petersburg, Fla.
- 3-4 2nd Semiconductor Surfaces Conference, Silver Spring, Md.
- \*3-5 3rd Annual International Visual Communications Congress, Society of Reproduction Engineers, SRE, Statler Hilton Hotel, New York, N. Y.
- \*8-10 2nd National Conference on the Application of Electrical Insulation, AIEE, NEMA, Shoreham Hotel, Washington, D.C.
- 26-30 American Association for the Advancement of Science, Chicago, Ill.

### January

- 6-9 Institute of High Fidelity Manufacturers 1960 High Fidelity Music Show, Shrine Exposition Hall, Los Angeles, Calif.
- 11-13 6th National Symposium on Reliability and Quality Control, Statler-Hilton Hotel, Washington, D.C.
- 12-15 Society of Plastics Engineers' 16th Annual Technical Conference, Conrad Hilton Hotel, Chicago, Ill.
- 25-29 Stress Measurement Symposium, Arizona State University, Tempe, Ariz.

### February

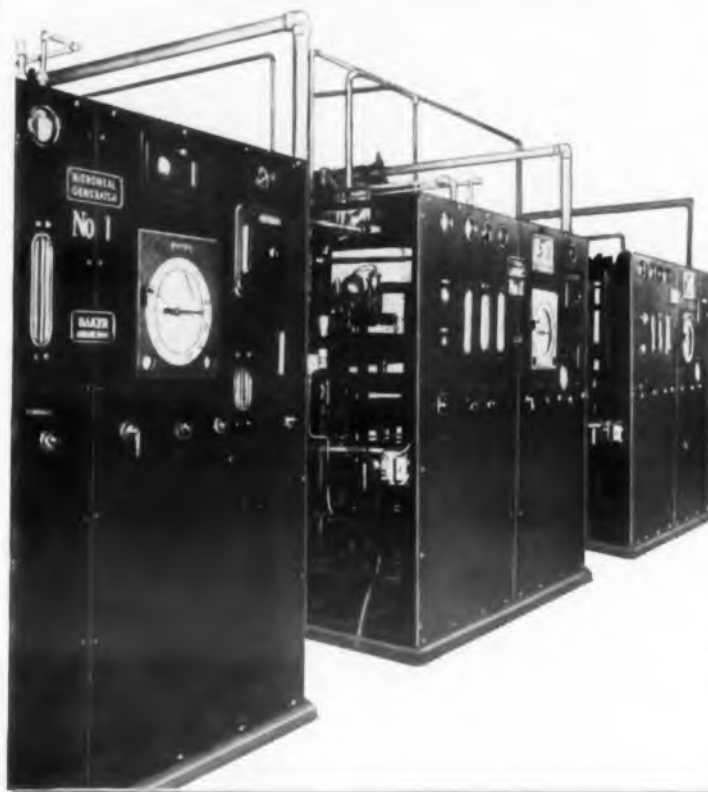
- 2-4 15th SPI Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Ill.
- 3-5 1960 Winter Convention on Military Electronics, PGME, Ambassador Hotel, Los Angeles, Calif.
- 10-12 7th Annual Solid-State Circuits Conference, IRE, AIEE, Philadelphia, Pa.
- 11-12 7th Annual Cleveland Electronics Conference, IRE, ISA, AIEE, Engineering and Scientific Center, Cleveland, Ohio.
- 11-13 1st Annual Electronics Representatives Association, Drake Hotel, Chicago, Ill.
- 19-23 3rd International Electronic Parts Show, Paris, France.

\*Includes meetings described herewith

### 9th Annual Eastern Joint Computer Conference, December 1-3

Delegates from industry, educational institutions, government agencies and nonprofit research centers will spend three days at the Statler-Hilton Hotel, Boston, Mass., exchanging technical information on computers, their current and future use, and the changes they are making in the nation's economy. A total of 27 technical papers—carefully selected to represent a wide range of current application and research in computer technology—will be delivered during the conference. In addition to listening to technical papers, many delegates will discuss current problems in the field during four concurrent evening panel sessions slated for December 2. Others will make inspection trips to either MIT's Lincoln Laboratory in

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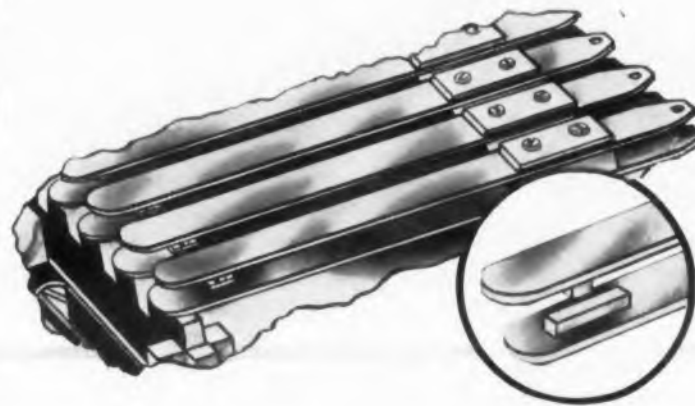
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You can now get ideally efficient crossbar contacts for your electrical relays—with as many contacts as you need, where you need them—with positive assurance of full, contact surface. This has been made possible through the development of Makepeace's 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.

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Lexington, or the Arthur D. Little Company in Cambridge. Thursday evening, December 3, a cash award for the best delivery of a technical paper during the Conference will be made. The main speaker for the evening will be Dr. Willis W. Ware, of the Rand Corp., Santa Monica, Calif. The Eastern Joint Computer Conference and its western counterpart are cosponsored by the American Institute of Electrical Engineers, the Institute of Radio Engineers and the Association for Computing Machinery. For additional information write to: George Wood, Office of Public Relations, MIT, Room 3-339, Cambridge 39, Mass.

### 2nd National Conference On The Application Of Electrical Insulation, December 8-10

Latest developments in the field of electrical insulation will be exhibited at the 2nd National Conference on the Application of Electrical Insulation, to be held at the Shoreham Hotel in Washington, D.C. The conference features a three-day technical program on the various phases and application of all types of electrical insulation. Particular emphasis will be placed on high temperature insulation, new insulating products, and new testing methods. The conference is co-sponsored by the American Institute of Electrical Engineers (AIEE) and the National Electrical Manufacturers Association (NEMA). For additional information write to: T. F. Hart, Chairman, Publicity Committee, C O Silicones Division, Union Carbide Corp., 30 E. 42nd St., New York 17, N.Y.

### 3rd Annual International Visual Communications Congress, December 3-5

The 3rd Annual International Visual Communications Congress will be held in the Statler Hotel in New York City. Each morning there will be a technical session at which speakers from in-plant graphic reproductions-visual communications departments and manufacturers of materials and services will discuss the latest available techniques in the field of electrostatic printing, microreproduction and retrievables, office copying machines, offset, diazo and other methods of reproduction. The conference is sponsored by the Society of Reproduction Engineers. Everett Kaestner, Bell Telephone Laboratories, New York City, is the general chairman.

### 4th Midwest Symposium On Circuit Theory, December 1-2

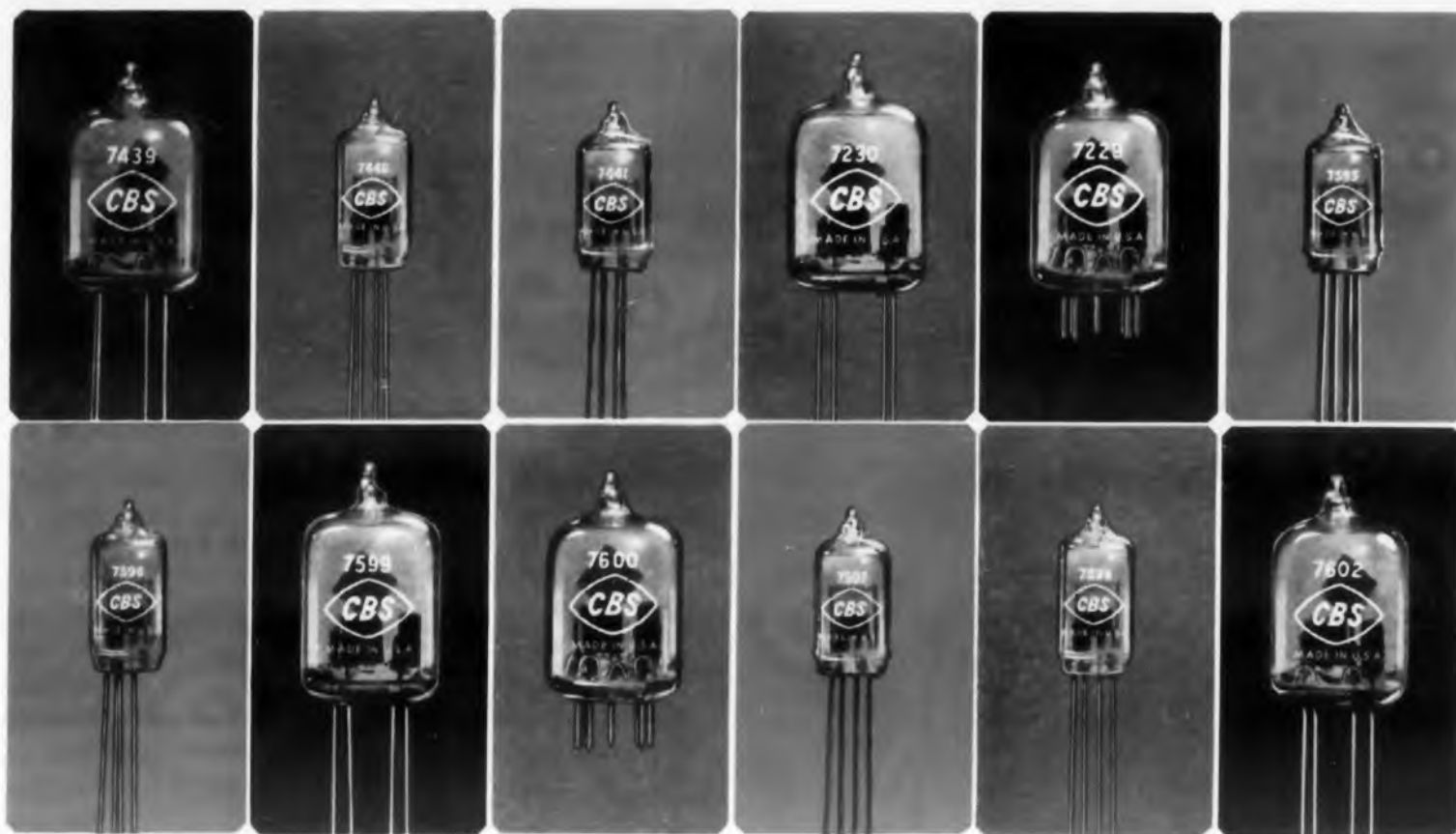
The program for the 4th Midwest Symposium on Circuit Theory is as follows:

Tuesday, December 1—9 a.m.

Session I. On Analysis of Networks

A Primary and Secondary Aspect of the Equations of Electrical Networks, M. B. Reed and M. L. Wolla, Michigan State University

Determination of Transient Response in Electric Circuit Analysis by Use of Mikusinski's Opera-



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<b>7441</b>	1500	20	1.6	0.4	100	Reliable
<b>7595</b>	3000	8	1.0	0.15	400	Reliable
<b>7596</b>	5000	15	—	—	100	Commercial
<b>7597</b>	5000	15	1.0	0.15	100	Reliable
<b>7598</b>	4000	15	1.0	0.15	500	Commercial

MINIATURE						
<b>7439</b>	2000	40	4.0	0.4	500	Com., flying leads
<b>7229</b>	2000	40	4.0	0.4	500	Com., base pins
<b>7230</b>	3000	10	2.0	0.2	500	Rel., flying leads
<b>7599</b>	6000	7	1.5	0.2	500	Com., flying leads
<b>7600</b>	6000	7	1.5	0.2	500	Com., base pins
<b>7602</b>	6000	7	1.5	0.2	500	Rel., flying leads

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## MEETINGS

tional Analysis, K. D. Struthers and T. J. Higgins, University of Wisconsin

Axiomatic Formulation of Circuit Analysis  
W. M. Brown, University of Michigan

Tuesday, December 1—1:30 p.m.

*Session II. On Realizability and Synthesis*

Simplified Formulation of the Properties (Foster and other) of the Driving Point Impedance of LC-Networks, L. C. Wilcox and M. B. Reed, Michigan State University

Low Q Filters, R. O. Rowlands, Pennsylvania State University

Synthesis of Grounded Two-Terminal-pair RLC Networks, S. L. Hakimi, University of Illinois

Passive Network Synthesis by a Matrix Transformation, R. P. Schuh, Oregon State University

An Extension of Prony's Method to Frequency Domain Approximation, J. B. Cruz, University of Illinois

Wednesday, December 2—8:30 a.m.

*Session III. From Analysis to Design*

A Useful Extension of the Nyquist Criterion to Stability Analysis of Multiloop Feedback Amplifiers, B. R. Meyers, University of Waterloo, Canada

Topological Consideration of the Realizability of a Communication Network, Omar Wing, Columbia University

Approximations to Wiener Optimum Filters and Predictors, F. J. Beutler, University of Michigan

Design of Combinational Switching Circuits Using an Iterative Configuration, D. L. Epley, University of Illinois

Wednesday, December 2—1:30 p.m.

*Session IV. Of Active Networks*

Recent Advances in Active Network Synthesis, M. E. Van Valkenburg, University of Illinois

Multi-terminal Representations in the Analysis of Control Systems, R. C. Dubes, Michigan State University

Multi-terminal Representations in the Analysis of Electronic Circuits, D. P. Brown and J. J. Land, Michigan State University

The Analysis of Large Systems Using Subsystems as Components, W. A. Blackwell and H. K. Kesavan, Michigan State University.

The location of all sessions will be Marquette University. For further information contact: Stanley Krupnik, Jr., Assistant Director, Dept. of Electrical Engineering, Marquette University, Milwaukee 3, Wisconsin.

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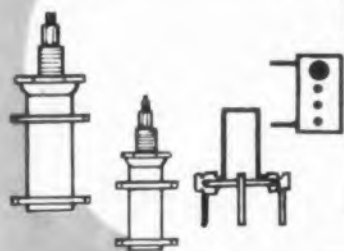
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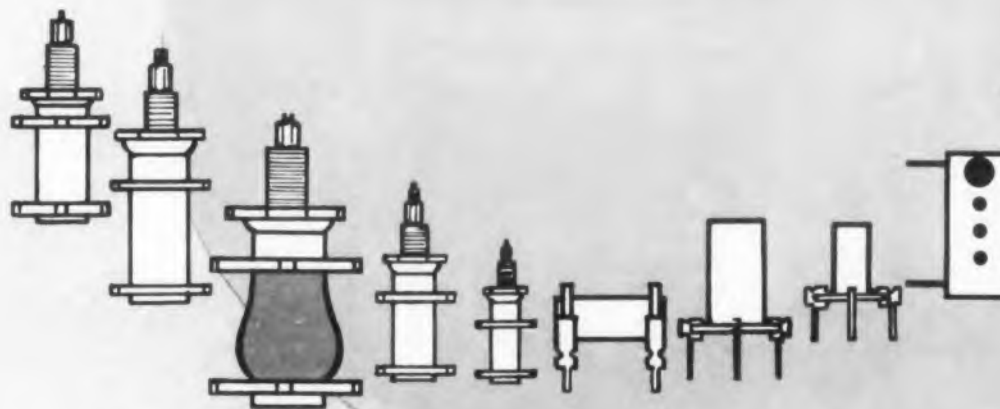
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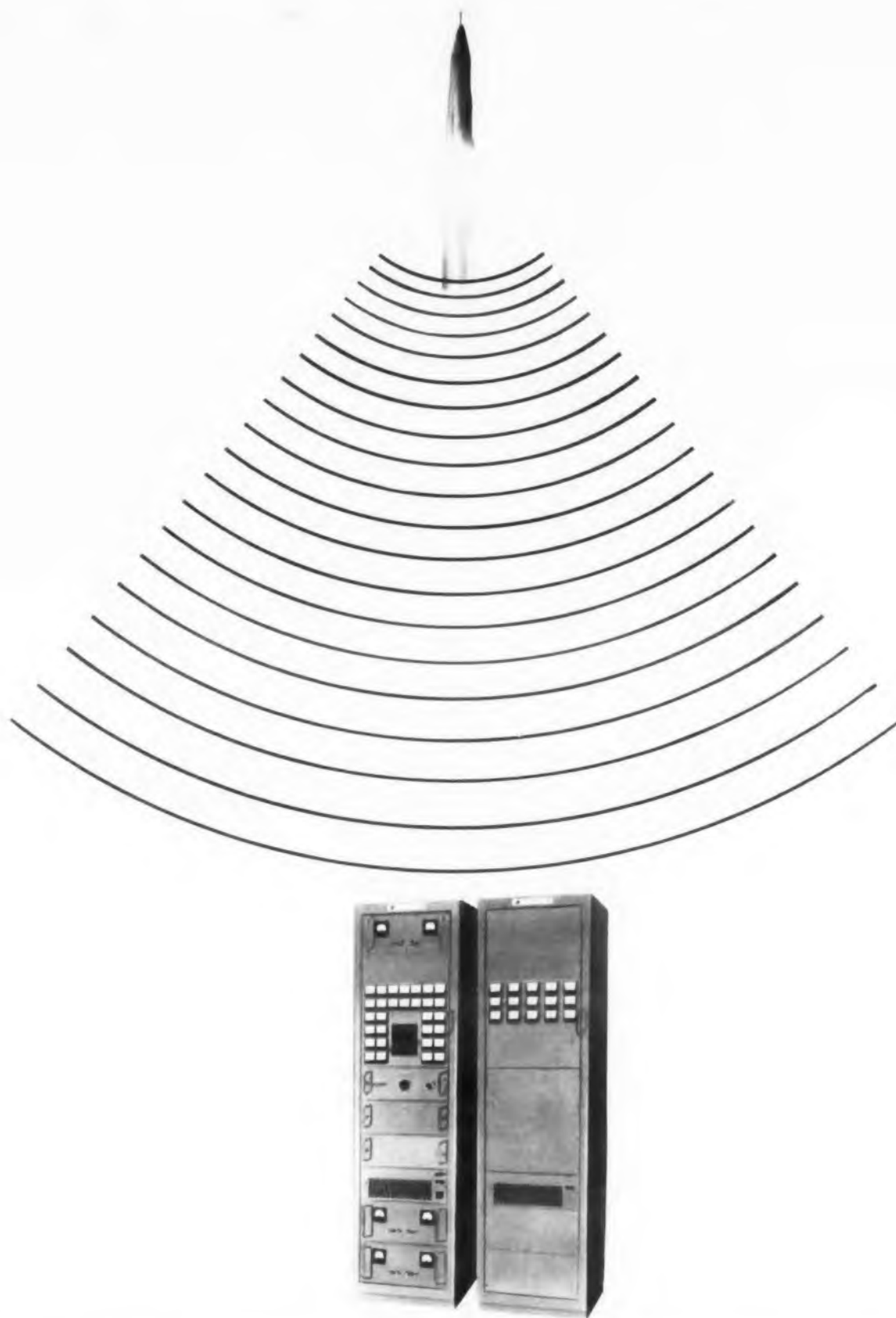
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# EDITORIAL

## "To Hell with Engineering. Let's Ship."

Production runs are getting shorter. Large-quantity orders are becoming a fond memory. Lead times get shorter and shorter, while more and more we hear—"To hell with engineering. Let's ship."

The problem boils down to the fact that too many engineers know *how* to finalize a design, but not *when*. It's true that many engineers fall in love with their first design, but then they want to improve it, and refine it, and clean up that last bug before they'll let it go. Then everyone else wants to clean it up—production, quality control, even purchasing.

When the design passes the sketch pad, the breadboard, the mockup, the model shop, the preproduction prototype—when it's made several scurries back and forth between some of these stages—when it finally gets to the production line—then it's really late. By this time, everybody's frantic, and the customer is screaming.

Everybody along the line contributed to the havoc, but with the best intentions. The electronic design engineer wanted to deliver the most sure-fire circuitry. He was sure he could squeeze another few watts out of a 6L6. He knew he could eliminate two resistors. He was certain he could knock the hum level down a few db. And of course, he wanted to try the very latest components—the ones that came in just as he was about to OK the design.

The production engineer wanted to make the product as easy to manufacture as possible. He wanted it to breeze through the production line with no problems at all—no lost nuts to chase, no impossible-to-get-at mounting holes.

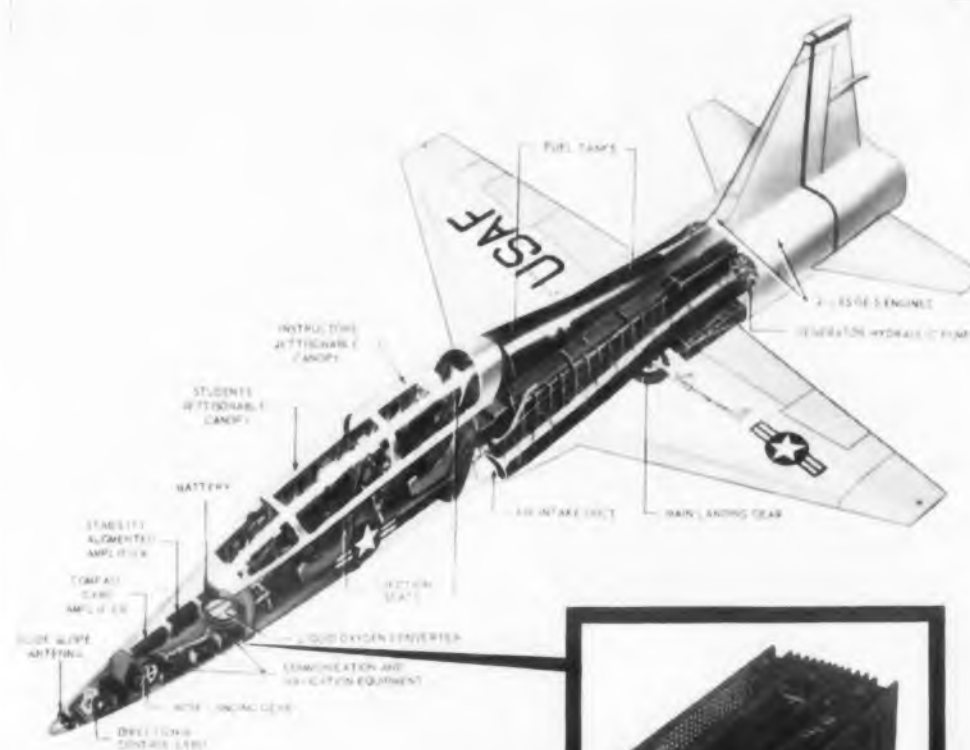
The purchasing agent wanted to buy the engineer's specified parts at the best possible price, with the fastest delivery, from the most reliable vendor.

Everybody wanted to make the equipment the best that ever left the back door. But everybody held it back. Everybody was engineering the job too long.

In short-run production, just as in mass production, it's important to know when to stop improving, when "that little extra" isn't worth while, when it's time to let go.

*George H. Rostky*

*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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# Designing For Short-Run Production

George H. Rostky  
Associate Editor



Standardization—A Powerful  
Tool ..... p 34



Modular Design—for Mass-  
Production Benefits ..... p 40



Planning Production ..... p 44



Ideas and Tools—Speed- Short  
Run Production ..... p 52

IN DESIGNING for short-run production, there are no universal truths. There are no short-cuts, no bee-lines, no direct through-ways to economical design for the low-quantity run. But there are many approaches, many techniques, many tools to ease the job and cut the cost. Each has its place.

## Tricks of the Trade

The short-run designer uses many tricks of the trade in trying to produce more efficiently. He looks for alternate and less expensive designs for the same job. He uses the same design for more jobs. He uses fewer parts for more functions. He uses standard, commercially available materials, parts, and processes.

Starting with the idea of designing for simplicity in production, he looks for what's easy to obtain. If he needs a chassis or a cabinet, for example, he checks a trade magazine or a catalog to see what's most suitable. He knows there's little excuse for not at least looking into commercial parts. But he also knows when to stop looking and start building.

He tries to design with in-the-shop supplies—stock room parts. But he tries lots of them. He doesn't want to select "hot" tubes or transistors.

He doesn't build a circuit that depends on a tube or transistor characteristic which isn't well controlled. He knows that a particular tube may have carefully-controlled  $G_m$ , but a poorly-controlled cut-off characteristic. If he's concerned with cut-off, he'll use a different tube type.

When he's forced to make something in the shop, he'll see if it's worthwhile to make a surplus.

He's wary of adjustments and knows that interacting adjustments are not the best way to win friends among production personnel.

In encapsulating assemblies, the designer doesn't mount a 10-cent resistor, which may burn out, with a \$50 transistor. He'll encapsulate reliable components that function together so he can minimize leads to be brought out.

He knows the road his product must take from his sketch pad to the back door, and he tries to save steps along the way—even small steps.

He watches for those "less important" characteristics of components. He doesn't bury himself in details, but neither does he scoff at them. He

### Our Special Thanks

We wish to thank

Mr. James M. Brearley

U. S. Navy Bureau of Aeronautics

Col. Marion C. Smith

Lt. Col. Lester E. Manbeck

Lt. Col. Kenneth J. Kiel

Mr. Leslie G. Ozier

U. S. Air Force

and the many others in industry and in the military for their special help in supplying information for this report.

knows that small details can hit him when he really doesn't need added troubles.

The successful short-run designer is mindful of changes in his preproduction prototype. He won't make those "nice" changes for a longer run or a redesign.

He dreads changes on the production line, so he won't carry engineering model shop designs into production.

He prefers catastrophic failures during the design stage. Subtle changes hurt.

### Problems Galore

The short run brings with it many problems not normally encountered in large quantity production. Some of these problems will never be solved. Others can be solved—at least in part. The many problems include:

- Expensive capital equipment cannot be purchased for one short run as the costs cannot be spread over many items.
- Efficient, high-output, production machinery can seldom be justified economically.
- Time spent for setting up a production line and time for setting up test facilities are large compared with the total time spent on a project.
- Parts purchased in small quantities tend to be most expensive.
- Fabricated parts may have to be made by the most expensive processes and by the most highly skilled labor.
- Experience gained in one short run may not seem useful in another.
- Training operators takes a relatively long time. A project may be completed before manufacturing personnel operates at peak efficiency.

Approaches to coping with the short run take many forms—some of them diametrically opposed. The philosophy that serves one manufacturer may be a woeful hindrance to another. But experts agree: In most cases, the best way to cope with short-run production is to make it as much as possible like long-run production.

Just how to make the short run look like a long run is the subject of the following pages. ■ ■

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## Standardization —

### A Powerful Tool

**S**TANDARDIZATION is one of the most trenchant tools in economical design for short-run production. It is used extensively in one form or another. Standardization can be applied to parts (or a family of parts), to procedures and techniques, or to processes. If properly implemented, standardization can become an enormous money-saver.

#### Standards Program Really Works

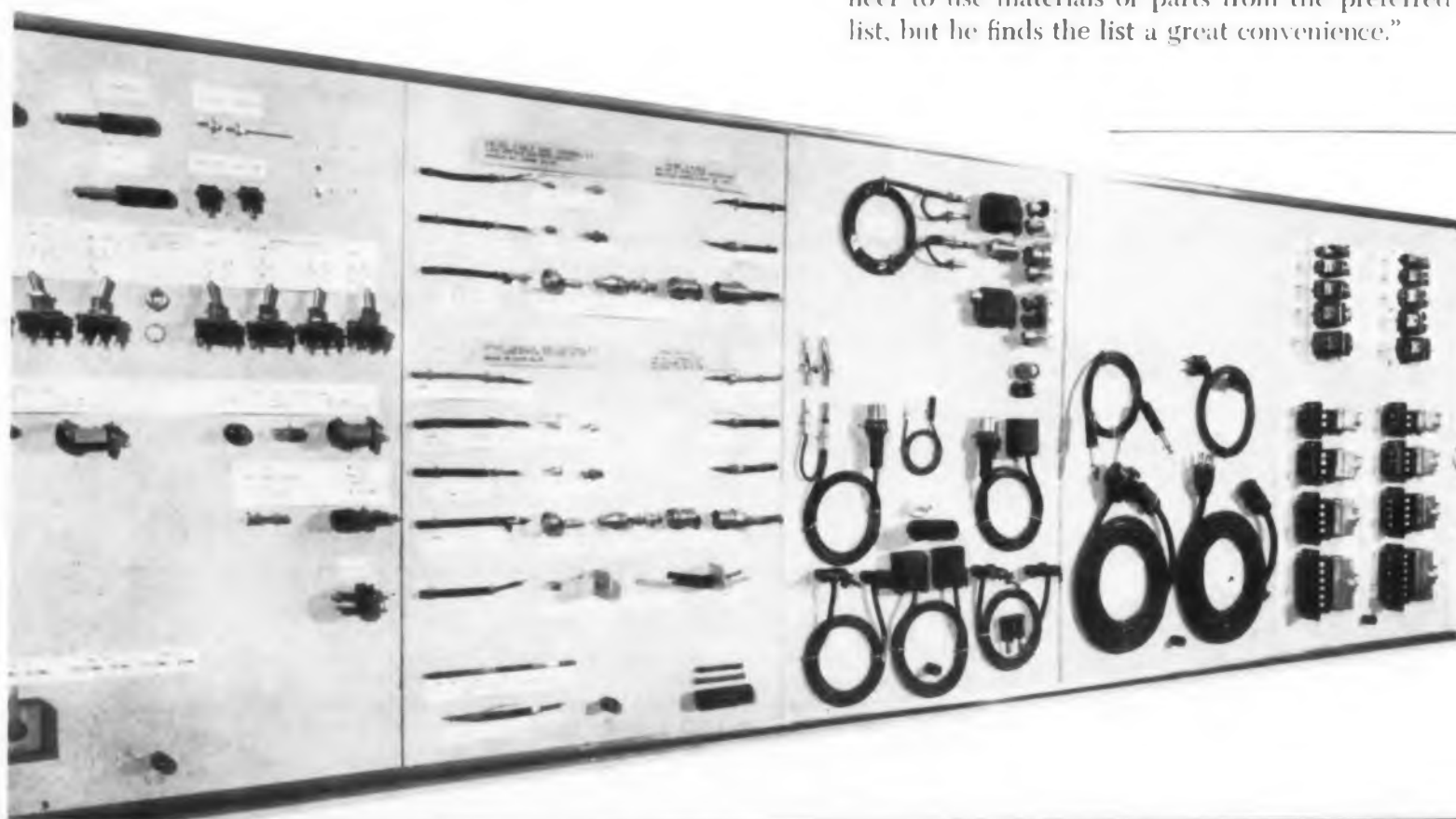
One of the most effective systems of standardizing on the parts level is that used by the General Radio Co. in W. Concord, Mass. Says manufacturing manager Harold Wilson, "Our standardization program really works. We don't compel an engineer to use materials or parts from the preferred list, but he finds the list a great convenience."

Under the supervision of Henry Littlejohn, supervisor of Experimental Shop and Test Facilities, the standards program has many unusual features. First of all, it was designed by engineers, not by stock room supervisors.

Engineers have notebooks, kept up to date by almost daily revisions, which list all the preferred components, materials, and design standards. An up-to-date wall display (Fig. 1), of all preferred components shows samples and lists prices.

The engineer knows that he can find all preferred parts in the stock room and knows that they can be purchased in quantity, readily. He knows also that his company has thoroughly tested samples of each part and can provide data which even the vendor may not have.

As an example, for a dpdt toggle switch, G-R will list dissipation factor of the dielectric, dielectric strength to ground, capacitance between ter-



**Fig. 1.** One of several displays showing "Components Preferred for New Designs." General Radio uses these boards to help engineers select and use standard parts. Other boards show resistors, capacitors, diodes, and a host of other parts.

minals and to ground, and other information not normally found in catalogs.

It took years to develop this program, but it pays off. The standards program takes a lot of engineering time out of selecting components.

Latest G-R equipments, according to Littlejohn, have 95 per cent of preferred parts applied according to recommended practices. The program has reduced the number of general purpose components catalogued and stocked from 12,000 to about 2500.

As specific examples, 10-32 machine screws, formerly stocked in seven head styles and 25 lengths, are now used in only one head style and 13 lengths. The number of electrolytic capacitor types has been reduced from 60 to 12 types.

#### "Flexible Standardization" Begins Early

In an entirely different field, Avien, Inc., of Woodside, N. Y., uses an approach called "flexible standardization." This is just another name for the philosophy of making a new product as adaptable to change as possible, without the need to alter any major component. Such standardization begins early in the design stage.

Avien has applied the principle to panel-mounted, servo-type instrument such as temperature sensing and recording instruments and fuel gage systems. Though these instruments provide a wide variety of displays of an even wider variety of input signals, they are all composed of three basic subassemblies: amplifier, motor and gear train, and rebalance potentiometer.

Amplifiers are all built to the same basic outline dimensions and are designed to tie into the instrument structure in the same manner. Motors fit into a standard frame size. Regardless of the characteristics of an individual motor, it is mechanically identical to any other.

Gear trains are designed so that, with the addition or deletion of one or two passes, any required response may be obtained. Provision is included for tap-offs for vernier sub-dial shafts.

The rebalance pots use a common housing and a common set of accessories. This results in pots with a required degree of accuracy conforming to almost any mathematical law. The housing allows for addition of a concentric winding for telemetry. A commutator and switches for control signals can be added to the instrument without any design changes.

#### Standardization Has Many Forms

Standardization can take many forms. It need not take the form only, of standardizing on specific products. It can take the form of a standard approach to purchasing and manufacturing.

Dr. Beatrice Hicks, president of Newark Controls Co., Bloomfield, N. J., has established a



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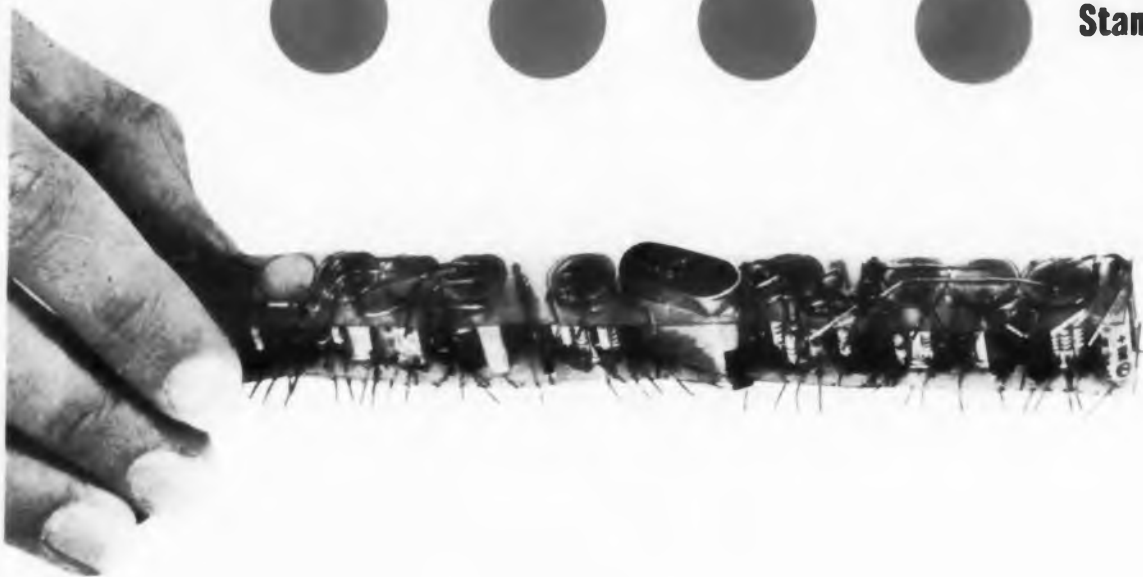
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## Standardization



**Fig. 2.** This high-density package, designed by The Sippican Corp., uses standardized welds for all connections. Mylar film jigging provides simple positioning for all components prior to welding and encapsulation.

"standard" priority system for parts. Leading her list, in order of decreasing desirability are:

- Use standard parts manufactured in large volume by other manufacturers—such as military standard parts, electrical connectors, automatic screw machine products, panels, handles, etc.

- Use standard parts, manufactured in large volume, which can be modified easily.

- Use standard parts manufactured in short run lots by other manufacturers. These include purchases from companies which own a tremendous number of dies, molds or tools, etc.

- Use simplified special parts that can be sub-contracted to short-run specialists such as companies which handle automatic screw machine work, stamping, casting, forming, etc. These manufacturers should be skilled in inexpensive low-life tooling.

There are circumstances when Newark Controls will fabricate parts in their own plant. They will fabricate their own parts when:

- Parts will be made at lowest cost. (They must have the tools and experience.)

- Time is at a premium.

- The part is experimental and the company wants engineering personnel to follow the process till standards have been established.

- Adequate control of the process is not obtainable through sub-contracting.

### Some Standards Don't Look Standard

For certain types of work, standardization may take a paradoxical twist. In the "high-density package," using conventional components closely packed together and encapsulated, it may appear that there is no standardization whatsoever.

A first glance at such a package (Fig. 2), seems to reveal no effort at standardizing. But extensive standardization is used for the process of welding all the connections.

Each joint in a planned assembly is studied and

standardized before any production takes place. This involves choosing the welding machine; welding head; electrode material, configuration and size; welding pressure; and welding current.

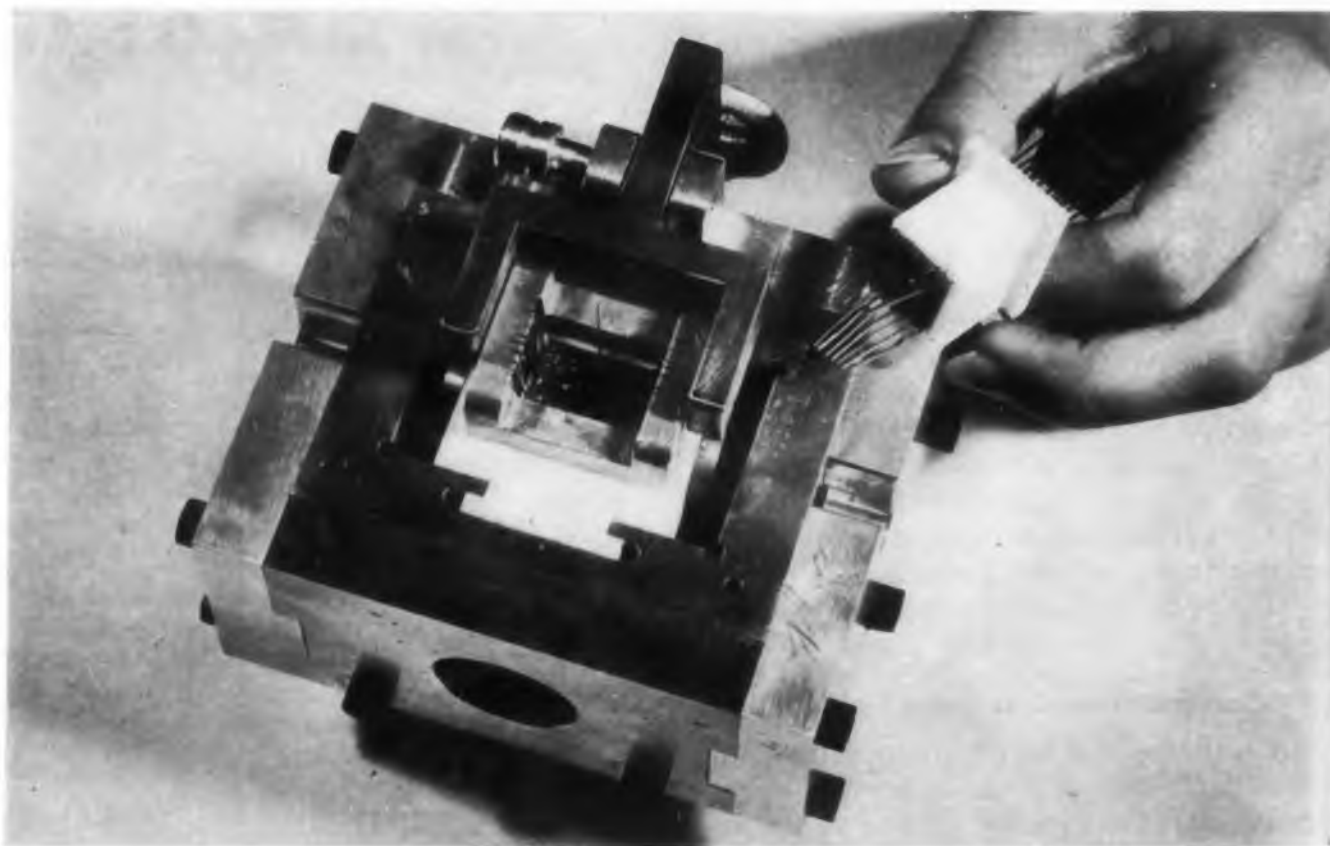
First units of a short production run take advantage of this pre-engineering and standardization of connections. In practice, the majority of welds in a package are found to have been standardized during previous work.

It is even possible to automate several aspects of low volume production using the high-density process. In one application, it was possible to build quantities of NOR switches and to apply

separate logic matrices later.

These matrices were designed entirely through a computer-programmed layout which resulted in a line-printer sheet. The sheet was reduced photographically to form a logic matrix positioning film. Usually, component positioning and jigging are obtained through Mylar films which are photographic scale reductions of drafted layouts.

Testing these packages is also automated to a high degree. One particular end connector involves up to 1000 pins which are interconnected through some 200 circuits involving perhaps 3000 connections.



**Fig. 3.** The value of early standardization of module size is emphasized by this encapsulation mold. The Sippican Corp. uses this mold for a high-density welded assembly.

A converging test of this subassembly may take 100 man-hours; this can be automated to involve only a few hours on a punched-card comparator. According to W. Van Alan Clark, president of the Sippican Corp. of Marion, Mass., "For short run production, using this process, it is neither necessary nor desirable to standardize on lead spacing or component location. Any standardization would be a hindrance rather than a gain."

But he goes on to stress the value of using standard molds where possible. Fig. 3 shows an example of the usefulness of a standard mold.

#### Try to Standardize a Missile

Standardizing is not always easy. In missile equipment, space limitations may prevent the use of standard modules. At Bendix Products Div.—Missiles, in Mishawaka, Ind., mechanical design engineers Grant Michael, Tom Collins, and John Cunningham point to configuration as a major limiting factor.

But even in this realm, they try to standardize as much as possible. They're trying to standardize on the size of printed circuit boards—at least in two dimensions. The length of the board, they may vary, or they may tie boards in series for larger circuits.

They use standard hardware where possible. They standardize on mechanical assemblies and try to use the same container wherever they can. They'll standardize on chassis and subchassis mounting bolts, and will specify only the easier-to-buy machine screw sizes: 2-56, 4-40, 6-32, 8-32, 10-32, 1/4-28, etc. They try to lean heavily on a preferred parts list, issued to all designers.

Their work is made more difficult by the fact that, though they may be designing for but a few assemblies, they must assume that someday they may be making thousands.

#### Try Standard Circuits

At Lear, Inc., in Grand Rapids, Mich., the emphasis is on using standard circuits or minor modifications for new applications. Cliff Voice, electronic design section head, shows, as an example, a transistorized 400-cycle servo amplifier. "We can use this in dozens of applications," says Voice. "We may have to modify the output transformer to drive different loads. Or we may have to adjust the input stage for different gain requirements. But we can use it again and again."

To emphasize his point, Voice shows how the one-watt amplifier can be used to drive an eight-watt servo-motor. "It's simple," he says, "it's a two-phase motor. We take seven watts from the line to power the fixed phase, and take one watt from our amplifier to power the control phase.

"Motor dissipation is the same as with balanced operation. We lose about 30 per cent efficiency in the torque for so large an unbalance, but it's



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## Standardization



worth it because we can use small power transistors—units we know and trust.”

Lear engineers have been designing with transistor circuits since 1954. According to electrical engineering department head Mel Frontjes, “. . . some of our engineers scarcely know what vacuum tubes are.”

All the basic circuits use silicon transistors rather than germanium. In many cases, the engineers could use germanium. But they feel that it's not worth redesigning reliable circuits to see if germanium will work. Besides, they don't have the time.

Coupled with Lear's emphasis on standard circuits, there is a drive to standardize packages—or at least—to go to standard packaging techniques and standard processes. An electronic packaging design section, headed by Roy Malarik, handles all the packaging.

This group tries to use standard transistor brackets, standard chassis types or other standard hardware items. Most important, it tries to package all the electronics with a view to using available machinery and available techniques.

Confronted by space limitations, the packaging engineers aren't always successful in using a standard chassis. But they're looking into new packaging techniques.

A promising package, they feel, is the micro-module which uses layers of 1/3-inch square ceramic wafers with components coated on them.

Lear engineers plan to investigate these micro-modules for their servo voltage amplifiers, quadrature rejectors, modulators, and demodulators. If these packages work well, Lear will standardize on these micromodular subassemblies—at least—for many applications.

### What's the Government Doing

In view of the enormous value of standardization, and in light of the cost-cutting role it could play in our country's space-age requirements, it seems strange that the government has contributed so little in an area where it could be so powerful.

But the picture may change. Since 1945, the Department of Defense has been active in establishing a complete line of certain kinds of standard components. Today, MIL-S-20708 encompasses drawings and specifications for 60 and 400 cycle synchros from size 8 to 37.

# New "METALLIZED" MYLAR Subminiatures

These units, available from several sources, can give design engineers excellent instrumentation at low cost. Since their use is mandatory under MIL-STD-710, they can play a vital role by reducing spares inventories.

By using these components, designers and manufacturers can avoid duplication of engineering charges as well as high costs due to short production runs.

Commenting on this progress, Samuel Sherwin, manager of the Ketay Dept. of United Aircraft Corp.'s Norden Div., in Commack, N. Y., says: "The benefits of MIL-S-20708 are available today. They are a good start. But the government should not stop at standardizing synchros. It should extend the standardization effort into other types of precision rotating components and allied equipment."

## Standardize Printed Circuits

Edward Kasner, project engineer of Stavid Engineering, Inc., in Plainfield, N.J., views another area where standardization could be invaluable—printed circuitry.

Says Kasner, "Though printed circuit boards are used by practically every firm that designs electronic equipment, and though each firm has established some standards, no comprehensive military standard has yet been evolved which is acceptable by all branches of the armed services.

"Various military agencies have issued their own standards—MIL-STD-275 (Ships), MIL-P-21193 (Nord), SCL-6224—but their contents too often conflict."

Kasner points with pride to Stavid's company-wide standards on printed wiring board design, layout, drafting, photography, preparation, fabrication, and inspection.

As if in answer, Louis Schlesinger of the Office of the Chief Engineer of the Navy's BuOrd points out that the government does indeed intend to extend standardization to other precision rotating components. The government also expects to sponsor the development of a standard series of amplifiers to match standard resolvers and servo motors. They hope to be able to package resolvers and amplifiers in single disposable containers—an answer to the trimming problem.

BuOrd hopes that standards, soon to be made available, will help simplify complex testing, evaluating, and inspection of many servo-type components. Some of these specs should standardize amplifiers, resolvers, servo motors and tach generators. In the distant future, there may be a spec for standard gyros.

DOD is currently sponsoring projects to insure and increase the benefits of standardized components in tomorrow's systems. The aim is to have components which can be interchanged among systems. ■ ■

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**SUPERIOR IR** Insulation resistance of these rugged Mylar dielectric types far exceeds the IR obtainable from paper designs. (See curve below for actual performance.) • DuPont's trademark for polyester film

**INSULATION RESISTANCE.** Greater than 30,000 megohm-microfarads at 25°C, but need not exceed 30,000 megohms.

**DISSIPATION FACTOR.** Less than 1% when measured at or referred to 1000 CPS—temperature of 25°C.

**VOLTAGE RANGE.** Available in 100, 200, 400 and 600 VDC.

**ACCELERATED LIFE TEST.** 250 hours at +100°C and 125% of rated voltage.

**CAPACITANCE TOLERANCES.** Standard tolerance ±20%; also available in ±10%, and ±5%.

**TEMPERATURE RANGE.** Full rated voltage from -55°C to +100°C, to +125°C with 50% derating.



**X663F**  
AXIAL LEADS



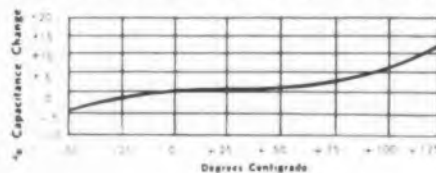
**X663FR**  
RADIAL LEADS

- ① TOUGH MYLAR CASE
- ② EPOXY END SEAL

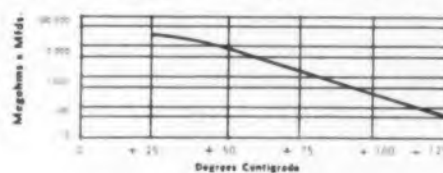
## TYPICAL SIZES-SHOWING THICKNESS • WIDTH • LENGTH

CAP. IN MFDS	100 VOLTS			200 VOLTS			CAP. IN MFDS	100 VOLTS			200 VOLTS		
	T	W	L	T	W	L		T	W	L	T	W	L
01	150	±.201	±.14	125	±.187	±.14	1.00	42	±.593	±.14	453	±.687	±.14
.1	250	±.319	±.14	250	±.359	±.14	2.00	40	±.718	±.14	453	±.734	±.14
.33	296	±.484	±.14	328	±.508	±.14	3.00	453	±.765	±.14	546	±.903	±.14
.47	359	±.546	±.14	343	±.621	±.14	4.00	500	±.890	±.14	656	±.1015	±.14
.68	347	±.535	±.14	421	±.758	±.14	5.00	484	±.847	±.14	820	±.1250	±.14

Capacitance Change vs. Temperature



Insulation Resistance vs. Temperature



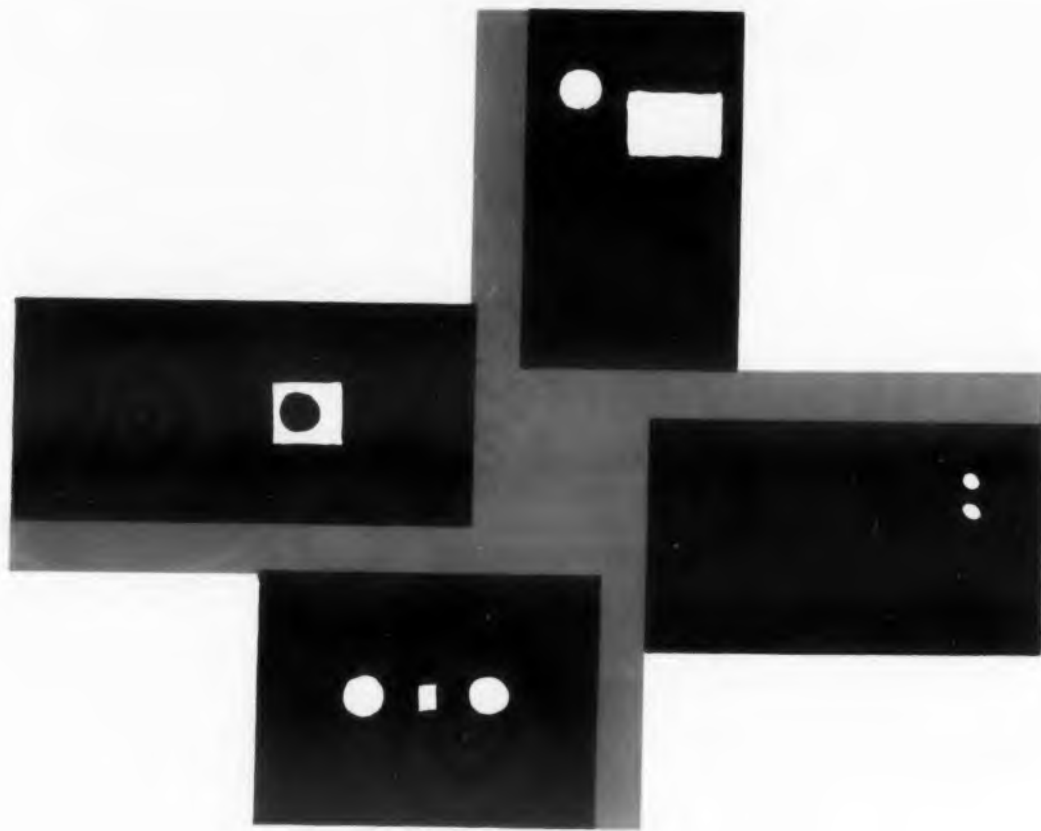
Write for literature on these NEW, "space-saving" types



**GOOD-ALL ELECTRIC MFG. CO. OGALLALA, NEBR.**

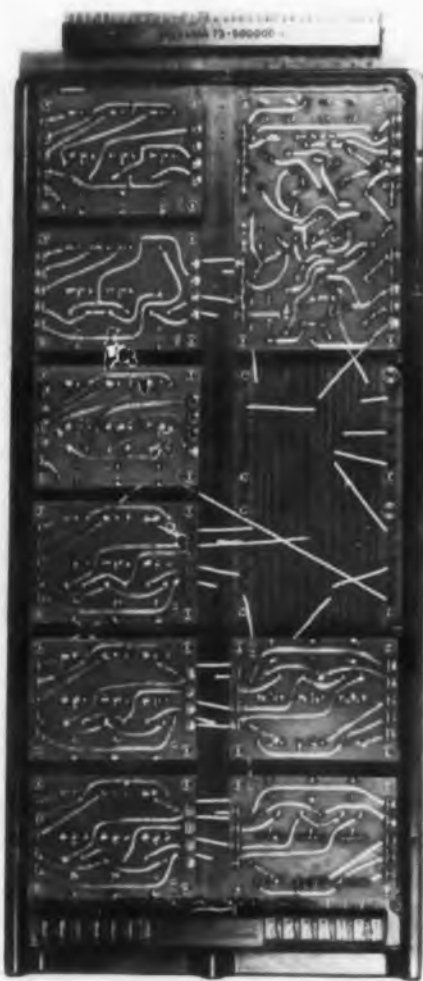
A LEADING MANUFACTURER OF TUBULAR, CERAMIC DISC AND ELECTROLYTIC CAPACITORS

CIRCLE 33 ON READER-SERVICE CARD

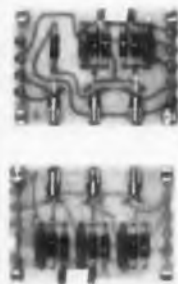


## Modular Design—

### Mass-Production Benefits



**Fig. 1.** Sylvania's "universal package" has one logic card and as many as 12 single-element component cards. The straight conductor runs, on the back of the board, can be seen through the glass-base epoxy laminate.



**M**ODULAR design, a powerful weapon in the war against the high cost of short-run production, is much akin to standardization. Many consider it a special form of standardization.

Its merits are impossible to evaluate in dollars and cents alone. How can one compute, for example, its value to logistics? Can one assign a money value to the fact that a military field computer may require an inventory of only 50 spare modules rather than thousands of spare parts?

#### Yields Mass-Production Benefits

Modular design enables designers to reap some of the benefits of mass production. Multiple-application modules can often be mass-produced by hundreds or thousands, though the system for which they were originally designed may require only dozens. In this way, the designer can often take advantage of cost-break quantity buying.

Like any good thing, modular design has its drawbacks. For one, use of standard, modular, building blocks may result in inefficient packaging density. But for many applications, this is outweighed by compensating advantages.

#### Modules Should Be Logical

Modules must, of course, be designed with care. The designer must not fall into the trap of designing half a function on one module and the other half on another. He must make his modules logical units wherever possible.

He has to be careful about interconnections; he should minimize them between subassemblies. He must remember that his subassemblies may

have to be handled, stacked, tested, and shoved around from position to position, even before they land in the final product.

#### Keep Circuits Simple

The aim of most modular design is to use simple and universal circuits. One of the most fruitful applications of such modules is in computers which use hundreds of identical circuits.

Often, six or eight basic module-types can serve as the backbone of a computer, while 15 or 20 others complete the machine.



**Fig. 2.** This single-element card is one of the bricks Sylvania used in building MOBIDIC.



**Fig. 3.** Librascope's universal-pattern circuit board permits assembly of logic modules before the computer design is firmed.

Like standardization, modular design takes different forms. One form is exemplified by the printed circuit card which carries one or more basic circuits. This card may be used in many applications without any change. Essentially, this type of module is used like an encapsulated assembly.

One of the newest module forms, the "micro-module," consists of components deposited on tiny ceramic wafers, stacked in layers to form complete circuits. Pioneered by the Signal Corps, with RCA as the leader contractor, these micromodules are slowly finding their way into military equipment.

A very popular module form is that of the basic card (or chassis) which can easily be modified to serve in many roles. It has basic circuitry or wiring which can be altered easily into many variations.

#### The Universal Package

An excellent example of this type of module is the "universal package" designed by John Marzilli and Michael Berberian of the Data Systems Operations of Sylvania Electronic Systems at Needham, Mass.

This package is intended to serve an unlimited variety of digital equipments. As shown in Fig. 1, it consists of one logic card with a maximum of 12 single-element component cards attached to it.

The logic card, with 35 straight conductors etched on one side of the board, has provision for inserting jumper wires at every contact with the element cards. At discrete intervals, there are provisions for jumpering between conductor runs or from a conductor to a contact point. Where



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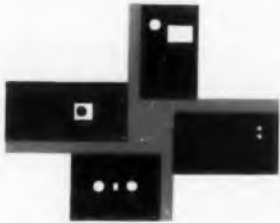
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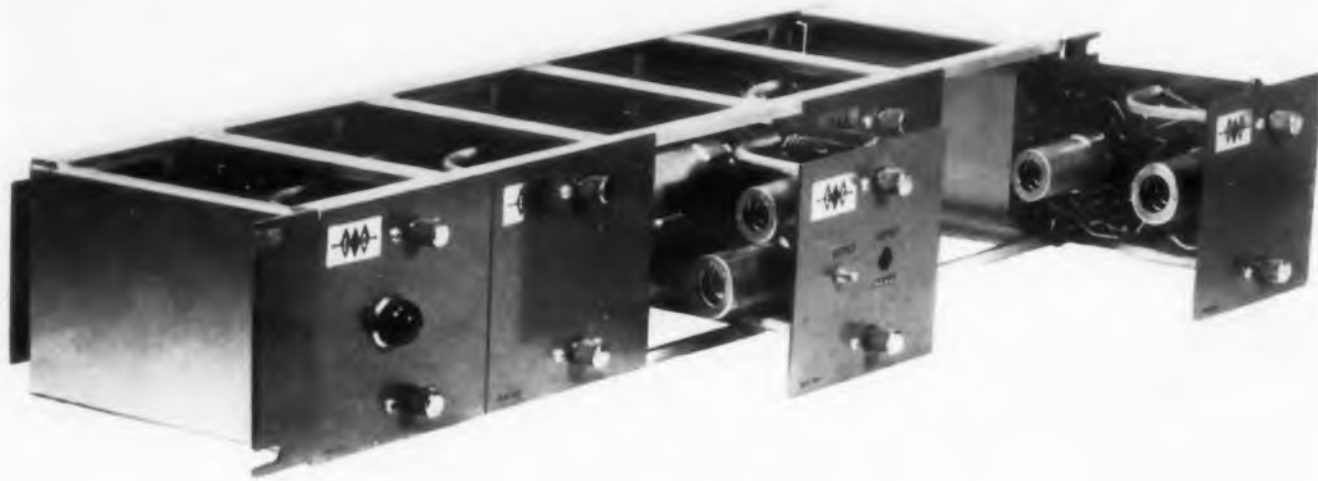
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CIRCLE 34 ON READER-SERVICE CARD

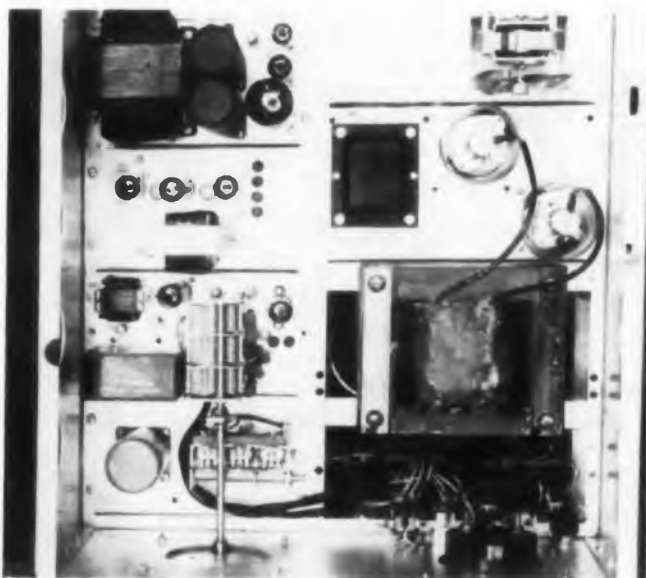
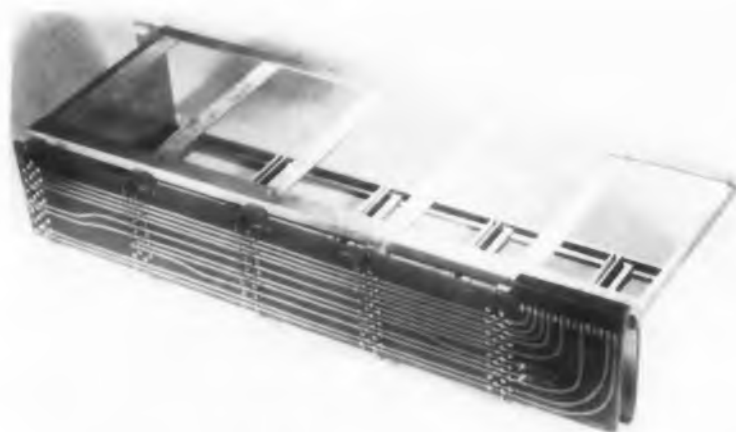


## Modular Design

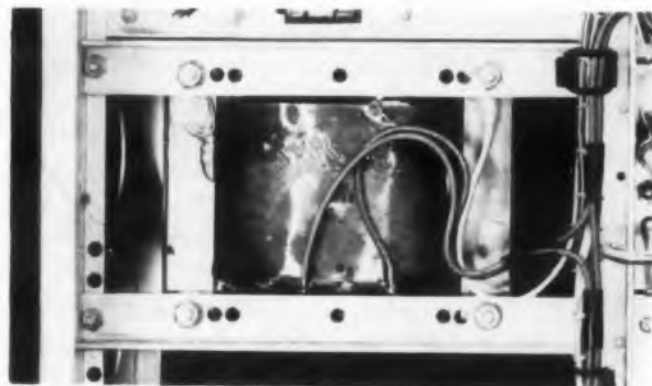


**Fig. 4.** A "special" pulse generator, designed and delivered quickly, at low cost, by using minor modifications of standard, compatible modules. Electro Precision Corp. calls them "Digitrol" building blocks.

**Fig. 5.** The basic frame for Electro Precision's "Digitrol" building blocks can carry a printed circuit card on its back for interconnections between modules.



**Fig. 6.** TIC's basic modules can be combined to form a wide variety of frequency converters.



**Fig. 7.** Output transformers for 100-watt frequency converters or 1000-watt units can be mounted on the same frame. The frame members are drilled and tapped to take several transformer sizes and they can be moved closer together or further apart.

necessary, the straight conductor runs can be interrupted by knifing away part of the conductive material.

The element cards, (Fig. 2), house the circuitry. They plug into the logic card through sturdy, conductive, contact fingers. The element cards have guide pins and alignment studs, coded to insure that the cards will be properly positioned on the logic card.

These small cards, available as single- or double-element units, can accommodate any digital circuit within the limits of the system. The logic packages, with combinations of etched circuitry and jumper wires, provide almost all the logical interconnections.

Together they are the building blocks of the mobile military computer MOBIDIC, and of the detection radar data take-off portion of BMEWS (Ballistic Missile Early Warning System).

### Computer "Stock" Card

For similar applications, Librascope engineers have developed a "stock" card shown in Fig. 3. With a universal printed pattern, this card can be modified by interconnections to yield many circuit functions.

Before final design of a computer, components can be added to the card to form as many as 33 individual logic modules. When the design is firmed, the modules can be interconnected.

This "stock" card technique, according to project engineer E. M. Zuehlke, permits a large amount of fabrication prior to full-scale production. Though it doesn't provide the most compact packaging, and though it's not particularly adaptable to mass production, the card saves a great deal of time in short runs.

On these cards, the printed circuitry is carried through from the base plug connector to a duplicate connector at the top of the card. This permits the card to be plugged into the computer and to have the entire plug available for testing or trouble-shooting. Troubles are quickly diagnosed without recourse to circuit-crawling with a scope.

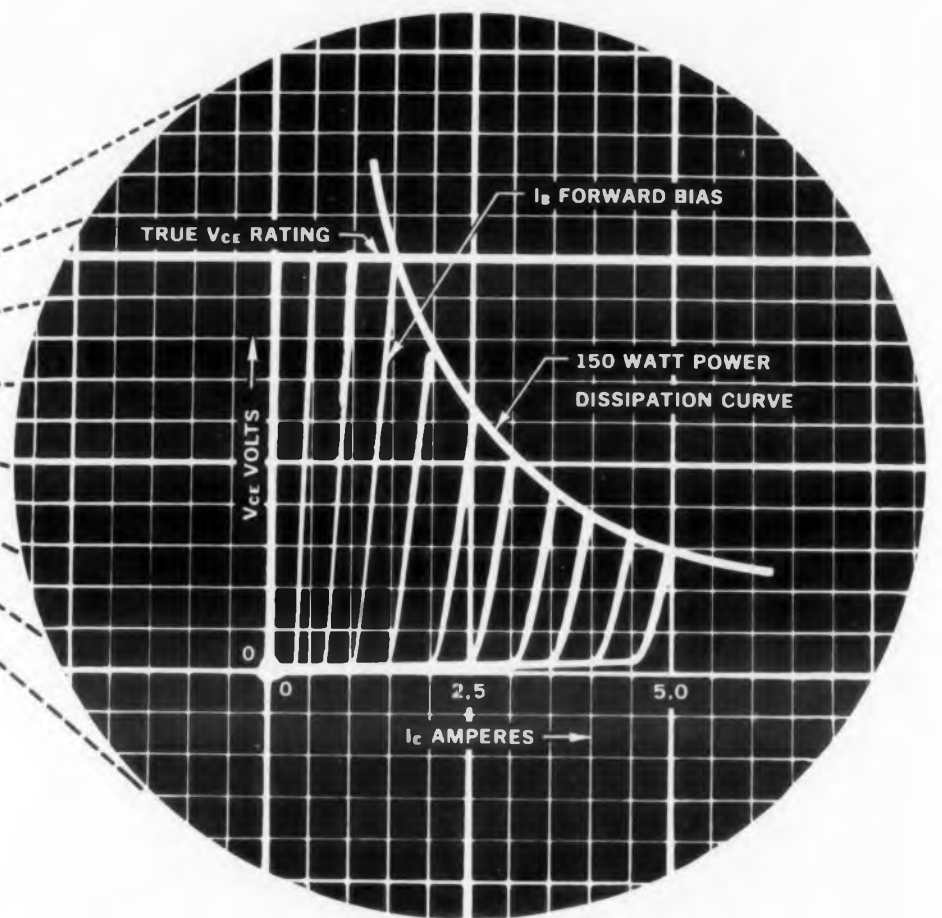
### Analyze, Then Design

Electro Precision Corp. of Arkadelphia, Ark., cuts the cost of special-purpose control systems and computer designs by using a compatible set of predesigned functional components.

After analyzing a large number of special-purpose computers, instruments, and control systems, Electro Precision broke them up into block diagram form, and regrouped the block diagrams to

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The voltage at which alpha equals one, and other voltage ratings commonly given for transistors such as  $V_{CES}$ ,  $V_{CER}$ ,  $V_{CEX}$  and  $V_{CBO}$ , are *above* the voltage rating given to these transistors.

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*TRUE* voltage ratings from 30 to 200 volts give you complete freedom in designing your equipment—you can op-

erate Westinghouse silicon power transistors at the manufacturer's ratings without risking transistor failure. This *TRUE* voltage rating of Westinghouse silicon power transistors coupled with their still unequaled low saturation resistance and low thermal drop makes them an ideal first choice for military, industrial and commercial applications.

Type	$V_{ce}^*$	$\beta$ (min)	$R_s$ (max)	$I_c$ A (max)	$T_j$ max. operating	Thermal drop to case (max)
2N1015	30					
2N1015A	60	10	.75 ohms		150°C	.7°C/W
2N1015B	100	@ $I_c = 2$ amp	@ $I_c = 2$ amp	7.5		
2N1015C	150		$I_B = 300$ ma			
2N1015D	200					
2N1016	30					
2N1016A	60	10	.50 ohms		150°C	.7°C/W
2N1016B	100	@ $I_c = 5$ amp	@ $I_c = 5$ amp	7.5		
2N1016C	150		$I_B = 750$ ma			
2N1016D	200					

\**TRUE* voltage rating (The transistors can be operated continuously at the  $V_{CE}$  listed for each rating.)

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Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Pa.

CIRCLE 35 ON READER-SERVICE CARD

establish a minimum of functional elements which would yield the largest number of configurations.

Modular units, to work from a common supply voltage, were built for functional elements like servo preamps, power amplifiers, servo multipliers, crystal clocks, frequency dividers, decade counters, and voltage regulators.

Each unit has its own front panel, so when an instrument is made up by plugging in the right combination of elements, the front panel is also completed. (See Fig. 4.)

Use of the plug-in modules slashes the time spent in detailed circuit design and in preparation of instruction manuals. Connectors, with in-line pins, are placed in the same relative position on the back of each module. As shown in Fig. 5, this simplifies wiring B-plus, ground, filament, input and output connections.

### Build Large Circuits From Small

Though modular design is a natural for computers, it shows its great value in other fields as well. One can take, as an example, the frequency converters manufactured by Tel-Instrument Electronics Corp. of Carlstadt, N.J.

Using basic circuit modules, shown in Fig. 6, TIC was able to economize on a wide variety of one-, two-, or three-phase frequency converters with power outputs ranging from 100 to 1000 watts.

Larger systems could be made from smaller ones, or two- and three-phase systems from single phase units, by adding basic modules and making minor wiring changes. The same size chassis is used for any output from 100 to 1000 watts.

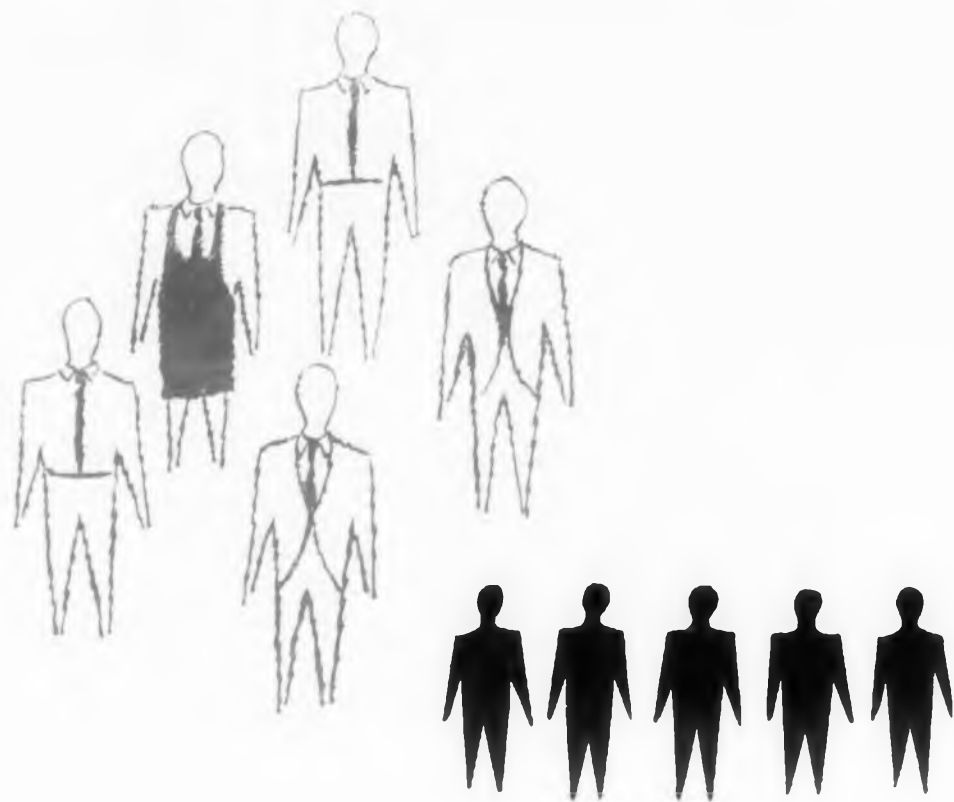
For converters with power outputs greater than 250 watts, forced air cooling was easily provided by a blower and pressure box underneath the chassis, and an exhaust box on top of the output chassis.

Output transformers, in a multitude of sizes, can be mounted on the same frame, suitably drilled and tapped as shown in Fig. 7.

TIC's modular design reduced size and weight dramatically. The modular version of its 500 watt unit, for example, weighs 140 pounds and occupies 4-1/4 cubic feet. This compares with 600 pounds and 16 cubic feet for the original, standard-construction counterpart.

TIC's senior mechanical engineer, George Kostick points to additional advantages of the use of modules: "They mean easier handling, storing, wiring, testing and fabrication because of the small size of individual modules. They increase flexibility of design and permit tighter cost control over parts and labor.

"And let's not neglect the more efficient use of machine time," Kostick continues, "due to fixed bearing and fabrication set-ups regardless of chassis type." ■ ■



## Planning for Production

**T**HE SPECIAL problems of the short run have forced manufacturers to evolve a whole new pattern of procedures—on the production line—and on back through the inception of design.

In groping for solutions, manufacturers have wandered down many strange pathways before arriving at "the best way" to organize for short-run production.

Most of the prevalent philosophies involve parallel courses of production planning and engineering. Many firms advance production planning to an early stage of design engineering. On the production line itself, techniques are in use which would be unheard of on a high-volume run.

### Use Technicians for Short Runs

An International Telephone and Telegraph Corp.'s Laboratories, in Fort Wayne, Ind., they

use highly skilled men for short-run production. Especially for very short runs, they feel there is great advantage in using technicians instead of unskilled assemblers.

Ralph Bruce, manager of Services, Ed Byer, executive engineer in the Instrumentation Lab., and Lambert Johnson, electronics engineer, all agree on the major advantage in using technicians: "You don't have to spell out production requirements so much when you encourage labor to think."

### "Flex" Shop Helps

For similar reasons, but in a different way, Lear, Inc. uses skilled labor. The Grand Rapids firm takes advantage of a "flexible" shop. The "flex" shop, a cross between a model shop and a full-scale production facility, improves liaison between engineering and production.

Since this shop has more highly skilled people, engineering can supply simpler drawings, thus saving time and expense.

### The One-Man Job

At General Radio Co., in W. Concord, Mass., the people on small-run production lines are all highly skilled. Each man on the line knows just what he's doing; he knows how to read a print and how to understand it; he thoroughly knows the instrument he's building.

One engineer is in complete charge of developing a piece of test equipment. And one skilled assembler (Fig. 1), puts it together. All parts are brought to his bench. For particularly complex instruments, one man may make a part of the overall instrument, while another will put the parts together. But the instruments stay put—the man moves.

Assemblers get to know their instruments. Working under an incentive pay plan, they learn to produce their instruments most efficiently.

### Move Parts or People?

Hewlett-Packard, of Palo Alto, Calif., and the Kin Tel Division of Cohu Electronics, of San Diego, use production-line approaches which are diametrically opposed. H-P uses a conventional mass-production technique of moving components past the assemblers, while Kin Tel moves the operators past the components.

On a different plane, both of these companies use an approach unlike those of G-R or ITTL. Both H-P and Kin Tel use unskilled assemblers. G-R and ITTL use highly skilled assemblers.



Fig. 1. A highly-skilled man assembles General Radio's new impedance bridge.



**Fig. 2.** A small part of Hewlett-Packard's "push-along" assembly line. H-P has more than a mile of conveyor like that shown in the foreground.

#### "Push Along" Slashes Delivery Time

By going to "push along" production, H-P's in-process inventory was cut directly in half. According to production manager Stan Selby, an inventory of \$1.5 million worth of uncompleted instruments was reduced to \$0.75 million when the company switched from "stand-up" batch production to the more usual mass production technique wherein girls remain at their work stations.

"We don't believe in handcrafting generally," says Selby. "We avoid having to hire highly

skilled people to do complex assemblies. We divide the job into simpler parts. But at the same time, we don't like 'stand-up' runs, where each girl does just one operation at a time, either. They're inefficient."

#### Delivery Starts Fast

"With the batch system," Selby explains, "the entire production run is finished before one instrument is available for delivery. With our push-along system, production lines start delivering

steadily. With the batch technique, test benches may be idle until all instruments are finished. Then they're swamped with work.

"With push-along operation, mistakes are discovered immediately. In 'stand-up' systems," Selby continues, "if a lead girl makes, say four mistakes in the first oscilloscope, the entire run will have four mistakes. This won't be discovered until the batch is tested.

"Moreover, we get better quality and fewer mistakes, because the responsibility for a given operation is fixed. This is very important. The instrument is the line supervisor's baby—and the operator at a given position knows she is responsible for her own work. She does a good job."

H-P's production line is a good example of the push-along system. All benches are conveyor type, with instruments on pallets, riding freely and easily along the length of the bench. (Fig. 2.)

There is more than a mile of conveyor throughout the plant area, so very little effort is required to send an instrument chassis along to the next station.

Selby estimates that efficiency is upped some 20 per cent by the operators' being able to sit down and have the instruments come by. "If a girl has to move 100 chassis a day, and each weighs 20 pounds," Selby calculates, "that's a total of one ton. That takes energy!"

H-P manufactures 400 different types of instruments with an average run of 50. For these short runs, as much planning as possible is done at the line level.

Line supervisors spend an average of four hours a week planning production runs. The oper-



**Fig. 3.** An operator at H-P can assemble even very complex subassemblies easily.





## Planning for Production

ators help with the breakdown of operations—and this helps build morale.

### "Stand-Up" for Very Short Runs

For very short runs, H-P uses the "stand-up" technique. If only one or two instruments are to be built, the time spent in planning and breaking down the operation would not offer a sufficient return, though the efficiency might increase. Up to 20 instruments might be manufactured by "stand-up" production.

Small, complex parts, like resistor boards or deeked rotary switches, are built differently. The philosophy is that of a miniature "stand-up" run. Lazy Susans (Fig. 3), with positions for up to 25 components, are filled with a batch of, say, rotary switch decks. The operator has a completed rotary switch to copy from.

She solders one component at a time, then spins the Lazy Susan from one switch to the next. Though the switch may be complex, a girl can produce it easily by doing one thing at a time and copying from the finished unit.

### Move Girls, Not Parts

Since Kin Tel started moving assemblers past components (Fig. 4), the company has saved as much as 35 per cent of labor costs on each item produced. Recently this amounted to savings of \$4600 on a short production run of galvanometers.

Under the old system of component assembly, operators worked on units moving by them. Learning to solder more than a few parts often took girls on the line as much as six days to reach 50 per cent efficiency, and four more to reach an efficiency of 85 or 90 per cent.

"Large, mass-producing industries can tolerate this loss of time," says Kin Tel's chief industrial engineer Ben Singleton. "Companies with short runs cannot; the entire run might be completed before the assemblers have learned the job."

Singleton, under the direction of Robert Lux, vice president for manufacturing, maintains that the "progressive operator" system is ideal for the short production run. Here's how the system works:

A lead girl attaches one part to the first assem-

bly in a line. A second girl watches her, then takes a container of parts and installs that part on each piece of equipment in the line.

Meanwhile, the lead girl solders the next part and a third girl repeats that operation all around the line.

### Learning Time Approaches Zero

In this way, the learning time for an operation is practically zero. By the time a girl has soldered the same part twice, she has become an expert in soldering that part. Using this system, Kin Tel recently produced 500 galvanometers without a single assembly error. "It is virtually impossible," claims Singleton, "for an operator to forget to place one component in each basic unit and in its correct location."

Several additional advantages soon become evident. All but very large units can be built completely in one location. They do not have to be moved from one operator position to another.

Under the "progressive operator" system, absenteeism costs no additional time, as any other operator can be assigned to a group and keep pace with the others in the group. On the conventional assembly line, substitute operators, usually paid at a higher base rate, had to fill gaps in the line.

Relief operators are not required, as girls can take breaks as soon as they have finished any cycle without stopping the line.

Production rates can easily be accelerated or decelerated by changing the number of girls at any time. This has particular value when parts shortages cause a line stoppage in the midst of a run.

And fluctuations of monthly schedules, that usually play havoc with conventional assembly setups, are easily accommodated.

### Define the Product

Bendix Products Div.—Missiles joins Hewlett-Packard and Kin Tel in opposition to the use of highly skilled assemblers. Says mechanical engineer John Cunningham, "We want to avoid complex assemblies. We don't want operations which require high skill. We want to make our parts as simple as possible."

His colleagues, Grant Michael and Tom Collins, emphasize Cunningham's comments: "If you have technical people assemble the equipment, you never define your product or document it adequately."

"A technician who knows a screw is short will go to a stock room and get a longer one. But next time you build the equipment, that technician may not be there, and his correction has not been reflected back into the drawing."

"The technician may introduce his own engineering skills in a design—but they never get on paper. Furthermore, if you need a highly skilled



Fig. 4. Kin Tel moves assemblers past stationary parts, cuts learning time to zero.

man to build the equipment, you're going to need a highly skilled man to maintain it in the field."

#### Plan Far Ahead

Most short-run production today involves not only low volume and high unit-cost, but also, a requirement for exceptional reliability.

To cope with these demands, many companies have organized not only their production lines but many other operations as well. In efforts to improve reliability and producibility at the earliest possible time, many try to integrate the work of several departments. Though all have the common goal—reliable, lower-cost production—the approaches vary widely.

At Librascope, Inc., in Glendale, Calif., production planning is aided by an active Industrial Engineering Department. This department develops manufacturing, assembly, test and handling techniques. Members of this department work hand-in-hand with design engineers from the early stages of design.

#### Make The Mockup Early

To reduce the lag between design and production of complex data-processing equipment, Librascope industrial engineers start mockup planning while a unit is in the final design stages. Particularly in defense equipment, where dimensions and configurations of cabinetry are specified in advance, preliminary mockups can be made to permit development of the most efficient production techniques.

Mockups, like those shown in Figs. 5 and 6, are generally constructed of wood. They follow in exact detail the exterior and interior dimensions and configuration of the equipment. Dummy sub-assemblies, meters and other integral components are made of wood, and placed in the mockups to determine the most desirable arrangement from a standpoint of production and servicing.

When the mockup is complete, cabling is designed and provisions are made to install it in special channels, or with clamps, or by other methods. Color coding is established both as a production aid, and as a help in future servicing. When the cabling has been worked out, diagrams are immediately turned over to the cabling department where special harness boards are prepared in advance of production.

#### Unitize The Wiring

Librascope has tackled one of the most difficult process in electronic production—the wiring itself. The necessity for proper positioning of what may be thousands of separate leads has defied any attempts at automation, or even of simple mechanical aids for the assembler.

Printed circuit boards were the answer for many applications, but even with use of such boards,



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CIRCLE 36 ON READER-SERVICE CARD

# WHICH BENDIX TRANSISTOR IS BEST FOR THE JOB?



## Planning for Production

terminals and subassemblies must still be hand-wired together. In a typical, large Librascope computer for a defense contract, connectors for printed circuit boards are mounted in a bay and connected by thousands of insulated wires. They must follow a direct point-to-point path from one terminal to another. This requires hundreds of hours of assembly time for a single computer cabinet.

To simplify the process, Librascope industrial engineers developed a two-phase assembly program. Rather than requiring the worker to stand at a cabinet and wire the entire bay, Librascope has grouped the connectors in three panels, which are individually wired (Fig. 7), at benches where the wirer may sit and work under optimum lighting conditions. At the completion of wiring, the units are bolted into the cabinet, and inter-connections between the separate panels are completed. (Fig. 8)



Fig. 5. At Librascope, wooden mockups of equipment are used to lay out wiring prior to actual production.

### TYPICAL OPERATION AND MAXIMUM RATINGS OF BENDIX GERMANIUM PNP TRANSISTORS

Type Number	PRIMARY APPLICATIONS				MAXIMUM RATINGS				TYPICAL OPERATION			
	Audio	Push-Pull	Switch	Power Supply	Collector Voltage V <sub>ce</sub> (a)	Collector Current I <sub>c</sub>	Thermal Resistance (b)	Junction Temp. T <sub>j</sub>	Current Gain		Circuit Gain db	Power Output W
									hFE	I <sub>c</sub> Adc		
<b>High Power Transistors (g)</b>												
2N155	X				30 V <sub>cb</sub>	3 Adc	3° C/W	85°C	40 (c)	0.5	33	2
2N176	X				40 V <sub>cb</sub>	3	—	90	45 (c)	0.5	35	2
2N234A	X				30	3	2	90	25 (c)	0.5	30	2
2N235A, B	X				40	3	2	90	40, 60 (c)	0.5	33, 36	2
2N236A, B	X			X	40	3	2	95	40, 60 (c)	0.75	33, 36	4
2N242	X				45 V <sub>cb</sub>	2	3	100	—	—	35	1
2N255	X	X			15 V <sub>cb</sub>	3	3	85	40	0.5	22	1
2N256	X	X			30 V <sub>cb</sub>	3	3	85	40	0.5	25	2
2N257	X				40	—	—	85	55 (c)	0.5	35	1
2N268, A	X		X		80 V <sub>cb</sub>	—	—	85, 90	—, 40	—, 2.0	31, —	1, —
2N285A	X			X	40	3	2	95	150 (c)	0.5	40	2
2N297			X		60 V <sub>cb</sub>	5	2	95	70	0.5	—	50 (d)
2N301, A	X				40, 60 V <sub>cb</sub>	3	—	—	63 (c)	0.7	33	3
2N307, A	X				35 V <sub>cb</sub>	1, 2	5, 3	75	80	0.2	—, 27	—, 1
2N399	X	X			40	3	2	90	40 (c)	0.75	33	8 (e)
2N400	X			X	40	3	2	95	50 (c)	1.0	36	6
2N401	X	X			40	3	2	90	40 (c)	0.5	30	5 (e)
2N418			X	X	80	5	2	100	50	4.0	—	100 (c)
2N419				X	45	3	2	95	60 (c)	0.5	—	5
2N420, A			X	X	40, 70	5	2	100	50	4.0	—	—
2N637, A, B	X		X	X	40, 70, 80	5	2	100	45	3.0	—	35, 70 (d)
2N638, A, B	X		X	X	40, 70, 80	5	2	100	30	3.0	—	35, 70 (d)
2N639, A, B	X		X	X	40, 70, 80	5	2	100	23	3.0	—	35, 70 (d)
2N677, A, B, C and 2N1029, A, B, C replaced by 2N1031, A, B, C												
2N678, A, B, C and 2N1030, A, B, C replaced by 2N1032, A, B, C												
2N1031, A, B, C	X		X	X	30, 40, 70, 80	15	1.5	100	40	10.0	—	75, 125, 250 (d)
2N1032, A, B, C	X		X	X	30, 40, 70, 80	15	1.5	100	75	10.0	—	75, 125, 250 (d)
2N1073, A, B (i)	X		X		40, 80, 120	10	2.0	100	40	5.0	—	100, 150, 200 (d)
2N1136, A, B	X		X	X	40, 70, 80	5	2.0	100	75	3.0	—	35, 70 (d)
2N1137, A, B	X		X	X	40, 70, 80	5	2.0	100	115	3.0	—	35, 70 (d)
2N1138, A, B	X		X	X	40, 70, 80	5	2.0	100	150	3.0	—	35, 70 (d)
B-177	X			X	30	3	2.2	90	150 (c)	0.5	39	2
B-178	X				30	3	2.2	90	40 (c)	0.5	33	2
B-179	X				40	3	2.2	90	25 (c)	0.5	28	2
<b>Medium Power Transistors (h)</b>												
2N1008, A, B	X	X	X		20, 40, 60	300mA	0.15°C/mW	85	95 (c)	10mA	—	400mW (f)
2N1176, A, B	X		X		20, 40, 60	300mA	0.20°C/mW	85	50 (c)	10mA	—	300mW (f)
<b>Military Types</b>												
2N297A (g)	X		X	X	50	5	2.0	95	70	0.5	—	35 (f)
2N331 (h)	X		X		30 V <sub>cb</sub>	200mA	0.15°C/mW	85	50 (c)	1.0mA	—	400mW (f)
2N1011 (g)	X		X	X	70	5	2.0	95	55	3.0	—	70 (d)
2N1120 (g)	X		X	X	70	15	1.5	95	35	10.0	—	250 (d)

(a) V<sub>ce</sub> except where noted. Equivalent V<sub>cb</sub>'s are 20-50% higher. (b) Collector dissipation is the difference between the maximum junction temperature and the mounting base temperature divided by the thermal resistance. (c) h<sub>FE</sub>, AC current gain. (d) Square wave output power. (e) Push-pull output. (f) P<sub>c</sub>—Maximum collector dissipation 25°C. (g) TO-3 package. (h) TO-9 package. (i) Diffused-Alloy-Power DAP transistor.

### CHARACTERISTICS OF BENDIX SILICON RECTIFIERS

Type Number	I <sub>o</sub> Adc	PIV V <sub>dc</sub>	Lib	Type Number	I <sub>o</sub> Adc	PIV V <sub>dc</sub>	Lib	Type Number	I <sub>o</sub> Adc	PIV V <sub>dc</sub>	Lib
1N536	0.75	50	10 uAdc (At 25°C)	1N1434	30	50	5 mAdc (At 150°C)	1N1612	5	50	1 mAdc (At 150°C)
1N537	0.75	100	10 uAdc	1N1435	30	100	5 mAdc	1N1613	5	100	1 mAdc
1N538	0.75	200	10 uAdc	1N1436	30	200	5 mAdc	1N1614	5	200	1 mAdc
1N539	0.75	300	10 uAdc	1N1437	30	400	5 mAdc	1N1615	5	400	1 mAdc
1N540	0.75	400	10 uAdc	1N1438	30	600	5 mAdc	1N1616	5	600	1 mAdc
1N547	0.75	600	10 uAdc								

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CIRCLE 39 ON READER-SERVICE CARD



**Fig. 6.** Worker prefabricates cable harness on wooden dummy of equipment. After harnessing is complete, cables are removed and installed in final equipment.

The two-stage assembly permits a greater number of wiremen to work on the terminal bays, and reduces fatigue and errors on the part of the workers.

A recent innovation has been the adoption of solderless crimped connectors, which has effectively increased production by more than 30 per cent, and has reduced "workover" of improper connections to a minimum. At the completion of wiring, the bays are tested automatically, by specialized equipment which checks continuity and potential of all connections in the cabinet.

#### Integrated Cooperation

Avien, Inc. of Woodside, N.Y., uses "integrated cooperation" among manufacturing, material control, purchasing, and manufacturing-engineering personnel.

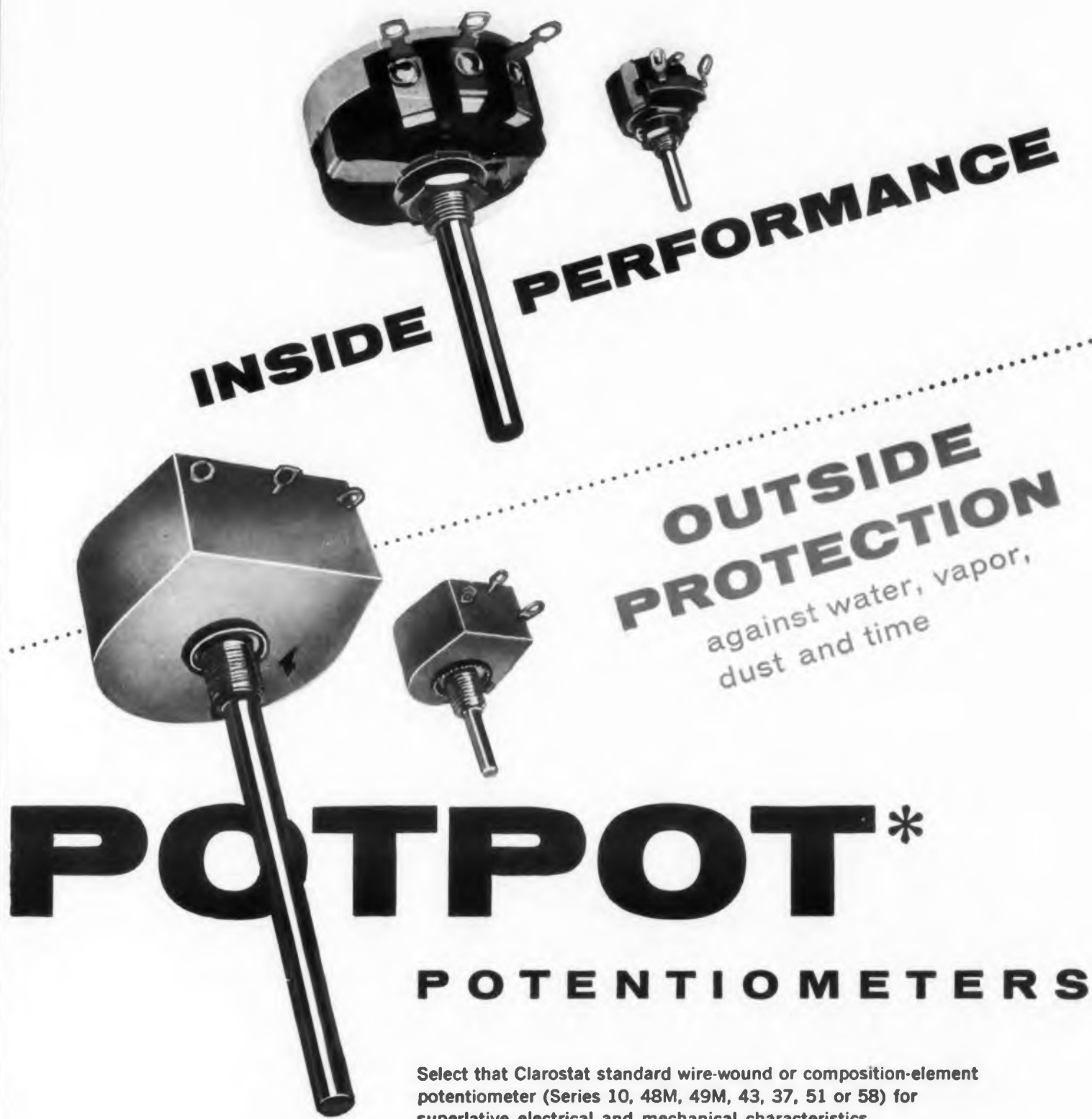
When engineering begins work on a new product, a production engineer is immediately assigned to the project.

The production engineer guides the design engineer by providing all the necessary production-capabilities information that may have a bearing on the design of the product. He points out characteristics in the initial design which can develop into serious production problems. When the unit is finally readied for production, the production engineer can bring to production a thorough knowledge of the new unit.

Keeping in close touch with the progress of engineering work, the manufacturing manager holds weekly "new unit status" meetings with representatives of all manufacturing sub-departments and with representatives of other operating departments.

#### Buy Long-Lead Items Early

Material control moves into the picture just prior to the final release of a new product by en-



Select that Clarostat standard wire-wound or composition-element potentiometer (Series 10, 48M, 49M, 43, 37, 51 or 58) for superlative electrical and mechanical characteristics.

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CIRCLE 37 ON READER-SERVICE CARD



## Planning for Production

gineering. Sufficiently ahead of time, engineering releases to material control a list of long-lead-time items that will be needed for the new product. These are specially coded on red IBM cards for immediate attention.

When the design is well advanced, a meeting is called to determine test and inspection requirements. A program is set up to assemble test and inspection equipment.

Arthur Gray, manager of manufacturing engineering, warns against the temptation to cut corners at this stage. "Inadequate test equipment," he points out, "always increases the possibility of

error or inaccuracy. When such inaccuracy is uncovered, it is frequently and wrongfully blamed on the product rather than the test equipment."

Gray hails Avien's integrated cooperation approach. "It pays off," he claims, "by providing a forum for interested parties to discuss all areas of the new product thoroughly." The "new unit status" meetings, he points out, act as a single, complete source of information on the status of all new products.

### Manufacturing Enters After Breadboard

A variation on this approach is used by Packard Bell Electronics of Los Angeles, Calif. There, the manufacturing processes start concurrently with the construction of the engineering prototype. Basis of Packard Bell's plan is a complete engineering-manufacturing group under a program manager.

This plan has been in effect on several test equipment programs, most notable of which has been the group support equipment for the Thor missile. Under this plan, all necessary manufacturing support personnel (purchasing, expediting, etc.) are assigned directly to the project on a full time basis.

During the latter part of the breadboard phase, and prior to the prototype stage, the manufacturing section works directly with design engineers

to evolve a design which not only meets performance requirements, but assures production reproducibility.

During this stage, engineering personnel are purposely transferred back and forth between manufacturing and engineering to add to their knowledge and capabilities.

An additional benefit gained by this procedure is that the manufacturing people become familiar with the equipment before they have to produce it. This extends their learning time.

To assure proper use of existing facilities, Packard Bell has formed a "make or buy" committee. Consisting of representatives from engineering, purchasing, and manufacturing, it generates a "make or buy" decision on all material for a program.

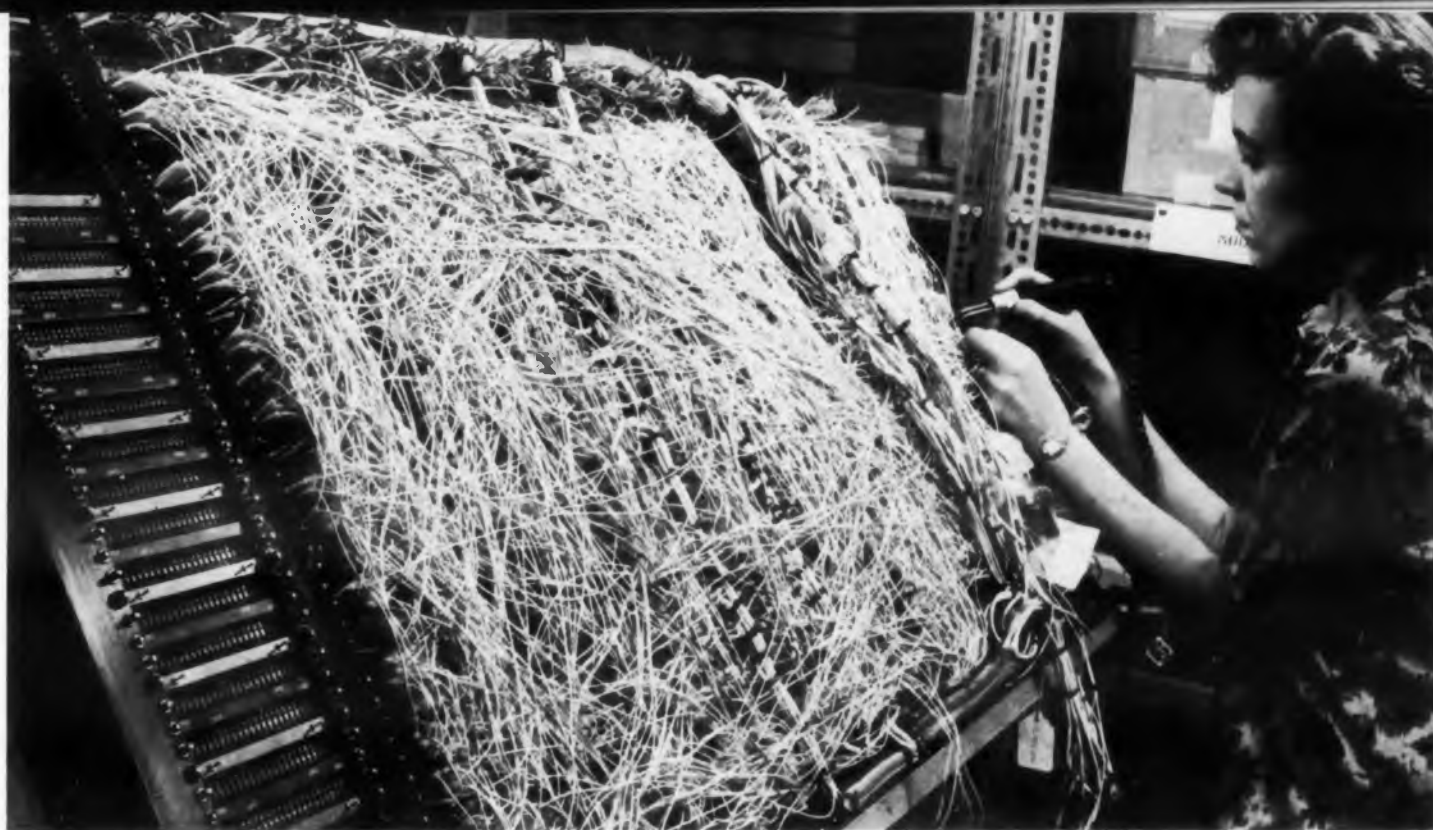
The advantages of Packard Bell's plan are manifold. According to Project Manager Max Ganstwig of the Technical Products Division, "... the plan not only considers the requirements of schedule, but includes the necessary controls to give reproducibility and interchangeability during a period when a large number of engineering changes may be encountered."

The idea of marrying engineering and manufacturing is not unique. In one form or another, it is practiced by many firms. At Epsco, Inc., in Cambridge, Mass., for example, engineering people

**Fig. 7.** (below) Worker makes point-to-point connections to terminals on connector panel for plug-in circuit boards. This is the first phase of a Librascope simplification of a wiring problem.



**Fig. 8.** Connector panels are grouped to form equipment bay. Here a worker interconnects panels—the second part of Librascope's two-phase assembly program.



move right into the pilot line production area during a pilot run of a product.

#### No Project Team

Lear, Inc., of Grand Rapids, Mich., is rather unique in not having project teams at all. Engineers are organized on a specialty basis rather than a project basis. Circuit designers do all the circuit design. Packaging specialists do all the packaging. Circuit designers do no packaging; hence, they make no packaging errors.

"Advantages of organization on a specialty basis are strong ones," say Mel Frontjes, head of the electrical engineering department. "Specialists carry ideas from one application to another. What they learn on Project A, they can apply on Project B."

Frontjes points to an additional advantage in that it's not necessary to repeat talent in different project groups. He admits though, that the specialty type of organization may not be practical for very large companies.

#### Only ME's Design the Package

At Bendix Products Div.—Missiles, in Mishawaka, Ind., only a mechanical engineer designs packages, except for critical ones like rf circuits. An electronics designer will double-check his package and finally, the two men will work together to prepare it for production.

Before packaging, a mechanical engineer may spend two or three days talking with the electronics man. He'll learn the circuit peculiarities to guard against. The electronics engineer may tell him, for example, to keep certain temperature-

sensitive components away from heat sources—or to watch out for noise and leakage across printed circuit tracks.

The Bendix man will construct a "bull" model, a breadboard which looks like the final package should look. Then the experimental shop will make the engineering prototype—to drawings rather than sketches.

#### Aim for Prototype Like Final Product

At Stavid Engineering Inc., the aim of design is to make an engineering prototype that will closely resemble the final production product. At this Plainfield, N. J., firm, people with production know-how are included in all the project design teams.

To design reliability into a product, rather than attempt to improve reliability after the design is completed, quality control, reliability, and component personnel contribute their specialized knowledge early in the design phase.

Project engineer Edward Kasner contends that this parallel planning is far superior to the traditional series plan in which design engineering is followed by production engineering.

Says Kasner, "The glorified breadboard model, ceremoniously referred to as the 'preproduction prototype' is invariably unfit for production. To improve producibility, it is turned over to a product engineering group (looked upon as production people by the design group, and as design engineers by the production group).

"This process," continues Kasner, "wastes time. It requires consultation between design and product engineers, about seemingly minor changes, at

the crucial time when the product should already be crossing the bridge to production."

#### Assemble by Hand or Machine

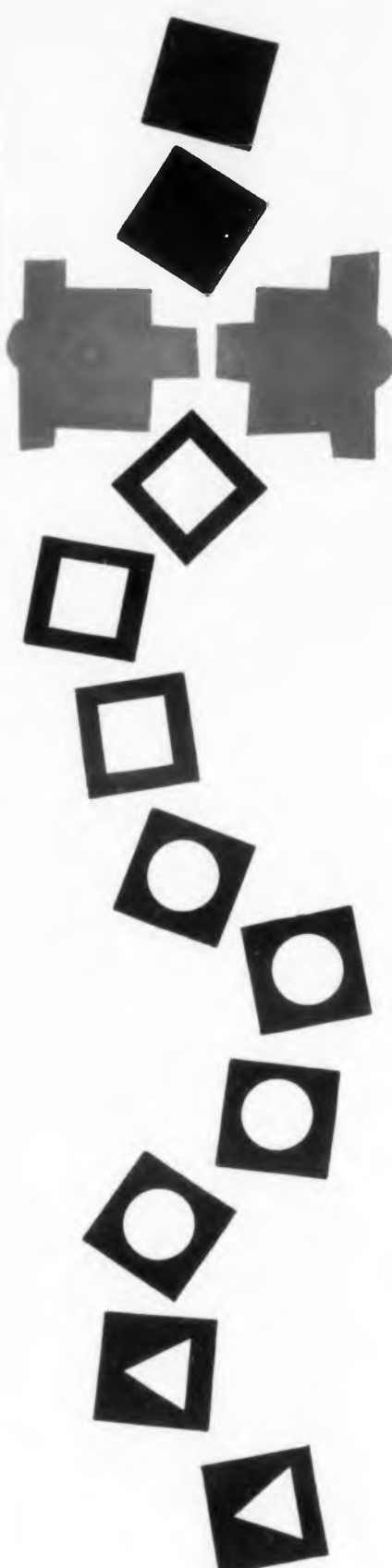
Kasner goes on to challenge a popular notion. "Mechanical assembly in *itself*," he says, "does not necessarily promote production efficiency. In the instances where mechanized assembly is used to economic advantage, the equipments were shrewdly engineered so the assembly operations could be most efficiently performed by the machinery intended for the task."

Warming up to his subject, Kasner continues: "Production-cost analyses, and time and motion studies have shown that the simple, repetitive motions performed by assembly machines can also be performed, optimally, by human operators.

"Psychological production aids such as air and color conditioning, proper illumination, music, coffee breaks, etc., do much to minimize operator boredom and fatigue. In many industries where these aids have been used, especially when supplemented by incentive-pay systems, industrial engineers have shown that the substitution of complex, expensive mechanization for human operators is not necessarily justified.

"The ideal electronic equipment design should be equally amenable to manufacture by either mechanized or manual means.

"With a mechanized-assembly capability inherent in its design, the military electronic product can be manufactured economically in small quantities by manual assembly methods and in large quantities by mechanized-assembly methods." ■ ■



## Ideas and Tools

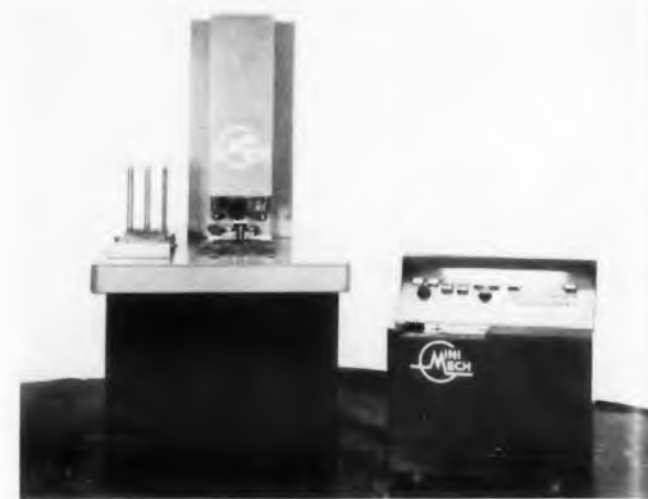
### Speed Short-Run Production



**Fig. 1.** Operators at Librascope guide circuit boards through Dynasert machine for automatic component insertion.



**Fig. 2.** Dynasert machines cut leads, bend them to fit holes in the circuit board, insert components, and crimp the leads.

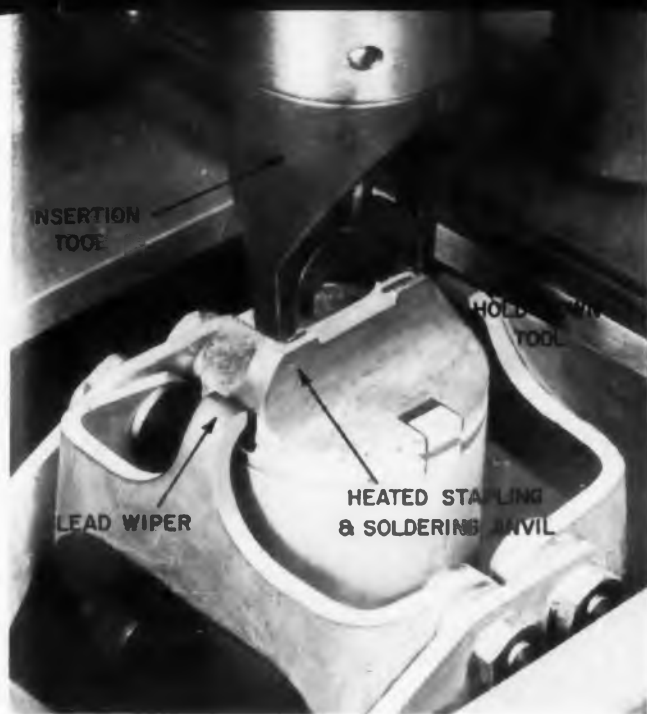


**Fig. 3.** Melpar's Mini-Mech selects components, positions boards, inserts components, and solders them in place. Unit at the right is the punched-card programmer.

**C**HARACTERISTIC of the short run is the fact that it can rarely justify the purchase of costly, single-purpose, mass-production machinery. But the short run can be mechanized—and to great advantage.

Before considering machinery for fabricating parts or assembling components, the design engineer should study his design. Many errors can creep into a design that can make it unproducible.

- First of all, he should design so his parts can be manufactured on standard machines—if at all possible.
- He should design for tools that exist, and should know the capabilities and limitations of available machines. He should know, for example, when to use a drill fixture, when to use a punch.
- He should be careful, for example, not to put a mounting hole where a machine can't get at it. He should not have too narrow a flange on a chassis. Bending brakes just can't handle narrow flanges reliably.
- He should pay particular attention to tolerances especially around sheet-metal bends—and should remember that tolerance errors add up.
- He should investigate the possibility of using production tooling on engineering models.
- He should take advantage of contract expendable tools—patterns, castings, jigs, punching templates, holding fixtures, etc.
- He should determine the extent of tooling he'll go to on the basis of his contemplated quantity.
- He should learn to adapt available equipment to his needs.
- He should not overlook processes which are usually considered for high production only. Die-casting, for example, is usually considered only for very large production lots. Yet, for close-toler-



**Fig. 4.** The component inserting tool and anvil of Mini-Mech, shown in the stapling position.

ance complex parts, it is often cheaper to die-cast as few as 50 pieces than to machine them.

#### How To Mechanize

Having assured himself that his design is producible and that the bugs are out, an engineer can begin to determine what machinery he can use for making parts or assembling components. At this point, he can become aware of a very important fact:

The key to mechanization of the short run is in the use of versatile machines—machines that can handle a variety of components or a variety of sizes—machines that can do more than one job—and machines that can be changed over quickly from one operation to another.

Fortunately, many commercial machines embody a high degree of flexibility.

#### Machines Can Assemble Parts

Perhaps the most useful machine for electronics work is one that can install components. Many such machines are in use. Engineers at Librascope, Inc. of Glendale, Calif., have speeded computer construction by using many automatic and semi-automatic assembly techniques.

They use precision drilled boards throughout assembly. Where eyelets are used, five semi-automated machines install as many as 60,000 per shift.

Dynasert machines insert components in these boards (Figs. 1 and 2), with one operator loading and tending three machines. The components are automatically aligned and sorted by these machines, wire leads are clipped to length, bent to fit the circuit board's holes, then crimped into place. The crimped leads hold the component

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General Instrument Semiconductor Division developed this paper thin gold bonded germanium diode under the Signal Corps micro-module program and is now delivering in production quantities against government contracts. Actual size is .310" square and .016" thick. 350 of them weigh just an ounce!

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## Ideas and Tools

firmly until they are dip-soldered to the printed circuit.

For larger boards, a Librascope-developed cycling feed automatically moves the boards into position for multiple insertion of diodes. For special test or prototype runs, manual insertion is used, but even here, special semi-automated lead-forming machines preform component leads at high speed.

The machines cut the leads to size, shape them, and bend them to any required angle. Parts are hopper-fed into the machines, and are automatically aligned and sorted before forming.

### Assemble, Then Solder

For component assembly, few systems are more versatile than the Mini-Mech System developed by Melpar, Inc. of Falls Church, Va., for the Navy Bureau of Ships. This equipment, shown in Figs. 3 and 4, is now commercially available, either as a complete unit, or in part.

Mini-Mech, programmed manually or by punched card can select components automatically from a supply of 24 types, and can install them in their proper places on automatically positioned, foil-clad circuit boards.

It handles only axial-lead components, and only up to about the size of a one-watt resistor. This takes care of about 90 per cent of all circuit requirements. Mini-Mech bends component leads into shape, simultaneously cleans them, then solders them (either through plain holes or eyelets) to the printed circuit foil, and provides an excellent heat sink during soldering. And the soldering is far more reliable than one could expect from a human with a soldering iron.

On the subject of soldering, A. Arnold Lawson, Melpar's project engineer who headed the design team responsible for Mini-Mech, poses this rhetorical question: "What is the mathematical probability of obtaining a reliable hand-soldered connection?"

Calculating quickly, Lawson estimates, "The mathematical probability of obtaining a reliable hand-soldered connection is almost as good as picking a winner at a dog track."

Lawson doesn't reveal how well he does at dog tracks, but he lists 10 possible causes for failure in soldered connections.

1. Temperature—too low or too high.
2. Timing—too short or too long.
3. Poor contact of iron to junction.
4. Improperly made junction.

## SILICONE NEWS from Dow Corning

# In Both Heat And Humidity



PHOTOS COURTESY CHRYSLER CORP. MISSILE DIV.

### Silicone Laminates Aid Missile Reliability

In these black boxes for the Jupiter missile control system, terminal boards are made of silicone-glass laminate. Specified for their excellent resistance to space age environments, silicone laminates are easy to work with, too. Soldering heat doesn't loosen terminals as complex wiring is accurately secured.

Throughout the electronic control system of the Army-developed Jupiter, Chrysler Corp. Missile Division engineers have specified numerous uses for Type GSG silicone-glass laminates. Made with Dow Corning silicone resins, these glass laminates conform to MIL-P-997, retain their excellent dielectric properties despite heat, moisture, storage, environmental aging, rapidly changing ambients, and vibratory shock. Silicone-glass laminates also have excellent resistance to ozone, arcing, corona, and fungus attack . . . even to the formidable combination of high humidity and high voltage.

As a result of these properties, glass laminates made with Dow Corning Silicones are highly reliable dielectrics for all units that must face adverse environments. In addition, they are easy to fabricate and assemble, having good physical properties and resistance to creep under pressure.



Your nearest Dow Corning office is the number one source for information and technical service on silicones.

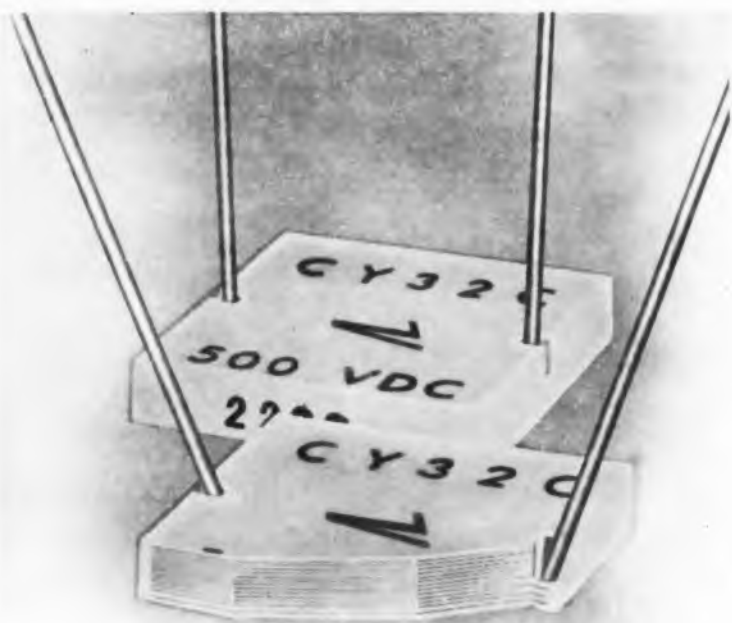


**Dow Corning**

CIRCLE 600 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 25, 1959

...in any environment, silicones protect



#### Fluid Short-Stop Deflects Moisture

Employed in many airborne guidance, tracking, computing, and telemetering units, "Vitramon" Capacitors are porcelain-bodied to resist adverse conditions such as heat and humidity. But Vitramon engineers realized that only a small amount of condensation on the porcelain could cause leakage paths and lead-to-lead shorts. They solved the problem by dipping each capacitor in Dow Corning silicone fluid. The micro-thin coating is moisture-repellent... durable. The silicone surface "beads" water, preventing condensed moisture from forming a conductive film.

CIRCLE 601 ON READER-SERVICE CARD

#### This Resin Is As Good As Its Bond

The Osborne Electronic Corporation makes, among other things, specialty transformers for airborne electronic systems. Look hard and you'll see an Osborne unit in the Jupiter Ground Support Equipment control box on the facing page. At the center of each Osborne transformer is a coil bobbin which must have maximum mechanical and electrical strength in minimum thickness to allow maximum copper content in the core window area. Normal tolerance is  $\pm .015$ . In addition, they must withstand temperatures from  $-65^{\circ}\text{C}$  to over  $200^{\circ}\text{C}$ , be free of voids or pinholes. Osborne engineers have found the most economical way of producing top quality silicone-glass laminate coil bobbins of special sizes and shapes for their custom transformers is by winding glass tape on a mandrel, then saturating it with Dow Corning solventless resin applied by paint brush. Dow Corning resin cures with heat; no pressure needed. It provides the high physical strength to resist heavy wire winding pressure.

CIRCLE 602 ON READER-SERVICE CARD



#### Silastic® Insulates Beyond The Call

This giant Klystron focusing coil, a product of Varian Associates, is destined for a vital role in space-age electronics. Designed for 5000 hours minimum life, it operates at 1650 watts input and is cooled by liquid heat-exchange. Inlet coolant temperature is  $125^{\circ}\text{C}$ !

Where does Silastic, the Dow Corning silicone rubber, fit in? It's over, under, and around every layer of the coil. A paste form of Silastic is coated on each successive winding and over the copper cooling coils as well. Dielectric strength, resiliency, and resistance to heat and moisture are essential. The coil must withstand water immersion tests, vibration tests, a shock test of 10 G's for 15 cycles of 11 micro-seconds each, and environmental testing which includes severe thermal cycling.

CIRCLE 603 ON READER-SERVICE CARD

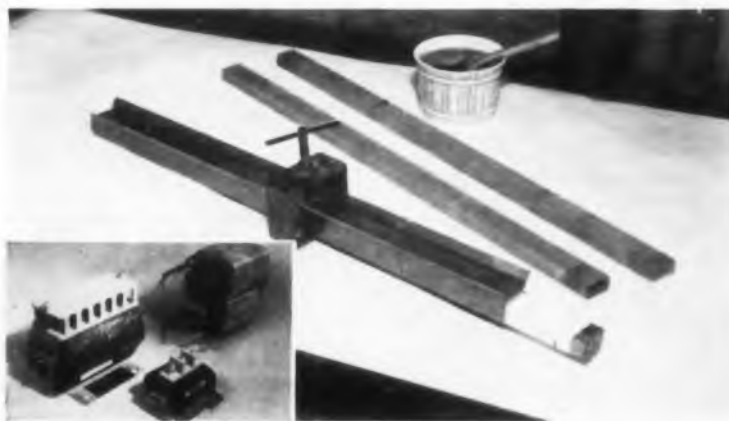


Fig. 5. Operator positions material by following a template on this Wiedemann turret punch press.

5. Improper fluxing.
6. Improper solder.
7. Improper heat capacity of the iron.
8. Disturbance of joint before solder has set.
9. Improper heat sinking.
10. Improper degree of cleanliness.

In view of these, he advises close supervision of all personnel with soldering irons in their hands. He recommends, as far more reliable, mechanization of soldering. He points out that Mini-Mech offers complete control of all the variables which are the general causes of failure. In controls the time, temperature, pressure, and quantity of solder which will be used in a connection.

#### Flexible Fabricators

After assembly machines, the most useful equipment for electronics manufacturing consists of tools for punching chassis and circuit boards. Here too, one can find versatility in commercial machines. One very versatile machine is Wiedemann's RA-41P turret punch press, shown in Fig. 5. Equipped with as many as 20 turret stations, it can quickly punch a wide variety of hole sizes and shapes. Individual punches and dies are easily replaced to increase the number of hole sizes and shapes available.

This machine combines the versatility, accuracy,

CORPORATION MIDLAND, MICHIGAN

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# DELCO RADIO ANNOUNCES REDUCED PRICES ON POWER TRANSISTORS



Effective November 1, Delco Radio's line of high quality, high reliability power transistors is now being offered at prices reduced as much as 34% in production quantities.

Lower prices are possible at this time as a result of new manufacturing techniques, design improvements, and increased production.

Delco Radio's power transistors have established enviable records for performance and reliability in virtually limitless applications. The new prices reflect Delco Radio's policy of offering products of the highest quality and performance at the lowest possible price.

These reduced prices will now permit many additional applications where transistor cost has been a limiting factor. Contact your Delco Radio representative for details and for applications assistance.

## DELCO RADIO

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726 Santa Monica Boulevard  
Tel: Exbrook 3-1465

CIRCLE 41 ON READER-SERVICE CARD



## Ideas and Tools



Fig. 6. General Electric's automatic positioning control combines with the power of this Wiedemann press to provide great production speed and flexibility.



Fig. 7. This Wales-Strippit Fabricator, with an auxiliary Duplicator, follows a template to provide a wide variety of precisely positioned holes.

and high speed of a pantograph for rapid hole location, with rapid punch and die selection.

Where quantities can justify the cost, the new, high-speed, tape-controlled Wiedematic press (Fig. 6), can prove enormously useful. Controlled by a modified General Electric Mark III automatic positioning control, this machine handles all press functions automatically—tool selection, material positioning, and piercing.

Tape control provides great advantages. From the viewpoint of inventory, it allows fewer pieces to be carried in stock since setting-up is merely a tape-out-of-the-file away.

From the viewpoint of engineering, it simplifies the preparation of information for the shop. With



Fig. 8. Complex, short-run jobs like these are handled quickly by the Wales-Strippit Fabricator-Duplicator.

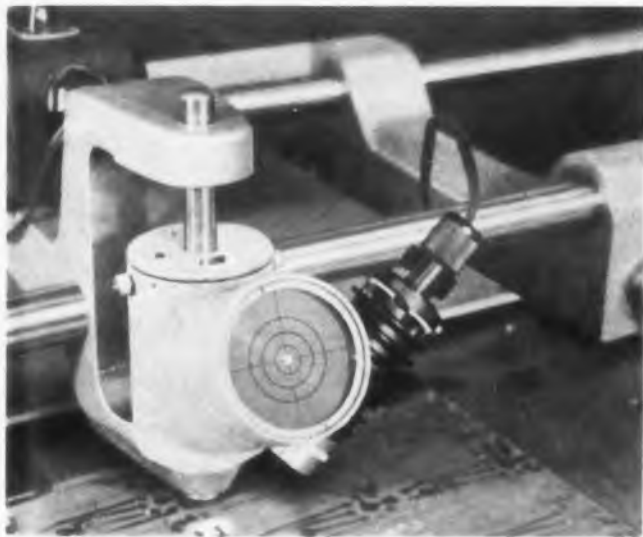


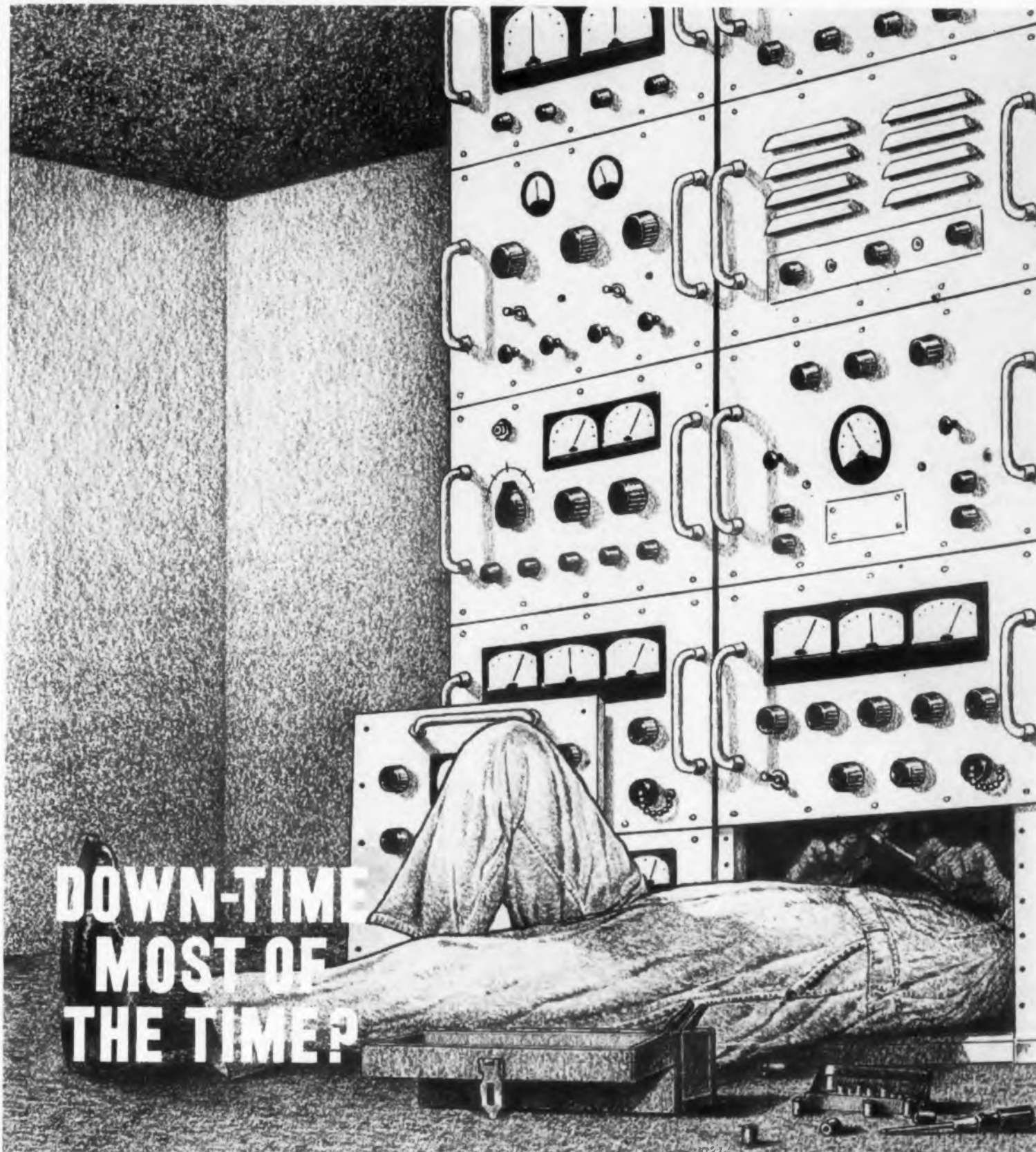
Fig. 9. The Dupl-O-Scope locates the position of holes optically. It can help the Fabricator prepare a template for use with the Duplicator.

tape-controlled machines, shop people no longer need conventional drawings.

#### Punch Chassis or PC Cards

Wales-Strippit, Inc. of Akron, N.Y., manufactures a "Fabricator" (Fig. 7), which punches, notches, or nibbles sheet material, and can dimple flush-head fasteners. It is just as useful in punching the metal chassis shown in Fig. 8 as in punching printed circuit cards.

With an accessory "Duplicator," the machine



**DOWN-TIME  
MOST OF  
THE TIME?**



Grant Slides have been the pattern for all slide designs. While Grant is flattered, it is important to point out to designers and engineers that Grant research, design and sales engineering have been and are the factors that place the nation's leading industrial manufacturers on our list of customers. If you require imaginative assistance in determining the proper slide for your equipment — or, if you'd simply like to discuss the possibilities for slides in your units, Grant sales engineers are at your service — as they have been ever since the first industrial slide (a Grant slide!) was marketed.

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CIRCLE 42 ON READER-SERVICE CARD



## Hold your frequency under fire (and ice)!

New linear permalloy core keeps filters frequency-stable over a wide range of temperature conditions—at half the cost

Designers of audio filter networks, faced with the high price of components and the need for frequency stability over a wide swing in ambient temperatures, can now benefit from a most significant development—the linear molybdenum permalloy powder core.

The linear cores we've developed are used with polystyrene capacitors. This combination costs as little as half the price of temperature-stabilized moly-permalloy cores and the silvered mica capacitors with which they must be used.

What's more, frequency stability is increased! For temperatures ranging from  $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  we have observed frequency stability variations as low as 0.05%. This is consider-

ably less frequency shift than normally expected with temperature-stabilized combinations.

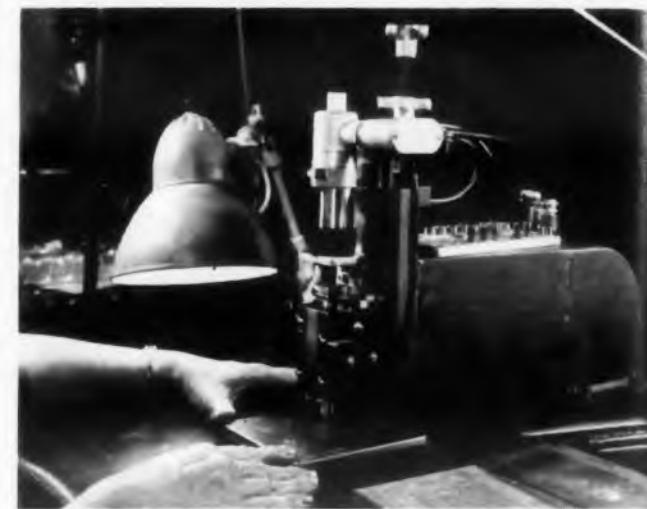
We guarantee the temperature coefficient of these linear cores within a very narrow range! Information regarding sizes, prices and performance behavior awaits your request. Popular sizes, in 125 permeability only, available immediately from stock. *Magnetics, Inc., Dept. ED-74, Butler, Pa.*

**MAGNETICS inc.**

CIRCLE 43 ON READER-SERVICE CARD



## Ideas and Tools



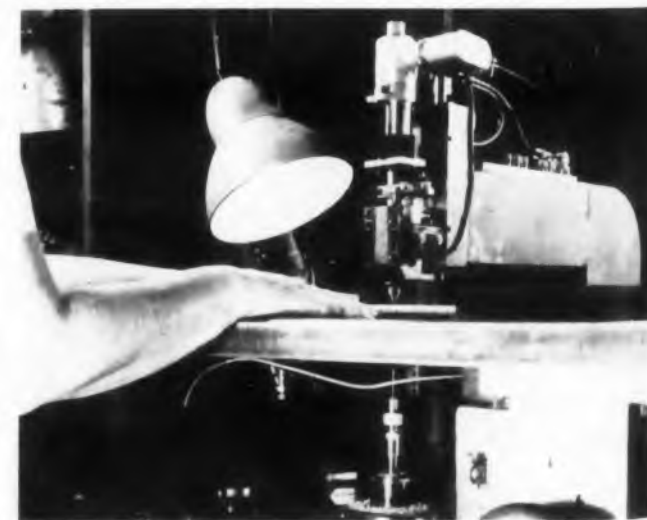
**Fig. 10.** Librascope-developed drill can drill as many as six circuit boards at a time. A "finger" follows a drilling path etched on the template, to position the boards.

uses a pantograph principle to follow the position of a stylus in template pilot holes.

Another accessory, the Dupl-O-Scope of Fig. 9, locates holes optically, from a drawing, layout, or sample part. On printed circuits, holes can be centered from the OD of round circuit connection points, even where the hole points on a sample are off-center.

### Upside-Down Drill Follows "Finger"

For automatic assembly on printed circuit boards, the holes for mounting component leads



**Fig. 11.** When the "finger" drops into an indentation, the drill rises from below.



Fig. 12. The new Hermes Engravograph can be used for marking or for deeper cutting applications.



Fig. 13. Hinchman's Unex Jet Molder uses interchangeable injection cylinders and dies.

must be positioned precisely. To meet this requirement, Librascope has developed a ganged-drill.

Using this machine, shown in Figs. 10 and 11, an operator gangs as many as six circuit boards by placing them in a special positioning fixture. The fixture, a rigid metal plate backed by a reinforced plastic, has a surface plate with a drilling path etched into the metal. Positioning indentations correspond to the holes to be drilled.

As the positioning finger drops into an indentation along the contact path, the operator touches a toe switch and a special carbide drill, located below the table, makes the holes.

The drill itself is completely automatic, rising at a controlled rate and spinning at a pre-set

## ALLIED CONTROL'S



Now by  
West Ger  
Company, Inc.  
Germany but with



TYPE-T-134  
H-1 3/16 • W-47/64 • L-1 11/64



TYPE-TAHG  
H-2 3/16 • W-1 7/16 • L-1 5/8



TYPE-TAH  
H-1 19/32 • W-61/64 • L-1 11/32



TYPE-TAF  
H-1 17/64 • W-41/64 • L-1 5/16



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H-2 • W-1 13/32 • L-1 13/32

### PERFORMANCE CHARACTERISTICS

#### Contact Arrangement

Up to 12 springs maximum form A, B or C

#### Contact Rating

2 amperes resistive or 1 ampere inductive at 29 volts d-c or 115 volts a-c

Low level or 5 ampere contacts available on request

#### Standard Coil Voltages

Suitable coil resistances can be supplied for operation at any voltage within the range of 0.5 to 130 volts d-c

#### Coil Power

Nominal: 700 milliwatts

Minimum Operate Power: 60 to 150 milliwatts depending on application, contact arrangement and coil resistance.

#### Timing at Nominal Voltage

Operate time: 7.5 milliseconds maximum

Release time: 3.5 milliseconds maximum

#### Vibration

10-55 cps at .062 inch double amplitude

55-500 cps at a constant 10g

Shock: 25g operational

#### Enclosure

Open, dust cover or hermetically sealed

#### Weight

Open type 1.0 ounce maximum

Sealed type 2.0 ounces maximum



# ALLIED CONTROL



ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, NEW YORK

CIRCLE 44 ON READER-SERVICE CARD

## Ideas and Tools



**Fig. 14.** Raytheon's Weld-power Control applied to solidly packed circuit "sticks."

speed. It cannot rotate until the exact position for a hole is located by the operator.

### Two-Job Engraver

Another versatile machine is the model ITX Engravograph manufactured by New Hermes Engraving Machine Corp. of New York City. This engraver, shown in Fig. 12, does two kinds of jobs. As a marking tool, it makes signs and nameplates, engraves names and numbers on parts, instrument panels, legend plates, dials and knobs. As a production tool, it handles many surface-cutting applications.

### Flexible Plastic Molder

For short-run plastic molding and encapsulation, Hinchman Manufacturing Co., Inc. of West Concord, Mass., makes a Unex Jet Thermoplastic Molder. Shown in Fig. 13, this machine uses in-



**Fig. 17.** Burndy's Hyfen connectors allow individual or gang connect or disconnect. The simple extraction tool is used for individual disconnect.

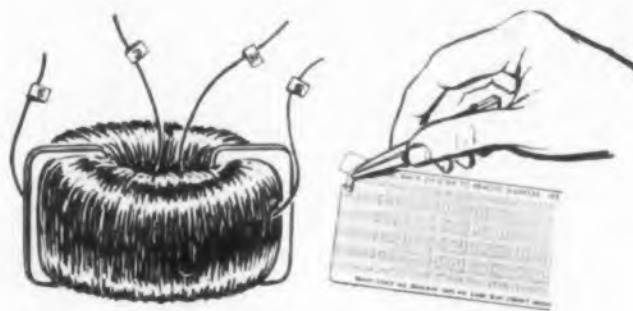
terchangeable injection cylinders and a variety of standard dies to make components of different materials, shapes or colors within minutes.

### Don't Overlook Welding

Within the past two years, welding has become more and more popular as a means of joining components. A proper weld can provide a far better joint than solder, and can remove the possibility of undetected cold solder joints.

Furthermore, in miniaturization applications, the bulge of a solder joint may occupy too large a volume. A weld, of course, takes up no additional space. In some low-noise applications, the noise contributed by the solder joint is objectionable. And since a weld is made in milliseconds, it is not necessary to heat-sink temperature sensitive components.

Welding lends itself beautifully to some of the new packaging techniques using conventional



**Fig. 16.** These "micro markers" flag the four fine terminal leads on this toroid. These markers are unaffected by coil-generated heat.

components. Fig. 14 shows Raytheon's Weld-power Controls used in Raytheon's Welded Module construction.

Raytheon's Commercial Equipment Division in Waltham, Mass., manufactures a variety of types of welding equipment for ultra-small and rather large applications. Flexibility is inherent in the design of the equipment.

For example, Raytheon can provide a welding system for a pilot run. This equipment includes a welding head, a simple fixture for manual feeding, and a power supply.

When the customer's requirements grow, Raytheon can supply equipment to automate the welder for high-volume production runs. The automated equipment provides completely automatic feeding, wire-cutting, welding, and ejection.

It uses part of the customer's original pilot-run equipment so that a customer can salvage more than 70 per cent of the cost of his pilot-run equipment when he switches to automatic equipment.



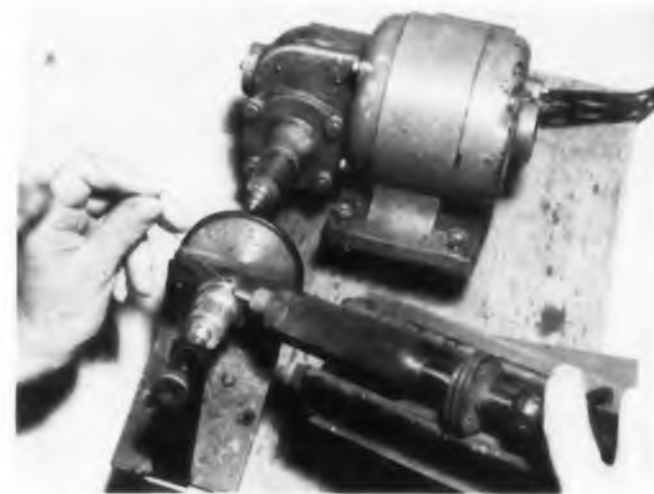
**Fig. 15.** All leads of this wiring harness are permanently marked with self-sticking markers made by W. H. Brady.

### Identify Parts

Positive identification of wires in mass-produced equipment and assemblies is important. In short-run production, it's often vital. Good identification, as in Fig. 15, can save hours and dollars in circuit checkout and hook-up time and can prevent costly errors due to improper connections.

One-of-a-kind assemblies can be marked almost as quickly and economically as their mass-produced counterparts. Particularly useful are the self-sticking wire markers like the Perma-Code series manufactured by the W. H. Brady Co. of Milwaukee, Wis.

These adhesive-backed markers are supplied on self-dispensing cards, ready for rapid application. Until recently, most markers were a bit too large for very small assemblies. But Brady's new "micro markers" can be used on even very small sub-miniature assemblies, as shown in Fig. 16.



**Fig. 18.** A simple hermetic-seal rig developed by Newark Controls.

### Watch the Connections

In short runs, just as in long runs, the reliability of equipment depends largely on the reliability of the connections. For short-run work, compression connectors of the Hyfen type can be particularly useful.

As shown in Fig. 17, these connectors, manufactured by Burndy Corp. of Norwalk, Conn., allow removal of individual wires with a simple extraction tool. This feature can be a boon to the man who has to check that hard-to-get line that always terminates in the center of a connector.

### Use What's Commercially Available

For short runs, a good rule is: "Don't make what you can buy." Too often, an engineer gets into a bind trying to fabricate customized components. The engineer usually has the fixed idea that "nobody's going to make the stuff in the kind of small quantities I need."

But many manufacturers do provide short-run services. Even cable, which usually comes in 5000 foot lengths can be purchased in small runs. Alpha Wire Corp. of New York City for example, uses special techniques to provide "customized cable" runs as short as 50 feet.

### Adapt What's Available

Often, when the purchase of specialized equipment is not justified, equipment on hand can be modified easily to fulfill a short-run requirement. For example, Newark Controls Company of Bloomfield, N.J., uses the simple rig shown in Fig. 18 to hermetically seal covers on gas density switches.

The cover fits snugly over the switch and is held in place by a nest and spring-activated clamp. The component is turned by a foot-pedal-operated, motor-driven shaft. A soldering iron heats the piece sufficiently in four revolutions so that solder can be hand fed during the fifth revolution.

Even unskilled operators can distribute the solder smoothly and evenly with this little fixture and the cost is negligible.

### Ideas Wanted

Designing for short-run production is challenging. The problems are many. Many of the techniques developed over the years for mass production simply cannot be applied to the short run.

But many can! They are waiting to be used—usually with modifications. But the modifications require thought and planning—lots of planning. With proper thought and planning and with the use of available mechanical aids, short-run production can be profitable.

The stimulation provided by the challenges of short-run production has even prompted some engineers to claim "The short run can be fun." ■ ■



# HOW MUCH HEAT CAN

# PRECISION POTENTIOMETERS TAKE?

Special Ketay sector potentiometers have been designed to operate in ambient temperatures up to 500° C.

Ketay precision single-turn, multi-turn, rectilinear and sector potentiometers for control and instrumentation purposes feature compactness and high sensitivity. They are custom engineered for applications once considered too severe because of shock, vibration, torque, resolution or destructive environment.

Potentiometers that meet the most rigid specifications result from:

*Creative Engineering*—for example, very accurate single-turn ganged potentiometers in size 9 with linearity as fine as 0.15% and 2" diameter units with linearity as fine as 0.07%.

*Superior Materials*—selection to give optimum service for particular performance and operational requirements.

*Advanced Manufacturing Techniques*—such as the ability to weld taps to a single turn of wire as small as 0.0004" diameter (1/10 the diameter of a human hair).

Ketay potentiometers are being produced in a wide range of types and sizes, from tiny precision pick-offs to complex function and multi-wiper units.

*Ketay precision components:*  
SYNCHROS  
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**KETAY** DEPARTMENT, Commack, Long Island, N. Y.  
CIRCLE 45 ON READER-SERVICE CARD



Low-pass linear phase electronic filter with a frequency range from 10 cps to 80 kc is designed to give a constant time delay and optimum transient response.



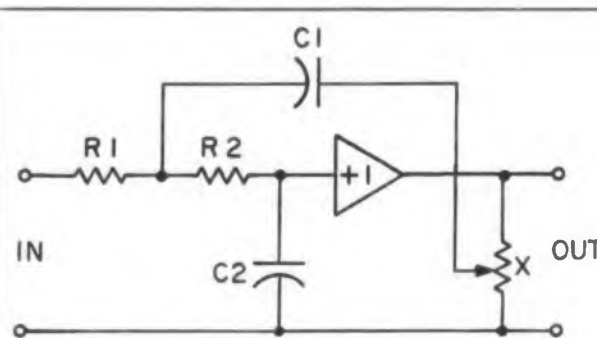
## Electronic Filter Provides Linear Phase

**P**RACTICAL solutions to design problems have produced an electronic filter with constant time delay and optimum transient response. By cascading three amplifiers having staggered dampings and natural frequencies, a low-pass filter with a terminal slope of 36 db per octave has been obtained. The instrument's output is not distorted by random signals.

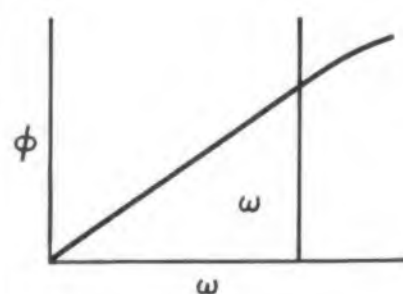
Designed by Ralph Morrison of the Dynamics Instrumentation Co., 1118 Mission St., South Pasadena, Calif., the Model 2200 covers the frequency range from 10 cps to 80 kc in tenth decade steps. Output has less than one mv rms noise and hum; drift is less than 10 mv per hour when the filter is operated from a regulated power line.

Since often the engineer wants to place the cut-off frequency of a low-pass filter as high as possible and still attenuate disturbing signals that are near the cut-off, the obvious solution is to extend the frequency response and increase the attenuation rate above the cut-off point.

This is possible within limits, notes Morrison, but there are undesirable side effects. One result of this kind of maximally flat filter is a poor transient response; another is time distortion. Both of these can be compensated for if square waves or sine waves are being processed. This is rarely the case, in practice. In fact, the square or sine wave response of a filter is usually only of academic interest.

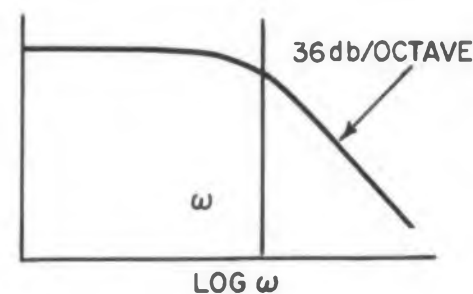


**Fig. 1.** Unity-gain dc amplifier with feedback network. Transfer characteristics are defined by passive elements rather than vacuum-tube characteristics. By interchanging R's and C's, filter can be made high-pass.



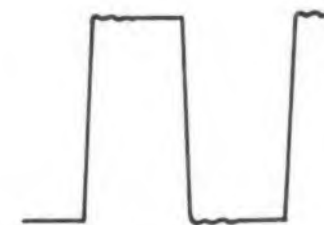
PHASE RESPONSE

(a)



FREQUENCY RESPONSE

(b)



TRANSIENT RESPONSE

(c)

**Fig. 2.** Phase response of cascaded system is shown in (a); frequency response in (b). At cut-off, frequency response curve is rounded, but this is said to be desirable. Rise time, in the transient response curve (c), is only 0.4 sec.

### Design

Each of the three cascaded amplifiers can be described as a single-degree-of-freedom system, with natural frequencies and dampings and only two energy storage elements like capacitors and inductors.

Requirements for the amplifiers include zero output for a zero input dc signal, freedom from drift and noise. Using feedback introduces the desired transfer characteristics—determined by passive elements and not by vacuum tube characteristics. The feedback circuit shown in Fig. 1 transforms a dc amplifier with high input and low output impedance into a single-degree-of-freedom system.

The transfer function of the system can be written

$$E_o/E_{in} = \omega_n^2 / (S+S_1)(S+S_2)$$

where  $S_1 = k\omega_n + j\omega_n \sqrt{1-k^2}$ , and  $S_2 = k\omega_n - j\omega_n \sqrt{1-k^2}$ .

When three amplifiers similar to the one in Fig. 1 are cascaded—and where  $S_1$  and  $S_2$  are  $6.4 \pm j4.0$ ;  $S_3$  and  $S_4$  are  $3.9 \pm j11.7$ ; and  $S_5$  and  $S_6$  are 20.4 and 5.37, respectively—the net result is a low-pass filter with a phase response like that in Fig. 2a. Frequency response and transient response for the same filter are shown in Fig. 2b and c.

Note that while the transient response is good the frequency response is rounded in the region of cut-off. Morrison contends that far from being undesirable, a low-pass filter with this characteristic is ideal for handling random signals.

### Other Considerations

A single switch on the filter provides for high-pass operation. This is accomplished by interchanging the R's and C's of Fig. 1. The circuitry was arranged so the crossover frequency for any low-pass-high-pass setting occurs at the three db point. For both modes of operation the terminal slope is 36 db per octave.

Input impedance is more than 100 K for all frequencies. Output impedance is low; maximum output voltage is  $\pm 20$  v with maximum output current of  $\pm 20$  ma. The low output impedance is to ensure that the filter transfer characteristics are relatively independent of loading, which is difficult to obtain with a passive filter.

To eliminate any troublesome ground tie between filter channels in a multichannel system, the Model 2200 is built so the shield and  $B_o$  (input-output common) are free from any cabinet connection. The power transformer is doubly-shielded to prevent common-mode power line signals from generating reactive ground currents.

For further information about this well-designed inear-phase electronic filter, turn to the Reader-service Card and circle 101.



## NEW FROM CORNING

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

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

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

In every characteristic, this new C-

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

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

Humidity: 1% max. resistance change

Shelf life: 0.2% per year, maximum.

Noise output: .1 microvolt per volt

Nominal length of the C-42 is  $1\frac{1}{16}$ "

$\pm \frac{1}{32}$ ". Power rating is 2 W at 70°C.

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

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



## CORNING GLASS WORKS

Electronic Components Department

CORNING MEANS RESEARCH IN GLASS

CIRCLE 46 ON READER-SERVICE CARD

# Intercoupling Circuit for Precision Amplifiers

Whether engaged on major project assignments or minor development work, George Hall enjoys the challenge of simplifying circuitry. He feels that a circuit devoid of reactive components, such as described, is ideal for medical and hi-fi applications.



**George H. Hall**  
Research Engineer  
Arthur D. Little, Inc.  
Cambridge, Mass.

Dc amplifiers, when compared with ac amplifiers and chopper-rectifier combinations, offer superior performance in terms of higher signal-to-noise ratio and zero phase shift over a wide band width. Drift, the serious drawback, is minimized drastically by the novel interstage coupling principle described.

**S**ERIOUS PROBLEMS associated with dc amplifiers are drift and the necessity to operate succeeding stages at higher and higher potentials. Using a tube and small bias battery arrangement<sup>1</sup> as an interstage coupling device results in size, weight and cost reductions when compared with conventional direct coupling techniques. In addition, the elimination of excessively high potentials by this coupling approach reduces the shock hazard and improves amplifier stability.

## Conventional DC Amplifiers

Comparing ac amplifiers, with chopper input and rectifier output, against dc amplification, dc amplifiers have no chopper noise, higher signal-to-noise ratio, and zero phase shift from dc up to frequencies where interelectrode capacity of tubes become effective. Furthermore, ac amplifiers are limited by being unable to go down to dc, and by having a narrower bandwidth than dc amplifiers. Therefore, dc amplifiers are especially desirable for use in instrumentation work requiring precision.

However, a serious problem in dc amplifier circuits is drift and the fact that the output of any given stage is at a higher dc level than desired

for input to the next stage. The usual methods of combatting this second problem are direct coupling, resistive divider coupling, or voltage regulator tube coupling. These methods are generally unsatisfactory.

When the control grid of a stage is maintained at the same dc potential as the plate of the preceding stage, the plate supply voltage must be successively higher for each stage so that the necessary grid potentials may be maintained. This results in high-voltage supplies which are expensive, unstable, and dangerous. In addition to the plate-supply problem, the filament supply is complicated by the restrictions in maximum cathode-filament voltage specified by the tube manufacturer, and by the generation of hum and noise when circuits are operated at levels far removed from ground potential.

Battery coupling is expensive, bulky, and introduces phase shift. Coupling with voltage regulator tubes results in additional noise and therefore is undesirable at low signal levels. Sometimes a voltage divider is used in the coupling circuit, but this method proportionately attenuates both the dc level and the signal level.

The novel interstage coupling principle de-

scribed permits dropping the potential level from the previous stage without appreciably distorting or diminishing the magnitude of the signal. The resulting amplifier is characterized by high gain, low drift, and low noise-to-signal ratio. Phase distortion is eliminated, because no reactive components are used in the amplifier circuit.

A simple circuit illustrating the technique is shown in Fig. 1.  $V_2$  is the coupling tube. Between its grid and cathode is a bias battery so that the grid is held negative by the small voltage  $e_{gk}$  supplied by this source. (A mercury cell is very satisfactory in all respects.) As the signal from the previous stage  $V_1$  varies, the plate voltage of the coupling tube changes. The plate-to-cathode voltage, however, remains substantially constant and equal to  $\mu e_{gk}$ . As a result, signal variations are transmitted to the cathode resistor and appear almost without loss at a dc level determined by the no-signal plate current times  $R_k$ , and the value of the negative bias supply.

Thus there is basically a fixed voltage drop across the top leg of the output divider composed of  $V_2$  and  $R_k$ . This is equivalent to inserting a large battery or a gas tube of constant voltage drop equal to  $\mu e_{gk}$ . In this instance, the volt-

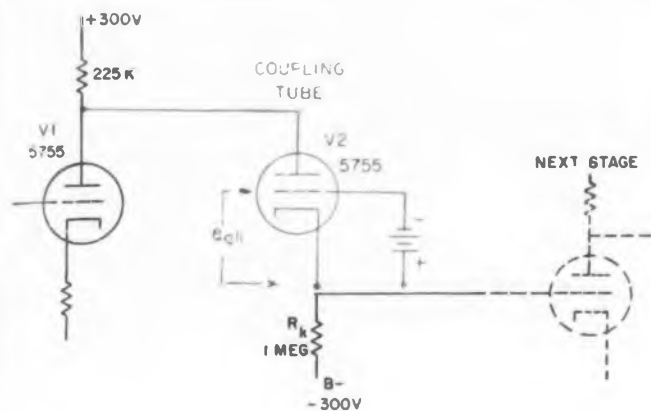


Fig. 1. Basic circuit illustrating the use of a tube (V2) plus bias battery as an interstage coupling element.

age gain of the tube is used to decrease the size of the battery required for this task. Alternatively,<sup>2</sup> may be considered a "high-vacuum neon lamp" whose running voltage is adjusted by the selection of the grid-to-cathode battery.

The application of the technique to a difference amplifier is shown in Fig. 2a. The characteristics of this coupling circuit may be shown as an equivalent circuit similar to voltage divider type circuit, but the two resistance elements are a resistor and the cathode-plate electron path of a vacuum tube.<sup>2</sup> The circuit constants are arranged so that the vacuum tube operates at a point on its characteristics where the dc plate-to-cathode resistance is high and the dynamic resistance, i.e., incremental change in voltage corresponding to a similar change in plate current, is relatively low. [Tube  $R_p$  (dc) is high—Dynamic  $r_p$  (ac) is low.] This coupling device is shown schematically with a plot of equivalent static resistance vs. dynamic resistances. (Fig. 2b)

At the operating point on the 5755 tube characteristics, the dc resistance is:

$$R_p = \frac{E_p}{I_p} = \frac{200}{1. \times 10^{-4}} = 2 \text{ meg}$$



Over the past half-century, HICKOK-pioneering in electrical indicating meters has resulted in such important developments as . . .

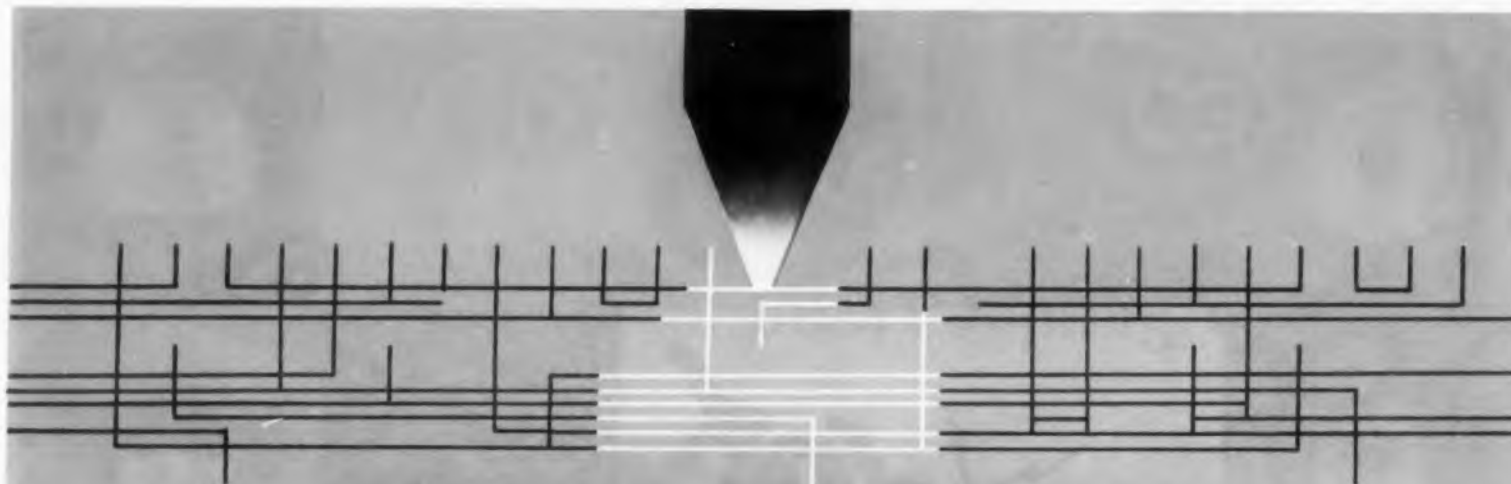
- ✓ Perfection of the internal pivot movement
- ✓ Development of the miniaturized long-scale (250° angular deflection) panel meters
- ✓ Origination of the sub-miniature (1" diameter) long-scale ruggedized meter
- ✓ . . . and, the latest break-through . . . ultra-sensitive class 0.5 Hickok Taut-Band Suspension (friction-free) panel meters.

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CIRCLE 47 ON READER-SERVICE CARD



## WELD-PACK REVOLUTIONIZES COMPONENT ASSEMBLY

Cutting size and weight 75% or more, the new "Weld-Pack" construction as produced by Sippican Corporation for MIT's Instrumentation Laboratory stacks components in true three-dimensional packaging of almost any shape or module. Packaging densities ranging to 260,000 components per cubic foot are achieved *only* through Weldmatic welding, which cannot damage adjacent components through unwanted heat. "Weld-Pack" eliminates unnecessary weight of phenolics and lack of continuity in printed wiring — gives designers unlimited freedom. For this fresh, new concept in packaging, Sippican Corporation depends on WELDMATIC electronic welders chosen after careful evaluation of *all* stored-energy equipment. Unvarying uniformity of welds; accurate, repeatable pressure — these are some of the WELDMATIC features so important to constructing "logic sticks" and other component packages to new standards of quality.

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(Above) Sippican assembler uses two Model 1032 Welding Heads and companion Weldmatic Power Supply in performing two separate welding operations on a "Weld-Pack" without changing electrodes or fixtures. (Right) Following wiring diagram on Mylar insulation sheet, operator welds nickel ribbon buss to both tinned copper resistor and dumet semiconductor leads in this computer logic stick.



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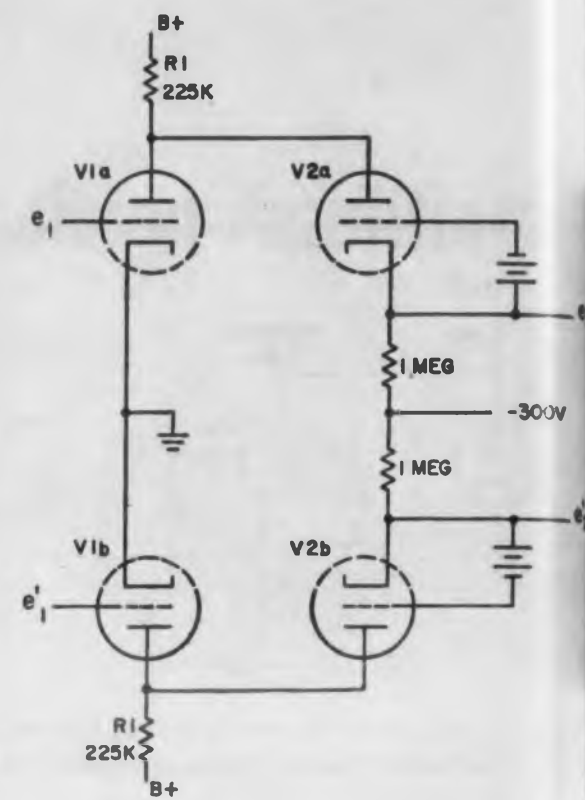


Fig. 2a. Interstage coupling principle applied to difference amplifier.

For dynamic tube resistance:

$$ep/ip = \frac{50}{4 \times 10^{-4}} = 0.0625,$$

or 93.75 per cent efficient for the transfer of the signal voltage.

The series resistor  $R_k$  is large (1 meg), and the voltage across it is applied to the grid of the succeeding stage. With this arrangement, the dc voltage across it is considerably less than the dc level across the tube as the other element of this divider. However, since the resistance of this resistor is much greater than the dynamic ac resistance of the vacuum tube, substantially all of the signal voltage appears across this resistor and is thus applied to the grid of the succeeding stage. This coupling circuit has very useful characteristics since it generates negligible noise and signal distortion, and the phase shift over a wide operating range is virtually unmeasurable.

### Typical Applications

This coupling unit is one key to simplifying dc amplifier circuitry, and it can be used in all types of conventional amplifiers, single-ended or differential.

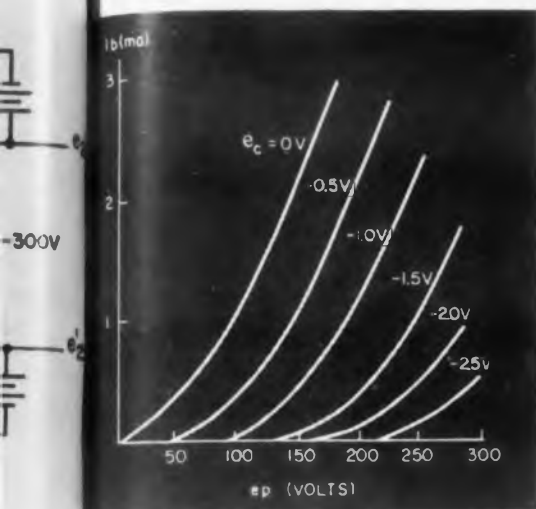


Fig. 2b. Average plate characteristic of 6755 tube used for interstage coupling.

A typical circuit incorporating this interstage coupling circuit is a pneumatic sine wave generator designed for use in testing hydraulic flight control systems. The amplifier in this system has a gain of 30,000, background noise is approximately 55 db down, and the bandwidth is 100 kc. Phase distortion is so low that it cannot be measured.

The circuit is especially suitable for any application that requires extremely high-quality amplification. It is particularly well adapted for medical amplifiers used in encephalography, catheter work, heart studies, and nerve impulse research where fidelity is of utmost importance. It will operate from dc to 0.5 mc for transient pulse measurement in biophysical work, and as an amplifier in all instruments requiring best possible fidelity. ■ ■

1. The interstage coupling circuit described is offered under license by Arthur D. Little, Inc., Cambridge, Mass.

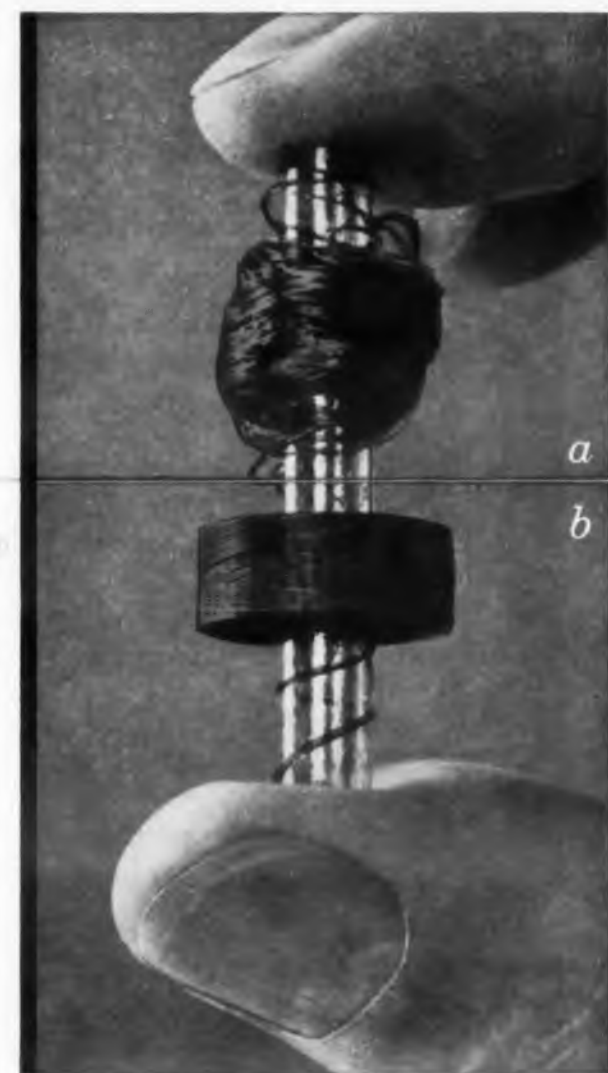
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- Thompson, North, Harris—"Fluctuations in Space-Charge Limited Currents at Moderately High Frequencies," RCA Rev. 4 (1940) 269-285, 441-472, RCA Rev. 5 (1941) 106-124, 244-260, 371-388, 505-524, RCA Rev. 6 (1941) 114-124.

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**EXAMPLE:** Coils wound with (a) conventional film wire; (b) Grip-eze. Note clean pattern of Grip-eze as compared to fall-down of conventional film wire.

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# Protect Transistors Against Destructive Transients

Supply voltage transients are one of the most frequent causes of transistor power amplifier failure. Here is a simple explanation of how transients penetrate circuitry, and an easy low-cost means of avoiding their destructive effects.

**Bernard B. Daien**

Contributing Editor, *ELECTRONIC DESIGN*

Supply voltage transients in transistor amplifiers can be effectively minimized with relatively low-cost components. By analyzing the transient paths and providing the necessary precautions, substantial savings in "down" time, replacement costs, and maintenance can be achieved.

## Built In Transient Susceptibility

The fundamental class B amplifier in Fig. 1 serves to clarify the text, and is also representative of basic servo amplifiers.

Driver transformer *T1* matches the high collector impedance of driver *TR1* to the low input impedance of the class B stage. In consequence, the inductance of one half the secondary winding appears between the base and emitter of each of the output transistors. Invariably the circuit designer thinks of this winding in terms of its dc resistance in his preoccupation with the stabilization problem (which demands a low dc resistance path between base and emitter). The effects of this inductance are therefore overlooked.

The power amplifier load impedance is made

quite small since the power output of a Class B stage

$$P_{out} = \frac{2 (\text{supply voltage})^2}{\text{collector to collector load resistance}}$$

A line transient will therefore encounter very little opposition in its path to the collectors of the output stage through the primary of *T2*. If the transient has a fast rise time, the above mentioned driver transformer *T2* will appear as an extremely high impedance to the sudden increase in collector junction leakage caused by the transient. Referring to Fig. 2, the base-to-emitter return path is seen to be a very low resistance for dc but essentially a high impedance for the fast transient, as compared with the relatively low emitter to base junction impedance. As a result, the increase in collector to base leakage due to the transient flows through the base-emitter junction, is amplified by Beta, and appears as a sudden large increase in collector current. Since the increase in collector current occurs during the existence of the transient, it is apparent that the

design limits for voltage, current, and power are simultaneously exceeded.

Another transient is the pulse which appears across the base-emitter junction of each output transistor through driver transformer *T1*, as *TR1* is similarly affected by the transient. Fortunately *TR1* has appreciable impedance in series with its collector, in the primary of *T1*, which usually protects it. The pulse which results may be of such amplitude and polarity as to exceed the low inverse rating of the base-emitter junction of the output transistor.

## Curing The Transient Problem

In Fig. 3 are simple circuit additions which minimize the effects of destructive transients.

Resistors *R1*, placed across each half of the secondary of *T1*, limit the maximum impedance of the base to emitter path to the value of *R1*. Suggested values for *R1* are 100 ohms, with lower values preferable. Drive power must be increased to allow for the shunting effect of *R1*, but this is a small price to pay for the improved transient

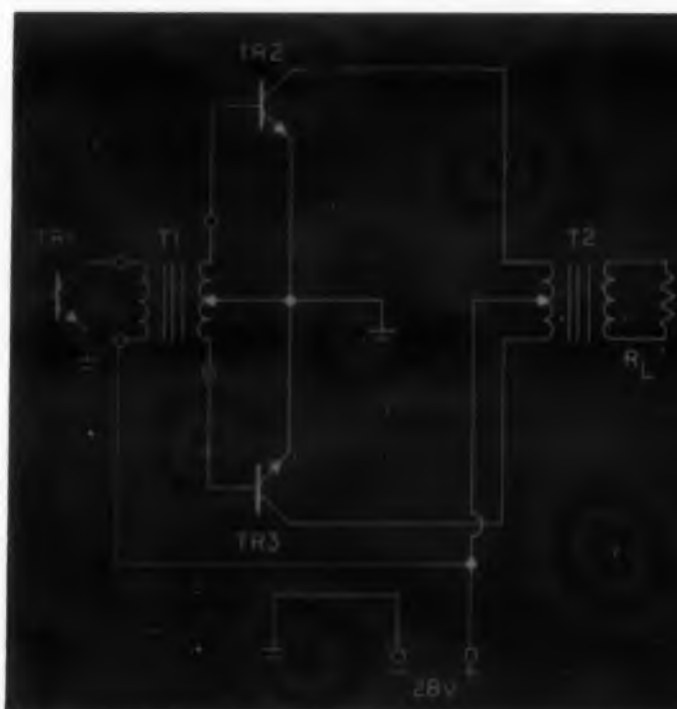


Fig. 1. The fundamental Class B or servo amplifier.



Fig. 2. Collector junction leakage paths.

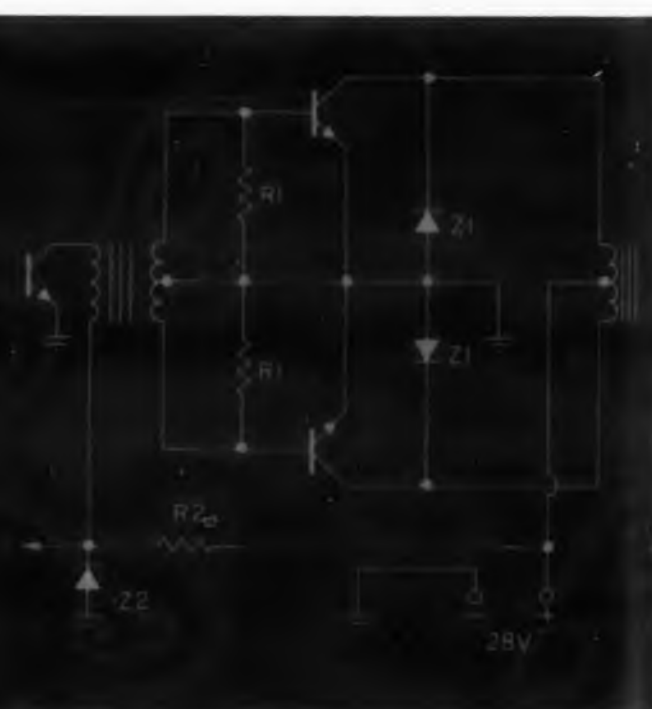


Fig. 3. The protected amplifier incorporates Zener diodes *Z1* for transient limiting and *Z2* as power supply regulator.

immunity afforded, and is certainly lighter, smaller, and less expensive than an LC filter in the power input lead.

Zener diodes,  $Z1$ , are placed across the collector to emitter of each output transistor. These Zeners are rated at 1 w and twice the voltage of the dc supply (to allow for the normal peak signal swing plus supply voltage.) The Zener simply affords protection against overvoltage; it does not protect against that portion of fast rise time transients below the Zener breakdown voltage.  $R1$  is therefore desirable despite the Zeners. Without  $R1$ , repetitive fast transients may result in sufficient heating to set off runaway.

Zener diode  $Z2$ , and its associated resistor  $R2$ , limit transients appearing at the collector of the driver transistor. This limits the pulse through  $T1$  to a reasonable value, protecting the base to emitter junctions of the output transistors.

#### Reducing Immunity Cost

By selecting the voltage rating of  $Z2$  somewhat lower than the minimum supply voltage anticipated,  $Z2$  functions as a regulator and decoupling filter for the driver and preamplifier stages. Unlike a capacitor, the Zener impedance remains small at low frequencies, hence prevents low-frequency feedback through the power supply more effectively than a capacitor. The regulated voltage so obtained may be used as a stabilized source for obtaining bias for the driver and preamplifier. The resulting reduction in operating point shift, due to changing line voltage, permits the use of less degeneration, enabling greater stage gains to be realized. The cost of  $Z2$  may therefore be recovered by eliminating the need for a decoupling section normally used.

The cost of  $Z1$  is recovered by using output transistors with a lower collector voltage rating, since the Zener affords positive overvoltage protection, eliminating the need for a "safety factor."

#### Practical Example

A 28-v servo amplifier, immunized in accordance with these principles, was repetitively pulsed with 300 v transients of 1 msec duration. The transients had extremely fast rise times. Despite this there was no observable deterioration of the amplifier or of the transistors which were tested before and after the pulsing. It is suggested that for extremely severe transient conditions,  $Z1$  be made as large as necessary to handle the peak current; 200 mw units proved unsatisfactory in this test.

The same amplifier without modification repeatedly suffered destruction of one or both of the output transistors after only a few pulses under the same test conditions. ■ ■

The author gratefully acknowledges the assistance offered by the AVION DIVISION, A.C.F. INDUSTRIES in the preparation of the necessary art work.



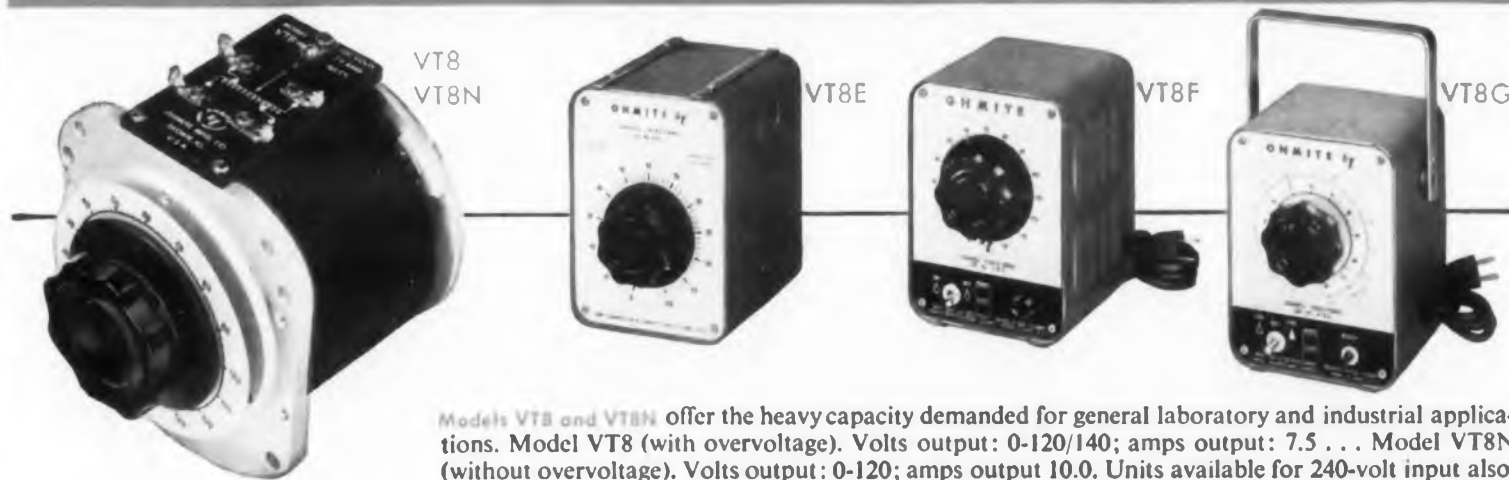
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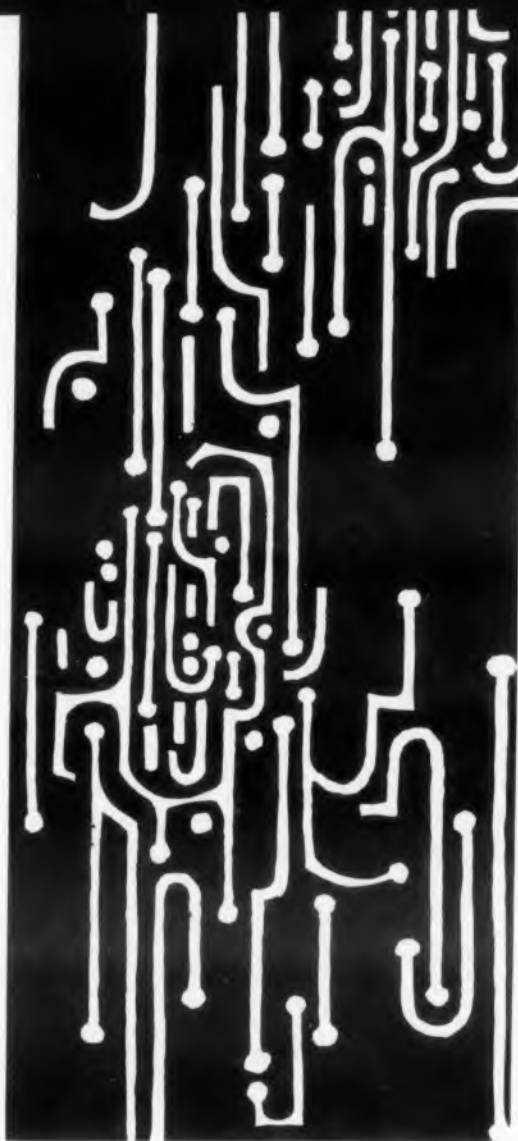
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W. Van Alan Clark, Jr., president of The Sippican Corp., describes himself as a backslid economist. A product of Williams and MIT, he joined the MIT faculty in 1946, becoming, in 1954, Associate Professor and Assistant Dean of MIT's School of Industrial Management.

He views the electronics industry as an ideal industry for the practical education of an economist since "it provides a maximum risk and a minimum profit potential."

In this article, he shows how an economist would solve the problem of module size.

## How Large Should a Module Be?



**W. Van Alan Clark, Jr.**

The Sippican Corp.

Marion, Mass.

**W**HAT'S the best size for an expendable module? The module may be a true chuckaway or a chuckaway which is actually "swapped" at the field level. It may be repairable at the depot level or separable at the depot level into yet smaller chuckaway modules.

Determining module size is complicated by the fact that the decision involves a number of cost elements which are hard to think about with intuition alone.

There are the costs which occur when the system is built. There are those which are required to fill the supply and maintenance pipelines to obtain full operation of the system. There are further costs which are in the future (which means that we must discount them to their present value). There are uncertain costs, whose value we must find by multiplying their probability by their cost when they do occur.

There are variables in repair cost which depend on the amount and kind of training that repair personnel must have at various repair points. And there are ultimate salvage values (negative costs) at the end of the useful life of a system.

Different sized modules can affect the value of a system by affecting its weight and size, its performance, and certainly, its reliability. These costs are very real but are usually hard to estimate, let alone document.

### **Make an Economic Model**

One way to look at this problem is to construct an economic model—an expression of the way the costs of the system may be expected to behave—and to optimize this expression.

Engineers are accustomed to optimizing equations to find the best part of a curve. Where the equation is known, they will differentiate it with respect to variable to be optimized and set the differential equal to zero. Then they will solve

for the best value of the variable.

Similarly, economists, who often don't have formal equations to deal with, explore margins to find the slope of the total cost curve. Often, they work with a cost curve and a value curve. By finding the effect of marginal changes in cost or value (by determining the slope of these curves), they learn something about the slope of the total cost curve and thus determine in which direction the optimal total profit point lies.

### Economics of Module Size

Applying these thoughts to the field of module size, one finds an expression of cost. Expressing it verbally the cost of a system is the sum of the following costs:

- The cost of constructing it.
- The cost of filling the supply and maintenance pipeline.
- The likelihood of system failures times the cost of these failures when they occur. This cost of failure includes down-time cost, repair cost (both labor and material), and in many cases, the cost of sending the system or parts of the system back for depot or factory repair.
- The cost to the performance of the system of added size and weight above the theoretical minimum (zero weight)\* regardless of cost.
- Today's value of the eventual salvage value (negative cost) of the system.

To behave like reasonable economists or economically literate engineers, we should reduce all future costs in a system to their present value. To recognize time as a factor in the equation, we should divide each cost by the compound interest factor  $(1+i)^t$  to obtain its present discounted value.

For simplicity, we can ignore the effect of time and build an equation of system cost which looks something like this:

$$\text{Total Cost} = C_c + C_{s \text{ and } m} + pF(C_{d/F} + C_{fr/F} + C_{dr/F}) + C_{\text{weight}} > 0$$

- Salvage Value

where  $c$  = construction  
 $s$  and  $m$  = supply and maintenance  
 $pF$  = probability of failure  
 $d/F$  = downtime per failure  
 $fr/F$  = field repair per failure.

If we look at this expression and think about it with respect to module size (i.e., take out the partial derivative for module size), we find that we may have no real data. But by estimating the way the module size affects the various terms, we can at least find out which terms are most signifi-

\* This is no joke. The best way to do an efficient job on a operation is to get rid of it. Thus, one can often eliminate a chassis (make it equal zero pounds) and make a self-supporting circuit module.

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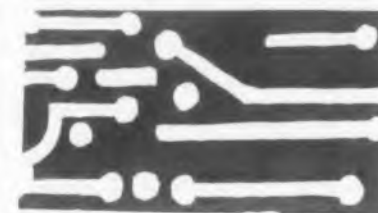
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cant and which terms dominate the equation in sheer orders of magnitude.

For any particular system, we may find these things happening:

Larger modules may make the system cheaper to build, for there may be less cabling and fewer connections. But if the system involves many unreliable components, smaller modules may be better.

The cost of putting the system in service will be greatly affected by module size. Large modules may permit a quantitative difference (in the amount of training needed by field service personnel), as well as an important qualitative difference (men may be more highly trained in system analysis with less emphasis on detailed electronic skills). It is the system which is important at the field level.

The size of modules will affect the nature of the logistic pipeline and the number of identical modules possible in the system. This, also, is a function of module size as the number of identical modules will affect the inventory required.

The probability of failure ( $pF$ ) is a function of many things. Among them is the manner in which failures occur. They may be a function of hours of use, times turned on and off, or exposure to specific environments.

Module size and the manner of joining modules can certainly affect the failure rate. Murphy's Law, which holds that what might come apart probably will, has not yet been abrogated. Thus, a totally "hard" system is likely to have fewer failures than one with many connectors and much cabling.

Failure probability is also affected by the amount of maintenance required in use. It is fairly certain that the reliability of many systems is reduced by their being worked on.†

The cost of a failure, once it occurs, is the sum of at least three costs.

1. The first, the cost of unscheduled downtime (or a fizzle), may be simply a by-event. Or it may be greatly affected by the number of minutes or hours involved in making the repair.

2. The repair cost is negligible when compared with the cost of on-line downtime in large elec-

† An airplane is most likely to have troubles immediately after overhaul. If you own one, make the mechanic go up with you for the first flight.

tronic systems. This tends to encourage large modules which can be exchanged after a quick diagnosis. For such major systems, large modules which are exchanged at the field level and repaired at the depot level, make logistic sense.

3. Consideration of the cost of the module eventually thrown away may reveal (in view of the total system costs) that many systems pay a very high price to save a small amount of material.

Weight and volume reduction have a high value in many systems. But they involve a cost which is hard to pin down with any precision. Increased weight, as it ripples through the design of a system, may involve an astronomical cost compared to the cost of reducing the weight in the first place.

In some cases, very high component density may impair system performance through interference. In other cases, large modules may improve performance through reduced line length.

Large modules almost certainly reduce system weight and size. They permit simpler chassis structures, less intermodular cabling, and fewer mechanical connectors or junction boxes.

#### Some Costs Aren't Important

Some terms are unimportant from the viewpoint of module size. Salvage value, for example, is likely to be far in the future. Discounting this event to its present value makes it an unimportant cost.

Other terms drop out entirely and are not even included in the original cost equation. Module size should not affect component cost or power consumption, for example. This is an obvious effect of differentiation; terms which do not vary in relation to the variable in question drop out.

This exercise of constructing a total system cost model may appear to be a foolish waste of time. To others, it may seem that the attempt to construct a cost model—even one arrived at inductively and with no proof—is nearly as valuable a design tool as is the construction of a physical model.

By looking at a design mock-up in physical form, we raise questions and find answers before being committed to expensive hardware. Similarly, by constructing an economic model, we raise questions and see answers in better perspective than we might by considering the various aspects of the design separately.

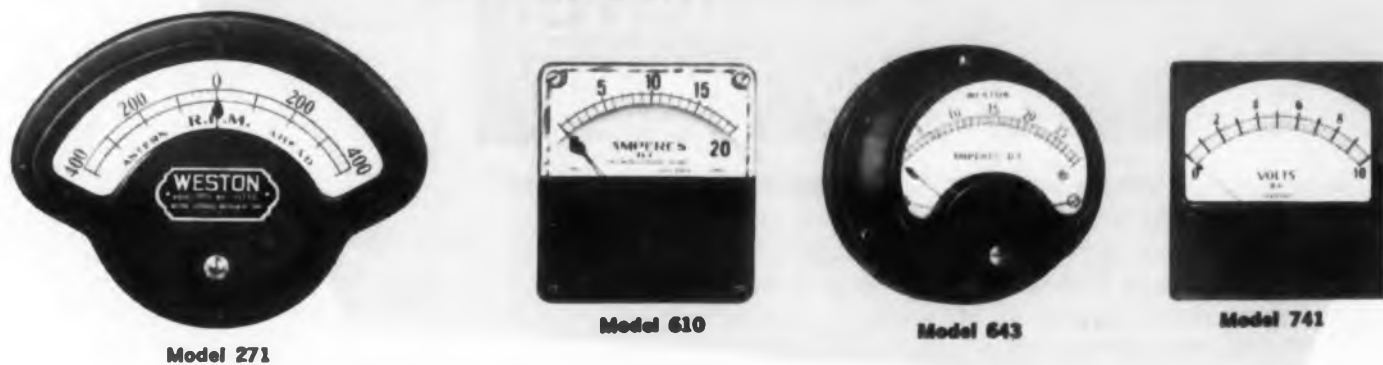
Most important, if we construct a total cost model which describes the costs of an apparatus over its lifetime, we quickly determine which costs are most important. We do not trap ourselves into choosing a design feature—module size—which minimizes one cost at the expense of some other cost of considerably greater magnitude. ■ ■

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D-C ammeters	X	X	X	X	X	X	X	X
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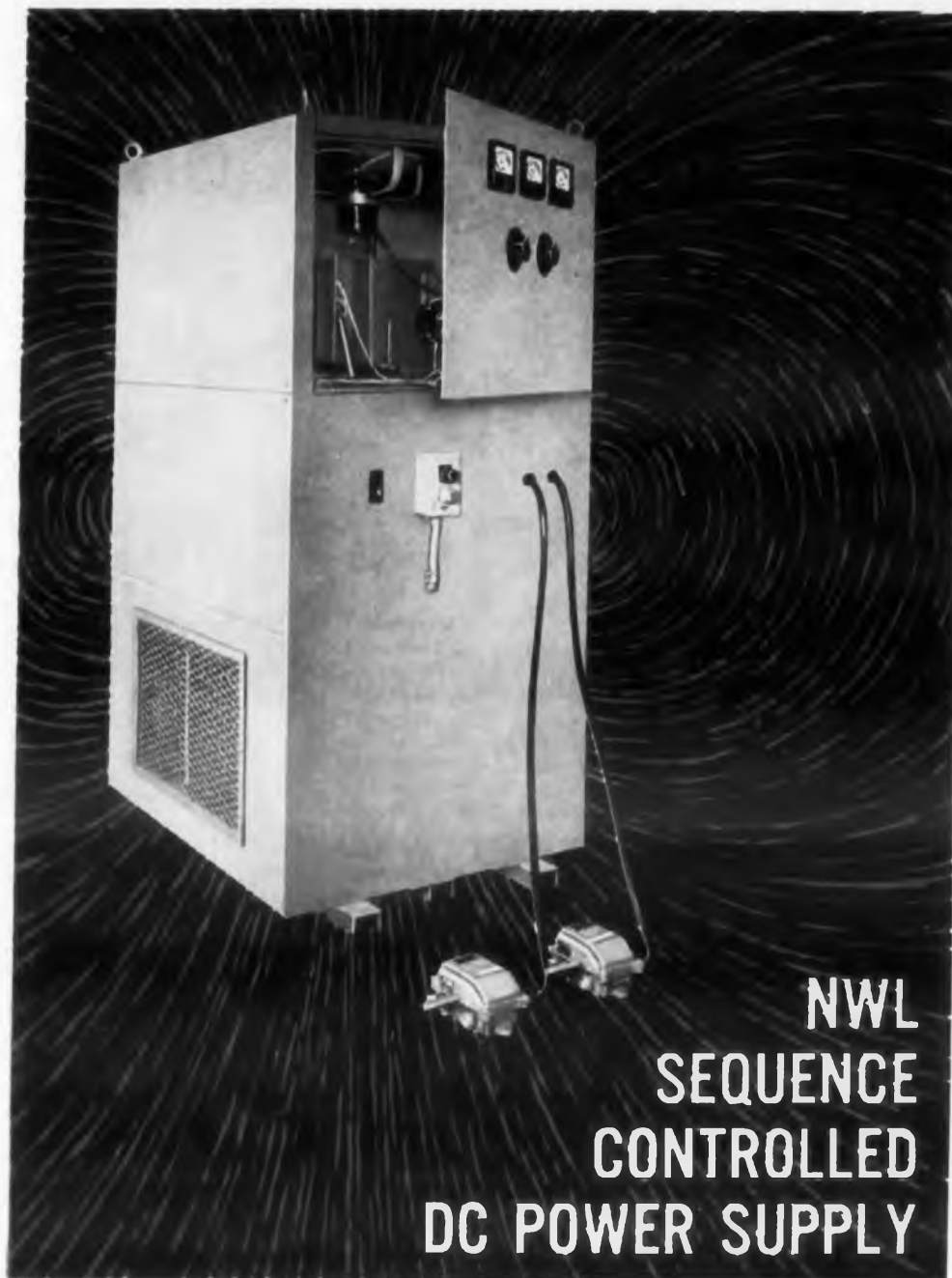


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## Solid State 10 mc Counter Uses Diode Logic

**T**HOUGH there's nothing new about counting at a 10 mc rate, there is something quite unusual about doing it with transistors in a commercial counter-timer.

Transistorizing a counter offers the advantages of cutting size and weight and reducing power consumption. But it presents a problem. For it is no small feat to switch 10 mc pulses and run them around a chassis—even with vacuum tubes.

To dodge the switching problems found in high-frequency vacuum-tube equipment, engineers at Computer-Measurements Co., 12970 Bradley Ave., Sylmar, Calif., used digital logic for switching.

In their Universal Counter-Timer, Model 727A, all switching is accomplished at dc levels only. No pulses or high frequencies are switched through mechanical switches or switch cabling. Instead, all pulses are gated to amplifiers and to the decade counting units by means of digital logic circuitry.

For example, in the time-base gate selector shown in the logic diagram, the AND gates are enabled by a mechanically-switched 12 volt signal which allows the various time base signals to pass to

an OR gate and thence to the amplifier driving the decade counters.

The AND-OR elements use IN34's in conventional diode logic configurations. Their effect on even the high frequency signals is negligible. Hence, no pulse reshapers are necessary.

For contrast, a gate selector in a typical vacuum tube counter would have pulses from time base dividers routed through a rotary switch and its associated cabling. The switch and cable capacitance would limit the frequency which could be switched.

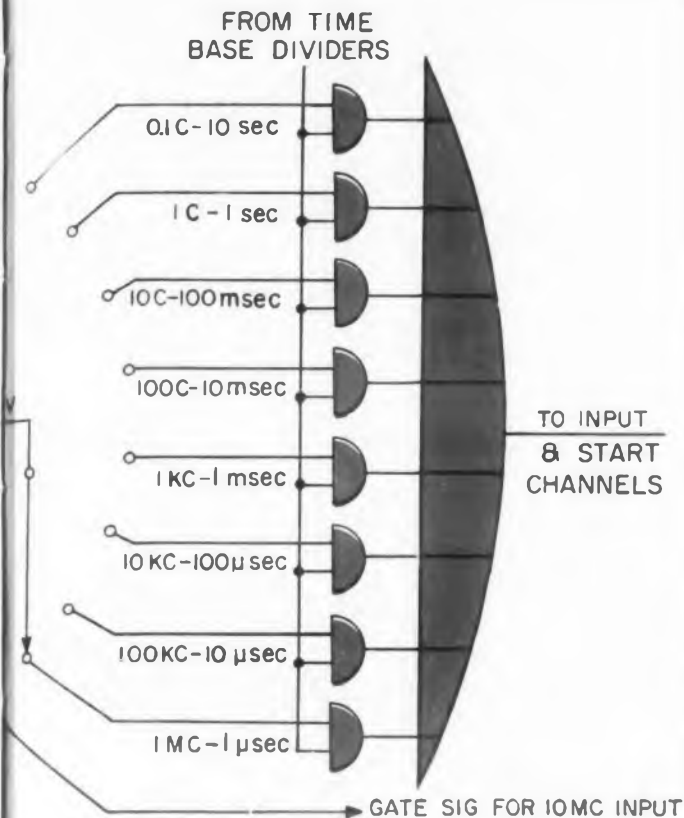
Vacuum tubes which generate control signals must first charge the cable capacitances before they can send a signal through to the output. This requires high power from the driving circuits, and at high frequencies, the tubes must really be driven hard.

The high frequency pulses which are forced through switching networks, long lines, and cables require reshaping to restore them to useful form. CMC's transistorized counter requires no pulse shaping.

Since all switching is at dc levels, the internal circuitry is adaptable to remote

# Electronic Products **NEWS**

by **CARBORUNDUM**  
Registered Trade Mark



Time-base gate selector uses AND-OR logic to switch high frequencies. Only dc goes through mechanical switch and cabling.

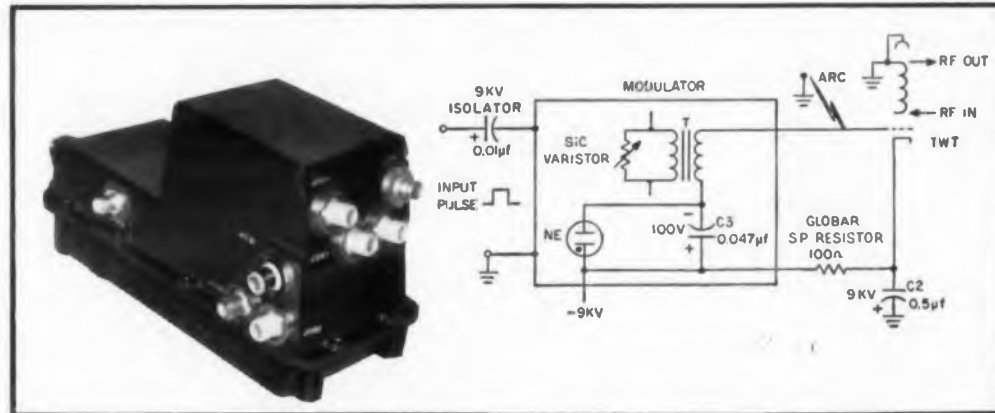
operation without regard to cable length, cable type, impedance matching, and switching transients. Thus, the instrument lends itself nicely to automatic programming, and all functions are brought out at the rear for remote use.

In praising the virtues of the new counter, CMC chief engineer J. B. Olson points to low power consumption, weight, and size, and to high reliability. His comparisons are impressive.

The transistorized counter consumes but 35 w. This compares with 320 w and 600 w for competitive vacuum tube versions. It weighs only 27 lb—quite a bit less than the 70 and 110 lb of vacuum tube counterparts. Its volume is less than a cubic foot as compared with almost two, and over 4 cu. ft. for competitive vacuum tube counters.

CMC has enough confidence in the unit's reliability to offer a two-year service-free warranty. Says Olson, "We don't expect to have to do any servicing on these units for a good five years—especially if we can devise a way to keep users from poking around inside."

For more information turn to the Reader-Service card and circle 103.



## MEGAWATT transient handled by GLOBAR® 5 Watt SP Resistor to protect Miniaturized Pulse Generator

A tough problem was recently solved by Ramo-Woolridge, a division of Thompson Ramo Woolridge, Inc. It concerned protection against a transient discharge that caused breakdowns in a miniaturized pulse generator.

The circuitry, as shown above, involved a modulator for a 1-kw grid-controlled traveling wave tube. The grid would often arc to ground, shorting the energy stored in the condenser C2 through the modulator circuit and vaporizing the decoupling resistor R or the bias filter C3.

The answer was found in a GLOBAR Type SP 100Ω resistor, able

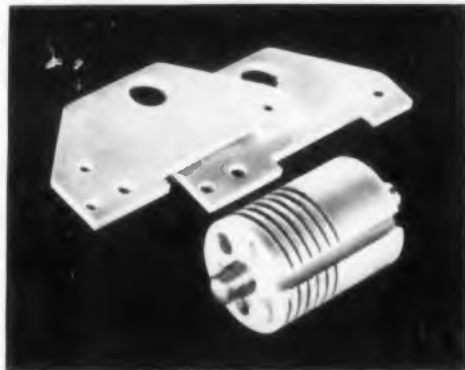
to withstand the periodic 8000-v. discharge for several microseconds and to take a temperature of 1000 F. Since this resistor is non-inductive, it works well as decoupling element during normal operation, in addition to giving the protection needed when arcing occurs. 5 watt size 1¼" long, 5/16" diameter, obviates any space problem.

This example may suggest many similar applications. For more details on GLOBAR resistors, write Globar Plant, Refractories Division, Dept. EDR119, Carborundum Company, Niagara Falls, N. Y.

CIRCLE 712 ON READER-SERVICE CARD

## CERAMIC DRUM AND END PLATES for radio tuner GROUND TO .001 ACCURACY

The drum coil and end plates shown in the photo are parts of a tuner for the Transport Radio Command and Ground Radio Command. The plate holes are ground to size with an



accuracy of  $\pm .001$  and the hole spacing is held to a tolerance of  $\pm .002$ . The drum with its stainless steel bearing sleeves is a direct ceramic-to-metal assembly. The bearings must withstand a vertical load of 60 lbs. Three of the end holes are tapped. The slot, the pitch and the depth of the spiral winding groove are ground to tolerances of  $\pm .001$ .

This is an example of the accurate specifications that can be met with equipment at Carborundum's Latrobe Plant, which specializes in ceramic, ceramic-to-metal and glass-to-metal assemblies. Facilities are available for small or large production runs. For more information, write Latrobe Plant, Refractories Division, Dept. EDC119, Carborundum Company, Latrobe, Pa.

CIRCLE 714 ON READER-SERVICE CARD

## Vacuum-tight, matched expansion GLASS-TO-METAL WINDOWS



Part No.	F	D	H
95.6006	11/16	.490	.175
95.6009	3/8	.281	.187
95.6010	7/8	.490	.078
95.6011	3/8	.250	1/8
95.6013	.220	.150	.150

Windows of the type shown above have a variety of applications where truly reliable vacuum-tightness or gas-tightness over a considerable temperature range is desired.

The advantage of these windows is that the frame and glass are united to form a chemically bonded, hermetically sealed unit. Use of KOVAR® alloy and borosilicate hard glass, which have practically identical expansion characteristics, eliminates stress and strain.

Large quantities of these windows are manufactured by Carborundum's Latrobe Plant, Bulletin 5133, giving complete information, is obtainable by writing to Latrobe Plant, Refractories Division, Dept. EDS119, Carborundum Company, Latrobe, Pa.

CIRCLE 713 ON READER-SERVICE CARD

## NEW BOOKLET AVAILABLE ON KOVAR® ALLOY



KOVAR is an iron-nickel-cobalt alloy used for making hermetic ceramic- or glass-to-metal seals. It has applications in

many types of electronic equipment. This booklet is a complete catalog of specifications and applications. For your copy write Latrobe Plant, Refractories Division, Dept. EDK 129, Carborundum Co., Latrobe, Pa.

CIRCLE 715 ON READER-SERVICE CARD



CIRCLE 712 THROUGH 715 ON READER-SERVICE CARD

# Kinney®

## New Vacuum Gage Measures Pressures in Two Ranges...

- ✓ 3 mm to 1  $\mu$  Hg
- ✓ 1  $\mu$  to 0.1 m  $\mu$  Hg

### GICT—Cabinet Model



The KINNEY GICT Ionization-Thermocouple Gage covers the range from 3000 microns to below  $10^{-7}$  mm Hg... a two meter instrument providing simultaneous Ionization Gage and Thermocouple Gage readings. Available in portable cabinet and panel mounted models. The standard unit is supplied with one position Compensated Thermocouple Gage and it can be supplied in modified form with 2, 3, 4, 5 or 6 position Gage at extra cost.

Designed with the more critical applications in mind, the KINNEY GICT brings an important advance in high vacuum instrumentation for use wherever an accurate and highly dependable instrument is required.

Get the full story on such features as: Compensated Thermocouple Gage Tubes, Automatic cut-off relay to protect Ion Tubes from burn-out, Outgas circuit for elimination of false pressure readings, and many others.

**KINNEY** MFG. DIVISION  
**THE NEW YORK AIR BRAKE COMPANY**  
 3561 WASHINGTON STREET • BOSTON 30 • MASS.

**WRITE...**

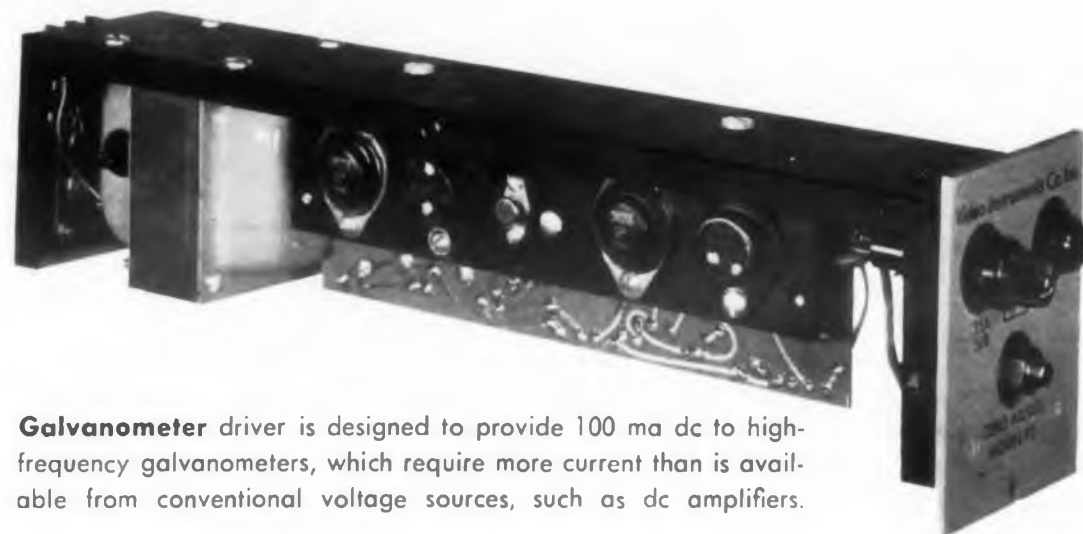
Ask for KINNEY  
 Bulletin No. 3811.1  
 just off the press.

Please send me Bulletin 3811.1 with full information on the GICT Ionization-Thermocouple Gage by return mail.

Name \_\_\_\_\_  
 Company \_\_\_\_\_  
 Address \_\_\_\_\_  
 City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 56 ON READER-SERVICE CARD

## High-Current Amplifier Drives Hi-Fi Galvanometers



Galvanometer driver is designed to provide 100 ma dc to high-frequency galvanometers, which require more current than is available from conventional voltage sources, such as dc amplifiers.

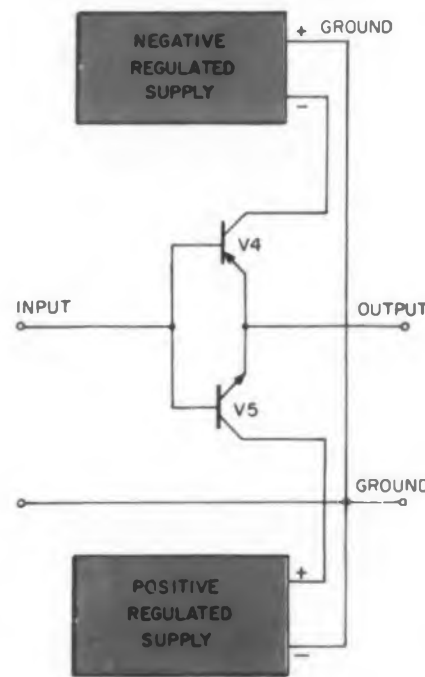


Fig. 1. Basic dc amplifier circuit has low input impedance, only 1 per cent accuracy.

**D**ELIVERING 100 ma at an output impedance of less than one ohm, a new dc amplifier fills a gap in the supply of voltage units for high-frequency galvanometers.

The recent availability of galvanometers with high-frequency response and their concomitant higher-current demand has created a need for an improved voltage supply. The new unit, priced at \$150, provides current that typical high-gain, dc amplifiers, telemetering receivers, demodulators, oscillators or detectors cannot.

Manufactured by Video Instruments, 3002 Pennsylvania Ave., Santa Monica, Calif., the Model 92 accepts maximum input signals  $\pm 15$  v, has an input impedance of 100 K. Voltages up to 300 vdc between input and case ground are rejected by 120 db. Voltages of 60 cps up to 20 v rms are rejected by 80 db.

An interesting circuit design is used in the Model 92. It improves on the conventional basic circuit.

In the basic circuit in Fig. 1, transistors  $V_4$  and  $V_5$  are complementary pnp-npn power transistors used as emitter-followers. These are used to couple the free

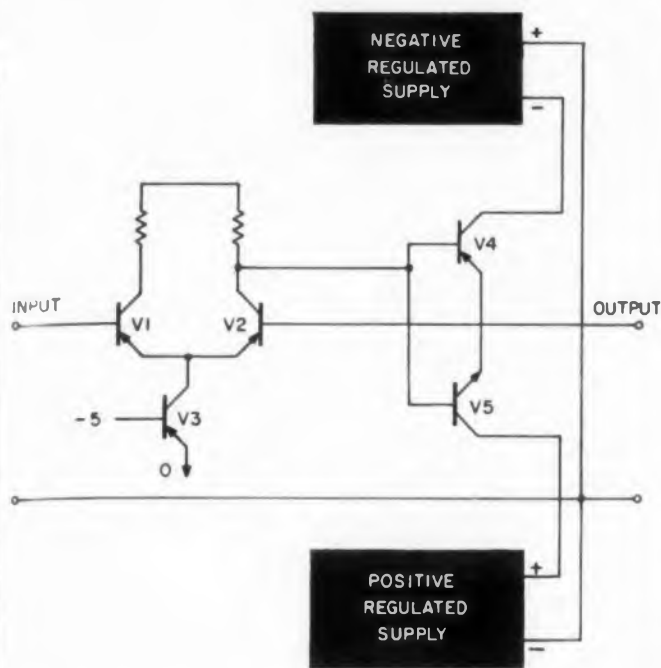


Fig. 2. Improved circuit has added transistor network to get 100 K input impedance and 0.2 per cent accuracy.

end of the regulated supplies to the output. Depending on the polarity of the input signal, either  $V_4$  or  $V_5$  conducts. Its emitter, connected to the output, will follow the input-signal voltage.

Simple. But there are two disadvantages. A low input impedance results, because the power to drive the transistor is supplied by the input. And because of the base emitter voltage drop, the output voltage will follow the input with an accuracy of only about 1 per cent.

#### Improved Design

To improve the accuracy to 0.2 per cent and to get a high (100 K) input impedance, the input signal is applied to one side of a differential amplifier (see Fig. 2). The other differential input is tied to the output of the transistors. These are driven by the output of the differential amplifier. In this way any difference between the input and output signals is sensed by the differential amplifier and used to correct the output.

$V_1$  and  $V_2$  have a voltage gain of 200; this provides 46 db over-all feedback, and the output voltage is now an accurate reproduction of the input to within 0.2 per cent.

The Model 92 has a built-in regulated power supply, uses 8 w of 115 v, 50 to 400 cps power. To protect the galvanometer, amplifier output is limited to  $\pm 11$  v.

For further information on this solid-state galvanometer driver amplifier, turn to the Reader's-Service Card and circle 102.



#### Formica team:

(l to r) Eldon Fender, R&D; John Fitzer, Manager of Process Engineering; and Fenton Hamilton, Manager of Industrial Products—demonstrates flame retardant properties of new paper-epoxy grade.

## Formica perfects new Flame Retardant grade

### New EP-37 Properties . . .

- Flame retardant
- Self-extinguishing
- Dimensional stability under both solder dipping and humidity conditions
- Million megohms IR
- Cold punch 1/16"
- 10# avg. bond strength
- 500°F. solder heat resistance for 25 secs.

The team shown above demonstrates the flame retardant, self-extinguishing properties of the newest Formica<sup>®</sup> copper clad, EP-37. Because of these unusually effective properties, the new paper-epoxy is well suited for use in computers, radio, tv, telephone and aviation electrical devices. Increased dimensional stability—30% greater than existing grades under moisture conditions—offers many other application advantages.

This basic new material offers the additional properties shown at left—so essential for dependable printed circuit performance. For complete information, send for free test sample and data information. Formica Corporation, a subsidiary of American Cyanamid, 4512 Spring Grove Ave., Cincinnati 32, Ohio.



a product of 

FI-2158

CIRCLE 57 ON READER-SERVICE CARD



# WAVEGUIDE COMPONENTS for microwave applications



**F**OR efficient use of your antenna, let Kennedy engineers design your feed system. Kennedy's line of waveguide components includes dual and linear polarization horns, transitions, duplexers, straight sections and bends. All of the components are designed for high-power use.

## ANTENNA EQUIPMENT

### • D. S. KENNEDY & CO.

COHASSET, MASSACHUSETTS    EVERgreen 3-1200

*West Coast Affiliate . . .*

**SATELLITE KENNEDY, INC. of CALIFORNIA**  
P. O. Box 1711, Monterey, California — FRontier 3-2461

*Down-to-earth SOLUTIONS to out-of-this-world PROBLEMS*

Tracking Antennas-Radio Telescopes-Radar Antennas  
"Trans-Horizon" Antennas-Tropospheric Scatter  
Ionospheric Scatter



CIRCLE 58 ON READER-SERVICE CARD

Replace both mechanical commutators and signal conditioners with

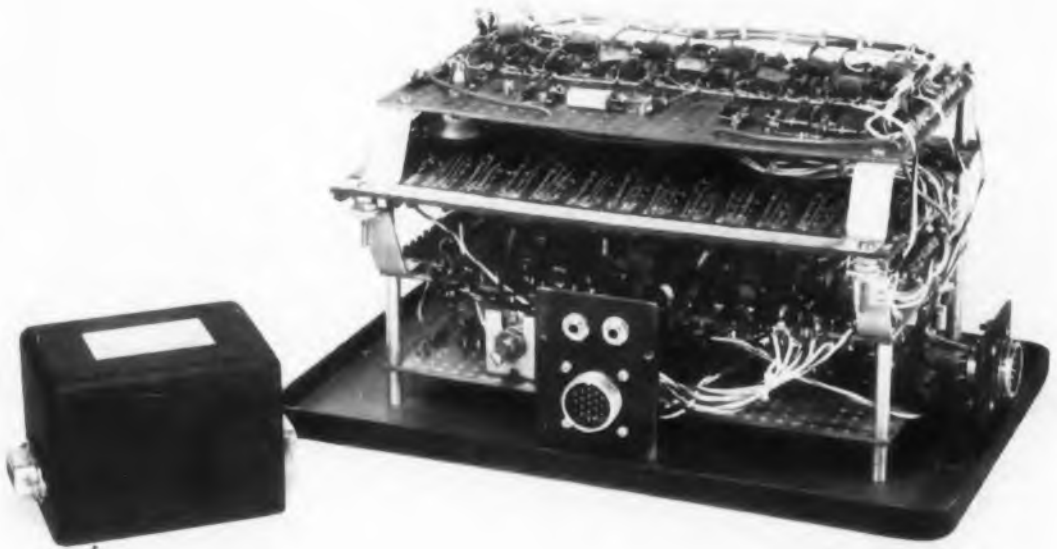
## Low Level Solid State Multiplexer

**L**OW LEVEL (5 mv full scale) transducer signals as well as high level (to 5 v) signals can be multiplexed for PAM, PDM or PCM telemetering with a new solid state commutator and signal conditioner package. No external signal conditioners or amplifiers are needed for use with standard thermocouples, strain gages, resistance bridges, pressure, acceleration or displacement transducers.

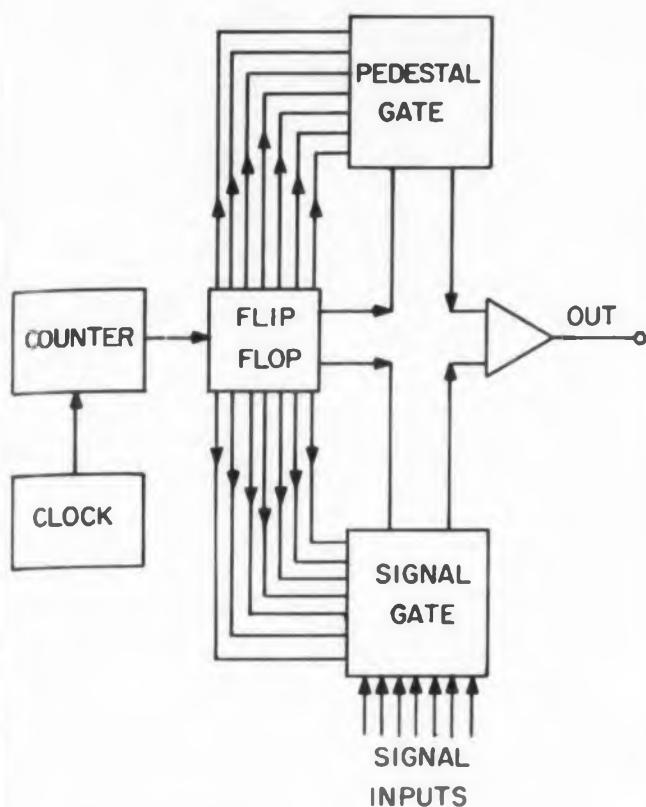
Now in production at Servomechanisms, Inc., 12500 Aviation Blvd., Hawthorne, Calif., the signal conditioner-and-

multiplexer provides strain gages and resistance bridges with excitation voltage from its own supply. Need for special power supplies is eliminated.

Telemetering engineers are not bound to the use of any particular type of transducer: the commutator provides for individual scaling of the 30 input channels. Any full scale signal from 5 mv to 5 v can be handled and converted to 0 to 5 v dc pulse amplitude modulation, pulse duration modulation or pulse code modulation signals.



Low level solid state commutator and signal conditioner give one per cent accuracy on 30 channels. At left is the production unit; next to it is the original breadboard.



**Block diagram** of the unit shown in the above photo. Counting clock and counter as one module, unit consists of five separate components.

Since both thermocouples and strain gages, for example, put out a 10-30 mv full scale signal and have 10-20  $\mu$ v threshold level resolutions, one of the problems has been for the mechanical commutator and signal conditioner to provide comparable accuracy and resolution. The new unit has a sense resolution of 10 to 20  $\mu$ v.

Consisting of five main modules as shown in the block diagram, the solid state multiplexer has an overall gain of 1000. Output impedance is 500 ohms, input on low level (0-5 mv input) 2 K, high level up to 500 K. Speed of commutation can be 25 kc. With some 30 channels in operation output noise on any given channel is held to 20 mv—according to Servomechanisms engineers this includes crosstalk. Usable information band is 90 per cent of the total on time.

Rated environment for the solid state device is zero to 71 C, 50 g acceleration and 38 to 2000 cps  $\pm$ 20 g vibration. Under all conditions of this environment and with all 30 channels in operation accuracy is said to be  $\pm$ 1 per cent of full scale. The new unit weighs 2 lb, measures 3-1/2 by 2-3/4 by 2-1/2 in.

For further information on this solid state commutator circle Reader-Service number 104.

*Need Better Electrical and Thermal Conductivity in a Glass-to-Steel Hermetic Terminal?*

For most applications, solid 446 stainless alloy electrodes are best suited to our users needs. They are ideally suited to the perfect mating between our V24M glass and the pin. This fusion of glass and metal together with compression accounts for the rugged leak-proof character of Fusite Terminals under rough production handling and makes for easy solderability.



## CONSIDER THE PLUS OF COPPER CORED ELECTRODES

When your application indicates the need for greatly improved electrical or thermal conductivity, you still need not sacrifice these inherent Fusite advantages. At slight additional cost, any of our terminals can be ordered with electrodes that have a copper core of as much as 25% of the total electrode area. Copper cored wire has up to 10 times increased current carrying capacity, yet, you maintain nearly all the advantages of solid 446 stainless.

*Would you like to make tests?*

Write Department C-7

**THE FUSITE CORPORATION**

**6000 FERNVIEW AVE., CINCINNATI 13, OHIO**

Woodford Mfg. Co., Versailles, Kentucky.

In Europe: FUSITE N. V. Königsweg 16, Almelo, Holland



CIRCLE 59 ON READER-SERVICE CARD

# NEW PRODUCTS

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



## **Tape Recorder's Dimensions Are 5 x 4 x 2 in. Complete**

This two-channel recorder measures 5 x 4 x 2 in. complete, including all electronics. Its total weight is 2 lb. All applicable parts of MIL-E-4158A for ground uses are met, but it can also be furnished for special flight and other applications. Power requirements are 2.5 w dc. The unit includes electronics for record and reproduce and a timing reference source. It operates at any tape speed to 48 ips, bi-directional, with end-of-tape sensing. Frequency response is up to 160 kc,  $\pm 3$  db at 48 ips.

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

CIRCLE 60 ON READER-SERVICE CARD



## **Miniature Rotary Switch Weighs Less Than 3 Oz.**

Weighing less than 3 oz and measuring 1.5 in. long and 1.375 in. in diam, the Ledex BD2E rotary switch can be used for stepping, counting, programming, circuit selecting and homing. It can be either self-stepped or externally impulsed. The switch is actuated by a rotary solenoid and remotely controlled. Up to four 12-position circuit wafers, with 2, 3, 4, 6, or 12-electrical position selective control, are available. Wire sizes to accommodate 3 to 300 v dc, 1000 v rms Hi-pot, are obtainable.

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

CIRCLE 61 ON READER-SERVICE CARD



## **Leads Emerge From One End Of Tantalum Capacitors**

The type TES tantalum electrolytic capacitors have both leads emerging from one end. Since a seal is required on only one end, there is a savings in overall length. The units are similar in performance to the axial-type TEF capacitors which meet all the requirements of MIL-C-3965 B. Containing a non-corrosive, wet electrolyte, the capacitors operate in a temperature range of  $-55$  to  $+85$  C. The larger of two case sizes measure 1 in. in length and 0.375 in. in diam. For several hundred hours, the units will stand 105 C at 80% of rated voltage and 125 C at 67% of rated voltage.

Transistor Electronics, Inc., Dept. ED, West Road, Bennington, Vt.

CIRCLE 62 ON READER-SERVICE CARD



ACTUAL SIZE

### Electro-Magnetic Brake Measures 0.405 in. Overall

With an overall length of 0.405 in. and an output torque of 16 oz.-in. min at 24 v dc, this electro-magnetic brake can be used in airborne and other miniaturized control applications. Made to meet or exceed applicable Mil specs, the unit has no slip rings, brushes, rotating coils, or other moving electrical parts. It comes in a size 8 frame and weighs 0.7 oz. Maximum drag torque is 0.05 oz.-in., and its life is a minimum of one million cycles at 60 cps. The unit consumes 2 w at 24 v dc and operates in a temperature range of 55 to 125 C.

Dynamic Instrument Corp., Dept. ED, 59 New York Ave., Westbury, L. I., N. Y.

CIRCLE 63 ON READER-SERVICE CARD



### Wirewound Resistor Rated At 1 Meg Measures 3/16 x 3/8 in.

The type 1274 wirewound resistor, measuring 3/16 in. in diam and 3/8 in. in length, is made with a maximum resistance of 1 meg. The maximum wattage rating is 0.25 w. Resistance tolerances as close as 0.01% can be had as well as temperature coefficients as low as  $\pm 3$  ppm per C. The unit meets all characteristics of MIL-R-9 B, Amendment 3, except physical size.

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

CIRCLE 64 ON READER-SERVICE CARD



## TRIPLE THE CAPACITY AT NO INCREASE IN SIZE

NEW FROM

# JFD



actual size

MINIATURE  
TRIMMER  
SEALCAP<sup>®</sup>

From JFD, pioneer in precision electronic components, comes the most important new miniature trimmer development in years!

Now you can have *triple* the range previously attainable in a miniature trimmer capacitor—at no sacrifice in volume—with new MAX-C Sealcaps.

Imagine the possibilities in your circuitry!

This new series incorporates revolutionary new advances in trimmer production which combines the advantages of a thin dielectric gap with the structural strength and ruggedness of a heavy wall glass tube. The result is a broad capacitance tuning range

at a 300 per cent saving in volume over other presently available piston trimmer caps.

Also, MAX-C Sealcaps feature a new sealed interior construction that locks out all atmospheric effects, locks in stable performance under critical extremes of altitude, vibration, shock, temperature and other rigorous environmental conditions.

These new trimmers along with the complete JFD line of miniature and subminiature trimmers, and LC tuners offer you new dimensions in design. For complete data, write today for bulletin #221.

#### MINIATURE PANEL MOUNT MAX-C SEALCAP SERIES

Model	Min. Max. (Pf)	DISTANCE BEYOND PANEL	MAXIMUM DIAMETER
MC601	1.0 14.0	2 3/4"	5/16"
MC603	1.0 28.0	1 1/4"	5/16"
MC604	1.0 42.0	3 3/2"	5/16"
MC606	1.0 60.0	1 1/2"	5/16"
MC609	1.0 90.0	1 3/4"	5/16"

Also available in printed circuit lug and lead, and 4 wire lead type.

# JFD

Pioneers in electronics since 1929

## ELECTRONICS CORPORATION

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JFD International, 15 Moore Street, New York, New York

JFD Canada Ltd., 51 McCormack Street, Toronto, Ont., Canada

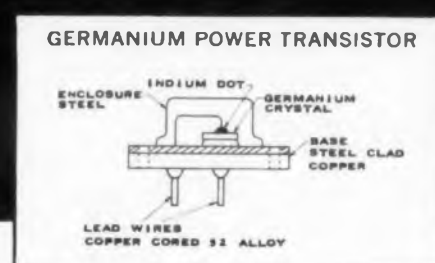
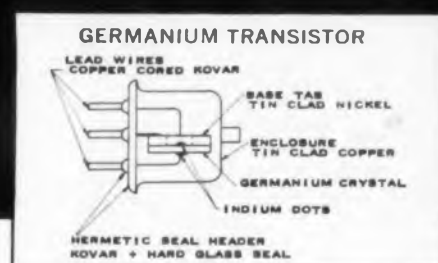
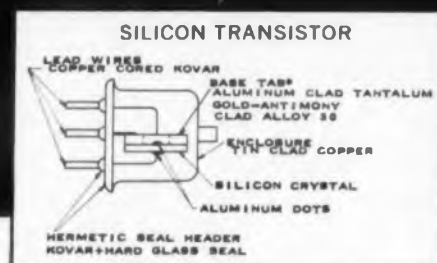
•TRADEMARK

CIRCLE 65 ON READER-SERVICE CARD

# General Plate Clad Metals

## IMPROVE PERFORMANCE - CUT COSTS

### In Semiconductor Applications



#### I BASE TAB MATERIAL

##### A For Germanium (Single Clad Only)

1. Tin Clad Nickel
2. Tin Clad Alloy 30 (42% Nickel-58% Iron)
3. 63.2% Lead-35% Tin-1.8% Antimony Clad Nickel
4. 63.2% Lead-35% Tin-1.8% Antimony Clad Alloy 30
5. 63.2% Lead-35% Tin-1.8% Indium Clad Nickel
6. 63.2% Lead-35% Tin-1.8% Indium Clad Alloy 30
7. 99% Tin-1% Gallium Clad Nickel
8. 98% Tin-2% Antimony Clad Nickel
9. 95% Tin-5% Antimony Clad Nickel
10. Tin Clad Steel
11. Tin Stripe on Nickel
12. Tin Clad Titanium

##### B For Silicon (Single or Double Clad & Stripes)

##### \*\*Solder

1. Gold
2. 99.5% Gold-.5% Antimony
3. 99% Gold-1% Gallium
4. 95% Gold-5% Indium
5. 99.9% Gold-.1% Boron
6. 99% Gold-1% Aluminum
7. 99% Gold-1% Arsenic
8. Fine Silver
9. 99.5% Silver-.5% Antimony
10. 95% Silver-5% Indium
11. Aluminum
12. High Purity Aluminum

##### BASE METAL

1. Nickel
2. Alloy 20 (40% Nickel-60% Iron)
3. Alloy 30 (42% Nickel-58% Iron)
4. Kovar
5. Titanium
6. Tantalum
7. Molybdenum
8. Silver
9. Platinum

\*\*NOTE: These solders may be single or double clad on any of the base metals listed above. Solders in group B may be purchased unclad.

#### II LEAD WIRE MATERIAL

1. Copper Cored Rodar (Soft Glass Seals)
2. Copper Cored 52 Alloy (Compression Seals)
3. Copper Cored 446 Stainless Steel
4. Nickel Clad Copper Wire
5. Copper Clad Nickel Wire

#### III WHISKER WIRE MATERIAL

1. 95% Platinum-5% Ruthenium
2. 99% Gold-1% Gallium
3. 99.5% Gold-.5% Antimony
4. 90% Platinum-10% Iridium

#### IV BASE MATERIAL

1. Aluminum Killed Low Carbon Steel Clad Copper
2. Stainless Steel Clad Copper
3. Nickel Clad Steel (Nifer)  $\times$
4. Nickel Clad Copper
5. Nickel Clad Tantalum
6. Silver Clad Tantalum
7. Aluminum & Nickel Double Clad Tantalum

#### V ENCLOSURE MATERIAL

1. Tin Clad Copper
2. Glass Clad Nickel Silver
3. Tantalum Clad Nickel Silver

If you are seeking metals with useful characteristics that can't be found in a single metal or alloy, investigate clad metals. General Plate Clad Metals do what other metals can't. Made by metallurgically bonding single metals or alloys to other metals in the solid state by exclusive processes\*, the composite metals give you the *combined* advantages of the selected metals and can *yield new advantages* such as lower cost, better fabricating qualities, improved parts performance, etc.

The General Plate Clad Metals for semiconductor applications described here comprise only a partial listing. To find out more about these or other combinations to meet your specific requirements, write directly to Industrial Metals Product Manager, or request our special catalog on clad and solid metals for electronics applications.

\*Patented processes of Metals & Controls Corporation.

## METALS & CONTROLS

711 FOREST STREET, ATTLEBORO, MASS. U. S. A.

A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

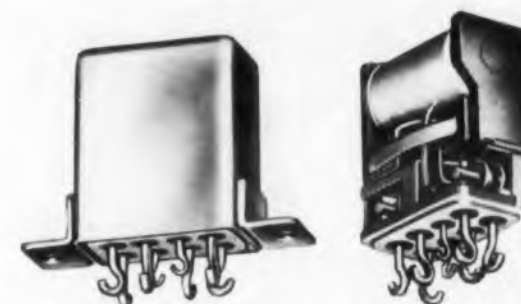
GENERAL PLATE PRODUCTS: Clad Metals • Electrical Contacts • Truflex® Thermostat Metal • Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

CIRCLE 66 ON READER-SERVICE CARD

## NEW PRODUCTS

### Can Type Relays

Rated for 10 amp dc operation



Type FC-215 miniature hermetically sealed can-type relays are rated for 10 amp dc operation. They withstand 30 g vibration and 50 g shock. Designed for operation at ambient temperatures to +125 C, they meet or surpass MIL-R-575C and MIL-R-25018 requirements. The standard operating coils are rated at 26.5 v dc nominal with a coil resistance of 400 ohms. Other dc coil resistances are available. The relay weighs 3 oz and the enclosure size excluding mounting and terminal provisions is 5/8 x 1-1/32 x 1-1/4 in. Hook type, long, and short wire lead terminals can be furnished. The headers have 0.2 in. grid spacing.

Struthers-Dunn, Dept. ED, Pitman, N.J.

CIRCLE 67 ON READER-SERVICE CARD

### Gyro Wheel Supply

Amplifier type



Type WS-213 gyro wheel supply is designed to drive three-phase gyros from a single-phase line. The unit contains a transistorized amplifier. One, two, or three gyros can be excited from the same wheel supply unit. The input is 115 v, 400 cps, single phase and the output is 10 v, 400 cps, three-phase. The initial balance at a specified load is 3% and the regulation is about 5%. The temperature range is -55 to +71 C. The supply is furnished in a hermetically sealed enclosure and meets applicable Mil specs for shock and vibration.

Harrel Inc., Dept. ED, 1788 First Ave., New York 28, N.Y.

CIRCLE 68 ON READER-SERVICE CARD

## Synchros

Transmitters, differentials, control transformers



These 60-cps synchro transmitters, differentials, and control transformers are designed for use in industrial servo systems. For operation in corrosive atmospheres, they have stainless steel housing, shaft, and ball bearing construction, plus laminations of corrosion resistant nickel steel. They may be used in servo systems for remote and automatic control of weighing operations and valve positions, and to regulate instrument dials and position potentiometers.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

CIRCLE 69 ON READER-SERVICE CARD



## High-Mu Triodes

Ceramic-metal construction

Made for uhf service in portable field equipment, missile-guidance systems, and satellite-communication applications, types 7552 and 7554 high-mu triodes are of ceramic-metal construction. They can operate at plate-seal temperatures to 225 C and withstand conditions of nuclear radiation. They have good thermal stability and need 12 min warm-up time to reach 90% of dc operating plate current. The 7552 is made for class A rf amplifier use up to 1000 mc and the 7554 is for class C operation as an oscillator, rf-amplifier, and frequency-multiplier up to 3000 mc. Both types can be operated at altitudes to 100,000 ft without pressurization and have a maximum plate-dissipation rating of 2.5 w.

Radio Corp. of America., Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 70 ON READER-SERVICE CARD

Packaging  
circuitry  
is like child's play  
with Alden  
Basic Building Blocks



CIRCLE 71 ON READER-SERVICE CARD

THE PLUG-IN COMPONENT IDEA —  
part of a continuing series

**A**lden plug-ins are beautifully, basically uncomplicated.

The design engineer starts with planning and layout. Alden offers him basic building blocks to solve that particular problem.

He wants to assemble his circuitry. Alden gives him everything he needs to tie that package up neatly — through a terminal card mounting system that unitizes circuitry in compact planes.

He is now ready to package his card-mounted sub-assemblies.

For this, Alden provides a variety of basic plug-in chassis, in which his circuitry is neatly deployed, function by function, in space-saving vertical planes. (That's it in the picture). These chassis plug in, lock, and eject with a half-turn of the wrist.

Where does he house his plug-ins?

He can go to his own standard racks. Or, Alden has basic "housing" units, called Uni-Racks, that help him there. (See the next Alden ad — look for our engineer friend).

All along the way, Alden makes servicing and trouble shooting simple. Tell tales to spot trouble automatically. Easily traceable interconnections, with all leads brought to a single check point, numbered and color coded for quick testing.

What does it add up to? Reliability in service.

We'll have more to say on this subject next time we appear on these pages.

Write now for Alden's 250-page handbook.

# ALDEN

PRODUCTS COMPANY  
11139 N. Main St., Brockton, Mass.



The Alden Basic Plug-in Chassis — with circuitry arranged in space-saving vertical planes for easy servicing, a typical chassis plugs in, locks, ejects with a half turn of the wrist.

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*Announcing...* **THE ASSOCIATION OF TWO IMPORTANT**

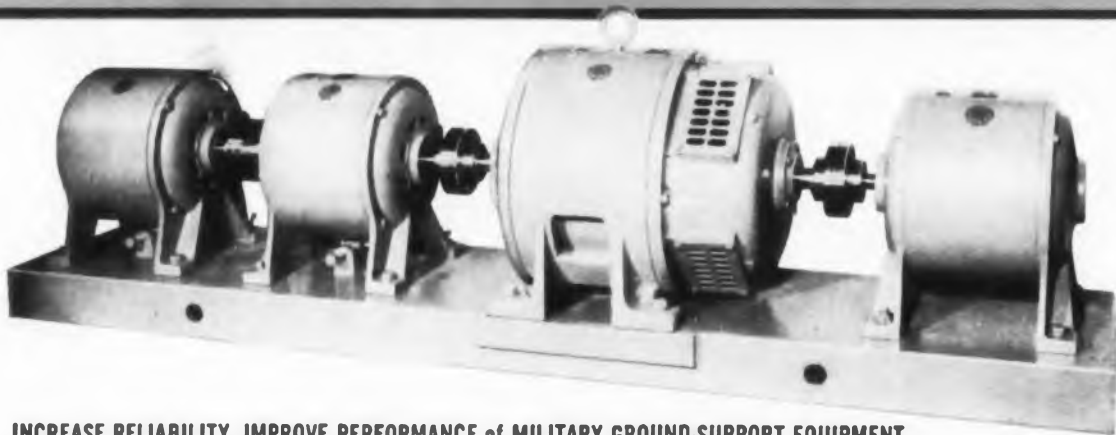
# **ELECTRIC SPECIALTY CO.**

*Pioneers in Power...* **Motors, Generators, Alternators, Converters,  
Dynamotors, and Positioning Devices.**

**Combining** their 53 years of experience in the design of military and industrial power systems and components.

**Offering** the first completely integrated, completely specified, modern **PRECISE-POWER SYSTEMS.**

**BRUSHLESS, MAINTENANCE-FREE REGULATED MOTOR-ALTERNATOR POWER-LINE BUFFER SETS**



**INCREASE RELIABILITY, IMPROVE PERFORMANCE of MILITARY GROUND-SUPPORT EQUIPMENT**

**MULTIPLE-OUTPUT PRECISELY-REGULATED MOTOR-GENERATOR SETS**



**ELIMINATE DOZENS OF ELECTRONIC POWER SUPPLIES, IMPROVE RELIABILITY of AUTOMATION SYSTEMS.**

## **ELECTRIC SPECIALTY CO.**

**202 South Street, Stamford, Conn.**

**CIRCLE 72 ON READER-SERVICE CARD**





ANAMES IN THE ELECTRICAL POWER FIELD...

# and REGULATORS, INC.

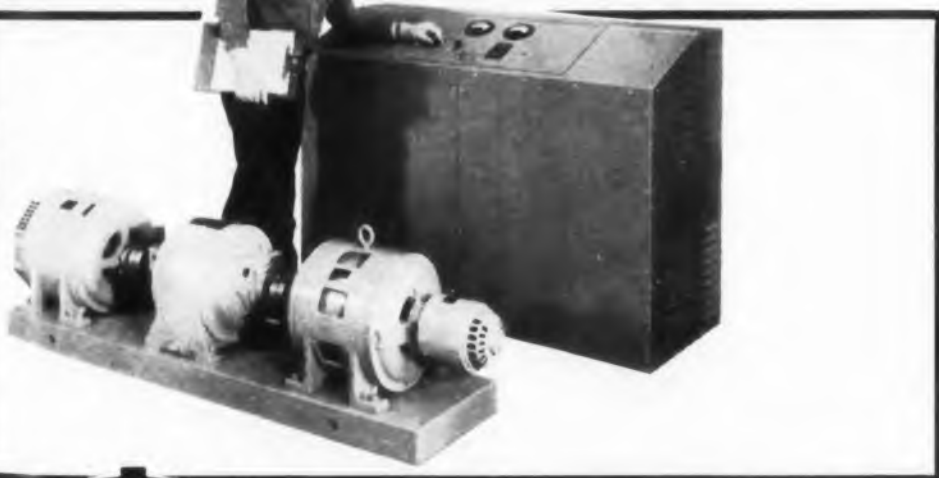
ters, *Pacemakers in Power*... Solid-State Rectifiers, Power Controllers,  
and Power-System Regulating Devices.

*Write* today for this complete, authoritative, 32-page  
illustrated technical manual describing  
ESCO-RI PRECISE POWER SYSTEMS.

Learn the facts about the *modern*  
way to build power supply reliability into  
*your* electronic system!

REGULATED HIGH-INERTIA

FREQUENCY CONVERTERS (60-400 cps)



CUT TOTAL POWER-SUPPLY COST, SIZE, HEAT, COMPLEXITY  
BY 50%-90% in ELECTRONIC COMPUTERS.



We invite  
inquiries on  
specific  
requirements.  
Consult us  
before  
specifying  
your power  
system!



## REGULATORS, INC.

453 Main Street, Wyckoff, N. J.

CIRCLE 73 ON READER-SERVICE CARD

# INTERNATIONAL RECTIFIER CORPORATION



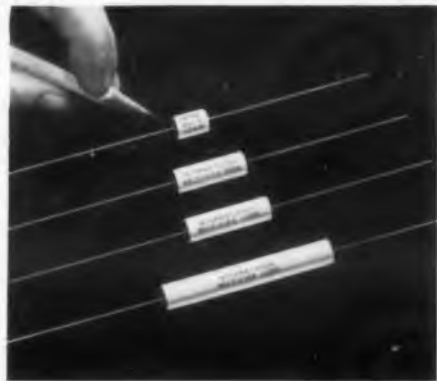
## RECTIFIER NEWS

### Silicon Plug-In Equivalent of the Type 866 Mercury Vapor Tube Can Improve the Design of Communications Equipment 9 Ways!

#### High Voltage Rectifiers for High Altitudes — up to 90,000 feet without Corona!

This new series of high altitude silicon cartridge type rectifier covers the PIV range from 600 to 10,000 volts, are ceramic-encased to prevent surface creepage and to minimize flashover problems encountered in high altitude operations. Units tested to 90,000 feet simulated altitude operated at 1600 volts with no evidence of corona.

Designated JEDEC types 1N2373 through 1N2381, this hermetically sealed cartridge series provides dc output currents from 75 to 250 ma (at



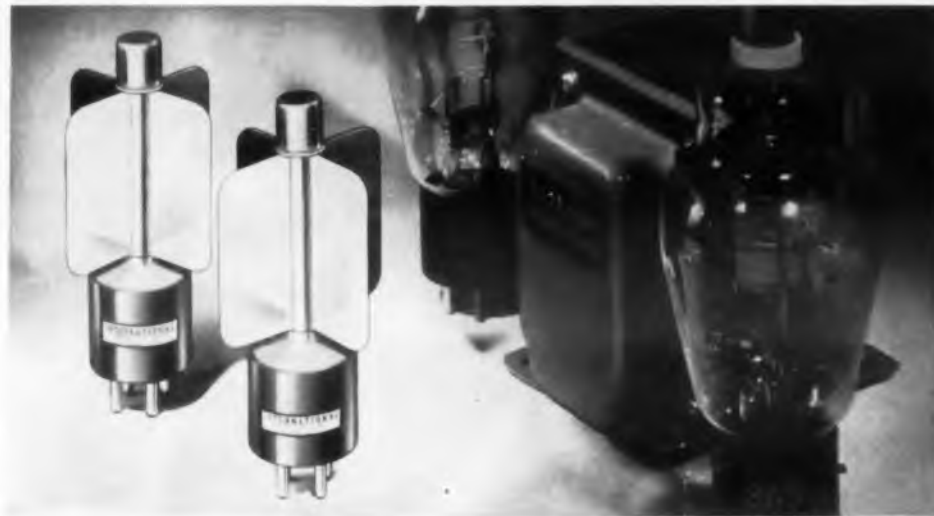
25°C). They have an operating temperature range from -55°C to +150°C, and feature wide application to radar power supplies, high voltage bias supplies and airborne/missile instrumentation... wherever miniaturization, top reliability, high temperature operation and high altitude performance are required.

To receive Bulletin SR-227...

CIRCLE READER SERVICE CARD NO. 547

#### Compact High Voltage "Packaged Rectifiers" Provide up to 100,000 Volts... up to 1 Amp!

If rectifiers in this voltage range fit into your project plans, write to our Electronics Products Department where ratings, configurations and package designs can be tailored to your most exacting requirements.



Fulfilling the need for a compact, reliable unit to replace cumbersome, short-lived Type 866 mercury vapor rectifier tubes, a silicon plug-in equivalent is now available to design engineers. It offers real miniaturization and the reliability needed in a variety of communication and power supply applications.

In a compact package  $\frac{1}{3}$  of the size of equivalent 866 tube circuitry, the new ST-7 silicon unit provides virtually unlimited life, operating temperatures from -65°C to +75°C, requires no warm-up time and generates a minimum of heat.

The ST-7 is a multiple junction cartridge, hermetically sealed for high reliability and is equipped with radial cooling fins to provide optimum power dissipation. Rated at 6,400 PIV, these units will supply dc output currents of 250 ma at 75°C ambient temperatures. The entire housing and cooling fins act as a highly efficient heat exchanger, and is equipped with a tube base for direct insertion into existing tube sockets if desired.

For complete data, and information on how it can improve equipment design 9 ways, ask for Bulletin SR-209...

CIRCLE READER SERVICE CARD NO. 548

### Silicon High Voltage Rectifiers feature Ultra-Stable Characteristics at High Temperatures...



CIRCLE READER SERVICE CARD NO. 549

Types 1N1130 and 1N1131 1500 PIV, 300 ma rated silicon rectifiers for missile and airborne equipment exhibit stability of characteristics at high temperatures never before attained. Units are stud mounted for optimum heat dissipation, may be operated up to 150°C. Their high inverse voltage (1500 volt minimum) and ability to withstand shock and vibration especially suits them for missile and airborne equipment. Choice of polarity eliminates the need for high voltage insulation between stud and chassis. Ask for Technical Bulletin SR-226.

## NEW PRODUCTS

### DC Amplifier

Bandwidth is from dc to 10 kc

Model 92 galvanometer driver-amplifier has a bandwidth from dc to 10 kc, 0.2% linearity, and provides  $\pm 10$  v at 100 ma. Typical voltage sources are high gain dc amplifiers, telemetering receivers, demodulators, detectors, oscillators, and transducer-demodulator combinations. The unit has an integral, regulated power supply. Circuitry is isolated from the case.

Video Instruments Co., Inc., Dept. ED, 3002 Pennsylvania Ave., Santa Monica, Calif.

CIRCLE 74 ON READER-SERVICE CARD

### Coaxial Connectors

For use up to 10,000 mc

Type QDS weatherproof, quick-disconnect type connectors are for use with medium size coaxial cables. They have a nominal characteristic impedance of 50 ohms, a piv of 1000 v, and may be used at frequencies up to 10,000 mc. They employ three-ball positive-locking coupling, and metal-to-metal cable clamping construction. Teflon insulation is used. For use with armored cables, armor clamps can be incorporated or standard clamping hardware can be furnished. They are made to conform to MIL-C-18867, MIL-Q-5923C, and MIL-Q-9858.

Gremer Manufacturing Co., Inc., Dept. ED, Wakefield, Mass.

CIRCLE 75 ON READER-SERVICE CARD

### TV Tube

Operates in altitudes to 60,000 ft

Designed for TV cameras in military and industrial use, type 7198 shock and vibration resistant image orthicon withstands operating conditions in altitudes to 60,000 ft. It operates at temperatures to 71°C and at relative humidities to 95%. The resolution capability of the tube is better than 600 lines and the response covers the range of 3200 to

◀ CIRCLE 547, 548, 549 ON READER-SERVICE CARD

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6261 • CABLE RECTUSA  
BRANCH OFFICES: NEW YORK CITY AREA OFFICE: 132 E. 70th St., TRafalgar 9-3330 • NEW YORK STATE AREA OFFICE: 2366 James St., Syracuse, N.Y., HOward 3-1441 • CHICAGO AREA OFFICE: 205 W. Wacker Dr., FRanklin 2-3888 • NEW ENGLAND AREA OFFICE: 17 Dunster St., Cambridge, Mass., UNiversity 4-6520 • PENNSYLVANIA AREA OFFICE: Suburban Square Bldg., Ardmore, Pa., Midway 9-142B • MICHIGAN AREA OFFICE: 1799 Coolidge H'way, Berkley, Mich., LINcoln 9-1144 • IN CANADA: International Rectifier of Canada, Ltd., 1581 Bank St., Ottawa, Ontario, Regent 3-6880

WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS • SELENIUM • GERMANIUM • SILICON

8950 A. Made to have a low target capacitance, the tube has negligible microphonics due to the movement of the target and mesh with respect to each other. It is capable of reproducing motion in low-light-intensity scenes with a minimum of smearing. When used with low-noise amplifiers, it produces signal information with illumination on the photocathode as low as 0.00001 ft-c.

Radio Corp. of America., Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

CIRCLE 76 ON READER-SERVICE CARD

### Solid State Relay

For teletypewriters

Made for installation in any teletypewriter, model 550 solid state relay provides automatic control of the printer drive motor. The relay energizes the motor at the first signal pulse, sustains operation throughout the transmission, and shuts down the motor after completion of the message. The delay period between the last received pulse and automatic shut-down is factory adjusted to 180 sec. The unit is a self-contained, plug-in module, housed in a drawn-steel case measuring 3-1/4 x 2-5/8 x 4-1/4 in.

Trepac Corp. of America, Dept. ED, 30 W. Hamilton Ave., Englewood, N.J.

CIRCLE 77 ON READER-SERVICE CARD

### Digital Computer

Easily programmed

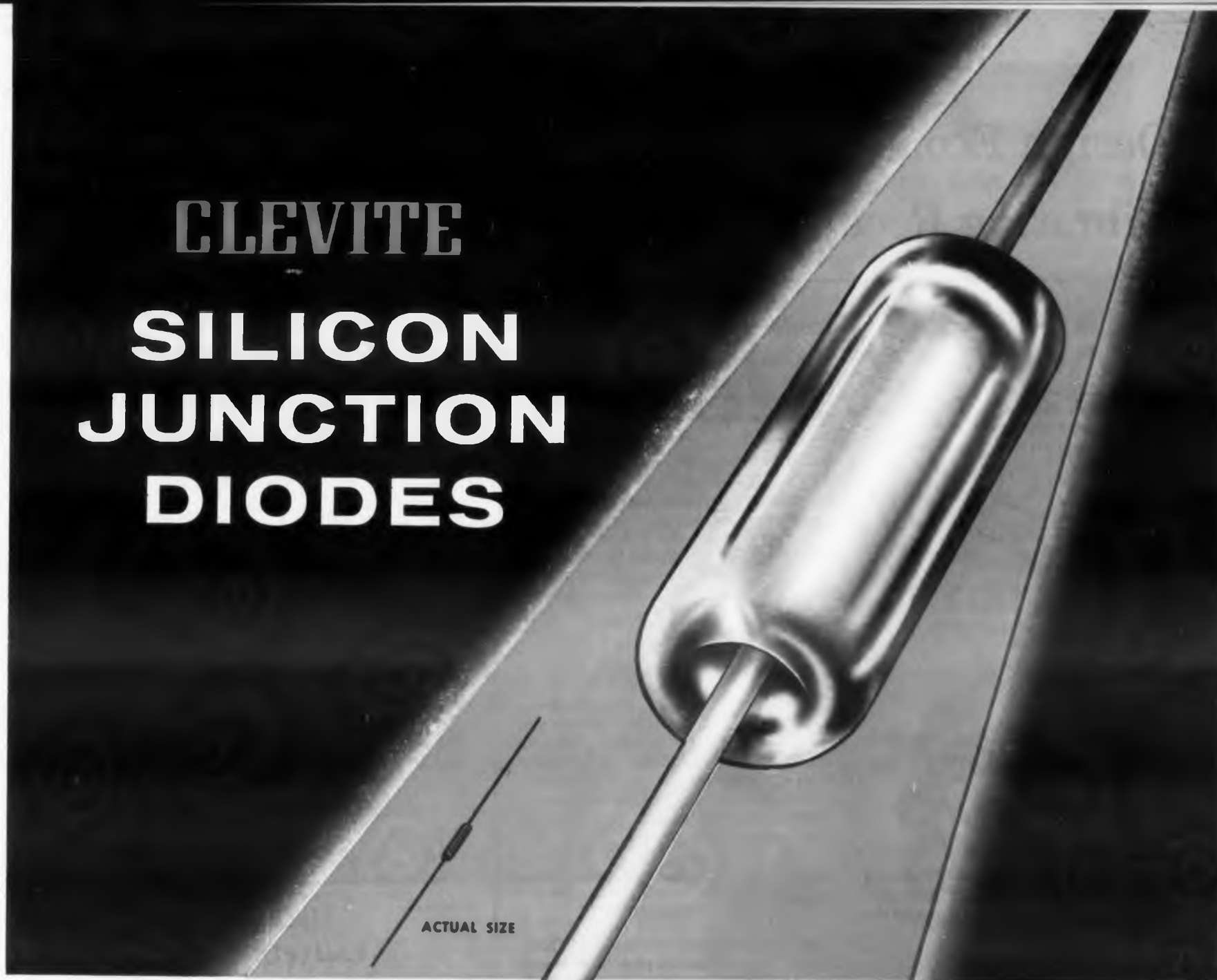
Type DE-60 digital computer is easily programmed and can be used by nontechnical personnel. The keyboard provides manual input through the automatic program control to the arithmetical center which computes, compares, iterates, branches, holds, or transfers information. It operates from 115 v 60 cps power and draws 150 w. Completely transistorized, it requires no special cooling system.

Clary Corp., Dept. ED, San Gabriel, Calif.

CIRCLE 78 ON READER-SERVICE CARD

CIRCLE 79 ON READER-SERVICE CARD >

# CLEVITE SILICON JUNCTION DIODES



250 MW Package . . . .  
Fast Switching and JAN Types  
Featuring . . . .

- **MECHANICAL RELIABILITY** — Rugged, hermetically sealed, subminiature packages. Designed to meet both military and commercial requirements.

- **ELECTRICAL SUPERIORITY** — Excellent high temperature operation . . . thermally stable . . . high forward conductance . . . efficient rectification.

- **JAN TYPES**—IN457, IN458 and IN459  
Conforming to JAN specifications.

For details, write for Bulletin B217A-1 B217A-2

### TECHNICAL DATA

Type	Max. DC Inver. Oper. Voltage	Forward Current @ Specified Voltage	Max. Inverse Current		
			@ 25°C	@ 150°C	Test Volts
IN457	60 V	20 ma @ 1.0 V	0.025 $\mu$ a	5.0 $\mu$ a	60 V
IN458	125 V	7 ma @ 1.0 V	0.025 $\mu$ a	5.0 $\mu$ a	125 V
IN459	175 V	3 ma @ 1.0 V	0.025 $\mu$ a	5.0 $\mu$ a	175 V
1N662	90 V	10 ma @ 1.0 V	20 $\mu$ a	100 $\mu$ a (@ 100° C)	50 V
1N663	90 V	100 ma @ 1.0 V	5.0 $\mu$ a	50 $\mu$ a (@ 100° C)	75 V
1N778	100 V	10 ma @ 1.0 V	0.5 $\mu$ a	30 $\mu$ a (@ 125° C)	100 V
1N779	175 V	10 ma @ 1.0 V	0.5 $\mu$ a	30 $\mu$ a (@ 125° C)	175 V

OTHER CLEVITE DIVISIONS

Cleveland Graphite Bronze • Brush Instruments  
Clevite Electronic Components • Clevite Harris Products  
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A DIVISION OF  
**CLEVITE**

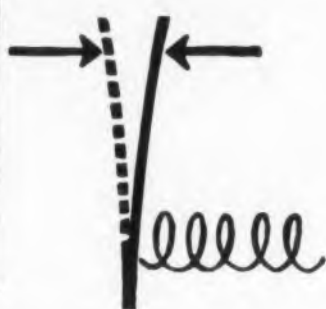
## CLEVITE TRANSISTOR PRODUCTS

241 CRESCENT ST., WALTHAM 54, MASS.  
TWInbrook 4-9330

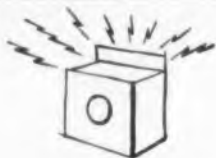


Silicon Junction Diodes Germanium Diodes Power Transistors Solder Lug Power Transistors

# Design Economies with Vibrating Reeds



## TIMING OR WARNING ALARMS



Vibration on case or housing creates buzz alarm for appliances, such as automatic washers, dryers, ranges, etc.

## TOY SOUND EFFECTS



Remotely controlled train whistles and engine noises generated by repetitive electrical or mechanical pulses.

## VIBRATION GENERATOR



Mechanical tapper tests for microphones of tubes or other components.

## LIGHT CHOPPER



Interrupts a beam of light at frequencies of 20 to 120 cps to provide a pulsating photoelectric output proportional to the light intensity.

## PULSE POWER GENERATOR



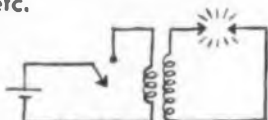
Typical application is for life testing devices such as relays which must be cycled rapidly. Cost is much lower than a geared motor with cam actuated switch performing a like function.

## FREQUENCY SENSITIVE RELAY



Used with frequency generators as low cost remote controls for garage doors, television, etc.

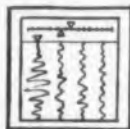
## IGNITION DEVICES



Used as independent breaker points for car and aircraft heaters, jet engines, and other ignition jobs.

## ECONOMICAL CHOPPERS

Available with power interrupting capability, low-noise and low-resistance variations.



Provides 100 cps from DC power source. Driving circuit isolated from chopper contacts. Now being used in medical and aircraft equipment. Frequency doubler chopper operates at 120 cps when driven by a 60 cps supply. Low cost 60 cps chopper for commercial use. Polarized, will follow a 60 cps source.

## FREQUENCY GENERATOR



Typical uses include: 20 cps bell ringers; 60 cps timing motors for jobs such as operating taxi meters (eliminates ticking); 60 cps constant frequency unit ( $\pm 1/2$  cps over a voltage range of 4 to 1) for precision timers, clocks, tape recorders, meters, etc. The latter is an exclusive, Oak patented design.

## TEST EQUIPMENT



Used in instruments to check for "holidays" in insulation on pipe lines, measure insulation resistance, and test ignition systems and timing of cars.

## HIGH POWER CONVERTER



In addition to units for all standard power ranges, Oak supplies a special high power vibrator (patented) which allows any number of vibrators to be operated simultaneously at the same frequency. Using this system, four vibrators have handled as much as 500 watts on an intermittent duty cycle.

There are many ingenious ways to use vibrating reeds, which can lower costs through simplified design.

If you've got an idea you'd like to develop, Oak's engineering specialists will be glad to help you work it out. Contact them today.

Oak also supplies a complete line of conventional vibrators, custom-built for any application.

# OAK

MFG.  
CO.



1260 Clybourn Ave., Dept. D  
Chicago 10, Illinois  
Phone: MOhawk 4-2222

## Specialized Applications with Vibrating Reeds

CIRCLE 80 ON READER-SERVICE CARD

## NEW PRODUCTS

### Pressure Switch

Range is 10 to 3000 psig



Having a range of 10 to 3000 psig, type P36-1001 pressure switch combines a transducer, a solid state carrier oscillator, a ring demodulator, and a switching transistor. The dc input voltage is converted to ac for excitation of a variable-reluctance magnetic circuit. The absence of mechanical contacts permits no chatter or shift in the electrical output due to vibration. The maximum working pressure is 200% of nominal switch pressure, the accuracy is  $\pm 1.5\%$  of setting, and the switch pressure adjustment is  $\pm 16\%$  of nominal switch pressure.

Wiancko Engineering Co., Dept. ED, 255 N. Halstead, Pasadena, Calif.

CIRCLE 81 ON READER-SERVICE CARD

### Electric Motor

Rated at 1/750 to 1/85 hp



Type S/L-1085 electric motor has ratings of 1/750 to 1/85 hp. The unit-bearing rotor turns on a stationary shaft at 3400 rpm without a load and from 2600 to 3200 rpm with recommended loads. The motor does not need lubrication and can operate over the temperature range of  $-10$  to  $+250$  F. Its uses include cooling electronic data processing machines, driving exhaust fans, and operating liquid circulating pumps in machines. It can be fitted with circulating blowers 2 to 3 in. in diam, plastic fans measuring 4 to 6 in., or gear blowers.

Howard Industries, Inc., Dept. ED, 1760 State St., Racine, Wis.

CIRCLE 82 ON READER-SERVICE CARD

# Lepel

## HIGH FREQUENCY HEATING UNITS

Lepel induction heating equipment represents the most advanced thought in the field of electronics. The most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations.

### FLOATING ZONE UNIT FOR METAL REFINING AND CRYSTAL GROWING

A new floating zone fixture for the production of ultra-high purity metals and semi-conductor materials. Purification or crystal growing is achieved by traversing a narrow molten zone along the length of the process bar while it is being supported vertically in vacuum or inert gas. Designed primarily for production purposes, Model HCP also provides great flexibility for laboratory studies.

Model HCP



### Features

- A smooth, positive mechanical drive system with continuously variable up, down and rotational speeds, all independently controlled.
- An arrangement to rapidly center the process bar within a straight walled quartz tube supported between gas-tight, water-cooled end plates. Placement of the quartz tube is rather simple and adapters can be used to accommodate larger diameter tubes for larger process bars.
- Continuous water cooling for the outside of the quartz tube during operation.
- Assembly and dis-assembly of this system including removal of the completed process bar is simple and rapid.

Electronic Tube Generators from 1 kw to 100 kw.  
Spark Gap Converters from 2 kw to 30 kw.

WRITE FOR THE NEW LEPEL CATALOG

All Lepel equipment is certified to comply with the requirements of the F.S.C.  
LEPEL HIGH FREQUENCY LABORATORIES, INC.  
55th STREET and 37th AVENUE, WOODSIDE 77, N. Y.

CIRCLE 83 ON READER-SERVICE CARD

for immediate  
delivery of  
**General  
Instrument  
semiconductors**  
at factory prices  
call your  
stocking distributor

The authorized distributors listed below carry a full stock of all General Instrument semiconductor — and can give you immediate delivery from stock

**SILICON RECTIFIERS**  
**SILICON DIODES**  
**GERMANIUM  
DIODES**



**CALIFORNIA:** Newark Electric Co., 4747 W. Century Blvd., Inglewood; Pacific Wholesale Co., 1850 Mission St., San Francisco; Shanks & Wright, Inc., 2045 Kettner Blvd., San Diego; Valley Electronic Supply Co., 1302 W. Magnolia Blvd., Burbank

**CONNECTICUT:** The Bond Radio Supply, Inc., 439 W. Main St., Waterbury

**DISTRICT OF COLUMBIA:** Silberman Industrial Sales Corp., 3400 Georgia Ave., N.W.

**ILLINOIS:** Merquip Co., 5904 W. Roosevelt Rd., Chicago; Newark Electric Co., 223 W. Madison St., Chicago

**INDIANA:** Brown Electronics, Inc., 1032 Broadway, Fort Wayne; Graham Electronics Supply, Inc., 122 S. Senate Ave., Indianapolis

**MARYLAND:** Radio Electric Service Co., 5 N. Howard St., Baltimore

**MASSACHUSETTS:** The Greene-Shaw Co., Inc., 341-347 Watertown St., Newton

**NEW YORK:** Hudson Radio & Television Corp., 37 W. 65th St., NYC.; Sun Radio & Electronics Co., Inc., 650 Sixth Ave., NYC

**OHIO:** Buckeye Electronics Distributors, 236-246 E. Long St., Columbus; The Mytronic Co., 2145 Florence Ave., Cincinnati; Pioneer Electronic Supply Co., 2115 Prospect Ave., Cleveland

**OKLAHOMA:** Oil Capitol Electronics, 708 S. Sheridan, P.O. Box 5423, Tulsa

**PENNSYLVANIA:** D & H Distributing Co., 2535 N. 7th St., Harrisburg; Herbach & Rademan, Inc., 1204 Arch St., Philadelphia

**WASHINGTON:** Seattle Radio Supply Co., 2115 2nd Ave., Seattle

**WISCONSIN:** Radio Parts Co., Inc., 1314 N. 7th St., Milwaukee

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

## *AUTOMATIC* MINIATURIZED silicon power rectifiers

**SMALL TO FIT YOUR SPACE REQUIREMENTS**

JEDEC TYPE NO.	MAXIMUM RATINGS			ELECTRICAL CHARACTERISTICS			
	PEAK INV. VOLT- AGE (V)	MAX. AVG. RECTIFIED CURRENT (mA)*		MINIMUM SATURA- TION VOLTAGE @ 100° C. (VOLTS)	MAXIMUM REVERSE CURRENT @ PIV (uA)		MAXIMUM VOLTAGE DROP @ 400 ma DC @ 25° C. VOLTS DC
		@ 25° C.	@ 150° C.		@ 25° C.	@ 100° C.	
1N645	225	400	150	275	0.2	15	1.0
1N646	300	400	150	360	0.2	15	1.0
1N647	400	400	150	480	0.2	20	1.0
1N648	500	400	150	600	0.2	20	1.0
1N649	600	400	150	720	0.2	25	1.0

\*Resistive or inductive load



Semiconductor Division

**GENERAL INSTRUMENT CORPORATION**

65 Gouverneur Street, Newark 4, N. J.

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

GENERAL INSTRUMENT DISTRIBUTORS: Baltimore: D & H Distributing Co. • Chicago: Merquip Co. • Cleveland: Pioneer Electronic Supply • Los Angeles: Valley Electronic Supply Co. • Burbank: Pacific Wholesale Co. • Milwaukee: Radio Parts Co., Inc. • New York City: Hudson Radio & Television Corp. • Philadelphia: Herbach & Rademan, Inc. • San Diego: Shanks & Wright, Inc. • San Francisco: Pacific Wholesale Co. • Seattle: Seattle Radio Supply • Tulsa: Oil Capitol Electronics

We've shrunk the size, but not the quality. All the outstanding characteristics and reliability you expect of products from General Instrument Corporation are present in these miniaturized units. Data sheets on these and other Automatic silicon rectifiers are available upon request.

CIRCLE 84 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 25, 1959

CIRCLE 85 ON READER-SERVICE CARD



**It's Mr. Fortin's job to be hard to please...** Bob Fortin isn't the easiest person in the world to get along with. He's in charge of RCA's Current Product Design Group...and he's never content to let well enough alone. No matter how well a tube performs, Bob is always sure it can be improved...and he's usually right. He keeps a watchful eye on manufacturing to spot problem areas; he helps devise and develop more accurate testing and inspection methods. Working with the Life Test and Rating Laboratory, Bob and his staff determine the limits within which tube types perform with maximum reliability. He constantly reviews tube design to make sure the best available methods and materials are used. Recently, for instance, Bob Fortin and his staff suggested the use of RCA's new vacuum-melt cathode material, N-132, in the RCA-5654 6AK5-W. This change substantially reduced leakage, extended tube life, and increased operating stability. With men like Bob Fortin on the job, you can always count on quality performance when you design around RCA Industrial Receiving Tubes. Make sure you specify the best...get in touch with your RCA Field Representative today.



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

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS

**EAST:** 744 Broad Street, Newark 2, New Jersey  
 HUmboldt 5-3900

**MIDWEST:** Suite 1154, Merchandise Mart Plaza  
 Chicago 54, Illinois—WHitehall 4-2900

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

## NEW PRODUCTS

### Heavy-Duty Hand Winder

Winding speeds are 300, 400, 800, and 1800 rpm

Models 510-AM heavy-duty winder has winding speeds of 300, 400, 800, and 1800 rpm at full 1/2 hp torque rating. For laboratory and production use, it winds wire gages as heavy as No. 10 AWG on spools to 8 in. in diam. It also winds extremely fine wires. The maximum coil OD is 12 in., loading distance between headstock and tailstock is 12 in., and the output end of the spindle is a 3/4-in. keyed slot. The unit is furnished with a 1/2 hp, 5000 rpm, 115 v, 60 cps motor with rheostat foot pedal, instant re-setting automatic counter, and a positive stopping magnetic brake. Also available, model 510 has a dial counter instead of an automatic re-set counter.

George Stevens Manufacturing Co., Inc., Dept. ED, Pulaski Road at Peterson, Chicago 46, Ill.

CIRCLE 86 ON READER-SERVICE CARD

### Silicone Impregnating Varnish

Curing temperature is 150 C

Type SR-220 silicone impregnating varnish cures at 150 C. Made for use in the production of transformers and electronics equipment, it can also be used over existing insulation systems. It has a high dielectric strength and long heat life. It also offers tank stability and excellent shelf life.

General Electric Co., Silicone Products Dept., Dept. ED, Waterford, N. Y.

CIRCLE 87 ON READER-SERVICE CARD

### Black Glass

For enclosure of semiconductor devices

Impervious to light, code 9361 black glass is for enclosure of silicon semiconductor devices. Offered in the form of beads and cases for sealing to 0.017 Dumet lead wires, the glass filters out virtually all wavelengths of the ultraviolet.

isible, and near infrared spectrum. It has a thermal coefficient of expansion of  $92 \times 10^{-7}$  per deg C. Softening point is about 675 C, annealing point about 495 C, and strain point about 445 C. The beads have an OD of  $0.053 \pm 0.002$  in. and an ID of  $0.023 \pm 0.002$  in. The cases have an OD of  $0.095 \pm 0.002$  in. and an ID of  $0.06 \pm 0.002$  in.

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

CIRCLE 88 ON READER-SERVICE CARD

## Capacitors

### Have drawn rectangular cases

Type 271P capacitors are designed to operate over the temperature range of  $-55$  to  $+85$  C, and type 272P capacitors will withstand operation at temperatures to  $125$  C without voltage derating. Both types have drawn-rectangular cases, use a dual insulation consisting of synthetic polyester film and high grade capacitor tissue, and use a synthetic polymer impregnant. They meet the requirements of MIL-C-25A and MIL-C-25B, but are more compact than the specified size.

Sprague Electric Co., Dept. ED, N. Adams, Mass.

CIRCLE 89 ON READER-SERVICE CARD

## Polyester Film Capacitors

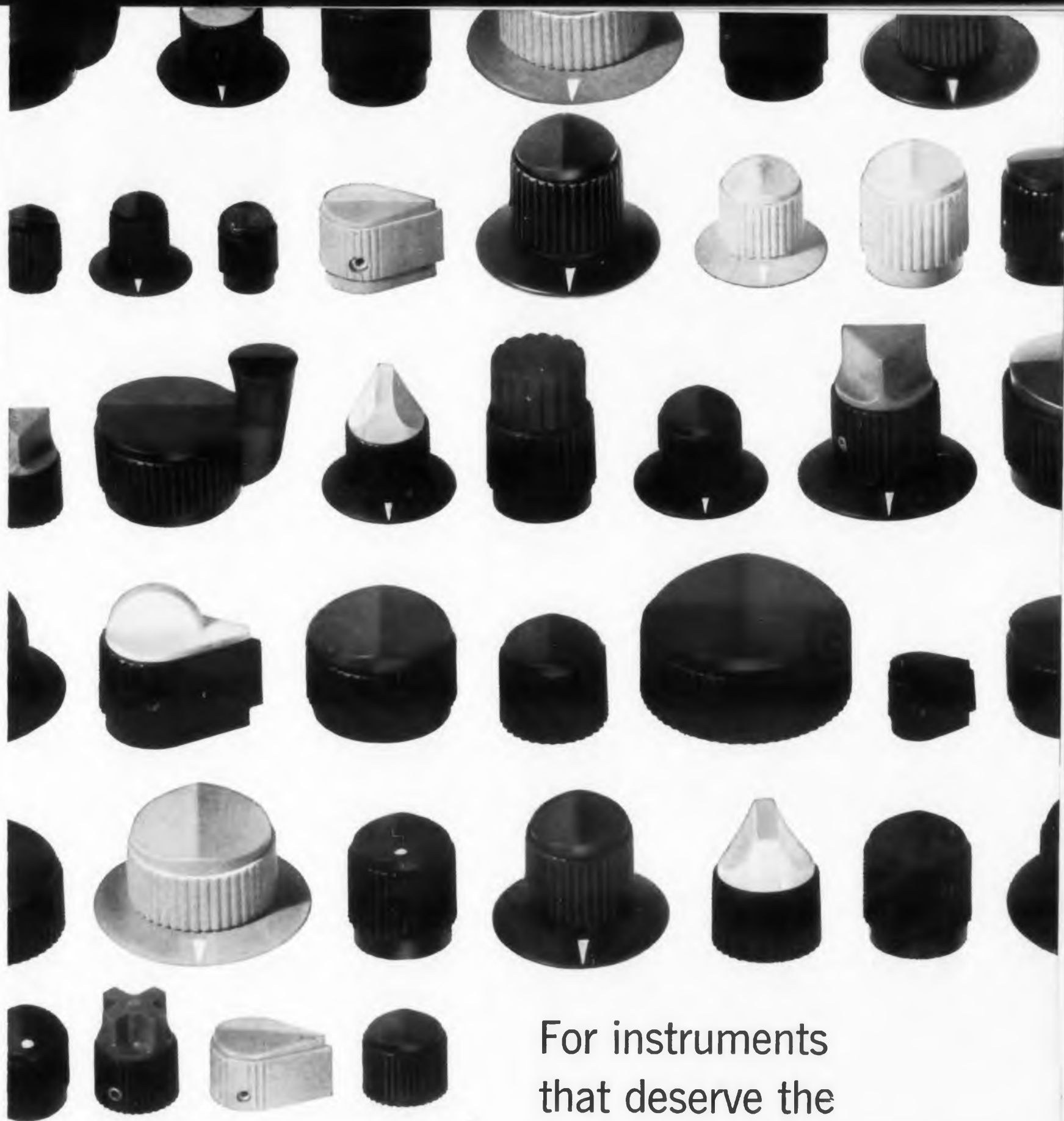
Temperature range is  $-55$  to  $+85$  C

Type 158P Filmite E capacitors operate over the temperature range of  $-55$  to  $+85$  C with no derating and have a dielectric of polyester film. They are protected against moisture by a polyester-film tape. The end seals are of a plastic resin which bonds with the film and the tinned leads providing a secure seal. They have good resistance to vibration and shock. Made for both military and industrial applications, they are suitable for potting and encapsulating in subassemblies and filters, digital computers, and in control apparatus.

Sprague Electric Co., Dept. ED, N. Adams, Mass.

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*\*Seven styles in six sizes — tactile shapes, color and color caps — plus hundreds of modifications on special order.*



*Excellence in Electronics*

For instruments  
that deserve the  
precision engineered look—  
specify Raytheon knobs

194 styles\* in stock for immediate delivery.

Military or commercial applications. For further facts, write Dept. 6477, Raytheon Company, Industrial Apparatus Division, Waltham 54, Massachusetts.

BURTON BROWN ADVERTISING



# FRANKLIN "ONE FLUID" and the IONOSPHERE

Creative Imagination enabled Benjamin Franklin to orient all the observed electrical phenomena to his own "one fluid" theory—the basis of all our comprehension of electricity today.

At National Co. creative imagination is continuing to broaden our comprehension of the physical universe and apply it to the realization of such new means of communication as Ionospheric scatter systems.

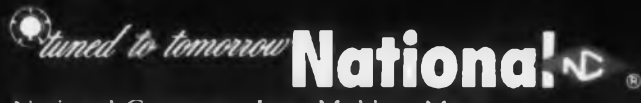
The implications and applications of such new means of communication are vast.

National Co. is a community of minds and talents that enjoys the challenge and the prestige of success in such advanced fields as multipath transmission, noise re-

duction, correlation techniques for signal processing, Tropospheric scatter systems, Ionospheric scatter systems, molecular beam techniques, long range microwave transmission, and missile check-out equipment using microwave and digital techniques.

National Co. has grown with the Tradition of New England electronics. Your needs and problems receive exceptional attention at National Co. because, here, *creativity is required, recognized and rewarded.*

Write or phone



National Company, Inc., Malden, Mass.

MANUFACTURERS OF MATERIEL AND EQUIPMENT FOR U.S. DEFENSE

## NEW PRODUCTS

### Servo Potentiometers

For airborne use

Series MFG rotary Metfilm servo potentiometers are for use in missiles and other airborne systems where extremes in temperature, acceleration, vibration, and shock must be met. The capsule contact design protects the sealed resistance element from environmental deterioration and provides for accuracy over a wide temperature range. The pressure contact eliminates the problem of sliding friction.

Technology Instrument Corp., Dept. ED, 531 Main St., Acton, Mass.

CIRCLE 92 ON READER-SERVICE CARD

### Servo Potentiometers

Multiturn type

This line of multiturn servo potentiometers consists of four miniature types and one medium size type which have wirewound construction on insulated copper mandrels. The three, five, and ten-turn types provide close mechanical tolerances and high electrical accuracy. A miniature ten-turn model is designed for ganging up to ten cups per shaft. All models are suitable for military use.

Technology Instrument Corp., Dept. ED, 531 Main St., Acton, Mass.

CIRCLE 93 ON READER-SERVICE CARD

### DC Power Supply

Provides 200 to 325 v dc

This dc power supply provides a continuously variable output of 200 to 235 v dc for load currents of 0 to 100 ma. Input is 105 to 125 v, 60 cps. Regulation is better than 1%. Ripple is less than 10 mv. An isolated ac voltage of 6.3 v at 3 amp is available at the output terminal connections.

Associated Specialties Co., Dept. ED, 1751 Main St., Orefield, Pa.

CIRCLE 94 ON READER-SERVICE CARD  
◀ CIRCLE 95 ON READER-SERVICE CARD



## Carbon Resistors

Are 1/8 and 1/4 w

These Hot-Coat plastic-compound, deposited-carbon, 1% resistors, 1/8 w type CEL and 1/4 w type CEH, are protected by a thick nonreactive coating. They are designed to meet the requirements of MIL-R-10509B.

Clarostat Manufacturing Co.,  
Dept. ED, Dover, N. H.

CIRCLE 96 ON READER-SERVICE CARD

## Rectifier Transformers

Miniature

Series I and H miniature rectifier transformers are useful in constructing compact low voltage power supplies which supply the collector voltage of transistors. They operate from an input of 115 v ac, 60 or 400 cps. Requirements of MIL-T-27, class R, grade 4, conditions 02 are met. They can be supplied either in a channel frame construction, hermetically sealed, or encapsulated.

Ferrotran Electronics Co., Inc.,  
Dept. ED, 693 Broadway, New York 12, N. Y.

CIRCLE 97 ON READER-SERVICE CARD

## Terminal Blocks

Pressure contact type

Made for heavy duty use, type 9-85 pressure contact terminal blocks are of one-piece construction, molded of general purpose phenolic or in plastics as per MIL-M-14E. The top and bottom are closed with molded plastic. Available in lengths from 2 to 12 terminals, they are rated at 85 amp, and 8000 v, breakdown voltage. A vise-like grip on each wire of through-connected pairs eliminates soldering and offers protection from accidental shocks.

Kulka Electric Corp., Dept. ED,  
63-643 S. Fulton Ave., Mt. Vernon, N. Y.

CIRCLE 98 ON READER-SERVICE CARD

CIRCLE 99 ON READER-SERVICE CARD ➤



Engineer A. M. Darbie installs a Tung-Sol/Chatham 6336A twin power triode in a Harrison Labs 2B regulator, part of a 200B high current power supply. Superior power handling ability of the 6336A lets Harrison Labs offer the regulator with a 5-tube complement in addition to a 7-tube model.

# Harrison Labs **LAB** gains flexibility with Tung-Sol/Chatham 6336A!

Harrison Laboratories, quality manufacturer of Berkeley Heights, N. J., offers designers its 2B regulator with a 5 or 7-tube complement. Superior power handling ability of Tung-Sol/Chatham's 6336A twin power triode makes possible the 5-tube version that features operation over a wider line voltage variation without change of transformer taps.

Over more than a year, Tung-Sol/Chatham's 6336A has performed with exceptional reliability. Users of Harrison Labs 2B regulator especially appreciate the reduced downtime and maintenance

stemming from 6336A's long life and electrical stability. In all, Harrison Labs evaluates the Tung-Sol/Chatham 6336A a wise design choice.

Harrison Labs adds another name to the growing list of manufacturers benefiting from the reliable efficiency of Tung-Sol tubes and semiconductors. So can you. Tung-Sol makes a quality unit for virtually every industrial and military need. Our applications engineers will gladly assess your circuitry and help discover how you can profit by specifying Tung-Sol. Tung-Sol Electric Inc., Newark 4, New Jersey. TWX: NK 193



**ts** **TUNG-SOL**

# Lambda Power Supplies have been the first choice of engineers in every independent poll



The only power supplies guaranteed for 5 years

This unprecedented five-year guarantee is the strongest proof of consistent trouble-free power supply performance ever offered. It is bolstered even further by a series of independent surveys which prove that Lambda equipment is preferred by more than 50% of the engineers who specify power supplies.

## CHECK LIST: LAMBDA REGULATED DC POWER SUPPLIES

Model	Style	Voltage Range (VDC)	Current Range (MA DC)	Regulation Impedance Ripple (Table I)	6.3 VAC Output (Amps)	Meters	Output Voltage Control	Output Terminals	Size Weight (Table II)	Price (U.S. and Canada) F.O.B. Factory Collage Pl., N. Y.	
<b>REGULATED POWER SUPPLIES—RACK MOUNTING</b>											
<b>TRANSISTORIZED</b>											
LT-1095	Rack	0-32	0-1000	A	—	None	Rear	Rear	S-1	285.00	
LT-1095M	Rack	0-32	0-1000	A	—	2 1/2" rect	Rear	Rear	S-1	315.00	
LT-2095	Rack	0-32	0-2000	B	—	None	Rear	Rear	S-1	365.00	
LT-2095M	Rack	0-32	0-2000	B	—	2 1/2" rect	Rear	Rear	S-1	395.00	
<b>TUBE REGULATED</b>											
C-200	Rack	0-200	0-200	C	10A	None	Rear	Rear	S-2	184.50	
C-200M	Rack	0-200	0-200	C	10A	3 1/2" rect	Rear	Rear	S-2	214.50	
C-201	Rack	125-325	0-200	C	10A	None	Rear	Rear	S-2	159.50	
C-201M	Rack	125-325	0-200	C	10A	3 1/2" rect	Rear	Rear	S-2	189.50	
C-202	Rack	325-525	0-200	C	10A	None	Rear	Rear	S-2	169.50	
C-202M	Rack	325-525	0-200	C	10A	3 1/2" rect	Rear	Rear	S-2	199.50	
C-400	Rack	0-200	0-400	D	15A	None	Rear	Rear	S-2	259.50	
C-400M	Rack	0-200	0-400	D	15A	3 1/2" rect	Rear	Rear	S-2	289.50	
C-401	Rack	125-325	0-400	D	15A	None	Rear	Rear	S-2	244.50	
C-401M	Rack	125-325	0-400	D	15A	3 1/2" rect	Rear	Rear	S-2	274.50	
C-402	Rack	325-525	0-400	D	15A	None	Rear	Rear	S-2	259.50	
C-402M	Rack	325-525	0-400	D	15A	3 1/2" rect	Rear	Rear	S-2	289.50	
C-800	Rack	0-200	0-800	E	20A	None	Rear	Rear	S-3	340.00	
C-800M	Rack	0-200	0-800	E	20A	3 1/2" rect	Rear	Rear	S-3	370.00	
C-801	Rack	125-325	0-800	E	20A	None	Rear	Rear	S-3	315.00	
C-801M	Rack	125-325	0-800	E	20A	3 1/2" rect	Rear	Rear	S-3	345.00	
C-802	Rack	325-525	0-800	E	20A	None	Rear	Rear	S-3	360.00	
C-802M	Rack	325-525	0-800	E	20A	3 1/2" rect	Rear	Rear	S-3	390.00	
C-1500	Rack	0-200	0-1500	F	30A	None	Rear	Rear	S-4	550.00	
C-1500M	Rack	0-200	0-1500	F	30A	3 1/2" rect	Rear	Rear	S-4	580.00	
C-1501	Rack	125-325	0-1500	F	30A	None	Rear	Rear	S-4	575.00	
C-1501M	Rack	125-325	0-1500	F	30A	3 1/2" rect	Rear	Rear	S-4	605.00	
C-1502	Rack	325-525	0-1500	F	30A	None	Rear	Rear	S-4	650.00	
C-1502M	Rack	325-525	0-1500	F	30A	3 1/2" rect	Rear	Rear	S-4	680.00	
20	Rack	200-325	0-100	G	3A	None	Rear	Rear	S-5	59.50	
20M	Rack	200-325	0-100	G	3A	3 1/2" rect	Rear	Rear	S-5	89.50	
29	Rack	100-200	0-100	H	3A	None	Rear	Rear	S-5	69.50	
29M	Rack	100-200	0-100	H	3A	3 1/2" rect	Rear	Rear	S-5	99.50	
32	Rack	200-325	0-300	J	2 @ 5A	None	Rear	Rear	S-6	139.50	
32M	Rack	200-325	0-300	J	2 @ 5A	3 1/2" rect	Rear	Rear	S-6	169.50	
33	Rack	100-200	0-300	I	2 @ 5A	None	Rear	Rear	S-6	154.50	
33M	Rack	100-200	0-300	I	2 @ 5A	3 1/2" rect	Rear	Rear	S-6	184.50	
50R	Rack	0-500	0-500	K	2 @ 5A	4 1/2" rect	Front	Fr & rear	S-7	420.00	
		0-50	Bias	L							
		0-200	High Imped.	M							
<b>REGULATED POWER SUPPLIES—PORTABLE AND BENCH</b>											
25	Bench	200-325	0-100	G	3A	None	Front	Front	S-8	69.50	
26	Bench	100-200	0-100	H	3A	None	Front	Front	S-8	79.50	
50	Bench	See Model 50R above								S-9	440.00
71	Portable	0-500	0-200	N	2 @ 5A	3 1/2" rect	Front	Front	S-10	310.00	
		0-50	Bias	P							
		0-200	High Imped.	Q							

**TABLE I**  
DC OUTPUT VOLTAGE REGULATION, IMPEDANCE, RIPPLE

REGULATION		Internal Impedance (ohms)	Ripple, rms (millivolts or %)
Line (105-125 VAC)	Load (min to max)	Less than	Less than
A	0.15% or 20MV	0.15% or 20MV	0.50 1 mv
B	0.15% or 20MV	0.15% or 20MV	0.025 1 mv
C	0.15% or 0.3V	0.25% or 0.5V	6 3 mv
D	0.15% or 0.3V	0.25% or 0.5V	3 3 mv
E	0.15% or 0.3V	0.25% or 0.5V	1.5 3 mv
F	0.15% or 0.3V	0.25% or 0.5V	0.75 3 mv
G	1%	1%	10 10 mv
H	1%	1%	10 5 mv
J	1%	1%	4 10 mv
K	0.15% or 0.1V	0.5% or 0.3V	2 8 mv
L	0.1%	unregulated	3,300 2 mv
M	0.1%	unregulated	17,500 5 mv
N	0.15% or 0.3V	0.15% or 0.3V	4 5 mv
P	0.1%	unregulated	5,500 2 mv
Q	0.1%	unregulated	25,000 5 mv

**TABLE II**  
SIZES AND WEIGHTS

Model	Size H x W x D (inches)	WEIGHT	
		Net (lbs)	Shipping (lbs)
S-1	3 1/2 x 19 x 14 1/4	35	65
S-2	5 1/2 x 19 x 14 1/4	53	80
S-3	7 x 19 x 14 1/4	84	100
S-4	8 1/2 x 19 x 14 1/4	120	140
S-5	5 1/2 x 19 x 8	19	23
S-6	10 1/2 x 19 x 9 1/4	42	52
S-7	10 1/2 x 19 x 14 1/4	89	140
S-8	8 x 14 x 6	19	23
S-9	12 1/2 x 22 x 15	110	158
S-10	13 x 8 1/2 x 14 1/2	49	85

### GENERAL SPECIFICATIONS

Sufficient tolerance is incorporated in the specifications to allow for normal commercial component and tube deviations. Tube replacements may be made with any equivalent tubes meeting E.I.A. specifications.

**INPUT** 105-125 VAC, 50-60 CPS, single phase. Exceptions: Models 50, 50R and 71—105-125 VAC, 50-60 CPS.

**DC OUTPUT Voltage Range:** Continuously variable over ranges specified, except where otherwise noted.

**Current Range:** The current ranges given apply to the entire DC output voltage range, and for input voltages from 105 to 125 VAC. No "de-rating" is necessary.

**Polarity:** Either positive or negative terminal may be grounded.

**AC OUTPUT** The AC output is unregulated, isolated and ungrounded. It has a value of slightly higher than 6.3 V

(when fully loaded) at an input of 115 VAC. This value allows for voltage drop in connecting leads. Dual outputs may be connected in series or parallel.

**DUTY CYCLE** Continuous duty at full load.

**METERS** Where meters are indicated, a separate voltmeter and milliammeter are provided.

**OVERLOAD PROTECTION** Ample protection is provided against external overload and internal failure conditions by means of fuses.

Circuit breakers of the magnetic, "trip-free" type are employed in Models 50, 50R, 71 and LT series as protection against external overloads. And in the LT series, the transistor complement is independently protected by special transistor circuitry.

**STYLE** Rack Models are designed for mounting on standard 19" relay racks.

Bench Models are provided with compact, specially-designed, ventilated cabinets equipped with carrying handles. The power supply units may be removed from their cabinets for mounting in standard relay racks (except Models 25, 26 and 71).

**RATINGS AND COMPONENTS** All components used are of the highest quality and are operated well within manufacturers' ratings. Hermetically-sealed, oil-filled capacitors are used exclusively, except in LT series, where special high purity foil, long-life electrolytics are used. "C" and "LT" series power supplies use hermetically-sealed magnetic components exclusively. Ample safety factors are provided in the design to insure the long life, and the dependable, trouble-free operation so desirable in industrial and laboratory applications.

All specifications and prices subject to change without notice.

## NEW PRODUCTS

### Diode

#### Monitors rf outputs

Type MA-437 (1N2771) point-contact silicon diode monitors power outputs of rf generating devices from 140 to 750 mc. Rectified current through the diode is monitored in a standard holder at three frequencies: 140, 375, and 750 mc, at input levels —2.8, 0, and 3.6 dbm. Within this power range, power monitoring error is less than 1 db. At any specific test frequency, the power error is less than 0.5 db. Cartridge construction is used. The output is coupled directly to a dc microammeter. Requirements of MIL-E-1 are met. Applications are in communications and TV transmitters.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 105 ON READER-SERVICE CARD

### Decommutation System

#### Uses phase-lock loop technique

Designed to operate on both PAM and PDM telemetry signals, type 90 decommutator uses the phase-lock loop technique to maintain synchronization with changes in commutation speeds of  $\pm 20\%$  and over several segments of complete signal drop out. Three operational-amplifier type integrators operate sequentially on data pulses to reduce crosstalk to less than  $\pm 0.1\%$  and to average out the effects of noise on the recovered pulses. Translators have outputs of  $\pm 15$  v and deliver 10 ma to a 1500-ohm load. Output impedance is less than 1 ohm from dc to 1000 cps. Translators have standard accuracies of 0.07%. Automatic zero level compensation reduces zero shifts of  $\pm 10\%$  to less than  $\pm 0.1\%$ . Automatic gain compensation readjusts  $\pm 10\%$  full scale shifts to less than  $\pm 0.1\%$ .

Telecomputing Corp., Data Instruments Div., Dept. ED, 12838 Saticoy St., N. Hollywood, Calif.

CIRCLE 106 ON READER-SERVICE CARD



**LAMBDA ELECTRONICS CORP.**

11-11 131 STREET • COLLEGE POINT 56, NEW YORK

INDEPENDENCE 1-8500 CABLE ADDRESS: LAMBDATRON, NEW YORK

Keep this  
check list handy

CIRCLE 107 ON READER-SERVICE CARD

## Relay

Miniature, spdt type



This spdt miniature relay is available with resistances of 50 ohms and 5 K. At 50 ohms the required pull-in is 18 ma, and at 5 K, 2.3 ma. The fixed contacts are made of nickel silver and the movable contacts are silver palladium. The unit weighs 0.37 oz and measures 0.402 x 0.687 x 0.812 in. The relay is for use in multichannel radio control equipment and in computers.

W. S. Deans Co., Radio Control Research and Development, Dept. ED, 8539 Albia St., Downey, Calif.

CIRCLE 108 ON READER-SERVICE CARD



## Spectrum Analyzer

Ranges are 0 to 70 mc and 0 to 5 mc

Type SPA-4 spectrum analyzer has independent frequency dispersion ranges of 0 to 70 mc and 0 to 5 mc. Negligible internal frequency modulation permits narrow band analysis free of fm. A variable if bandwidth from 1 to 80 kc for analyzing wide or narrow pulsed rf signals is provided. The sensitivity is 100 dbm. The unit includes linear and power amplitude scales, a precisely calibrated log, a tuning head with a 10 to 40-mc frequency range, and a self-contained marker oscillator.

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

CIRCLE 109 ON READER-SERVICE CARD

Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers •

# ESC EXTRA

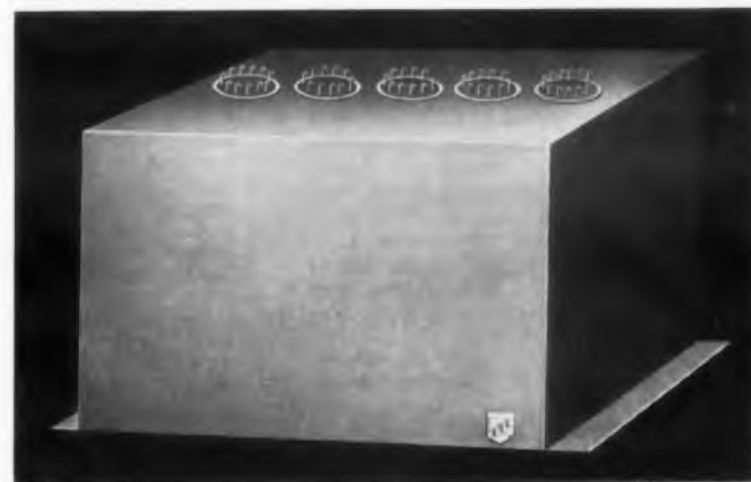
Pulse transformers • Medium and low-power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

# ESC DEVELOPS DELAY LINE WITH 170 to 1 DELAY TIME/ RISE TIME RATIO

## Model 61-34 Perfected For Specialized Communications Application

PALISADES PARK, N. J.—An entirely new Lumped-Constant Delay Line, with a proven 170 to 1 delay time/rise time ratio, has been announced by the ESC Corporation, Palisades Park, N. J. The new delay line, known as Model 61-34, was specifically designed for a specialized communications application calling for the exceptionally high delay time/rise time ratio.

ESC, the world's leading manufacturer of custom built and stock delay lines, is already widely recognized in the electronics industry for its exceptional engineering advances. In October, 1958, ESC broke through an existing design barrier and produced a delay line with a 145 to 1 delay time/rise time ratio. It had been thought, prior to the announcement of the Model 61-34, that ESC had reached the ultimate in this type of delay line.



## SPECIFICATIONS OF NEW DELAY LINE MODEL 61-34

Delay time/rise time ratio: 170/1

Delay: 200 usec.

Rise time: 1.16 usec.

Attenuation: less than 2 db

Frequency response: 3 db = 325 KC

50 taps with an accuracy of  $\pm 0.2$  usec. at each tap.

Complete technical data on the new unit can be obtained by writing to

ESC Corporation, 534 Bergen Boulevard, Palisades Park, New Jersey.

CIRCLE 110 ON READER-SERVICE CARD



A personal and (let us hope) encouraging message to an  
**ELECTRONICS ENGINEER IN A QUANDARY:**

When Dame Destiny crooks her finger at you and says, "Let's go with Bendix in Kansas City, old boy!" you face a set of small problems that are well worth solving . . .



There is an excellent possibility that very soon we shall be offering you the position you've been waiting for. It could be a position at a higher level than the one you now hold and—have little doubt about this—you'll be tempted.

You may, during this period of decision, suffer torments like the engineer we picture above. (We sympathize with him . . . most of us have been through it ourselves.) We'd like to help you then but we know that you yourself must measure these personal cataclysms and weigh them against the advantages of your professional future here. We can only suggest that Kansas City abounds with other potential playmates or sweethearts, other teams hopefully waiting for a star player, and—who knows?—your new drapes may need only slight alteration to fit Kansas City windows.

We're supremely confident that *somehow* you will find the resolution and ingenuity required to solve these problems if we give you sufficient incentive.

So let's talk about incentive.

Because Bendix, Kansas City, is a long term prime contractor for the AEC, we can say little here about our products except that they are advanced electronic, electro-mechanical devices designed and manufactured to extraordinarily high levels of reliability. After only ten years we have become the city's largest manufacturer, and we're still expanding. Recently-inaugurated programs make most likely that we can offer you a position that will fully utilize your talents in design, production or supervision.

You should find our salary offer of more than passing interest.

In general, we need *electronic engineers* with at least a BS degree, although

in some openings a degree in *physics* is acceptable. Experience should range upwards of 5 years.

We welcome *design and development engineers* qualified in the design and development of miniaturized airborne electronic equipment, radar, servo, video, IF amplifiers or vacuum tube applications.

*Automation engineers* with a degree EE or physics would be well-advised to learn about our current major expansion into fully automated testing of electronic assemblies.

*Vacuum tube application engineers* will find us attentive when they speak of their work in ruggedized sub-miniature tubes, planar triodes, thyratrons or special purpose microwave tubes.

*Reliability engineers* (preferably with an electrical degree and at least 7 years experience, including some statistical work) will discover that our ever-increasing emphasis on reliability assures them a place in the sun.

We wish we could present all the facts you'll need to weigh, but we find we've barely started. There's much more to say . . . how the Bendix environment stimulates professional creativity and personal progress, how this area provides pleasant, easy-going, economical living, educational advantages, cultural and recreational facilities, etc. . . . but these can wait. For the moment let us simply assure you that—in far less time than you think—you and your family will feel at home here.

We're ready to get very specific regarding your financial incentive. We must first hear from you. May we, soon?

Write Mr. T. H. Tillman, Professional Personnel, Bendix, Box 303-MU, Kansas City, Missouri.



**KANSAS CITY DIVISION**

CIRCLE 923 ON CAREER INQUIRY FORM

**NEW PRODUCTS**

**Ferrite Shutter Switch**

Has no moving parts



Model W574-1A-1 ferrite shutter switch is for use in monopulse and doppler radar systems, surveillance, and fire control systems. It has no moving parts and can be used as a shutter or switch element. The frequency range is 13.5 mc  $\pm$  15 mc, isolation is 25 db min, and the insertion loss is 0.3 db max. The input vswr transmit is 1.1:1 max at center frequency and the input vswr reject is 30:1. Rise time is 100  $\mu$ sec max, control coil power is 2 w max, and the ambient temperature range is  $-85$  to  $+105$  C. The unit weighs 5 oz and measures 2-3/8 x 1-5/16 x 1 in.

Kearfott Co., Inc., Microwave Div., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

CIRCLE 111 ON READER-SERVICE CARD



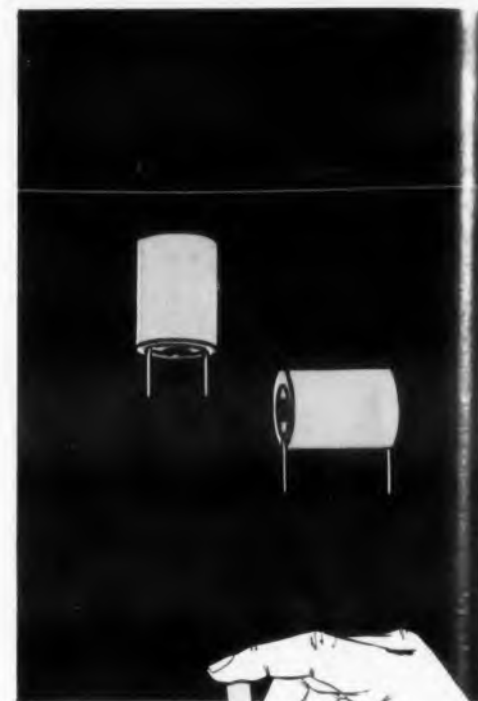
**Tape Handlers**

For 35, 80, and 100 ft of tape

These three continuous-loop transports handle magnetic tape in lengths up to 35, 80, and 100 ft. Designed for detailed analysis programs, such as those with analog computers and wave analyzers, the loop mechanisms have an isolated tape path under the multitrack record and playback heads for precise low-flutter performance. Tape widths up to 2 in. can be changed. The units have up to nine tape speeds, dual tension sensors, slide mounting, and integral power supplies. Series 3190 transport has a full view door with safety interlock. An adapter for series 3170 transports is also available.

Minneapolis-Honeywell Regulator Co., Dept. ED, 10721 Hanna St., Beltsville, Md.

CIRCLE 112 ON READER-SERVICE CARD



ACTUAL SIZE

New Miniature  
**VARIABLE  
 INDUCTOR**

FOR VERTICAL OR HORIZONTAL MOUNTING IN PRINTED CIRCUIT BOARDS

This new, ultra tiny Variable Inductor, with amazing subminiature characteristics, has stable inductance at extreme temperature variations and high reliability, along with light-weight and miniature size features.

- **INDUCTANCE RANGE:** 0.10 to 4700  $\mu$ H
- **INDUCTANCE ADJUSTABLE:**  $\pm$  20%
- **ENVIRONMENTAL:** Encapsulated in epoxy resin for protection against climatic and mechanical conditions.

**WRITE TODAY**

Free Descriptive Literature Available



**ESSEX ELECTRONICS**

DIVISION OF  
**NYTRONICS, INC.**

550 Springfield Ave., Berkeley Heights, N. J.

CRestview 3-9300

CIRCLE 113 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 25, 1959

ENGINEERING  
**REPORT**

ON OTHER BENDIX  
COMPONENT PACKAGES



## CAM COMPENSATOR

Efficient compensating device for servo system error.



The type CP-20-A1 is a simple, entirely mechanical means of correcting an output data shaft in relation to either servo loop errors, sensing errors, or known environmental factors affecting the system. Eliminates need for adjusting remotely placed or inaccessible units. Ask for full details.

## CLUTCHED SYNCHRO

Transmits corrective signal, or establishes new reference.



The type CP-4-A1 is an integrated unit containing a high-precision pygmy Autosyn\* synchro and an electro-magnetic clutch. Has general systemic application where it is desired to transmit a corrective signal, or to establish a new reference as a result of a temporary condition. Removal of electro-magnetic clutch excitation instantly re-establishes Autosyn, or signal source, at zero. Three unit-mounted resistors provide for proper output voltage as well as correct phase relationship of output voltage to excitation voltage. Write for further information.

\*REG. U. S. PAT. OFF.

Manufacturers of  
**GYROS • ROTATING COMPONENTS  
RADAR DEVICES  
PACKAGED COMPONENTS  
INSTRUMENTATION**

Eclipse-Pioneer Division



Teterboro, N. J.

CIRCLE 126 ON READER-SERVICE CARD

## Delay Line

Delay time is 1  $\mu$ sec



Having a delay time of 1  $\mu$ sec and a rise time of 0.2  $\mu$ sec, type 10C5-5/14 delay line comes in a 0.4 x 1.5 in. case. A lumped constant unit, it is suitable for printed circuit and transistor applications. The characteristic impedance is 1400 ohms, the attenuation is 3%, and the temperature coefficient is 0.03% per deg C. The temperature range is -55 to +105 C. The unit is molded in a hermetically sealed brass tube with the leads brought out through glass-to-metal end seals. Mil specs are met.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

CIRCLE 127 ON READER-SERVICE CARD

## Flowmeter

For aircraft use

Consisting of a flowmeter transmitter and a flow-rate indicator, this flowmeter system measures the fuel flow rate in aircraft by mass rather than by volume. Flow rates to 1200 pph can be measured. Its power requirements are 115 v 400 cps. It operates within the temperature range of -65 to +250 F and has a life of 500 hr continuous operation. The unit measures 3 in. long and 2 in. in diam and weighs about 2 lb. Indication may be by an illuminated pointer or an integrally-lighted dial scale; unlighted indicators are also available.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

CIRCLE 128 ON READER-SERVICE CARD

## Quadruple Exhaust Blower

Produces 250 cfm

For electronic cabinet cooling applications, model 4EB300 quadruple exhaust blower produces 250 cfm of air. Designed for rack mounting, it has vertical and diagonal exhausts with ventilators on the front and rear of the cabinet. Panel height is 5-1/4 in. The filter is easily changed without removing the unit from the cabinet. The motor meets CC-M-636A specifications.

McLean Engineering Labs., Inc., Dept. ED, P.O. Box 228, Princeton, N.J.

CIRCLE 129 ON READER-SERVICE CARD

ENGINEERING

**REPORT**  
ON BENDIX COMPONENTS



## ONE-MINUTE SYNCHRO SYSTEM ACCURACY

Electrical two-speed Autosyn\* synchro features—

- ACCURACY UNAFFECTED BY THERMAL AND MECHANICAL STRESS
- HIGH SIGNAL-TO-NULL RATIO
- ELIMINATION OF GEAR ERROR FOUND IN MECHANICAL TWO-SPEED SYSTEM
- ADAPTABILITY TO GYRO PICKOFF

Developed to meet need for accurate data transmission with maximum system simplicity. Produces two electrical outputs from single shaft, thereby eliminating inaccuracies of two-speed gear system as well as installation and maintenance costs of additional unit.

The synchro contains two separate sets of windings. One set pro-

duces the normal signal pattern of one cycle of output voltage, while the other produces eleven cycles, for each rotation of the synchro shaft. Increase in accuracy is very close to the 11-to-1 theoretical maximum, resulting in a system error of  $\pm 1$  minute when used back-to-back with similar units.

\*REG. U. S. PAT. OFF.

**ADDITIONAL CHARACTERISTICS:**

Input voltage (to rotor)	26 volts, 400 cycles, single phase
Input current	200 ma max.
Input power	2.5 watts max.
Signal-to-null ratio	350:1
Sensitivity (mv/degree)	3500

For more detailed information on specific applications, write—

Eclipse-Pioneer Division

Teterboro, N. J.



District Offices: Burbank and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C.  
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

CIRCLE 130 ON READER-SERVICE CARD

**10,000,000 PERFECT OPERATIONS:  
reliability... achieved by the  
remarkable A.P.I. meter-relay**

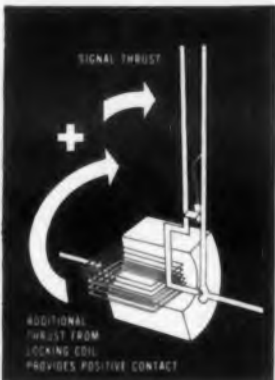


Suitable for any electrically-measurable variable, the A.P.I. meter-relay gives you sensitive monitoring, reliable control, combined in a single compact unit. It is an essentially simple instrument, yet a highly accurate and dependable one.

**HERE'S HOW IT WORKS**



1. Basically, the A.P.I. meter-relay is an indicating meter with built-in contacts. One contact is on the moving (signal-indicating) pointer; the other, on the adjustable (set-point) pointer. The indicating pointer is a free-moving element. The meter-relay has the high sensitivity inherent in a well-designed D'Arsonval movement.



2. At the instant of contact, a locking coil, wound integrally with the armature coil, supplements the torque developed in the meter movement. It is this locking coil — exclusively featured by A.P.I. — that assures positive contact every time. It holds the contacts together, maintains firm pressure to provide a good control circuit.



3. "Making" of the contacts loads the flexure spring on the set-point contact arm. When the contacts are released, they are immediately pushed apart by the force of the spring-loaded arm. There is no teasing or sticking; the break is decisive. Wiping action keeps contacting surfaces clean.

*If you need fully-reliable, stable control at a practical cost, you ought to have a look at our Catalog 4E. A copy is yours on request.*



**ASSEMBLY PRODUCTS, INC.**  
Chesterland 17, Ohio

S.A. 1805

CIRCLE 131 ON READER-SERVICE CARD

**NEW PRODUCTS**

**Nonreactive Resistance Standards**

Accuracy is 0.01%



These nonreactive resistance standards have an accuracy of 0.01% from dc to 50 kc. Model AC440 covers the range of 11,111 ohms in 0.1-ohm increments. Other models have from one to five dials, increments as small as 0.01 ohms, and resistance values up to 100,000 ohms. The method of reactance compensation used permits a choice of minimum inductance error, minimum resistance error, or the best compromise. The effect of shielding capacity is eliminated.

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

CIRCLE 132 ON READER-SERVICE CARD

**Amplifier**

Differential transformer type



Model 401C differential transformer-amplifier provides an output suitable for viewing on cathode ray oscilloscopes or for direct drive of pen or light beam galvanometer recorder. The instrument has an internal excitation supply, self-checking features which eliminate drift errors, and five calibrated sensitivity ranges which cover all usual scientific and industrial requirements. The frequency response is flat from 0 to 200 cps and useful to 500 cps. The accuracy is 2% with a maximum resolution of 0.000005 in. of core displacement.

Daytronic Corp., Dept. ED, 225 S. Jefferson St., Dayton 2, Ohio.

CIRCLE 133 ON READER-SERVICE CARD

**NOW...  
A HIGH-HEAT  
NON-SLIP  
LACING TAPE**



**GUDEBROD'S  
TEMP-LACE H**

Gudebrod synthetic rubber finish has now tamed slippery Teflon\* by coating it with synthetic rubber. Once cables are laced with Temp-Lace H, they're laced for good... because there's no knot-slip; no harness slip. Assemblies stay tight and firm.

Flat-braided of pure, inert Teflon, Temp-Lace H is non-corrosive to hands or instruments. Now coated with Gudebrod's non-flaking, fungistatic rubber finish, it's non-slip, and flexible from -40° to 220°C. It won't cut through insulation.

Temp-Lace H is available in five sizes; or we will engineer a tape to meet your specifications. Write today for Data Book giving complete information on ALL Gudebrod Lacing Tapes and Drive Cords.

\*Du Pont's TFE fluorocarbon fiber

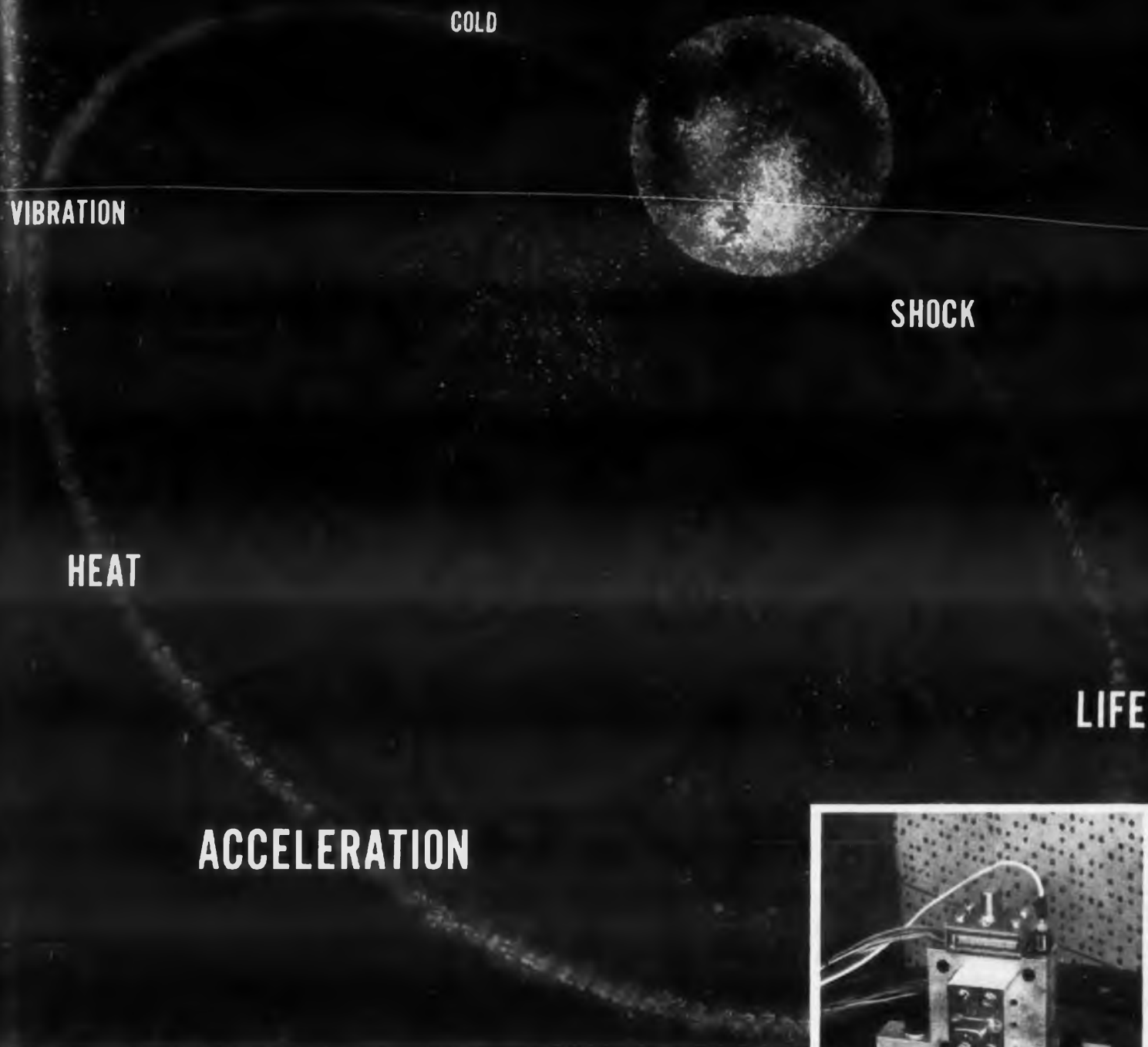
**GUDEBROD  
BROS. SILK CO., INC.**

ELECTRONIC DIVISION  
225 West 34th Street, New York 1, N.Y.

EXECUTIVE OFFICES  
12 South 12th Street, Philadelphia 7, Pa.

CIRCLE 134 ON READER-SERVICE CARD

**GE SEALED RELAYS—unmatched for reliability**



## To the moon and back without leaving our lab

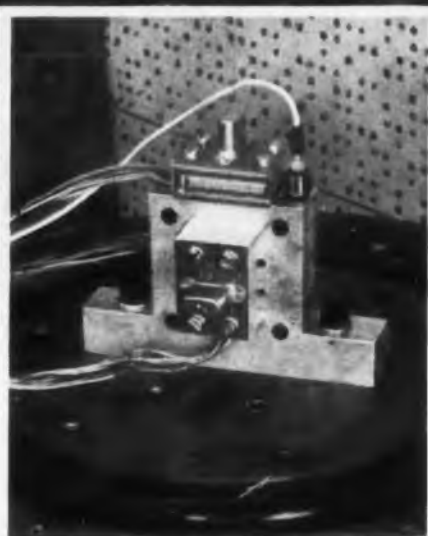
Rapid acceleration, vibration, violent shock, extreme temperatures—these are the environmental conditions found on a trip to the moon . . . and in General Electric's relay-testing laboratory as well. Here, exhaustive tests—simulating operating and atmospheric conditions—are conducted to continually verify the reliability of G-E sealed relays.

Even in standard production testing, General Electric goes well beyond requirements to assure reliability. Each lot of G-E relays is subjected to 27 tests and measurements before being released for shipment. For example, every relay built is subjected to a 15-cycle

dynamic contact-resistance check—the prime indicator of cleanliness.

For one demanding application, General Electric and the customer scheduled 109 tests for each unit. A 5% lot sample was subjected to destructive tests including monitored six-hour vibration and load-life tests. A single relay failure meant rejection of the entire lot. During this contract, 23 consecutive lots (over 4000 relays) were processed without a lot-sample failure!

But testing is only part of G.E.'s reliability story. Design leadership (such as produced the Unimite, the world's smallest 1-amp relay) and advanced



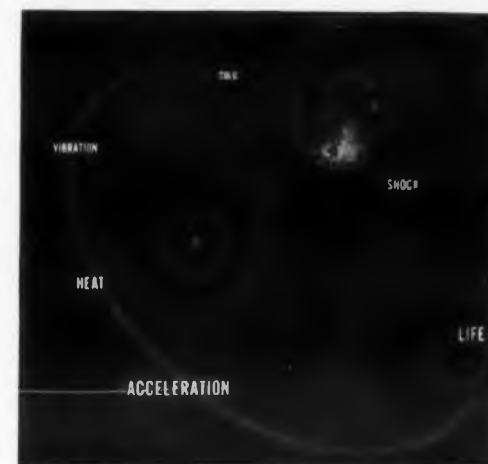
manufacturing techniques (including new inert-arc welding to eliminate contact-contaminating solder and flux) consistently produce superior relays.

Obviously, all relays don't require the same testing—but whatever your needs—General Electric has the know-how and facilities to meet them. See your G-E Sales Engineer, or mail the coupon at right. General Electric Co., Specialty Control Dept., Waynesboro, Va.

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

CIRCLE 135 ON READER-SERVICE CARD



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

G-E miniature, sub-miniature, micro-miniature and Unimite 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. G.E.'s complete line of sealed relays includes these basic types:



**MINIATURE:** Long-life type; rated 5 amps at 28 volts d-c; in 2- or 4-pole double throw and 6-pole normally-open forms. Ideal for ground use.



**SUB-MINIATURE:** 2 amps at 28 volts d-c, 115 volts a-c, double-pole double-throw. Excellent thermal life.



**MICRO-MINIATURE:** Crystal-can type, double-pole and new welded 4-pole units. Rated 2 amps, 28 v d-c or 115 v a-c. Grid-space terminals available.



**UNIMITE:** The world's smallest 1-amp sealed relay; single-pole type. Isolated contact chamber, high speed 1.5 millisecond operation.

General Electric Co.  
Section A792-11  
Schenectady 5, N. Y.

Please send me a free copy of the  
1959-60 Sealed Relay Catalog.

Name \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_  
State \_\_\_\_\_

**GENERAL  ELECTRIC**

## NEW PRODUCTS

### Control Transformers

Come in frequencies of 50 to 2600 cps



For control applications, these miniature epoxy-molded power transformers are available in va ranges to 25 va and in frequencies from 50 to 2600 cps. They can be supplied to meet MIL-T-27 grades 2 and 5. Nickel-plated brass screw stud terminals are furnished. Mounting may be strap, insert, or stud type.

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

CIRCLE 136 ON READER-SERVICE CARD

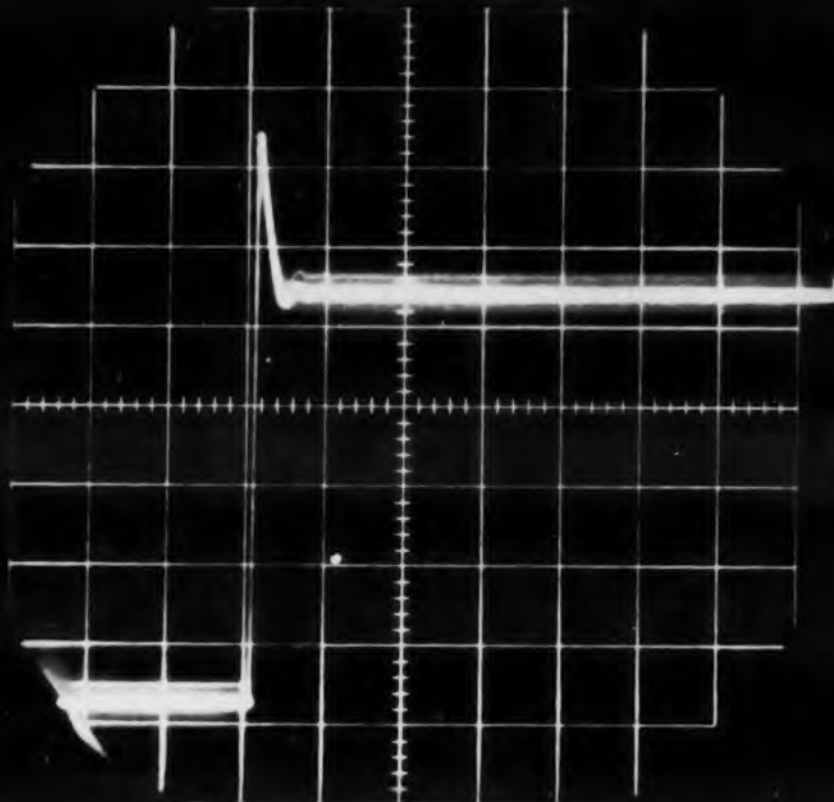
### Drive Unit

Worm gear type

For use with rotary components such as resolvers, syncros, potentiometers, and capacitors, type PDW-1 worm gear drive unit has a 180:1 ratio which allows direct dial readings of 1 min of arc. Compact in design, the unit has a plexiglass hairline indicator and large size engraved dials. The spring loaded gears are made of stainless steel or aluminum. Spring loaded ball bearings help to eliminate backlash. All parts are mounted in a machined, one-piece aluminum housing. Units can be supplied with the input shaft projecting from the back of the housing to allow driving from the rear and dial readout on the front.

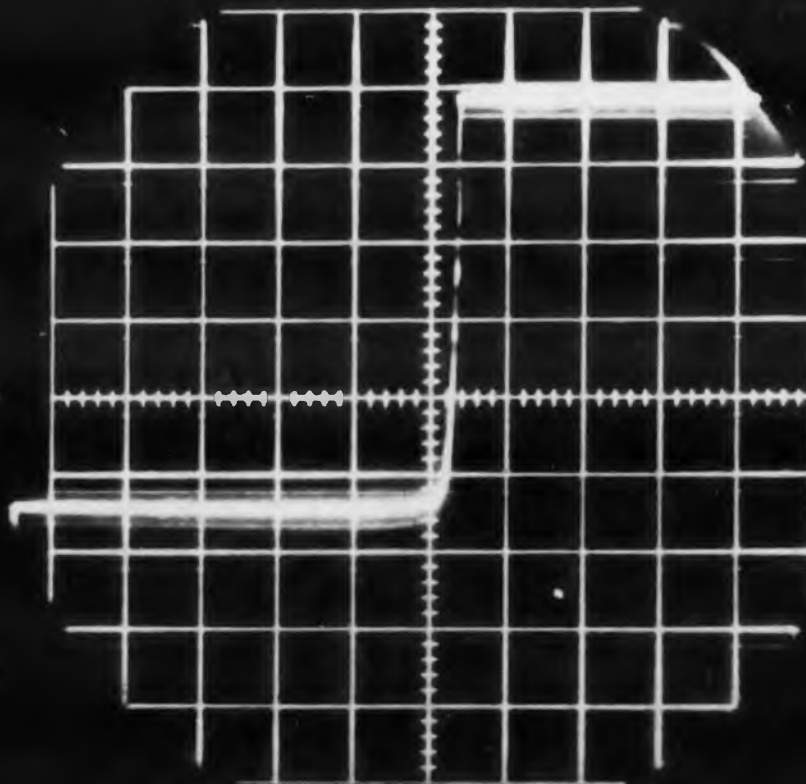
Acton Labs, Inc., Dept. ED, 533 Main St., Acton, Mass.

CIRCLE 137 ON READER-SERVICE CARD



Actual photographs of power supply turn-on at 28v setting. Scope settings: 5v per cm vertical, 0.2 sec. per cm horizontal.

## TRANSISTOR KILLER: THE VOLTAGE SPIKE...



## TAMED BY NEW PERKIN MTR DC POWER SUPPLIES

The voltage spike in the top photo could destroy the transistors in your circuit in microseconds. This one happens to be a "turn-on" transient—one of several treacherous, instantaneous overshoots encountered in the everyday use of dc supplies. For complete protection against line and load transients, use new Perkin MTR power

supplies. Combining the best two solid-state regulation principles, they use magnetic amplifiers for high efficiency and transistors for instantaneous regulation and low ripple. Made without tubes or moving parts, they give you long, trouble-free service. They're ideal for continuous-duty and unattended operation; Perkin MTR units sustain shorts and overloads indefinitely without suffering internal damage or shooting spikes into the load. After shorts, they resume normal operation automatically. And their protection is constant... even if an internal transistor fails, your Perkin MTR power supply continues to regulate smoothly and safely!

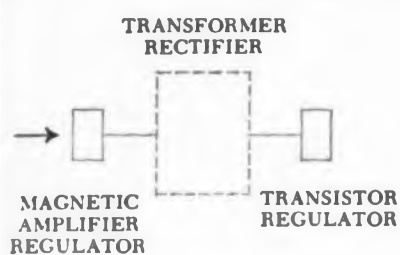
PERKIN



# PERKIN



MODEL NO. MTR-636-15



### NEW SOLID STATE REGULATION PRINCIPLE:

*magnetic amplifiers for efficiency and reliability, transistors for fast response*

Rugged magnetic amplifiers provide steady-state regulation of line and load. Fast-acting transistors suppress ripple and transients. Because the transistors function only during instantaneous line and load changes, their actual use is held to a minimum. MTR units thus have far better dynamic regulation than magnetic amplifier-regulated power supplies and much higher reliability than fully transistorized supplies.

### PERKIN / MTR REGULATED LOW-VOLTAGE DC POWER SUPPLIES

*prompt delivery*

Model No.	D.C. Output		Static Regulation		Dynamic Regulation		A.C. Input 60 CPS		Ripple
	Volts	Amps	Line	Load	Line†	Load††	Volts	Phase	RMS
MTR060-1 A	0-60	1	±10MV	±25MV	±10MV	±.2V	95-135	1	2MV
MTR060-5 A	0-60	5	±10MV	±25MV	±10MV	±.3V	95-135	1	2MV
MTR036-5	0-36	5	±10MV	±10MV	±10MV	±.2V	105-125	1	1MV
MTR036-15	0-36	15	±10MV	±10MV	±10MV	±.2V	105-125	1	1MV
MTR636-15	6-36	15	±25MV	±50MV	±25MV	±.75V	105-125	1	5MV
MTR636-30	6-36	30	±25MV	±75MV	±25MV	±.85V	105-125	1	5MV
MTR615-5	6-15	5	±10MV	±50MV	±0.1%	±.2V	105-125	1	3MV
MTR28-2	24-32	2	±0.1%	±0.1%	±0.1%	±.2V	105-125	1	5MV
MTR28-3	24-32	3	±0.1%	±0.1%	±0.1%	±.3V	105-125	1	5MV
MTR28-5	24-32	5	±0.1%	±0.1%	±0.1%	±.3V	105-125	1	5MV
MTR28-10	24-32	10	±0.1%	±0.1%	±0.1%	±.4V	105-125	1	2MV
MTR28-30	24-32	30	±0.1%	±0.1%	±0.1%	±.5V	105-125	1	5MV
MTR28-100	24-32	100	±0.1%	±0.1%	±0.5%	±2.0V	208/230/ 460 ±10%	3	20MV

†For 10V step change on 115V nominal input units; 10% step change on Model MTR 28-100

††For changes no load to full load or full load to no load. On fractional load changes, specifications are improved.

All models have Automatic Current Limiting protective circuitry which eliminates fusing. Voltage and current are automatically reduced to a safe level on overloads of 125% rated output and above, including dead short circuits. Over-

loads and shorts can be sustained indefinitely without damage to the power supply. All units available standard 19" rack or cabinet mount. Dynamic impedance down to 25 milliohms.

WRITE FOR COMPLETE PERKIN CATALOG on tubeless power supplies and new technical article on dc power sources for transistorized circuits.



## PERKIN

ENGINEERING CORPORATION

345 Kansas Street, El Segundo, California • ORegon 8-7215

New England Area Office: 46 Amesbury St. • Lawrence, Mass. • MURdock 3-3252

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Atlanta, Ga.—BLackburn 5-6660  
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Dallas, Tex.—FLeetwood 7-7080

Dayton, O.—CHapel 4-5551  
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Philadelphia, Pa.—WAlnut 7-1820  
Phoenix, Ariz.—WHitney 6-2111  
St. Louis, Mo.—PARkview 1-6403

San Diego, Calif.—ATwater 3-2081  
San Francisco, Calif.—EMerson 9-3354  
Seattle, Wash.—PARKway 3-9000  
Syracuse, N.Y.—GIBson 6-0220  
Washington, D.C.—JUniper 5-7550  
Agincourt, Canada.—AXminster 3-7011

## Insulation Papers

Melting point is 1900 F

Made of synthetic mica, the Crystal M insulation papers have a melting point of above 1900 F when heated in a closed system, and convert to a higher melting ceramic body when heated in an open system. The material has an index of refraction of 1.5, a bulk density of 2.7 g per cc, and is insoluble in water and organic solvents. It may be manufactured in calipers from 2 to 10 mils, but is now available at 5 mils only. It can also be made in blocks weighing from 10 to 20 lb per cu ft, and compression-molded shapes. Metal fibers, powders, and other conductive materials such as graphite can be included in the paper to produce controlled resistivity. It can be used on wires and cables as high temperature insulation and can be laminated to other materials.

Minnesota Mining and Manufacturing Co., Dept. ED, St. Paul 6, Minn.

CIRCLE 138 ON READER-SERVICE CARD

## Millivolt Potentiometer

Range is -11 to +101 mv

Type 8690 millivolt potentiometer has a range of -11 to +101 mv, eliminating the need to reverse input leads. It can be used in routine in-place checking of thermocouples, recorders, and controllers as well as for tests involving temperature measurements and calibration studies. The measured values are read directly in digits and a scale interpolation is obtained from a central reading window. The limit of error is ±0.05% of reading +20 μv without reference junction compensation, and ±0.05% of reading +40 μv with reference junction compensation. Completely self-contained, it has a manually-operated reference junction temperature compensator. It has a nine-position function switch.

Leeds & Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia, Pa.

CIRCLE 139 ON READER-SERVICE CARD

◀ CIRCLE 140 ON READER-SERVICE CARD

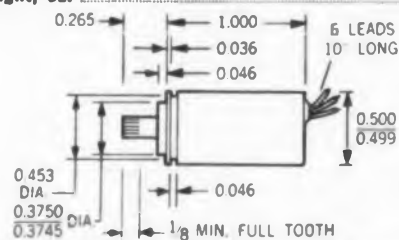
**imc**  
**SIZE**  
**5**  
**SERVO**  
**ONE**  
**INCH**  
**LONG**



**EPOXY ENCAPSULATED/RUGGED CONSTRUCTION**

IMC's new BT505 Size 5 servo motor is miniaturized for stringent aircraft and missile applications ■ Only one inch in length, this 400 cps servo motor is a rugged low inertia unit with high torque to inertia ratio ■ Its high torque per watt is unusual for its small size and weight ■ Control phase designed for transistor operation ■

Stall Torque, Oz. In.	0.09
No Load Speed, RPM	9500
Rotor Inertia, GM-CM <sup>2</sup>	0.15
Theo. Accel. RAD/SEC <sup>2</sup>	42,500
Time Constant, SEC	0.024
Weight, Oz.	0.68



	MOTOR	
	FIXED PHASE	CONTROL PHASE
Voltage, Volts	26	26
Current, Amps*	0.080	0.080
Power Input, Watts*	1.75	1.75
Power Factor*	0.85	0.85
R. Ohms DC	185	185
R. Ohms*	276	276
X. Ohms*	173	173
Z. Ohms*	325	325
Effective R, Ohms	383	383
Parallel Tuning Cap for Unity P.F., MFD*	0.60	0.60

\* Measured at Stall

**imc Magnetics Corp.**  
 Formerly: **Induction Motors Corp.**  
 570 MAIN STREET / WESTBURY, L. I., N. Y. • 6058 WALKER AVENUE / MAYWOOD / CALIF.

CIRCLE 141 ON READER-SERVICE CARD

**NEW PRODUCTS**

**AC Amplifier**

For airborne and telemetering use



Model WC-222 ac amplifier is for use in telemetering instrumentation, for amplifying the output of capacitive generator type transducers, and in missile nose cone instrumentation. The input signal range is 0 to 660 mv. A variable gain up to 20 db is available. The output impedance is about 5000 ohms. Frequency response can be altered to meet specific requirements. Both limited and unlimited outputs to match subcarrier oscillators and storage devices are available. Silicon transistors are used throughout. Potting and sealing offer resistance to environmental conditions and to shock and vibration. The largest dimension of the unit is 3-1/2 in. Requirements of MIL-E-8189 and MIL-T-5272 are met.

The Wurlitzer Co., Electronics and Defense Products Dept., Dept. ED, N. Tonawanda, N.Y.

CIRCLE 142 ON READER-SERVICE CARD

**Universal Bridge**

Accuracy is 0.1%



Type B-221 universal bridge provides for two, three, or four terminal measurements of an impedance or transfer admittance with an accuracy of 0.1%. Measurements provided are: capacities from 0.0002  $\mu$ f to 11  $\mu$ f, resistance of 10 ohms to 100 meg, and inductance from 1 mh.

Wayne Kerr Corp., Dept. ED, 1633 Race St., Philadelphia 3, Pa.

CIRCLE 143 ON READER-SERVICE CARD



**audible and visual  
 WARNING DEVICES**

*—small, accurate,  
 extremely reliable*

**Miniature Keyers, Flashers and Signals** are as small as 2 cubic inches ... weigh as little as 2 ounces. Accuracy of flashing rates is nominally  $\pm 10\%$ .

**Solid state reliability.** Units are static, and employ only semiconductors. Elimination of rotating parts and thermal elements means increased life and drastically reduced maintenance.

**MIL Specs.** Units are designed and manufactured to applicable Mil Specs.

**Applications:** Warning systems for fire and overheat, landing gear, air speed limits, navigation and position lights, stall indicators ... tracking signals, signal coding. Any mounting orientation and connector. Write for complete data.

Other solid state devices, DC-DC converters, DC-AC sine wave inverters, frequency sensors, voltage sensors, time delays and programmers, etc.

**JORDAN ELECTRONICS**  
 a division of  
 THE VICTOREEN INSTRUMENT COMPANY

3025 W. Mission Rd., Alhambra, Calif.

CIRCLE 144 ON READER-SERVICE CARD

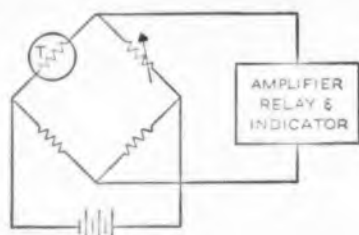
## Using Thermistors

Edited by  
FENWAL ELECTRONICS, INC.

### STABLE THERMISTORS PERMIT HIGH CONTROL ACCURACY WITH SIMPLE CIRCUITRY

Circuit shown for the Fenwal Electronics' Model 150 Temperature Controller is typical. It has a sensitivity of 0.001°C throughout its working range!

New, extremely stable, probes permit full exploitation of thermistors' inherently high sensitivity to temperature change.



Fenwal Model 150 Thermistor Controller

Operating characteristics of the new probes are precisely predictable and repeatable over the entire control range. Furthermore, the large change in resistivity of a probe in response to a small temperature change greatly simplifies circuit design. (Resistance can change as much as 4000 ohms — or more — for a change of only 1° in temperature.) In most cases, a standard resistance bridge circuit is ample for measurement of signal output.

For full details on thermistors, send for Catalog EMC-2. Further details on Model 150 also available on request. Write FENWAL ELECTRONICS, Inc., 310 Mellen Street, Framingham, Mass. And simplify your circuit design problems with a G200 Experimental Kit of thermistors. Available from Fenwal Distributors or the Framingham plant.



Making Precision Thermistors

Make Your Design Ideas Come True  
CIRCLE 145 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 25, 1959

**RF CABLE CONNECTORS.**—Snap-on versions of the firm's standard 50- and 75-ohm ConheX connectors are available. A spring ring or band around the slotted coupling sleeve provides the attachment means. These connectors are reduced in length and diameter.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N. Y.

CIRCLE 146 ON READER-SERVICE CARD

**NYLON STRAPPING.**—Has 5/8 in. width and is 0.07 in. thick. It is available in either 25 or 50 ft rolls in black or natural color. It can be furnished either plain or with continuously-spaced center holes. The strapping can be used as cable clamps and hangers for wiring, switches and other components. It can be safely used in temperatures from -60 to +250 F.

Weckesser Co., Dept. ED, 5701 Northwest Highway, Chicago 46, Ill.

CIRCLE 147 ON READER-SERVICE CARD

**MOTOR.**—Designed to conform to specifications CC-M-636, this motor is totally enclosed, and self cooled. The motor operates from 115 v ac, 60 cps, single phase. It measures 4.25 in. in diam by 6.75 in. in length and weighs 10 lb. Designated model 33N29, the unit is rated at 1/4 hp at 3300 rpm.

Western Gear Corp., Electro Products Div., Dept. ED, 132 W. Colorado Blvd., Pasadena, Calif.

CIRCLE 148 ON READER-SERVICE CARD

**GROMMET.**—This one-piece solid grommet is made from Zytel 103 nylon. It can be used in the temperature range of -65 to +300 F. The grommet is inserted through the aperture and flanged over with a tool. Each size, from 3/16 to 2.5 in. in diam, fits sheet gages ranging from 0.025 to 0.25 in. in four basic lengths.

Western Sky Industries, Dept. ED, 21301 Cloud Way, Hayward, Calif.

CIRCLE 149 ON READER-SERVICE CARD

**DISCRIMINATOR CHECKOUT SYSTEM.**—Will operate in automatic, semi-automatic, and manual modes. In the automatic mode, up to 18 discriminators can be given an 11-point checkout in 11 sec at an accuracy of better than 0.1% linearity.

Dynatronics, Inc., Dept. ED, Box 2566, Orlando, Fla.

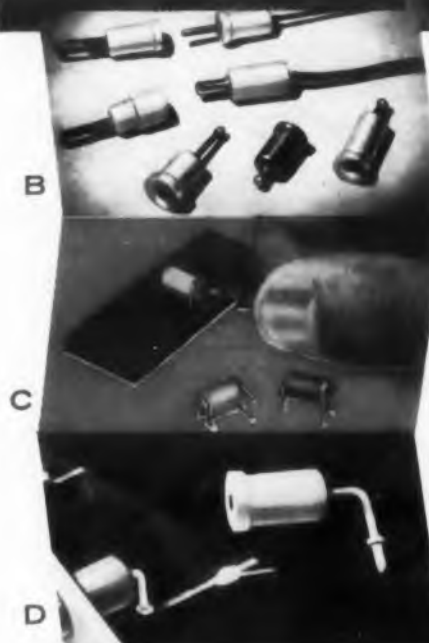
CIRCLE 150 ON READER-SERVICE CARD

**OXIDE CERAMICS.**—The Degussit line, sintered at about 1900 C, includes alumina, spinel, stabilized zirconium oxide, magnesium oxide, and kaolin bonded corundum. Type A1-23 pure alumina, sintered into tubes, rods, discs, and other configurations, is stable in oxidizing and reducing gases, in a high vacuum, and against all metals.

Materials for Electronics, Inc., Dept. ED, 152-25 138th Ave., Jamaica 34, N.Y.

CIRCLE 151 ON READER-SERVICE CARD

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**A** Non-breakable patch-cord board with "Press-Fit" jacks mounted in metal plate to take matching plugs and cords.

**B** Typical "Press-Fit" jacks and plugs in wide range of designs and sizes, even to subminiature test-point jacks.

**C** Printed-wiring "Press-Fit" jack that mounts in three holes forming a triangle, and is dip-soldered from underside of board.

**D** Simple "Press-Fit" jack that mounts in printed-wiring board and right-angle panel.

Making and breaking electronic connections is easier with *genuine* Sealectro "Press-Fit" jacks and plugs and break-away connectors. Wide choice of types provides just the *right answer* for each application. And it's easier, because:

■ One-piece jack or plug. No threads, nuts, washers, lockwashers or other hardware required. Minimum labor.

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■ "Press-Fit" jacks, accepting probes from .040" to .090", have heat-treated beryllium contacts for easy insertion and withdrawal, as well as longest service life.

#### LITERATURE...

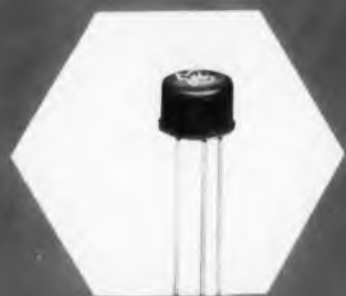
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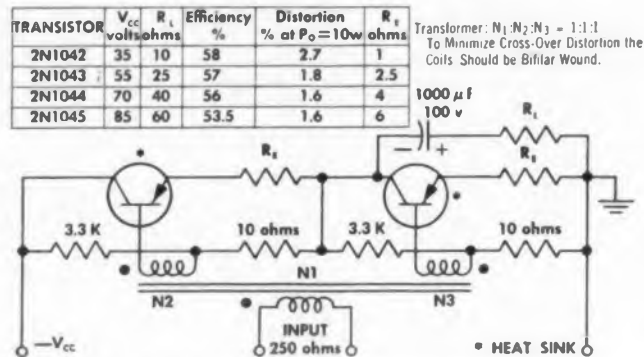
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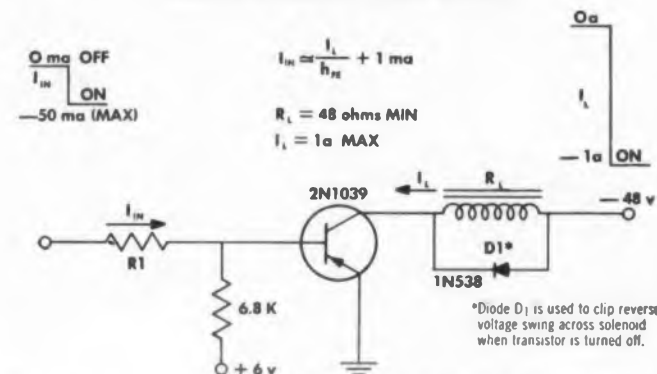
Dept. ED-6 • 223 W. Madison Street  
State 2-2944 • Chicago 6, Illinois

CIRCLE 153 ON READER-SERVICE CARD

TYPICAL AUDIO AMPLIFIER 10 WATTS OUTPUT



TYPICAL SOLENOID RELAY DRIVER



20-w power transistors:

switching circuits • relay drivers •  
audio and pulse amplifiers



ACTUAL SIZE

TI 2N1042 series alloy-junction transistors **guarantee** 20 w dissipation at 25°C with voltage ratings of -40, -60, -80, and -100 v. You get guaranteed 20-to-60 beta spread at -3 amps and low 0.16 ohm saturation resistance at the -3 amp maximum collector rating.

1.25-w power transistors:

medium speed switching circuits • relay drivers •  
low-power audio and pulse amplifiers



ACTUAL SIZE

TI 2N1038 series alloy-junction transistors **guarantee** 1.25 w dissipation in moving free air at 25°C with voltage ratings of -40, -60, -80, and -100 v. **Guaranteed** 20-to-60 beta spread at -1 amp and low 0.2 ohm saturation resistance assure reliable performance.

TI GERMANIUM POWER TRANSISTOR CHARACTERISTICS AT 25 C

Type	Dissipation at 25°C Watts	Max Collector Voltage Volts	Max Collector Current Amps	h <sub>FE</sub>		Collector Reverse Current I <sub>co</sub> max	Typical Saturation Resistance R <sub>CS</sub> Ohms
				min	max		
2N456	50	-40	-5	10 @ -5a	50	-2ma @ -40v	0.048
2N457	50	-60	-5	10 @ -5a	50	-2ma @ -60v	0.048
2N458	50	-80	-5	10 @ -5a	50	-2ma @ -80v	0.048
2N511	80	-40	-10	10 @ -10a	30	-2ma @ -20v	0.025
2N511A	80	-60	-10	10 @ -10a	30	-2ma @ -30v	0.025
2N511B	80	-80	-10	10 @ -10a	30	-2ma @ -40v	0.025
2N512	80	-40	-15	10 @ -15a	30	-2ma @ -20v	0.025
2N512A	80	-60	-15	10 @ -15a	30	-2ma @ -30v	0.025
2N512B	80	-80	-15	10 @ -15a	30	-2ma @ -40v	0.025
2N513	80	-40	-20	10 @ -20a	30	-2ma @ -20v	0.025
2N513A	80	-60	-20	10 @ -20a	30	-2ma @ -30v	0.025
2N513B	80	-80	-20	10 @ -20a	30	-2ma @ -40v	0.025
2N514	80	-40	-25	10 @ -25a	30	-2ma @ -20v	0.025
2N514A	80	-60	-25	10 @ -25a	30	-2ma @ -30v	0.025
2N514B	80	-80	-25	10 @ -25a	30	-2ma @ -40v	0.025
2N1021	50	-100	-5	10 @ -5a	30	-2ma @ -100v	0.08
2N1022	50	-120	-5	10 @ -5a	30	-2ma @ -120v	0.08
2N1038	1.25	-40	-1	20 @ -1a	60	-125µa @ -20v	0.2
2N1039	1.25	-60	-1	20 @ -1a	60	-125µa @ -30v	0.2
2N1040	1.25	-80	-1	20 @ -1a	60	-125µa @ -40v	0.2
2N1041	1.25	-100	-1	20 @ -1a	60	-125µa @ -50v	0.2
2N1042	20	-40	-3	20 @ -3a	60	-125µa @ -20v	0.16
2N1043	20	-60	-3	20 @ -3a	60	-125µa @ -30v	0.16
2N1044	20	-80	-3	20 @ -3a	60	-125µa @ -40v	0.16
2N1045	20	-100	-3	20 @ -3a	60	-125µa @ -50v	0.16
2N1046	35	-80	-3	20 @ -3a	160	-1ma @ -40v	0.9

germanium and silicon transistors  
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sensitive silicon resistors

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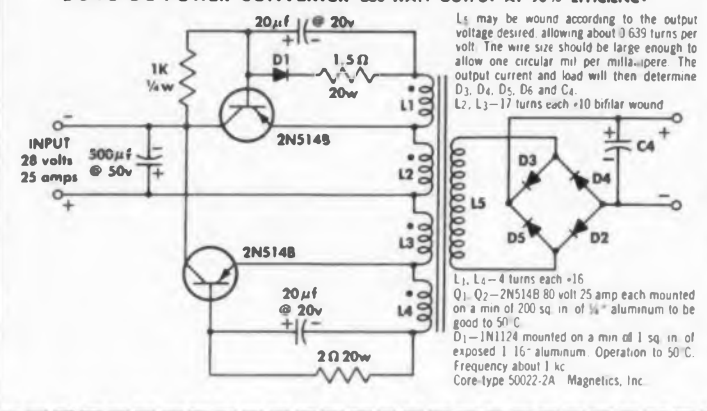
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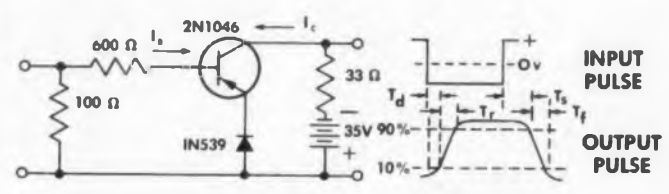
CIRCLE 154 ON READER-SERVICE CARD  
◀ CIRCLE 155 ON READER-SERVICE CARD

DC-TO-DC POWER CONVERTER 630-WATT OUTPUT AT 90% EFFICIENCY



$L_1$  may be wound according to the output voltage desired, allowing about 0.639 turns per volt. The wire size should be large enough to allow one circular mil per millivolt. The output current and load will then determine  $D_1, D_2, D_3, D_4$  and  $C_1$ .  
 $L_2, L_3$ —17 turns each +10 bifilar wound  
 $L_4$ —4 turns each +16  
 $Q_1, Q_2$ —2N5148 80 volt 25 amp each mounted on a min of 200 sq. in. of  $\frac{1}{8}$ " aluminum to be good to 50°C.  
 $D_1$ —1N1124 mounted on a min of 1 sq. in. of exposed 1 1/2" aluminum. Operation to 50°C. Frequency about 1 kc.  
Core-type 50022-2A Magnetics, Inc.

TYPICAL SWITCHING CHARACTERISTICS



TYPICAL SWITCHING TIMES

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

TEST CURRENTS

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

ACTUAL SIZE



10 to 25-amp switchers:  
high current switching applications

TI 2N511 series alloy-junction transistors guarantee collector currents of -10, -15, -20, and -25 amps in -40, -60 and -80 v ratings. All units provide low 0.025 ohm saturation resistance and typical switching times at 25°C of 12.5  $\mu$ secs ( $t_{on}$ ) and 8.0  $\mu$ secs ( $t_{off}$ ).

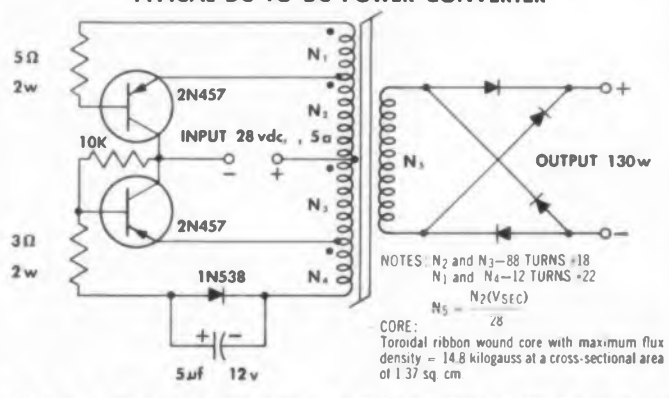
ACTUAL SIZE



high power/high frequency  
switchers:  
computer core drivers • deflection circuits  
• light weight converter applications

TI 2N1046 alloy diffused transistors combine high power, high frequency and high voltage performance in a single package. Guaranteed 35-w dissipation, collector breakdown voltage to -80 v, and low 0.75 ohm saturation resistance with 12 mc typical alpha cutoff insure reliable operating characteristics.

TYPICAL DC TO DC POWER CONVERTER



NOTES:  $N_2$  and  $N_3$ —88 TURNS +18  
 $N_1$  and  $N_4$ —12 TURNS +22  
 $N_5 = N_2(V_{SEC})$   
CORE: Toroidal ribbon wound core with maximum flux density = 14.8 kilogauss at a cross-sectional area of 1.37 sq cm

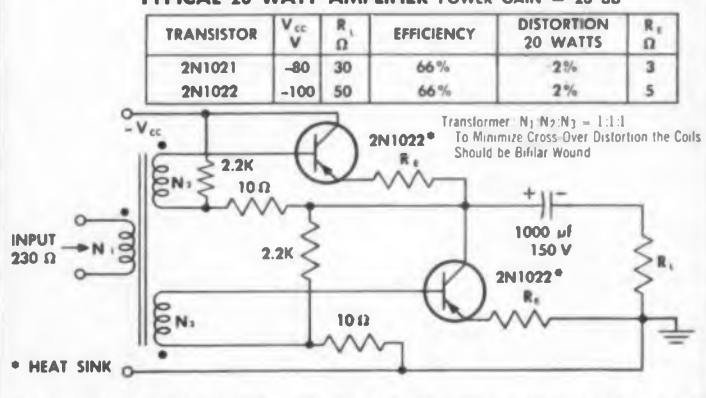
ACTUAL SIZE



high beta power amplifiers:  
audio amplifiers •  
current switchers • power converters

TI 2N456 series alloy-junction transistors with guaranteed 50-w dissipation, -40, -60, and -80 BV<sub>CBO</sub> ratings and less than 0.048 ohm saturation resistance provide optimum performance characteristics.

TYPICAL 20 WATT AMPLIFIER POWER GAIN = 23 db



TRANSISTOR	V <sub>CC</sub> V	R <sub>L</sub> Ω	EFFICIENCY	DISTORTION 20 WATTS	R <sub>e</sub> Ω
2N1021	-80	30	66%	2%	3
2N1022	-100	50	66%	2%	5

Transformer:  $N_1:N_2:N_3 = 1:1:1$   
To Minimize Cross-Over Distortion the Coils Should be Bifilar Wound

ACTUAL SIZE



high voltage power converters:  
audio • servo •  
power applications

TI 2N1021 and 2N1022 alloy-junction transistors guarantee maximum operating voltages of -100 v and -120 v respectively, low 0.08 ohm saturation resistance, and typical betas of 60 at -1 amp, 23 at -5 amps. You get guaranteed collector reserve current of -2 ma maximum at full rated voltage.

Check the specifications at left for the unit most suited to your particular requirements.

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# FANSTEEL 35 AMP. Silicon Power Rectifiers

1N SERIES—TYPE 4A

We're making them and shipping them out faster than ever to meet your increased needs for Fansteel Type 4A Silicon Power Rectifiers . . . and more help is on the way. Work on Fansteel's expanded plant facilities is nearly completed and soon, Type 4A 35 Amp. Silicon Power Rectifiers will be shipped even faster, with *stock delivery* on all popular ratings.

1N Series operate within  $-65^{\circ}\text{C.}$  to  $+165^{\circ}\text{C.}$  ambient range and are unaffected by storage temperatures to  $+200^{\circ}\text{C.}$  Maximum peak reverse voltages 50 to 400; they deliver up to 105 amps in bridge circuits. Type 4A's are shock and vibration resistant, hermetically sealed . . . can be mounted in any position.

Ask for complete data . . . Bulletin 6.305-1



E5911A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

CIRCLE 156 ON READER-SERVICE CARD

## NEW PRODUCTS

### Servo Amplifier Comes with power supply



Model 652 servo amplifier contains its own power supply which furnishes both regulated plate voltage and regulated filament voltage to the dc amplifier section. The unit accepts several dc input or feedback signals and produces an output signal compatible with most electrohydraulic servo valves. The amplifier has a maximum gain of 100 differential ma per v when driving a 4000-ohm center-tapped load, and produces a maximum differential current of  $\pm 40$  ma. It has front panel controls for gain, dither, balance, and level. Power required is 115 v 60 cps.

American Measurement & Control, Inc., Dept. ED, 240 Calvary St., Waltham 54, Mass.

CIRCLE 157 ON READER-SERVICE CARD

### Frequency Converter For ground check-out use



For use in laboratories and in ground check-out equipment, model W-1477 frequency converter changes 60 cps power to 115 to 200 v, 400 cps, three-phase power with a 750 va load capability. The standard frequency stability is 0.1%; special units having a frequency stability of 0.01% can be supplied. The maximum distortion at any load does not exceed 5% and the phase balance is  $120 \pm 2$  deg. Regulation of standard units with variation of input line from 110 to 120 v and variation of load from 0 to 750 va is less than 2%. The unit operates loads that vary from 0.85 lead to 0.9 lag PF. It withstands transient voltages of 80 v dc without damage. Operating life is in excess of 25,000 hr. Designed to fit a 19-in. relay rack, the unit has over-all dimensions of 7 x 19 x 17 in.

Electrosolids Corp., Dept. ED, 13745 Saticoy St., Panorama City, Calif.

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WMB DC-15 M/Cs

A new instrument with many varied facilities including:

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ELECTRONIC DESIGN • November 25, 1959



**Rheostat  
Potentiometer**  
Has enclosed design

The model E miniature rheostat potentiometer is now furnished in an enclosed style, consisting of a lightweight, drawn aluminum housing which is dust-tight. The three rheostat terminals are brought out to corresponding terminals on the back panel. Exclusive of the shaft, the enclosure measures 1-3/64 in. diam and 1-7/32 in. long. The unit is rated at 12.5 w at 40 C ambient temperature. It can be used in military as well as industrial applications.

Ohmite Manufacturing Co., Dept. ED, 3661 Howard St., Skokie, Ill.

CIRCLE 161 ON READER-SERVICE CARD



**Zener Regulators**  
For low voltage regulation

Designed for low voltage regulation, these Zener regulators come in two types: type RS-6 single anode unit and type RT-6 twin anode unit. Type RS-6 has a reverse voltage breakdown voltage of  $6 \pm 1$  v and a maximum dynamic impedance of 15 ohms. The RT-6 has 20 ohms maximum dynamic impedance at the same reverse breakdown voltage. Both ratings are at 10 ma dc. Both units are encapsulated in a hermetically sealed, corrosion-resistant case and operate over the temperature range of  $-50$  to  $+80$  C. Their applications include voltage reference and regulation for 12 and 24-v mobile power systems, replacement of gaseous tube regulators and reference units, and biasing and coupling elements in transistor circuits.

Hoffman Electronics Corp., Semiconductor Div., Dept. ED, 930 Pitner Ave., Evanston, Ill.

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**FANSTEEL**  
**S-T-A**  
**SOLID TANTALUM CAPACITORS**

If you're now using—or planning to use—solid tantalum capacitors, here's good news. All ratings, all sizes of Fansteel S-T-A Capacitors are now available from stock for immediate shipment. New and bigger production facilities, just completed, mean that now we can meet the constantly growing demand for Fansteel S-T-A's without delay . . . without interrupting your production schedules. Order "close-to-the-belt" or order for months ahead—S-T-A stocks are here when you need them.



The most complete range of ratings . . . consolidated into four miniature case sizes . . . unsurpassed stability at operating temperatures from  $-55^{\circ}\text{C}$ . to  $125^{\circ}\text{C}$ . . . ask your Fansteel representative for full information or get complete specifications in Bulletin 6.112-5.

**FANSTEEL**

**RELIABILITY**

CS911A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

CIRCLE 163 ON READER-SERVICE CARD

# TANTALUM... *After 37 Years* *Our Most Important Product*



**GLEN RAMSEY**, Vice President Fansteel Metallurgical Corporation and General Manager of Rectifier-Capacitor Division, displays (in right hand) porous tantalum anode he developed in 1936—the achievement which made today's miniature tantalum capacitors possible. One of the early applications of this anode was in a Fansteel surge arrester (shown on desk). Left hand holds present day tantalum capacitors.

There have been few developments in the past century that have been of more benefit to science and industry than the discovery by Fansteel of a method for producing tantalum commercially.

Our scientists have continued through the years to work on ways to improve tantalum and ways to use it. The development of the tantalum capacitor is one of the most important "firsts" at Fansteel. Contributing greatly to the age of miniaturization in electronics, the tantalum capacitor is characterized by long life, stability and highest reliability.

In 37 years of tantalum leadership—through research, development, production and application—we have constantly learned more and more about tantalum. Fansteel experience with tan-

talum and tantalum capacitors adds the extra ingredient to Fansteel Capacitor Grade Tantalum. This experience can't be found in technical literature. And it can't be bought. But we have it, and it is available to you.

There is no short cut to perfection in anything, certainly not in a metal like tantalum. It has taken Fansteel a long time to reach its position of leadership, and we feel that there is still some distance to travel. But we have gone far enough to assure continued supply of Capacitor Grade Tantalum in quantity, and continued improvement in quality. Fansteel Metallurgical Corporation, Rectifier-Capacitor Division, North Chicago, Illinois.



## CAPACITOR GRADE TANTALUM

A Premium Grade of Tantalum available to capacitor manufacturers in these forms:

FOIL • SHEET • STRIP • WIRE • ROD • FABRICATED WIRE LEADS  
SINTERED POROUS ANODES • METAL POWDER

CIRCLE 164 ON READER-SERVICE CARD

## NEW PRODUCTS



### Frequency Synthesizer

Has three ranges

Type XUB frequency synthesizer has ranges from dc to 100, 1000, and 10,000 cps with crystal-locked steps of 1, 10, and 100 cps and a maximum error of 0.5, 5, and 50 mc. The output voltage is continuously variable from 3 mv to 3 v, sinusoidal and spurious frequencies suppressed by more than 60 db. The instrument can be used in calibrating direct reading frequency meters, in investigating mechanical resonant systems, in measuring if crystals, and in engineering control.

Rohde and Schwarz, Dept. ED, P.O. Box 275, Passaic, N.J.

CIRCLE 165 ON READER-SERVICE CARD

### X-Y Plotter

Operates from differential transformers



Designed to operate from differential transformers, model HR-94 plotter may be used to plot small mechanical movements or any related variables which can be converted to mechanical movements. Applications include plotting contours of miniature bearing races, plotting surface and gear tooth irregularities, stress, strain, pressure, spring, and bellows deflections. The multiplication factor is adjustable to 1000:1 with a total error of less than 0.15%. Movements of 20  $\mu$ in. are detectable. Signal, reference, and rebalance circuits are 400 cps originating from a built-in tuning fork oscillator. The servo systems operate from 50 or 60 cps line frequency. Pen speed is 2 in. per sec. Standard 24 x 36 in. paper or 24 in. roll stock graph paper may be used.

Houston Instrument Corp., Dept. ED, 1717 Clay Ave., Houston 3, Tex.

CIRCLE 166 ON READER-SERVICE CARD



## Paints

### Electrically conductive types

These electrically conductive silver paints are used in color coding surfaces of components such as disc thermistors and in coding complex printed wiring. The paints can be brushed on the terminals of electronic control assemblies during tests to facilitate connections. Available are a silver conductive coating No. SCE22 and coatings having resistances of 20, 200, and 2000 ohms. Type RSE32, having a resistance of 2000 ohms, has abrasion, solvent, and slip resistance. The paints may be air dried or baked. Primers and thinners can also be furnished.

Micro-Circuits Co., Dept. ED,  
New Buffalo, Mich.

CIRCLE 189 ON READER-SERVICE CARD

## DC Power Supply

### Provides 4 to 35 v

This transistorized dc power supply provides from 4 to 35 v at 0 to 4 amp. The output is continuously variable by means of a knob on the front panel. Regulation is 0.1% for load and line variations with no internal adjustments. The unit operates from a 105 to 125 v, 60 cps line. It measures 3-1/2 x 10 in. and can be mounted in a 19-in. rack. Fully enclosed, it is also suitable for bench use. All parts are easily accessible.

Dynamic Controls Co., Dept. ED,  
155 Massachusetts Ave., Cambridge,  
Mass.

CIRCLE 190 ON READER-SERVICE CARD

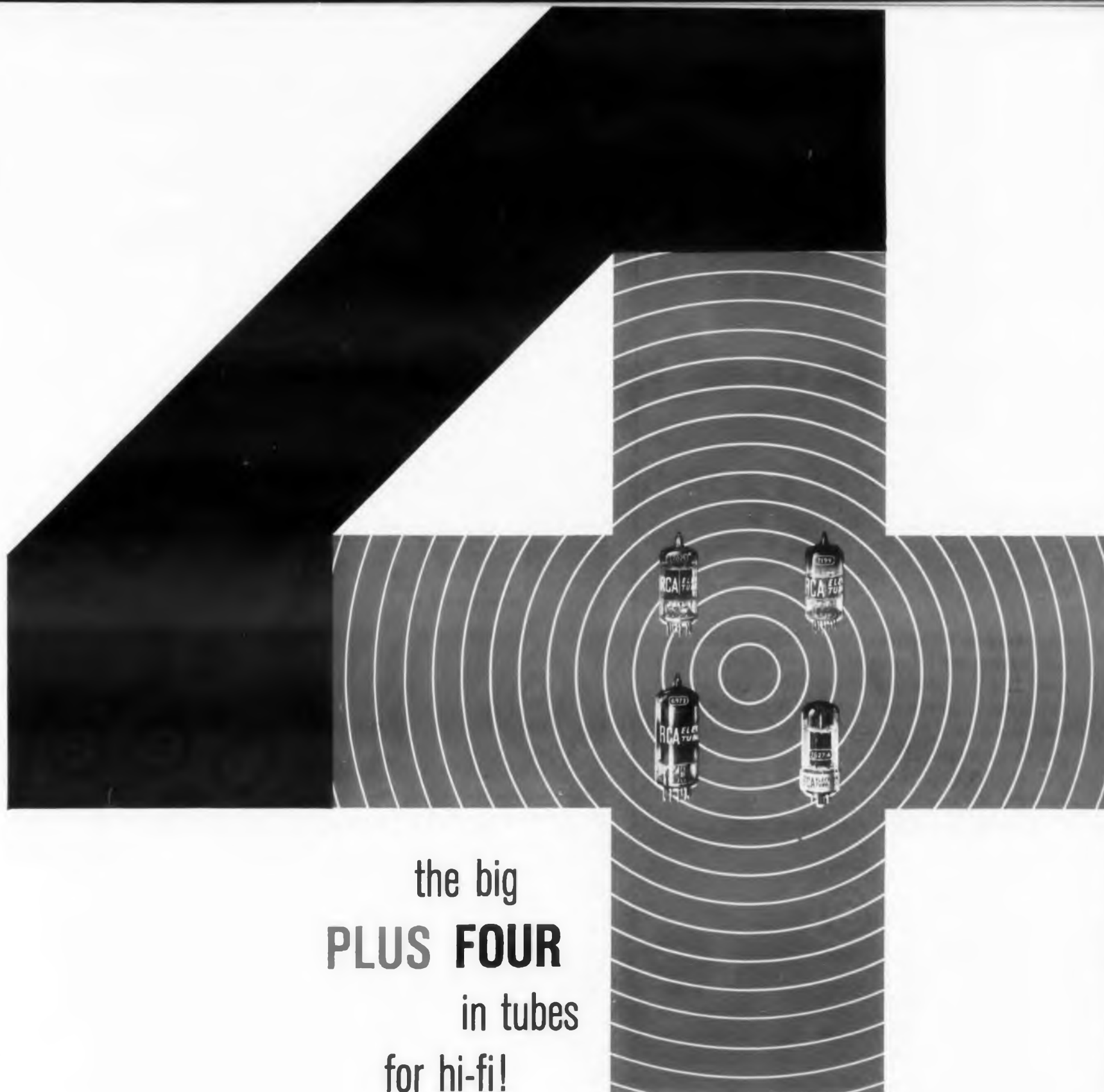
## Digital Data Printer

### Stands 50 g shock

Designed for military uses, model 2000 digital data printer withstands 50 g shock. The unit operates directly from electronically generated decimal or binary-coded decimal data sources. It operates in the temperature range of 0 to 125 F and can be stored for indefinite periods in temperatures from -65 to +160 F.

Clary Corp., Dept. ED, San  
Gabriel, Calif.

CIRCLE 191 ON READER-SERVICE CARD



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in tubes  
for hi-fi!

**RCA-7025 ...** "low noise and low hum" characterize the performance of this high-mu twin triode—ideal for your pre-amplifier designs.

**RCA-7199 ...** "versatility" keynotes the applications for this tube—a sharp-cutoff pentode and a medium-mu triode in one envelope—for low-level stages.

**RCA-6973 ...** "compact, but powerful" can describe monophonic and stereophonic power amplifiers designed around this 9-pin miniature—a pair in Class AB1 can deliver up to 20 watts output.

**RCA-7027-A** "power deluxe"—up to 76 watts with only 2% distortion from a pair in Class AB1 audio service—new structure design provides exceptional electrical stability and reliability.

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS

From pre-amplifier to power amplifier, mono or stereo, you can design a comprehensive line of high-fidelity products around these 4 RCA tube types. And your designs with RCA tubes add up to recognition . . . for quality, performance, prestige. Contact your RCA Field Representative for details. For technical data, write RCA Commercial Engineering, Section K-18-DE4, Harrison, N. J.

EAST:  
744 Broad St., Newark 2, New Jersey,  
Humboldt 5-3900

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

WEST:  
6355 East Washington Boulevard, Los  
Angeles 22, Calif., Raymond 3-8361

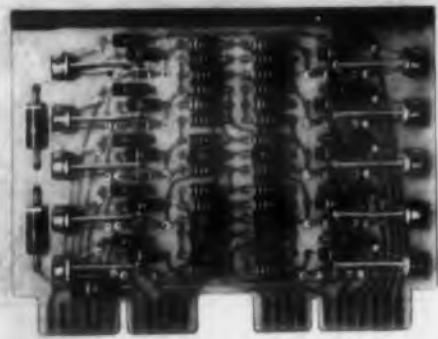


**RADIO CORPORATION OF AMERICA**  
Electron Tube Division  
Harrison, N. J.

## NEW PRODUCTS

### Indicator Driver

Is a BDC-to-decimal converter



Type NX-101 Nixie driver is a BDC-to-decimal converter that accepts the 8-4-2-1 binary decimal code from a decimal counter and applies the appropriate drive signals to the corresponding cathode of a Nixie tube. Each of the 10 stages consists of a npn transistor and a resistor decoder. The unit decodes signals from any flip-flop capable of sustaining an additional 3 ma in the on-transistor and having an off-collector potential of +17 v min. The power requirements are +195 v  $\pm$  2% at 5.5 ma, +20 v  $\pm$  5% at 9.5 ma. Input specifications are +18 v  $\pm$  10%, -5% at 3 ma, and the output specifications are +20 v at 2 ma.

Computer Control Co. Inc., Dept. ED, 983 Concord St., Framingham, Mass.

CIRCLE 167 ON READER-SERVICE CARD

### Silver-Zinc Battery

Has matched dual outputs

Model P43A silver-zinc battery consists of two battery sections having identical output and capacity. It is for use where standby capacity is required, or where one circuit must meet a heavy peak current demand, while the other has a steady, non-fluctuating load. Each 19-cell section provides a current of 3 amp at 26.5 v. Maximum current is 12 amp with a discharge time of 25 min at 3 amp. Capacity is 1.3 amp-hr. Internal voltage regulation insures less than 10% voltage fluctuation under maximum surge loads. Both sections are automatically activated in 0.5 sec; the signal required is 4 amp at 28 v. The unit withstands shock to 100 g, acceleration to 50 g, and vibration to 8 g along all three major axes. The temperature range is 40 to 80 F; units operating from -65 to +165 F can be provided. The battery measures 5 x 5 x 6 in. and weighs 7 lb.

Cook Batteries, Telecomputing Corp., Dept. ED, 3850 Olive St., Denver, Colo.

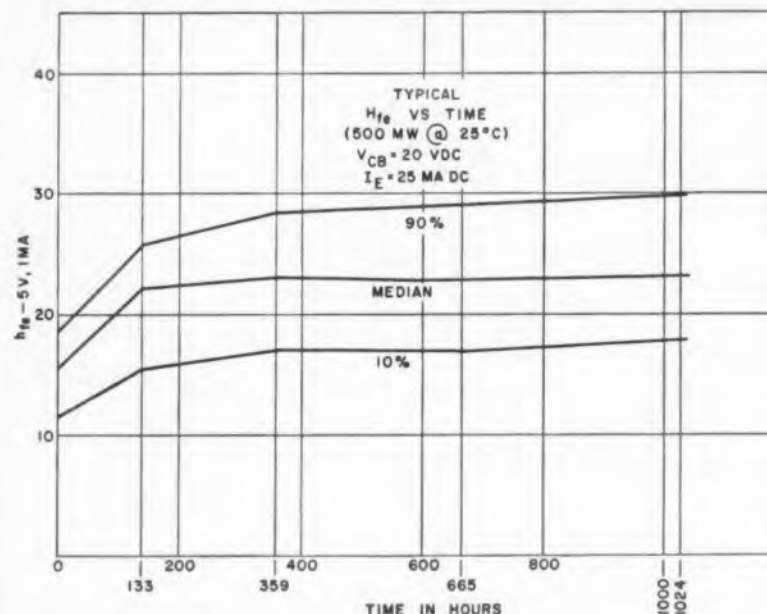
CIRCLE 168 ON READER-SERVICE CARD

## GENERAL ELECTRIC SEMICONDUCTOR NEWS

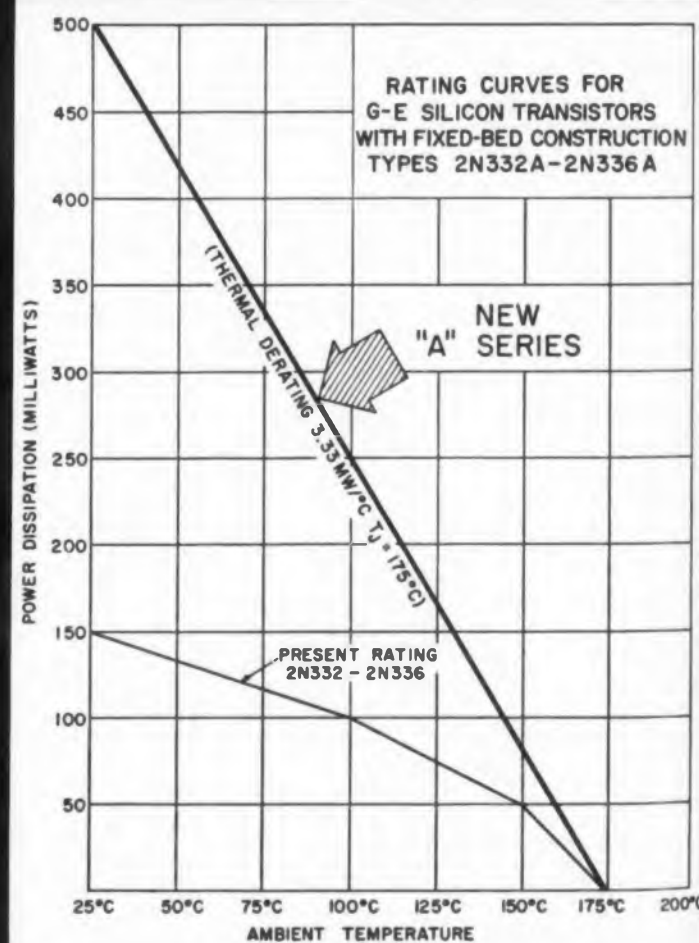
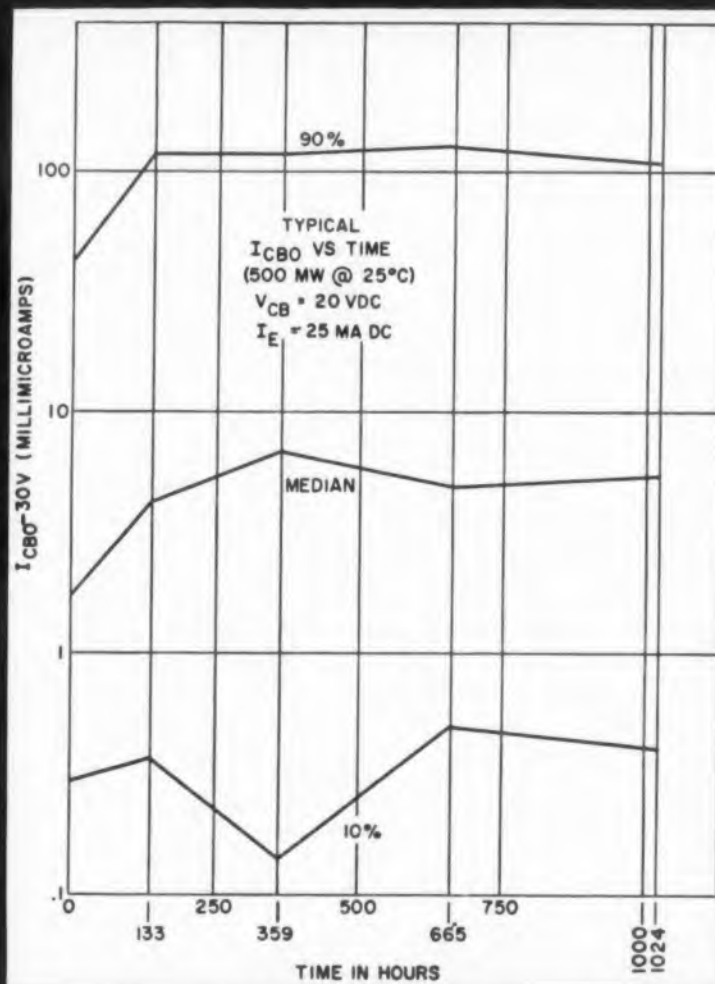
# New silicon triodes dissipate



Greatly magnified photo of silicon transistor showing Fixed Bed Construction. All parts are firmly fastened, with no suspended parts except wire lead. Transistor reacts as a solid block in resisting shock and vibration. Power dissipation is inherently higher.



Power dissipation of the 2N332A-through-2N336A silicon transistors (see chart below) ranges from 500 mw at 25°C to 83 mw at 175°C without heat sink. Note also (see chart below, left) the extremely low I<sub>CBO</sub> throughout 1000 hours of testing. Nearly 90% of units fall within 100  $\mu$ A. Beta spread (chart above) is stable out to 1000 hours.



# 500 mw without heat sink at 25°C

FIXED BED MOUNTED TRANSISTORS 2N332A-through-2N336A ALSO FEATURE:

4 VOLT  $V_{EB}$  . . . GUARANTEED 45 VOLT  $V_{CE}$  . . . .005  $\mu A$  MAX.  $I_{CBO}$

AT 25°C AND 30 VOLTS . . . PHYSICAL AND ELECTRICAL STABILITY

The 2N332A-through-2N336A line of silicon NPN triodes is a new series of amplifier and switching transistors capable of much higher performance than ever before achieved.

Collector dissipation without heat sink is 500 mw at 25°C . . . 83 mw at 150°C. Since reliability is related to junction temperature, even those designs which do not require maximum-rated power may be enhanced greatly by this device series because of the wide safety-factor potential provided.

**FOUR OTHER ADVANTAGES**—Collector-to-emitter voltage is guaranteed at 45 volts. Collector leakage current is a maximum of 500  $\mu A$  at 30 volts and 25°C. Collector-to-emitter leakage current is 60  $\mu A$  at 150°C. Minimum cutoff frequency is 2.5 mc, typical  $f_{\alpha}$  is 10 to 15 mc.

**FIXED BED MOUNTING**—Fixed Bed Mounting is an exclusive G-E construction technique which contributes to the extreme stability obtained by

this series of transistors. Storage and operating tests have resulted in a performance rate of better than 99.2% after 1000 hours.

Besides the demonstrated electrical characteristics, General Electric's silicon transistors can absorb physical punishment far beyond normal specifications. All parts are solidly fixed together and react as a solid block in resisting shock and vibration. Test units have been fired from a shotgun, struck with a golf club and rattled freely in an auto hubcap for 700 miles—and worked afterward.

**IMMEDIATELY AVAILABLE**—All types are available now from warehouse stock. Call your General Electric Semiconductor Sales Representative for complete details on the "hot" transistor line that operates the coolest. General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

## TYPE 2N333-THROUGH-2N335 SILICON TRANSISTORS MEET MIL-T-19500/37A SPEC.

Designing to the new MIL-T-19500/37A Spec? General Electric types 2N333, 2N334 and 2N335 can be supplied from warehouse stock to meet this specification.

### SPECIFICATIONS

#### Absolute Maximum Ratings (25°C)

<b>Voltages</b>		
Collector to Base	$V_{CB}$	45 volts
Collector to Emitter	$V_{CE}$	45 volts
Emitter to Base	$V_{EB}$	4 volts
<b>Current</b>		
Collector	$I_C$	25 ma
<b>Power</b>		
Collector Dissipation RMS	$P_C$	500 mw @ 25°C (Free Air) 83 mw @ 150°C (Free Air)
<b>Temperature</b>		
Storage	$T_{STG}$	-65 to 200°C
Operating Junction	$T_J$	-65 to 175°C

#### Electrical Characteristics (Typical at 25°C)

	2N332A	2N333A	2N334A	2N335A	2N336A	
<b>DC Characteristics</b>						
Forward Current Transfer Ratio (low current) ( $I_C = 1$ ma, $V_{CE} = 5$ V)	$h_{FE}$	16	27	36	45	75
Saturation Voltage ( $I_S = 1$ ma, $I_C = 5$ ma)	$V_{CE}(\text{Sat})$	.5	.45	.42	.4	.4 volts
<b>Cutoff Characteristics</b>						
Collector Current ( $V_{CB} = 30$ V; $I_E = 0$ ; $T_A = 25^\circ\text{C}$ )	$I_{CBO}$	1	1	1	1	1 $\mu A$
Collector Emitter Current ( $V_{CE} = 30$ V; $I_S = 0$ ; $T_A = 150^\circ\text{C}$ )	$I_{CEO}$	60	60	60	60	60 $\mu A$
<b>Low Frequency Characteristics</b> ( $V_{CB} = 5$ V; $I_E = -1$ ma; $f = 1000$ cps)						
Forward Current Transfer Ratio	$h_{FE}$	16	30	38	52	95
Input Impedance	$h_{ie}$	750	1300	1700	2000	3700 ohms
Output Admittance	$h_{oe}$	3.5	5.0	6.0	7.0	8.0 $\mu\text{hos}$
Output Admittance	$h_{ob}$	.25	.2	.18	.15	.13 $\mu\text{hos}$
<b>High Frequency Characteristics</b> Common Base ( $V_{CB} = 5$ V; $I_E = -1$ ma)						
Output Capacity ( $f = 1$ mc)	$C_{ob}$	7	7	7	7	7 $\mu\text{f}$
Cutoff Frequency	$f_{cb}$	10	11	12	13	15 mc
Power Gain (common emitter) ( $V_{CE} = 20$ V; $I_E = -2$ ma; $f = 5$ mc)	$G_s$	11	11	12	12	12 db

# GENERAL ELECTRIC

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## Bias Supply

For measuring infrared photoconductors



Made for use with photoconductors or thermistor bolometers, model 501 bias supply has voltage ranges of 0 to 50, 100, and 500 v and current ranges of 25, 100, 250, and 1000 ma. The current through the detector provides a monitor of the detector or of the cooling system. The resistance of a detector under actual conditions of use can be measured. Battery operated, the unit has a low noise figure. The battery life is 6 months under normal conditions. Accuracy is 1%. Fine control on voltage and overload protection on the microammeter are provided.

Infrared Standards Lab., Dept. ED, 10555 Magnolia Ave., Riverside, Calif.

CIRCLE 170 ON READER-SERVICE CARD

## Phase Shifter

For X-band use



This X-band phase shifter provides an electronically variable mismatch for frequency control of low-power magnetrons and klystrons. It can be designed to fit a number of frequency control and antenna phasing systems applications, including magnetron frequency controllers and serrodyne phasers. Phase variation is  $\pm 45$  min. phase shift, driving power requirements are 0.6 w max, and typical dc coil characteristics are 200 ohms max at -100 ma max. The power handling capacity is 2 kw peak and 2 w avg. The unit uses a longitudinal magnetic field with a ferrite rod supported in a foam dielectric.

Litton Industries, Dept. ED, 336 N. Foothill Road, Beverly Hills, Calif.

CIRCLE 171 ON READER-SERVICE CARD

# PESCO STATIC INVERTERS

NO  
TRANSISTORS

HIGHLY  
RELIABLE

FEWER  
COMPONENTS

SHORT  
CIRCUIT  
PROTECTED



A high degree of efficiency and reliability is assured by the new PESCO

Static Inverter developed by BORG-WARNER research.

Utilizing controlled rectifiers and no transistors, the new unit offers exceptional performance under space flight conditions.

Fewer components increase reliability. Operation at ambient temperatures of  $-55^{\circ}\text{C}$  up to  $+135^{\circ}\text{C}$  is possible without fans or coolers. Built-in short circuit protection, automatic or manual (local or remote) reset, is accomplished without fuses or circuit breakers. Other outstanding characteristics include:

Voltage Regulation to  $\pm 1\%$ ; Frequency Regulation to  $\pm .005\%$ ; Inherent sine wave output.



STATIC INVERTERS available from 250 VA to 3000 VA.



PESCO PRODUCTS DIVISION  
Borg-Warner Corporation  
3310 Vanowen Street • Burbank, California  
24700 No. Miles Road • Bedford, Ohio

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## NEW PRODUCTS

### Shift Registers

Repetition rates are 10 to 400 kc



The SRA-10 ten-bit magnetic shift registers are available with positive or negative outputs in five models: 50 kc at 6 and 12 v, 100 kc at 6 and 12 v, and 200 kc at 12 v. All units operate from zero to rated speed. The low shift drive permits 200 bits to be driven by 100 ma with a 5-v peak drop across the series shiftline. The serial input and output are permanently wired on the printed wiring board. At rated repetition rates, the power consumption is 1.2 w. Suitable for military and industrial applications, the units have a life expectancy of over 100,000 hr.

Di-An Controls, Inc., Dept. ED, 40 Leon St., Roxbury 15, Mass.

CIRCLE 173 ON READER-SERVICE CARD

### Excitation Power Supply

Regulation is 0.2%



Designed for use in transducer excitation, ac meter calibration, and distortion measurement, model AP-0069 3-kc excitation power supply has a regulation of 0.2% under all conditions and a nonfundamental output of less than 0.05%. The power output capability is 5 w. Typical applications include excitation of bridge-type testing devices for production or incoming inspection, excitation of strain gage or potentiometer transducers, and use as a source in carrier data equipment.

C. A. Rypinski Co., Dept. ED, 2005 N. Oaks Ave., Pasadena, Calif.

CIRCLE 174 ON READER-SERVICE CARD

## SPECIAL REPORT ON SYNCHROS:



Induction Motors of California Size 8 Synchros

### Induction Motors of California Manufactures Complete Synchro Series

A full line of size 8 (.750" diam.) and size 11 (1.062" diam.) synchros, resolvers and linear transformers for indication and control are manufactured by Induction Motors of California, Maywood, California, in general accordance with MIL-S-20708.

#### GENERAL SPECIFICATIONS FOR TYPICAL SIZE 8 SYNCHROS

26 VAC 400 CPS  
 $\pm 7'$  MAXIMUM ERROR  
30 MV MAXIMUM NULL

IMC TYPE	INPUT (MA)	PHASE SHIFT (DEGREES)	OUTPUT (VOLTS)
Torque Transmitter 9708-002	150	12	11.8
008-235	100	8	11.8
Control Transformer 9708-003	120	12	23.5
9708-007	7	17	22.5
008-334	29	8	22.5
Resolver Transmitter 9708-004	50	22	10.4
Linear Transformer 9708-005	110	10	18.0
Control Differential 9708-006 (Rotor Primary)	100	12	11.8

Detailed Specifications Available Upon Request

#### OVER 100 DESIGNS AVAILABLE

Induction Motors of California has over 50 standard Size 8 designs. Any of these may be furnished with electrical or mechanical variations to suit your particular application.

Over 50 standard Size 11 synchro designs, including Navy BuOrd types, have been produced to meet exact customer requirements. A typical group of 115V and 26V BuOrd synchros immediately available are:

11CT4b 11CX4b 11CDX4b  
11TX4b 11TR4b

Specifications on synchro components, as well as complete information on step-servo motors and solenoids manufactured by our company, are available when requested on company letterhead.



### Induction Motors of California

DIVISION OF  
IMC MAGNETICS CORP., N.Y.  
6060 Walker Avenue, Maywood, California  
LUdlow 3-4785

Representatives in principal cities

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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 176 ON READER-SERVICE CARD

## PAM/PDM Simulator

Tests decommutation systems



Model S9A transistorized PAM/PDM simulator provides simulated PAM and PDM telemetry signals and supplies pulse trains that conform to IRIG standards. The unit performs preliminary calibration and checks functional operation of decommutation equipment. In PAM operation, the frame synchronization pulse duration can be two or three sample periods. Synchronizing pulse amplitude is 10 v peak-to-peak. The PDM output signals swing from +4 to -6 v and the output signal reference is not adjustable. Accuracy of simulated analog data is within  $\pm 2\%$  and sampling rates can be varied  $\pm 25\%$  of standard rates. The unit operates from 115 v ac power. It mounts in a standard 19-in. rack and is 3-1/2 x 17-3/4 in.

Telecomputing Corp., Data Instruments Div., Dept. ED, 12838 Saticoy St., N. Hollywood, Calif.

CIRCLE 177 ON READER-SERVICE CARD

## Harmonic Generators

Consist of two waveguides



Designed to generate energy in frequency ranges where signal sources are not readily available, these harmonic generators consist of two waveguides coupled to each other by means of a probe structure terminated in a crystal element. The input waveguide receives the excitation frequency, which is coupled to the crystal to cause harmonic generation in the output waveguide. The harmonic frequency then propagates through the output waveguide. Three models are available, providing frequencies from 53 to 90 kmc. A BNC jack is provided for monitoring crystal current or for the application of dc bias.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, N.Y.

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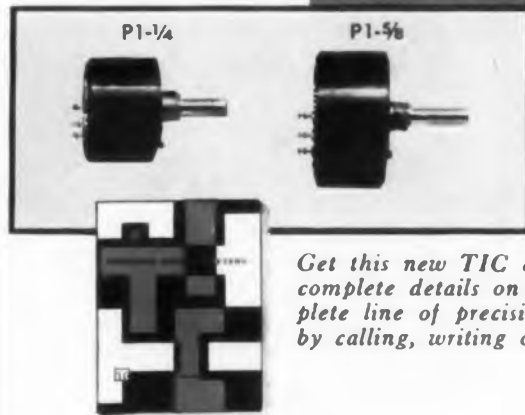
# TWELVE IMPORTANT CONTROLS

Uses include such equipment as aircraft instrument panels, shipboard control centers, ground control equipment in either fixed or mobile installations, industrial process control centers, electronic test instruments and computers. Twelve important controls to meet your design problems provide a new standard in reliability of operation.

TP SERIES — Types TP05, TP09, TP11, TP13, TP17 and TP20, in 6 sizes from 1/2" to 2" diameter. Each is a single-turn, high torque, rotary, wire-wound pot, engineered for peak performance under severe environmental conditions. Threaded bushings, precision register, mounting nut, lock washer and locating pin permit exact positioning for precise control. Available with non-linear functions, including complete series of sine-cosine functions. Accurate, dependable, long-life performance.



designed  
for  
precise  
setting



Get this new TIC catalog with complete details on the most complete line of precision potentiometers by calling, writing or wiring.

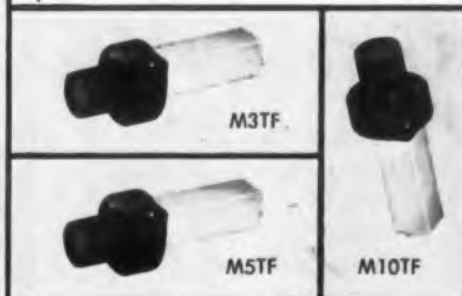
TECHNOLOGY INSTRUMENT CORP.

555 MAIN STREET, ACTON, MASS.

CIRCLE 179 ON READER-SERVICE CARD

high torque panel control  
POTENTIOMETERS

MTF SERIES — Types M3TF, M5TF and M10TF. Housed in corrosion resistant box-like enclosures, all have a lead screw shaft arrangement for driving the wiper transversely from end to end of the resistance element. Encapsulated metallic film resistance element provides infinite resolution, 3, 5 or 10 turns (1080°, 1800°, 3600°) of rotation for accurate setting. Threaded bushing, with concentric locking device supplied to provide simple panel mounting knob for precise manual control.



P SERIES — Types P1-1/4, P1-5/8 and P3 with numerals designating diameters. Especially designed for low cost commercial applications. These rotary type pots feature low inductance and capacitance. Available in linear or non-linear functions, single or ganged assemblies.

Subsidiaries:  
Technology Instrument  
Corp. of Calif.  
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California  
Acton Laboratories, Inc.,  
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Tucson Instrument Corp.,  
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**GUARANTEED**

CLOSED

OPEN

for  
**100,000 CYCLES**  
and  
**800,000 BREAKS**

**NEW**

miniaturized  
solenoid actuated  
**CAM SWITCH**

- ✓ Hermetically sealed
- ✓ Extremely compact, light weight
- ✓ "Reliability engineered" for guaranteed performance
- ✓ Shock & vibration tested in conformance with MIL-E-5272A
- ✓ Operates 24 to 30 volts, DC, at 125°C ambient
- ✓ Rating, 1 amp.
- ✓ Size, 1 3/4" x 1 21/32" x 2 3/4"
- ✓ 7-pole, 18-position shorting with interrupter and homing

Designed to meet standards for guided missile systems, this new Cam Switch is typical of special designs by Tech Labs which can be easily adapted to specific needs. Write for complete data.

**TECH** LABORATORIES, INC. PALISADES PARK, NEW JERSEY

CIRCLE 180 ON READER-SERVICE CARD

114

## NEW PRODUCTS

### Pulse Generator

Rise time is less than 2.5  $\mu$ sec



Model 120B pulse generator has a rise time of less than 2.5  $\mu$ sec. Two independent outputs are available providing precise widths from 2.5 to 25  $\mu$ sec. Repetition rates from 10 cps to 10 mc may be controlled externally. A fast flexible gating input is available for complex pulse-time and pulse-amplitude selection. A 15-v trigger output may be used to initiate timing cycles or to trigger an oscilloscope.

E-H Research Labs., Inc., Dept. ED, 1922 Park Blvd., Oakland 6, Calif.

CIRCLE 181 ON READER-SERVICE CARD

### Control Consoles

In aluminum, magnesium, or stainless steel

Made of aluminum, magnesium, or stainless steel, these control consoles can be adapted to individual requirements in military and commercial applications. The sloping panel can be punched or drilled to specifications and is easily removed. The counter top is made of smooth Formica or Texolite bonded on plywood. The universal panel mounting can accommodate a variety of chassis, panels, slides, and other components. The consoles have a utility drawer and full-swinging front and rear doors.

Falstrom Co., Dept. ED, Passaic, N.J.

CIRCLE 182 ON READER-SERVICE CARD

### Direct-Recording Oscillograph

Has 24 channels

Type 1108 direct-recording oscillograph allows recording of up to 24 channels of hf, high-sensitivity information from dc to 5000 cps. Chart speeds are adjustable in 15 variations from 0.05 to 80 in. per sec. This dry and dustless unit produces records without processing of any kind. The light source is a high pressure mercury vapor lamp with maximum output in the ultraviolet region.

Minneapolis-Honeywell Regulator Co., Heiland Div., 5200 E. Evans Ave., Denver 22, Colo.

CIRCLE 183 ON READER-SERVICE CARD

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TUCSON  
Standard Radio Parts, Inc.  
218 N. 1st Avenue  
Phone: MA 3-2545

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ZEnith 0271

OAKLAND  
Elmar Electronics  
140 Eleventh Street  
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TWX: OA-73

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Atlas Electronic, Inc.  
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1415 India Street  
Phone: BElmont 9-0361

SAN FRANCISCO  
Pacific Wholesale Co.  
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Phone: KLondike 2-0700

#### COLORADO

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1254 Arapahoe Street  
Phone: AMherst 6-1671  
TWX: DN 941

#### CONNECTICUT

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Radio Shack Corp.  
230-234 Crown St.  
Phone: NH 466  
Phone: SP 7-6871

#### D. C.

WASHINGTON  
Capitol Radio Wholesalers, Inc.  
2120-22 Fourteenth Street, N.W.  
Phone: HObart 2-0800

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Electronic Supply  
61 N.E. Ninth Street  
Phone: FRanklin 7-2511  
TWX: MM 186

MELBOURNE  
Electronic Supply  
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909 Morningside Drive  
Phone: PARKway 3-1441  
TWX: 7138

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631 W. Central Avenue  
Phone: GA 5-5531

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1309 North Dixie  
Phone: TEMple 3-5701  
TWX: WP-38

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Phone: TRinity 3-1651

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100 North Western Ave.  
Phone: HAYmarket 1-6800  
Newark Electric Co.  
223 W. Madison Street  
Phone: STate 2-2944  
TWX: CG 1401

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Phone: MEIrose 4-8488

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Howard & Redwood Streets  
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Kann-Ellert Electronics, Inc.  
11222 Triangle Lane  
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Radio Shack Corporation  
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Phone: REgent 4-1000  
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CAMBRIDGE  
Electrical Supply Corp.  
205 Alewife Brook Parkway  
Phone: UNiversity 4-6300  
TWX: CAMB MASS 429

#### MICHIGAN

DETROIT  
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2306 Puritan Street  
Phone: UNiversity 1-6700  
TWX: DE 803

#### MINNESOTA

MINNEAPOLIS  
Law Bonn Co.  
1211 LaSalle  
Phone: FEderal 9-6351

#### MISSOURI

ST. LOUIS  
Interstate Supply Co.  
4445 Gustine Ave.  
Phone: FLanders 1-7585

#### NEW JERSEY

CAMDEN  
General Radio Supply Co., Inc.  
600 Penn Street  
Phone: WOODlawn 4-8383 (N.J.)  
WAlnut 2-7037 (Phila.)

CLIFTON  
Eastern Radio Corp.  
312 Clifton Ave.  
Phone: GREGory 1-6600

MOUNTAINSIDE  
Federated Purchaser, Inc.  
1021 U.S. Route 22  
Phone: ADams 2-8200  
TWX: WSFd NJ 319

#### NEW MEXICO

ALAMOGORDO  
Radio Specialties Co.  
209 Penn Ave.  
Phone: HEMlock 7-0370  
TWX: 5671U

ALBUQUERQUE  
Electronic Parts Co.  
222 Truman St., N.E.  
Phone: ALPine 6-0946

Radio Specialties Co., Inc.  
6323 Acoma Street, S.E.  
Phone: AMherst 8-3901  
TWX: AK 561

#### NEW YORK

BINGHAMTON  
Federal Electronics, Inc.  
P. O. Box 208  
Phone: PIONEer 8-8211

BUFFALO  
Radio Equipment Corp.  
312 Elm Street  
Phone: MADison 9676

JAMAICA  
Peerless Radio Dist., Inc.  
92-32 Merrick Road  
Phone: REpublic 9-6080

MINEOLA, L. I.  
Arrow Electronics, Inc.  
525 Jericho Turnpike  
Phone: PIONEer 6-8686  
TWX: G CY NY 460

Schwaber Electronics  
Post Office Box 669  
60 Herricks Road  
Phone: PIONEer 6-6520  
TWX: G LY NY 580

NEW YORK  
Harrison Radio Corp.  
225 Greenwich Street  
Phone: BARclay 7-7777  
TWX: NY 1-177

Harvey Radio Company, Inc.  
103 West 43rd Street  
Phone: JUdson 2-1500

Hudson Radio and TV Corp.  
37 West 65th Street  
Phone: TRafalgar 3-2900

Milo Electronics Corporation  
530 Canal Street  
Phone: BEakman 3-2980  
TWX: NY 1-1839

Sun Radio and Electronics  
650 Sixth Ave.  
Phone: ORegon 5-8600  
TWX: NY 1-4022

Terminal Radio Corp.  
85 Cortlandt Street  
Phone: WORTH 4-3311

ROCHESTER  
Rochester Radio Supply Co., Inc.  
600 East Main St.  
Phone: LOKust 2-9900

SYRACUSE  
Syracuse Radio Supply Co.  
620 South Salina Street  
Phone: 74-2927

#### NORTH CAROLINA

WINSTON-SALEM  
Dalton-Hege Radio Supply Co.  
912 West 4th St.  
Phone: 5-8711  
TWX: W-Sal 373

#### OHIO

AKRON  
Akron Electronic Supply, Inc.  
107-117 South Arlington St.  
Phone: PORTage 2-8818

CINCINNATI  
Herringer Distributing Co.  
115 Corwin Street  
Phone: GA 1-5282 TWX: CI 125

COLUMBUS  
Thompson Radio Supplies, Inc.  
182 East Long St.  
Phone: CAPital 1-7434

DAYTON  
The Stotts-Friedman Company  
108-112 North Jefferson Street  
Phone: BALdwin 4-1111

#### OKLAHOMA

TULSA  
Indel Supply, Inc.  
Post Office Box 3443  
538 South Lewis Avenue  
Phone: WE 9-7585

#### PENNSYLVANIA

PHILADELPHIA  
Albert Steinberg & Company  
2520 North Broad Street  
Phone: BALdwin 3-9400

Almo Radio Co.  
913 Arch Street  
Phone: WAlnut 2-5918

PITTSBURGH  
Camradio Co.  
1121 Penn St.  
Phone: EXpress 1-4000  
TWX: PG 438  
(Note: See Camden, N. J. also)

#### RHODE ISLAND

PROVIDENCE  
Wm. Dandreta & Co.  
28 Wolcott Street  
Phone: UNion 1-2800

#### SOUTH CAROLINA

GREENVILLE  
Carolina Radio Supply Co.  
227 West Washington St.  
Phone: CEdar 2-6740

#### TENNESSEE

NASHVILLE  
Electra Distributing Corp.  
1914 W. End Ave.  
Phone: ALPine 5-8444

#### TEXAS

DALLAS  
Engineering Supply Company  
6000 Denton Drive  
Phone: FLEetwood 7-6121  
TWX: NNG

HOUSTON  
Harrison Equipment Company, Inc.  
1422 San Jacinto Street  
Phone: CAPitol 4-9131

#### UTAH

SALT LAKE CITY  
Standard Supply Co.  
225 East Sixth South St.  
Phone: ELgin 5-2971

#### WASHINGTON

SEATTLE  
Seattle Radio Supply, Inc.  
2117 Second Avenue  
Phone: MA-2345

TACOMA  
C & G Radio Supply Co.  
2502 Jefferson Street  
Phone: BRoadway 2-3181

#### WISCONSIN

MILWAUKEE  
Taylor Electric Co.  
4080 N. Port Washington Rd.  
Phone: WOODruff 4-4321  
TWX: MI 118

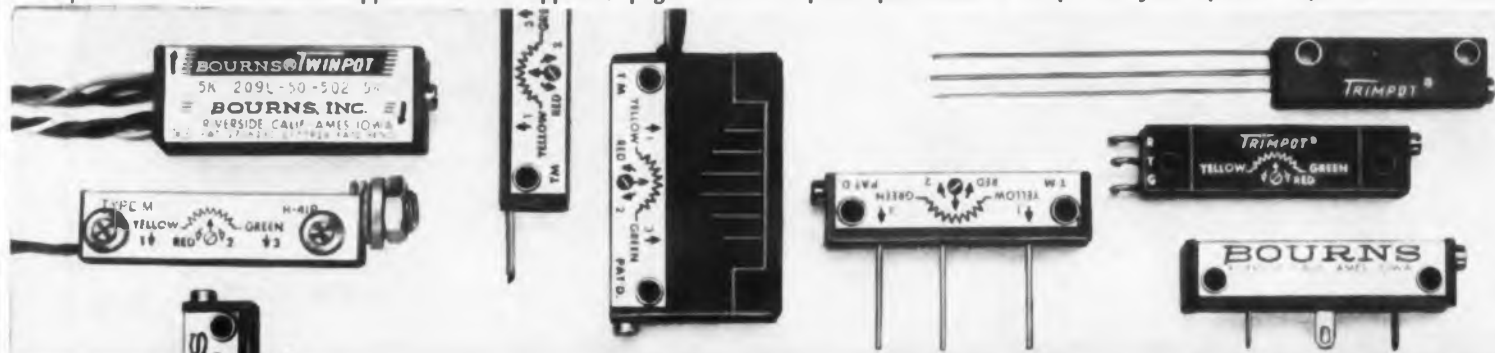
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Exclusive manufacturers of TRIMPOT®, TRIMIT®, Pioneers in potentiometer transducers for position, pressure and acceleration.

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115





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

 <p><b>1N1838</b></p> <p>The first and only Germanium Mixer Diode specifically designed for ultra-low noise performance in Doppler receivers. 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. Particular emphasis has been placed upon minimizing crystal noise in the range from 1 to 100 kc.</p>	 <p><b>1N263</b></p> <p>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 <i>any</i> 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 (<math>Z_{if}</math>) . . . 140 to 210 ohms; RF impedance (VSWR) . . . 1.3 max; Overall noise figure (<math>N_{Frec}</math>) . . . 7.5db max.</p>
 <p><b>1N26 1N26A 1N26B</b></p> <p>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.</p>	 <p><b>1N78 1N78A 1N78B 1N78C</b></p> <p>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 (<math>L_c</math>) reduced to 6.0db max; IF impedance (<math>Z_{if}</math>) range tightened (400 to 565 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.</p>

Write Special Components Dept. ED 1159, Lansdale Tube Company Division, Philco Corporation, Lansdale, Pa.

## NEW PRODUCTS

### Photoconductive Cell

Made of cadmium sulphide



Type ORP90 cadmium sulphide photoconductive cell has an average cell current of 20 ma at 10 v dc, 4.5 ft-c, with the lamp color temperature at 1500 K. The maximum ac cell voltage is 250 v. The unit mounts in any position and can be used in the ambient temperature range of -40 to +70 C. Having a high sensitivity, the unit provides a maximum response in the red and infrared region.

International Electronics Corp., Dept. ED, 81 Spring St., New York 12, N.Y.

CIRCLE 186 ON READER-SERVICE CARD

### Waveguide Switch

For use in the S-band

Type SP2T remote-controlled waveguide switch is for airborne, marine, and ground use in guidance and communications in the S-band from 2.6 to 3.95 kmc. It can be switched under power and has a switching time of 0.02 sec. When used as a power divider during the switching cycle, the vswr is 2.1:1. The rf characteristics include 60 db isolation and 1.15:1 max vswr. The unit weighs 4.5 lb.

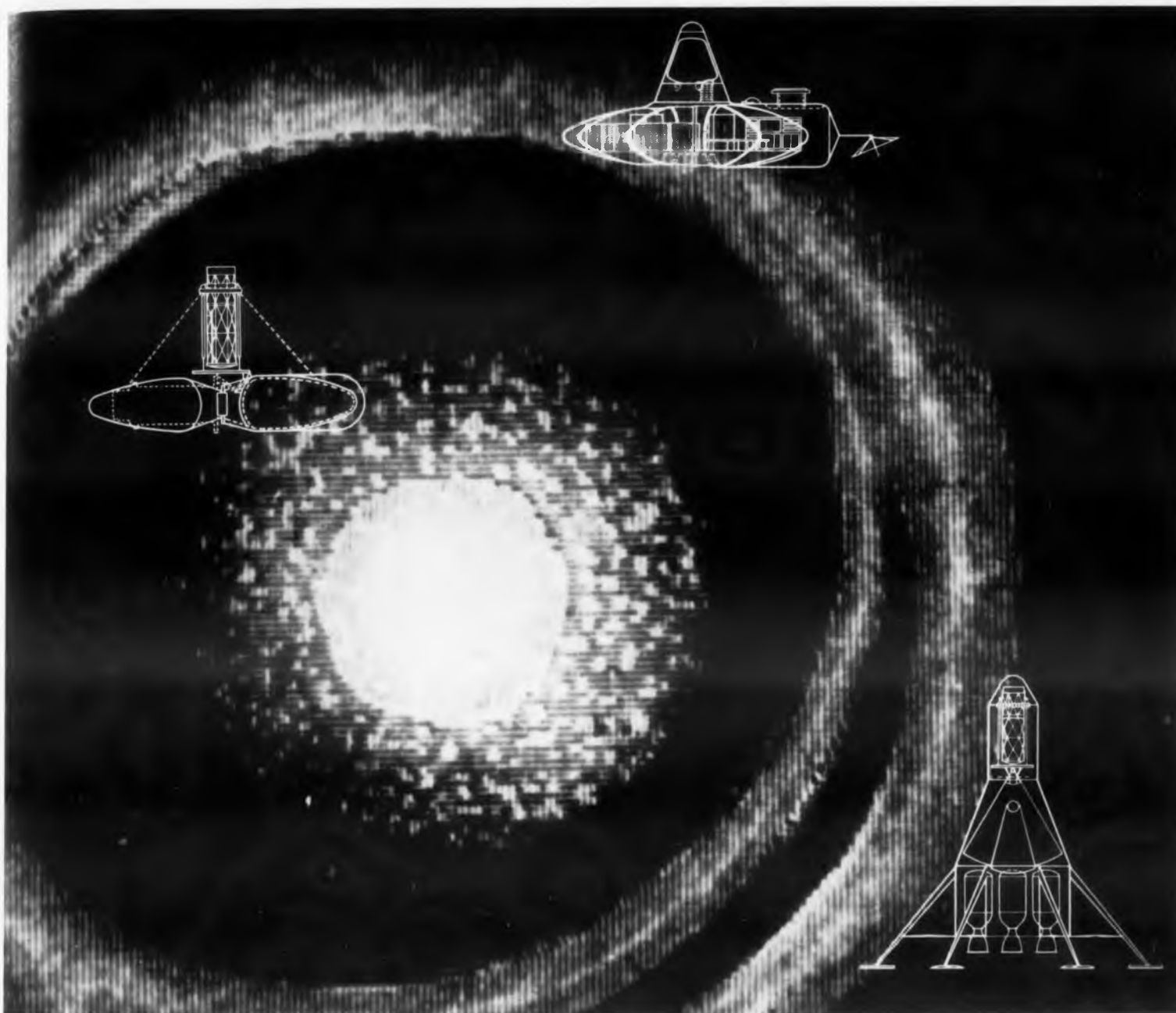
Don-Lan Electronics Co., Dept. ED, Santa Monica, Calif.

CIRCLE 187 ON READER-SERVICE CARD

CIRCLE 188 ON READER-SERVICE CARD

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





## *New styles for the man-about-space*



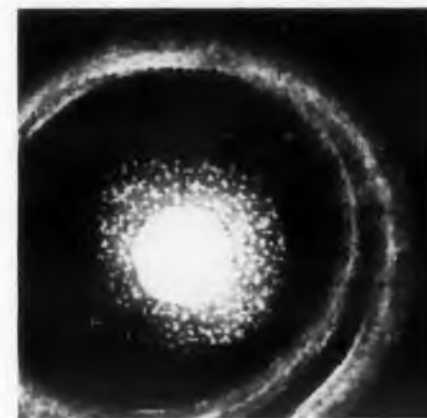
Every time a space traveler leaves home (earth), he has to wrap himself in the complete environment necessary to his physiological and psychological well-being. Styling sealed space capsules to suit man's every requirement has been a major project at Douglas for more than ten years. Forty basic human factors areas were explored in these studies. Now Douglas engineers have evolved plans for practical space ships, space stations and moon stations in which men can live and work with security thousands of miles from their home planet. We are seeking qualified engineers and scientists who can aid us in furthering these and other out-of-this-world but very down-to-earth projects.

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**Douglas Aircraft Company, Inc.**  
**Santa Monica, Calif.**

## Gertsch Complex Ratio Bridge



-measures both in-phase and quadrature voltage ratios - with high accuracy

This instrument cancels quadrature effects, giving a sharp, true null.

In eliminating quadrature voltage, this Gertsch bridge achieves an in-phase ratio accuracy as good as 0.001%. Quadrature voltage ratios are read as rectangular coordinates, tangent of phase-shift angle, or magnitude of phase-shift angle in degrees directly.

Write for complete data in Bulletin CRB.

- SELF-CONTAINED PHASE-SENSITIVE DETECTOR
- SIX-PLACE RESOLUTION
- TWO FREQUENCY RANGES
  - 30 TO 1000 CPS
  - 50 TO 3000 CPS

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## 256 resistors per cubic inch

*micro-miniature, wire-wound*

The newly-developed Kelvin Type 301-P precision, noninductive wire-wound resistor measures only 1/8" dia. x 1/4" long, with axial or axial/radial leads. Resistors are encapsulated to withstand extreme humidity, severe mechanical shock, and a temperature range of -65°C to +125°C. Temperature coefficient is ±.002%/deg. C; Wattage rating is 0.10, 100 K ohms max., 1 ohm min., 100 v max. All connections are welded. Kelvin "relaxed winding" techniques produce tension-free windings... practically eliminating resistance drift with age and "shorts" or "opens" frequently caused by thermal shock. All units are temperature-cycled and tested, surpassing military requirements.

Send for complete literature on encapsulated and ceramic types.



**KELVIN**  
ELECTRIC COMPANY

5907 Noble Avenue, Van Nuys, Calif.

CIRCLE 193 ON READER-SERVICE CARD

## NEW PRODUCTS

### Transistor Transformers

Miniature size



These transistor transformers are available in MIL-AG construction 1 x 1 x 1-3/8 in. or in cylindrical construction 15/16 in. in diam and 1-3/8 in. high. The use of mu metal in place of steel cans provides a hum pick-up reduction of about 20 to 30 db. The units are supplied with either high compression glass or ceramic terminals. They meet MIL-T-27A grade 4 class R and have a life rated at 10,000 hr.

Microtran Co., Inc., Dept. ED, Valley Stream, N.Y.

CIRCLE 194 ON READER-SERVICE CARD

### DC Motor

Provides 16 oz-in. torque at 1000 rpm



Designed for use as a magnetron tube drive, model P7P6TFRP 28 v dc permanent magnet geared motor provides 16 oz-in. torque at 1000 rpm. It is furnished with a thermal protector for overload and stall conditions as well as a radio filter. The requirements of MIL-I-6181B are met.

Western Gear Corp., Electro Products Div., Dept. ED, 132 W. Colorado Blvd., Pasadena, Calif.

CIRCLE 195 ON READER-SERVICE CARD

### Galvanometers

Compact design

Compact in design, these galvanometers are designed for operation in horizontal, vertical, or tilted positions. Model 2435 reflecting galvanome-

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**TRANSCO**  
**Y-40**



AT 11 KMC

VSWR 1.1

INSERTION LOSS .2 db  
CROSSTALK 30 db

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**extreme  
sensitivity  
10 mc to  
44,000 mc**



**PANORAMIC'S  
SPA-4  
SPECTRUM  
ANALYZER**

**MORE USEABLE SENSITIVITY**

BAND	RF SENSITIVITY*
10 — 420 MC	—95 to —105 dbm
350 — 1000 MC	—90 to —100 dbm
910 — 2200 MC	—90 to —100 dbm
1980 — 4500 MC	—80 to —95 dbm
4.5 — 10.88 KMC	—80 to —95 dbm
10.88 — 18.0 KMC	—70 to —90 dbm
19.0 — 26.4 KMC	—60 to —85 dbm
26.4 — 44.0 KMC	—55 to —85 dbm

\*measured when signal and noise equal 2X noise  
Using one tuning head which contains one triode and two Klystron oscillators, Model SPA-4 offers more exclusive advantages for applications demanding extreme sensitivity, stability, versatility, accuracy.

- Three precisely calibrated amplitude scales—40 db log, 20 db linear, 10 db power.
- Two independent frequency dispersion ranges—continuously adjustable—0-70 mc and 0-5 mc. Negligible internal frequency modulation permits narrow band analysis of FM problems.
- Variable I.F. bandwidth from 1 kc to 80 kc.
- Push-button frequency selector.
- Synchroscope output with 40 db gain.
- Accurate measurement of small frequency differences. A self-contained marker oscillator, modulated by a calibrated external generator, provides accurate differential marker pips as close as 10 kc.

Tremendous flexibility and many unique advances of Panoramic's compact SPA-4 make it unsurpassed for visually analyzing FM, AM and pulsed signal systems; instabilities of oscillators; noise spectra; detection of parasitics; studies of harmonic outputs; radar systems and other signal sources.

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OWens 9-4600

CIRCLE 197 ON READER-SERVICE CARD

ter consists of an internal-magnet galvanometer system, a 10-in. folded optical system and a lamp-and-scale reading device assembled in one unit. Four interchangeable oil-damped galvanometer systems are available with periods of 4 sec or less. Model 2340 pointer galvanometer has an internal-magnet system which permits changing the sensitivities by loosening two screws on the top plate. It has a clear plastic window.

Leeds & Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia, Pa.

CIRCLE 198 ON READER-SERVICE CARD

**Snap-Action Switches**  
For printed circuit applications



For printed circuit applications, series S30-42B switches have special terminals for easy insertion. They have positive overtravel stop and over 50 actuator variations. Gold flash contact material can be supplied for low voltage applications. The following ratings are available: 10 amp at 125 v ac, 5 amp at 250 v ac, and 1/3 hp at 125 to 250 v ac. The switch measures 1/4 x 1/2 x 1 in.

Cherry Electrical Products Corp., Dept. ED, 1650 Deerfield Road, Highland Park, Ill.

CIRCLE 200 ON READER-SERVICE CARD

**Laminated Plastic**  
Glass-base, epoxy resin

Type GEC-111 glass-base, epoxy-resin laminated plastic meets the specifications for NEMA grade G-11 and military grade MIL-P-18177B type GEB. A sheet 1/8 in. thick retains at least 68% flexural strength after 1 hr at 300 F. The material is suitable for use as the base material for copper-clad laminated plastics. In continuous use, the maximum temperature to which it is resistant is 350 F. Water absorption after 24 hr immersion is 0.2% max. The laminated plastic is furnished in sheets having thicknesses of 0.01 to 1 in. Sheets up to 3/32 in. thick may be cold punched. As a copper-clad laminate, it is supplied with rolled copper foil, type GEC-111R, or with electrolytically deposited foil, type GEC-111E.

Taylor Fibre Co., Dept. ED, Norristown, Pa.

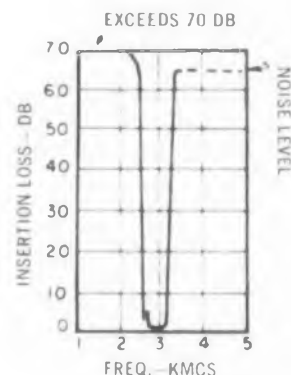
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**New high-power  
band-pass filter**

**ELIMINATES RADAR INCOMPATIBILITY**

*—permits two or more systems  
to operate in the same band  
with a minimum of interaction.*



Here at last is a filter which narrows the overall radiated bandwidth of a radar transmitter to an optimum width. The ANTRAN filter also provides pre-selectivity to receivers, making them sensitive only to a narrow bandwidth. Unit attenuates unwanted signals and passes desired signal, with only 1/2 db insertion loss... filters out unwanted radiation and spurious energy, including subharmonics and harmonics for a specific application. This is the only filter insuring compatibility of similar multiple radar systems.

**ACCEPTS HIGH POWER.** Whatever RF power goes through your waveguide will go through the ANTRAN without breakdown. Cut-off points can be designed for a specific radar system or problem.

**EASY TO INSTALL** — the ANTRAN fits into a standard waveguide junction, using existing hardware. No extras to buy—merely install the filter. Or, if you prefer, we will install it and be responsible for its successful operation.

Units available on 30-day deliveries. Send us your requirements for a quotation. Bulletin 101 on request.

**SPECIFICATIONS**

- Range of frequencies: 200 MC to 10,000 MC
- Power Ratings: to customer specs.
- Bandwidth: to customer specs.
- SWR: no greater than 2:1 in pass band
- Band Pass
- Insertion Loss: less than 1/2 db.



— a division of  
International Electronics Manufacturing Company

2nd Street Extended,  
Greenwood Acres,  
Annapolis, Md.

CIRCLE 202 ON READER-SERVICE CARD

For LABORATORY or INDUSTRIAL APPLICATION  
with COMMERCIAL or MIL-SPEC REQUIREMENTS

## SPECIFY SYSTRON COUNTERS

- RELIABLE BEAM-SWITCHING COUNTING DECADES
- IN-LINE INDICATION • 50% TUBE REDUCTION

Systron offers a complete line of standard and custom counters, precision engineered to deliver dependable, accurate results for any and all applications. Next time, specify Systron Counters, and get the finest!



MEGACYCLE  
MICROSECOND  
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MODEL 1031

The Universal Counter-Timer measures: Frequency from 0 to 1,000,000 cycles per second — Time intervals from 1 microsecond to  $10^7$  seconds — One or ten periods from 0 cps to 1,000,000 cps — Phase Angles from 0 to  $360^\circ$  — Ratio of two external frequencies. Ideal all-purpose counter.



100 KC  
FREQUENCY  
COUNTER  
MODEL 1010

This high speed electronic counter is combined with an accurate time base to provide an IN-LINE indication of frequency from 0 to 100,000 cps and periods from 10 microseconds to  $10^7$  seconds. It is ideal for use as an electronic tachometer, or a multi-purpose laboratory instrument.



TELEMETRING  
COUNTER  
MODEL 1043

Specifically for measuring sub-carrier frequencies in IRIG FM/FM telemetry, Model 1043 also serves as a frequency counter for precise low frequency measurements. Features a normalized count of 20,000 in  $1/5$  second for each of 18 IRIG channels and a period selection up to 100,000 for low frequency measurements.



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## NEW PRODUCTS



DC Modulator  
1s spdt, 60 cps

This spdt, 60 cps, dc modulator is suited for computer systems, servo mechanisms, automation, and vacuum tube voltmeters. Each unit has less than 1-mv dc offset, and less than 1 mv-drift over long service periods. Normal contact dwell time is 55%, changing less than 2% during the first 1000 hr. A magnetic driving system prevents magnetic and electrostatic interference between coil and contact. The rms noise voltage generation is kept below 1  $\mu$ v. Life expectancy is from 10,000 to 25,000 hr.

Millivac Instrument, Div. of Cohu Electronics, Inc., Dept. ED, Schenectady, N.Y.

CIRCLE 204 ON READER-SERVICE CARD

## Contacting Counters

Two designs available

Series 1100 and 1200 contacting counters are compact units designed for telemetering shaft rotation and position. Series 1100 counters have electrical contacts which correspond with each number on each wheel. Series 1200 counters have precision resistors mounted between the contacts to form a stepped potentiometer or voltage dividing network; resistance ratios are directly proportional to the visual indication.

Photocon Research Products, Dept. ED, 421 N. Altadena Dr., Pasadena, Calif.

CIRCLE 205 ON READER-SERVICE CARD

## Recording System

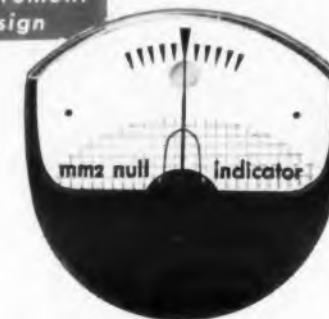
Digital

This digital recording system may be used for any recording of data where input variables in the form of emf's in the range of 0 to 10 mv are available. It will sequentially select to 200 input variables and digitally record each with three-digit point identification by means of a motorized tape punch. The data is recorded in an eight-channel code. Cycle time per data point is 1 sec. The maximum recording cycle is 15 min. Accuracy is  $\pm 0.5\%$  of full scale.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 206 ON READER-SERVICE CARD

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advancement  
in instrument  
design



## MEDALIST\* null indicators

READABLE... WIDE RANGE SENSITIVITY

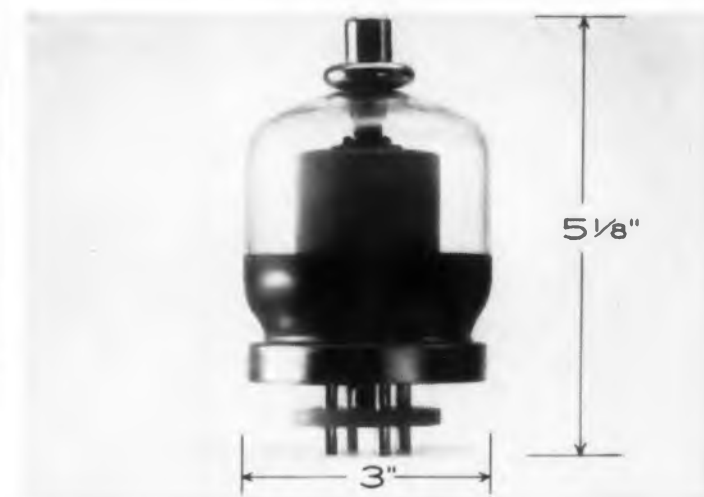
Modern MEDALIST design provides for greater readability and modern styling in minimum space. Unique core and magnet structure provides  $1/2$   $\mu$ a/mm sensitivity at null point with sharp square law attenuation to 100  $\mu$ a at end of scale in Type A. Internal resistance is 2000 ohms. Other sensitivities available. ASA/ML  $2\frac{1}{2}$ " mounting. Standard and special colors. Bulletin on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Company, Manchester, N. H., U. S. A.

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## NEW PULSE MODULATOR TETRODE FOR SEVERE ENVIRONMENTS

This recently developed Eimac pulse modulator tetrode is designed for operation under severe physical environments. In prototype equipment, this tube is withstanding in excess of 10G vibration. Identified as the Eimac X-643F, the tube operates at:

- DC Plate Voltage: 20 Kilovolts
- Pulse Plate Current: 18 Amperes
- Heater Voltage: 6.0 Volts

Except for heater voltage, electrical characteristics are similar to the widely-used Eimac 4PR60A. Write today for complete technical data, specifications, and application information.



**EITEL-McCULLOUGH, INC.**  
San Carlos, California

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ELECTRONIC DESIGN • November 25, 1959

## HI-POWER EFFICIENCY



RIGHT ANGLE ADAPTER, 350-5000 MCS.



CABLE CONNECTOR, 350-5000 MCS.



WAVEGUIDE TO COAX ADAPTER, 2350-3600 MCS.



S-BAND SCIMITAR ANTENNA, 2350-5000 MCS.



COAX SLOTTED LINE, 1500-5000 MCS.



LT TO "N" TYPE TRANSITION, 350-5000 MCS.

These operational configurations comprise a representative selection of Tamar "hardware" designed and tested to meet all military and industrial specifications.



**TAMAR ELECTRONICS, INC.**

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Direct Philadelphia phone: WALnut 5-3660

## NPN-PNP Power Transistors

Collector current is 3 amp max



These complementary npn-pnp power transistors have a maximum collector current of 3 amp, a minimum large-signal current gain of 30 for a collector current of 0.5 amp, and a maximum thermal resistance 3 deg per C per w. Types 2N1320 through 2N1334 plus type 2N1078 are hermetically-sealed in welded TO-10 male and TO-13 female packages and exceed the requirements of MIL-T-19500A. The use of these transistor pairs in push-pull class B circuits eliminates the need for input and output transformers. Other uses are in balanced modulators and collector-coupled multivibrators. They are available with collector-to-base voltages up to 100 v at 25 C and can be supplied with solder lugs or flying leads.

CBS Electronics, Semiconductor Operations,  
Dept. ED, 900 Chelmsford St., Lowell, Mass.

CIRCLE 211 ON READER-SERVICE CARD



**Silicon Diodes**

Recovery time is  
0.8  $\mu$ sec

Designed for operation from  $-65$  to  $+150$  C, types 1N690 through 1N693 silicon diodes have a maximum recovery time of 0.8  $\mu$ sec to return to 10 K when switched from a forward current of 2- $\mu$ sec pulse of 500 ma to a reverse voltage of  $-50$  v. They switch from a 5-ma forward pulse to  $-40$  v and recover to 100 ohms in 0.5  $\mu$ sec. Forward conductance is 400 ma at 1 v and leakage is 50  $\mu$ a at 150 C. These diodes meet the requirements of high current pulse circuits for high speed computer switching, pulse clamping, gating, blocking, and diode logic circuits.

Sperry Semiconductor Div., Sperry Rand Corp.,  
Dept. ED, S. Norwalk, Conn.

CIRCLE 212 ON READER-SERVICE CARD

The 11-T Series operates on the Therm-O-Disc free bimetal disc principle to provide a "snap action" of the contacts. Temperature calibration is factory preset and non-adjustable. This new series is designed for both single pole single throw and single pole double throw operation. Available with normally open or normally closed contacts. Surface or watertight mountings. Enclosed or exposed bimetal discs. Your choice of inclined blade, vertical blade or screw terminals.

minimum production order  
quantity accepted—25

write for free bulletin

**THERM-O-DISC, Incorporated**  
MANSFIELD, OHIO

This  
is  
a new  
*Therm O Disc*  
\*11-T  
series  
thermostat

designed for  
dependability, efficiency  
and economy... in a minimum of  
space

for operating temperatures up to 350° F.  
UNDERWRITERS' LABORATORY RATINGS  
(basis 100,000 cycles — max. temp. 350° F.)

Resistive Heater Load:	Inductive Load:	Pilot Duty:
6000 Watts, 240 VAC	10 Amps, full load @ 120 VAC 60 Amps, locked rotor @ 120 VAC 5 Amps, full load @ 240 VAC 30 Amps, locked rotor @ 240 VAC	125 Volt Amps,
3000 Watts, 120 VAC	Recommended Direct Current Ratings 1 Amp, 125 VDC 12 Amps, 30 VDC	120/240 VAC

\*interchangeable with Therm-O-Disc Type E Series thermostats

CIRCLE 213 ON READER-SERVICE CARD



## WHO MAKES FINE MOTORS THIS SMALL?

Globe Industries makes motors this small to make your design more compact, reliable and salable. If you make miniature instrument packages for space exploration — if you build airborne and ground support equipment — if you want to design smaller typewriters, computers, recorders or other products, look at these 3 motors:

**TYPE VS**—The smallest, most powerful precision miniature d.c. motor for its size. Only  $\frac{3}{16}$ " flat, four VS motors fit in a regular cigarette pack with room to spare. It has the power to lift its own weight to the top of the Empire State Building in 1 minute! Typical continuous torque—.25 oz. in.; typical intermittent torque—.5 oz. ins. We can design gear units, governors and brakes to meet MIL specs also.

**TYPE SS** — Only  $\frac{3}{8}$ " in diameter, Type SS d.c. motors typically produce continuous duty torques of .3 oz. in.; intermittent torques to .6 oz. ins. With the basic Type SS motor you can specify any of 21 planetary gear speed reducers or 28 spur gear speed reducers. Governors and brakes are available also. Designed to meet MIL specs.

**TYPE MM** — The most widely used precision  $\frac{1}{4}$ " d.c. motor in the world, MM motors typically produce .5 oz. in. in continuous duty applications — 1.0 oz. in. intermittent duty. Choose from 101 ratios of planetary gear speed reductions. Brakes, governors and clutches can be included. MIL specs are invited.

For details about these motors request Bulletin VSM. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

### GLOBE INDUSTRIES, INC.

PRECISION MINIATURE A.C. & D.C. MOTORS, ACTUATORS, TIMERS, GYROS, STEPPERS, BLOWERS, MOTORIZED DEVICES

# GLOBE

CIRCLE 214 ON READER-SERVICE CARD

## NEW PRODUCTS

### Proximity Limit Switch

Operates from — 50 to +250 F



Made to operate from —50 to +250 F, this proximity limit switch has only one moving part. Like a mechanical limit switch, it has a self-contained set of contacts that operate in response to the actuating means provided. Like proximity switch systems, it operates without physical contact with the actuating means. It operates without transistors, tubes, coils, relays, or amplifier. Protection from coolants, abrasive dust, and dirt is provided. Dimensions are 1-1/2 x 1-1/2 x 4-1/2 in.

General Equipment and Mfg. Co., Inc., Dept. ED, 116 S. Campbell, Louisville 6, Ky.

CIRCLE 215 ON READER-SERVICE CARD



### Rate Gyro

Measures 1-5/8 x 3-1/2 in.

Type RG24-0103 rate gyro measures 1-5/8 in. in diam and 3-1/2 in. long, including the connector. It has a dc motor and potentiometer pickoff. Made for high altitude rocket research, it operates in the temperature range of —65 to +180 F. It withstands shock of 75 g for 6 to 12 msec on any axis, acceleration of 50 g, and vibration of 0.06 in. double amplitude at 10 to 2000 cps. Output potentiometer values can be provided to meet the usual requirements. The motor operates on 28 v dc 150 ma max running current.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

CIRCLE 216 ON READER-SERVICE CARD



## Transistor Tester

Direct readout type

Model 545-B transistor tester has direct readout of the input impedance, the hybrid parameter Beta, and the collector cut-off current with accuracies of 5%, 3%, and 2%, respectively. Voltage for the transistor under test comes from either an internal battery or an external dc source. Designed for both laboratory and production use, the instrument may be used to detect defective transistors, match and compare transistors, check tolerances, and to accumulate design information for transistor circuits. The Beta ranges are from 0 to 30, 100, and 300. Test frequency is normally 1 kc from an internal oscillator, but any frequency from 200 cps to 50 kc may be used by plugging in an external oscillator. Input impedance may be measured from 500 to 20,000 ohms. Collector cut-off current is measured from 0 to 50 ma.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

CIRCLE 217 ON READER-SERVICE CARD

## Trimmer Potentiometer

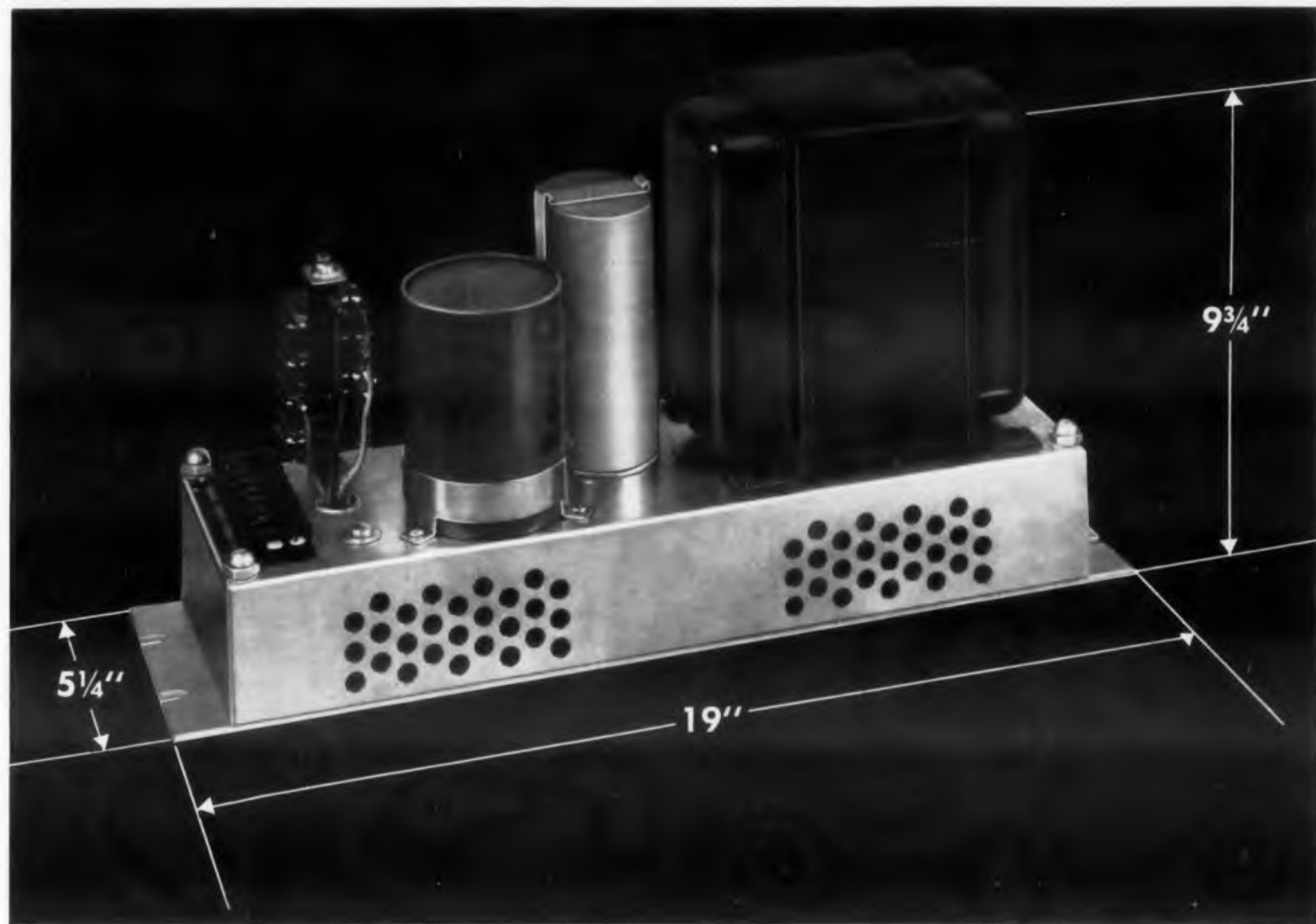
Power rating is 0.25 w



Model 235 carbon potentiometer has a power rating of 0.25 w, an operating temperature range of  $-85$  to  $+257$  F, and resistance values from 1 K to 30 meg. It has a 22-turn screwdriver adjustment, a self-locking shaft, and an idling wiper. Three terminal types are available: stranded insulated leads, solder lugs, and printed circuit pins. The unit measures about  $5/16 \times 1/4 \times 1-1/4$  in. and weighs 3 oz.

Bourns, Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

CIRCLE 218 ON READER-SERVICE CARD



Sola Constant Voltage DC Power Supplies are designed for intermittent, variable, pulse or high-ampereage loads.

## Sola packs 6 amps of 300-watt regulated dc power into 5 1/4 inches of relay-rack space

Looking for a source of regulated dc power that fits into a small space? You'll probably find that the Sola Constant Voltage DC Power Supply offers what you want.

This compact unit has exceptional performance characteristics, too — it delivers current in the "ampere range," regulates within  $\pm 1\%$  even under a  $\pm 10\%$  variation in line voltage, has less than 1% rms ripple, and even tolerates dead shorts. It is 80% efficient and has a very low static output impedance.

How's it done? Sola managed it through a balanced assembly of three complementary components . . . a special Sola Constant Voltage Transformer is teamed up with a semiconductor rectifier and a high-capacitance

filter. Electrical characteristics of the transformer maximize most of the advantages of the rectifier and filter, while virtually eliminating all their disadvantages. The resulting regulated dc power supply is simple, highly reliable, compact and moderately priced.

These benefits are exhibited by the entire line of Sola dc power supplies. Sola has designed and produced hundreds of ratings to meet requirements of equipment manufacturers. The company is set up to handle specific needs for custom-designed units in production quantities. A Sola sales engineer can supply all the facts. In addition to this custom service, Sola currently stocks six models ranging from 24 volts at six amps to 250 volts at one amp.

For complete data write for Bulletin 31K-CV-235.

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.



A DIVISION OF BASIC PRODUCTS CORPORATION

CIRCLE 219 ON READER-SERVICE CARD



A Gulton VO  
"Button Cell" Battery  
Powers This  
LIFE LITE\* Flashlight

\*Trademark

**reliable . . . long-lived  
. . . rechargeable!**



You can read a watch in the dark with any flashlight. The difference in the one the night nurse is using is that it will probably last a lifetime.



That's because it's powered by a *sealed* nickel cadmium button cell battery that's recharged simply by plugging it into an ordinary wall socket for a few hours.

*Result:* A dependable flashlight that can't corrode and never needs battery replacement.

**How Can You Use These Versatile Batteries?**

The rechargeable *Life Lite* is only one of many interesting ways in which imaginative engineers are employing these Gulton VO batteries.

Other applications: transistorized radios, guidance canes, missiles, photoflash power packs—*wherever small size, large capacity, light weight, long life, no maintenance, complete reliability, and easy recharging are desired.*

**Most Complete Line Available**

"VO" cells are available in capacities of 100, 180, 250, 500 and 1750 mah; have a nominal 1.2 voltage; can be packaged in any combination to meet your voltage specs. Patented sintered plate construction provides exceptional cycling characteristics; highest capacity per unit size. Like more information? Write us for Bulletin No. VO-110.



Available from stock—  
GLENNITE BATTERY DISTRIBUTORS  
92-15 172nd Street, Jamaica, New York  
**Gulon Industries, Inc.**  
Alkaline Battery Division, Metuchen, New Jersey,

CIRCLE 220 ON READER-SERVICE CARD

**NEW PRODUCTS**

**Millivolt Potentiometer**

Range is  $-10.1$  to  $+100.1$  mv

Type 8686 portable millivolt potentiometer has a range of  $-10.1$  to  $+100.1$  mv. As a laboratory instrument, it can be used to calibrate millivoltmeters and potentiometer indicators, recorders, and controllers. In industrial use, it can perform on-the-line checking of recorders and controllers and temperature checking. It can measure throughout the entire emf range of thermocouples without reversing the leads. The measured value appears in a central reading window as a single row of digits plus a scale interpolation. Small fluctuations of measured voltage can be followed rapidly and accurately because the final increment of potentiometer voltage is spread over the 220-division slide-wire.

Leeds & Northrup Co., Dept. ED,  
4934 Stenton Ave., Philadelphia, Pa.

CIRCLE 221 ON READER-SERVICE CARD

**Subcarrier Oscillator**

Measures  $1-3/8$  x  $7/8$  x  $1-1/16$  in.

Type TS-50 voltage controlled subcarrier oscillator measures  $1-3/8$  x  $7/8$  x  $1-1/16$  in. The weight is  $1-3/4$  oz. The unit is transistorized, encapsulated, and has no adjustments. It operates from  $-55$  to  $+125$  C.

Vector Manufacturing Co., Dept. ED, Southampton, Pa.

CIRCLE 222 ON READER-SERVICE CARD

**Pressure Transducers**

Range is 0 to 2 through 0 to 100 psi

Made to meet the requirements of the explosion test described in MIL-E-5272A procedure 1, these absolute pressure transducers have a range of 0 to 2 through 0 to 100 psi. Resistance is 1 to 15 K, resolution is 0.2% to 0.5%, linearity is  $\pm 0.6\%$ , and hysteresis is 0.4% to 0.5%.

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**11,600  
Standard  
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Shapes**

**WITH NO TOOLING COST!**



Choose from more than 11,600 sizes, shapes and heights of square, round, rectangular boxes and covers — pay no tooling charge! All can be trimmed and modified to your specification . . . brackets and fasteners can be installed, holes and louvers punched, etc. Complete facilities for welding and painting too! Send print or contact your Zero Representative for quote on custom deep drawn parts using the exclusive Zero-Method tooling.

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factories in Burbank, California and Palmer, Massachusetts

CIRCLE 223 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 25, 1959



The power rating is 0.8 w at 45 C and the operating temperature range is -55 to +120 C. Model 409 has outputs which are linear with pressure or altitude and are used for automatic flight control systems. Model 509 differential pressure version has outputs which are linear with pressure or air speed for telemetering flight test data.

Bourns, Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

CIRCLE 224 ON READER-SERVICE CARD

## Signal Source

Covers from 1 to 11 kmc

Model 229T signal source covers the entire spectrum from 1 to 11 kmc in four segments: 1 to 2, 2 to 4, 4 to 8, and 8 to 11 kmc. The individual signal sources are all contained in a single housing. The instrument features cw operation plus internal modulation for pulse, square wave, and fm output. There are also provisions for external modulation. Each section includes a

signal generator followed by a low-level traveling wave tube amplifier driving a high level traveling wave tube output stage.

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

CIRCLE 225 ON READER-SERVICE CARD

## Gear Mechanisms

Come in sizes 8, 10, 11, 15, and 18

These standard gear heads, speed reducers, and speed increasers have a wide variety of ratios and come in sizes 8, 10, 11, 15, and 18. Designed for extreme reliability, they transmit higher torque in a comparatively shorter over-all length. All units operate from -55 to +150 C and have a maximum backlash at the output shaft of 30 min. They use either sleeve or ABEC 7 ball bearings. Mil specs are met.

Kinetic Instrument Corp., Dept. ED, 1070 Linwood St., Brooklyn 8, N.Y.

CIRCLE 226 ON READER-SERVICE CARD



## WHEN NULLS - PHASE - VOLTS - COUNT ...

specify NORTH ATLANTIC'S PHASE ANGLE VOLTMETER—

"A standard of industry"

### FEATURES

Direct reading 0-360°, no ambiguity.  
1mv to 300v full scale.  
VTVM operation to 50kc.  
10 microvolt null sensitivity.  
10 meg input impedance.  
Available in any frequency.  
Unaffected by harmonics with optional filters.  
Low noise.  
Signal and/or Reference Isolation.

### PLUG-IN ACCESSORIES

- Reference Isolation Module
- Bridging Transformer Module
- Summing Module



**NORTH ATLANTIC** industries, inc.  
603 main street, westbury, n.y. EDgewood 4-1122

CIRCLE 227 ON READER-SERVICE CARD

# AIRPAX

## Transistor Chopper



ACTUAL  
SIZE

... requires no  
external drive

transformer

The AIRPAX type 6025 transistor chopper has a SPDT switching action capable of handling signal voltages up to 100 volts. Inclusion of drive transformer in the assembly provides signal and drive isolation.

Switching action can be any frequency from 50 to 5000 CPS, using sine or square wave drive. Ideal for use in operational amplifiers, DC measuring instruments, servo systems, and similar applications where fast response and wide-band operation is a necessity.

- High Signal Handling Capacity
- Wide Frequency Range
- Minimum Drive Power Requirement
- Impervious to Shock and Vibration
- Phase and Dwell Time Unaffected by Temperature Changes



CM31

CAMBRIDGE DIVISION, CAMBRIDGE, MARYLAND

CIRCLE 228 ON READER-SERVICE CARD

# IF YOU USE BWOs/TWTs

**YOU NEED**  
*the new* **PRD 813**  
**power supply**



CIRCLE 229 ON READER-SERVICE CARD

Only a microwave engineer who has extensive experience with Travelling Wave Tubes and Backward Wave Oscillators can fully appreciate this latest advancement in the power supply art.

Look at these *exclusive* features...

- *built-in* delay line sweep over the entire range from 150 to 3600 volts
- *built-in* Automatic Gain Control
- *built-in front panel* switching for grid or anode modulation
- *built-in* digital readout for delay line supply
- *built-in* dual output jacks for parallel tube operation or external metering

PLUS automatic sequential application of filament, grid and collector, delay line, and anode voltages... each with its own *front panel adjustments*.

Naturally, there is automatic safety overload protection in the anode, delay line, and collector current circuits. The best news (of course) is that the PRD 813 BWO/TWT Power Supply is available FROM STOCK.

For the full story on the PRD 813, contact your nearest PRD representative or write:

**POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.**

*Factory & General Office:*

202 Tillary St., Brooklyn 1, N. Y. ULster 2-6800

*Western Sales Office:*

2639 So. La Cienega Blvd., Los Angeles 34, Calif.  
UPton 0-1940



## NEW LITERATURE

### Precision Counters

230

This two-page data sheet gives technical details, including dimensional drawings and illustrations, of precision degree and mil counters. The units have no transfer masks or shade and no interrupted gearing. Series AD-1 counts hours, degrees, mils, minutes, etc., returns to zero and repeats. Photographs, technical data, and dimensional drawings are included. Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago 14, Ill.

### Mica Products

231

Revised catalog and price list No. 25, which deals with compressed sheet mica products, includes these two new materials: India alkyd vinyl segment plate, and India epoxy segment plate. The latest listings are also carried on flexible mica Mylar combinations, epoxy mica molded rings, and alkyd vinyl mica molded V rings, as well as the firm's standard lines. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.

### Definition Of Relay Terms

This standard contains definitions of the various types of relays such as electromagnetic, thermal, magnetostrictive, and electric field devices, as well as approximately 200 other terms associated with relays. Several diagrams are used in the publication to clarify definitions. The standard, No. C83.16-1959, was based, in part, on a booklet published in 1955 by the National Association of Relay Manufacturers, as well as on other sources. Send \$2.00 to the American Standards Association, Dept. PR 101, 70 E. 45th St., New York 17, N.Y.

### Voltmeter and Power Supply

232

Features, applications, circuitry, and specifications of a dc voltage standard and null meter are included in bulletin No. 15-7, two pages. The bulletin describes the model 301 high-precision instrument that can be used to measure dc voltages in the range of 1 to 501 v, full scale. Data is also given on the instrument's use as a dc voltage standard. A circuit diagram and description provides data on the instrument's operation. Detailed specifications are listed. Cohu Electronics, Kin Tel Div., 5725 Kearny Villa Rd., San Diego 12, Calif.

## Resistors

233

The firm's Bobbinless precision wirewound resistor is described in brochure No. GR-30. It contains complete details and specifications on three of these resistors. By eliminating the bobbin and floating the resistive element in a special viscous fluid, the resistors gain in stability and reliability. The resistors are available in power ratings up to 1/2 w, with tolerances as low as 0.05%, and a temperature coefficient as low as 2 ppm per deg C. General Transistor Corp., 91-27 138th Place, Jamaica 35, N.Y.

## Plastic Parts

234

This four-page bulletin describes extruded shapes and precision fabricated parts made from nylon, Delrin, or Penton. It outlines the advantages, uses and limitations of the three plastic materials. Text is arranged in three columns, one for each material. The bulletin also tabulates stock sizes of extrusions available in rod, tubing and strip form. A tabular comparison of the material's properties is also included. The table covers basic mechanical, electrical, thermal and miscellaneous properties. National Vulcanized Fibre Co., 1059 Beech St., Wilmington 99, Del.

## Automatic Testing Systems

235

Programmable Automatic Testing Systems are described in this four-page bulletin, No. 1100. Included are systems for missile checkout, dynamic system testing, quality control, simulation and production testing. Products covered are: an automatic multiple circuit analyzer, a universal test station, and a computer test set. The bulletin contains photographs. Consolidated Diesel Electric Corp., 880 Canal St., Stamford, Conn.

## Indicator Lights

236

This four-page brochure, Form L-162, describes four series of assemblies designed to mount in a 15/32-in. clearance hole from the front of the panel. The assemblies contain two-terminal sub-miniature indicator lights. The series discussed are: the neon series which uses a T-2 neon glow lamp; and the incandescent series which also includes water-tight assemblies and edge lighting assemblies. All assemblies meet applicable Mil specifications. Complete lamp data, illustrations of the assemblies, features, specifications, and schematics are included. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N.Y.

proven reliability for all applications

# 3 NEW MIL SPEC POWER TRANSISTORS FROM MOTOROLA



For highest reliability in the toughest environments, specify one of these new Motorola germanium PNP, alloy junction power transistors:

- TYPE 2N1011 — 3AMP to 80 Volts (meets MIL-T-19500A/67 Sig C)
- TYPE 2N1120 — 10AMP to 80 Volts (meets MIL-T-19500A/68 Sig C)
- TYPE 2N297A — 3AMP to 60 Volts (meets MIL-T-19500A/36 Sig C)

Immediately available from Motorola's bonded warehouse, these high-voltage units are designed for use in military equipment where semiconductor devices must meet MIL-T-19500 specs—including audio amplifier, power supply and converter applications in aircraft and ground support equipment. Motorola's copper-strap internal construction provides the ruggedness they need for operation under environmental extremes at temperatures ranging from  $-65^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$ . All are hermetically sealed in an industry standard TO-3 package with type 2N1120 having .052" pins with solder lugs attached.

Production Quantities available from Motorola stock for immediate delivery. For engineering quantities, contact your nearest Motorola Semiconductor distributor.

## WHAT IS YOUR POWER NEED?

Motorola's complete range of industrial power transistors gives you power for every purpose. Three separately designed series offer current handling capacities of 3, 10 and 25 amps...and a wide range of voltage ratings to suit your individual requirements. All of the transistors listed in the adjoining table have welded hermetic seals and meet or exceed mechanical and environmental requirements of MIL-T-19500A.

POWER TRANSISTOR	Maximum Ratings			Typical Electrical Characteristics	
	Type Number	BV <sub>CB0</sub> volts	BV <sub>CE0</sub> volts	h <sub>FE</sub> @ I <sub>C</sub> amps	
<b>25 AMP</b> TO 100 VOLTS	2N1167*	100	75	25	25
	2N1166	100	75	25	25
	2N1165*	80	60	25	25
	2N1164	80	60	25	25
	2N1163*	50	35	25	25
	2N1162	50	35	25	25
T <sub>J</sub> = 100°C					
<b>10 AMP</b> TO 100 VOLTS	2N630*	100	75	18	10
	2N629*	80	60	18	10
	2N628*	60	45	18	10
	2N627*	40	30	18	10
	2N1120*	80	70	20	10
T <sub>J</sub> = 100°C					
<b>3 AMP</b> TO 80 VOLTS	2N375	80	60	22	3
	2N618	80	60	35	3
	2N297A	60	50	35	2
	2N1011	80	80	45	3
T <sub>J</sub> = 100°C					

\*Supplied in TO-3 package with solder terminals.

FOR COMPLETE TECHNICAL INFORMATION regarding Motorola power transistors contact your nearest Motorola Semiconductor regional office:

RIDGEFIELD, NEW JERSEY  
540 Bergen Boulevard  
Whitney 5-7500  
from New York WI 7-2980

CHICAGO 39, ILLINOIS  
5234 West Diversey Avenue  
Avenue 2-4300

HOLLYWOOD 29, CALIFORNIA  
1741 Ivar Avenue  
Hollywood 2-0821

OUTSIDE U.S.A. AND CANADA WRITE: MOTOROLA INTERNATIONAL, S.A.  
4545 West Augusta Boulevard  
Chicago, Illinois



"DEPENDABLE QUALITY - IN QUANTITY"

**MOTOROLA  
SEMICONDUCTORS**

MOTOROLA, INC.,  
5005 E. McDOWELL, PHOENIX, ARIZONA

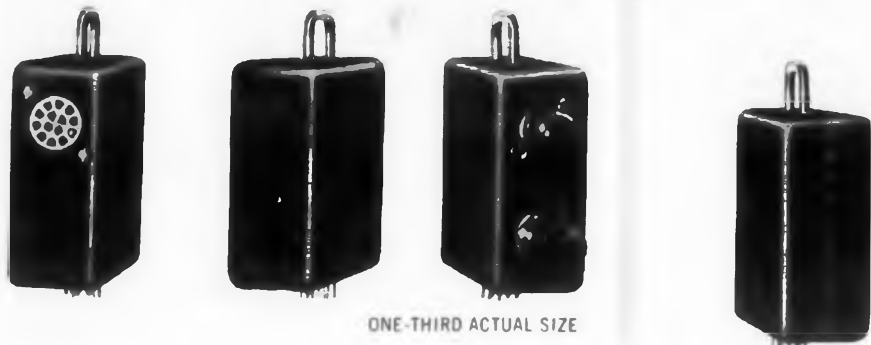
CIRCLE 237 ON READER-SERVICE CARD

**NEW  
EECO**

*Transistorized*

**DECADES**

for extremely  
reliable operation  
in the 0 to 250 kcs range



ONE-THIRD ACTUAL SIZE

#### APPLICATIONS

New EECO N-Series Transistorized Decades are miniaturized plug-in units designed for reliable pulse counting and frequency division in the frequency range of 0 to 250,000 pulses per second.

#### FEATURES

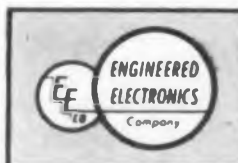
- Small, compact size.
- Simple power supply requirements (for example, Models N-101 and N-102 require only -12 volts).
- Low power consumption.
- Compatible with EECO T-Series circuits.
- Auxiliary 9-step staircase output available.
- Most units plug into special 13-pin miniature socket. Others take standard 29-pin socket (Continental No. MM-29-22S).
- Pin connections arranged for in-line wiring of power and grounds.
- Extreme reliability, due to saturation techniques and consistent derating of component tolerances.

#### WIDE SELECTION

EECO N-Series plug-in Decades are available in the following standard models:

MODEL	DESCRIPTION
N-101	No readout.
N-102	Incandescent readout.
N-104	Incandescent readout (remote). Typically a projection readout module.
N-105	Nixie readout. (Can be cabled to remote Nixie.)
N-106	Nixie readout with preset control switch. (Can be cabled to remote Nixie.)
N-107	Incandescent readout with inputs for external preset control.
N-108	Incandescent readout (remote) with inputs for external preset control.
N-111	No readout, but with 1-2-4-2 code.

*Additional information on N-Series Transistorized Decades and other EECO products available on request.*



**ENGINEERED ELECTRONICS COMPANY**

(a subsidiary of Electronic Engineering Company of California)

506 East First Street • Santa Ana, California

CIRCLE 238 ON READER-SERVICE CARD

#### TYPICAL SPECIFICATIONS

The N-102 Transistorized Decade, which includes visual readout of numerals 0 through 9 displayed vertically and illuminated by incandescent lamps, is identical electrically with Model N-101. Abbreviated specifications are as follows:

#### INPUT

Minimum Trigger Input: (0-100 kcs): 7 volts pos. pulse or step at 0.5  $\mu$ sec. rise time. (100 kcs to 250 kcs): 7 volts pos. pulse or step at 0.2  $\mu$ sec. rise time.

Max. Operating Frequency: 250 kcs.

Input Impedance: 470  $\mu$ fd. capacitance, max.

DC Reset input is provided (normally supplied by EECO T-129 DC Reset Generator).

#### OUTPUT (No Load)

Amplitude: 8 volts, peak to peak.

Output Levels: (N/10) and (N/10):  
-11 volts DC and -3 volts DC, nom. Staircase: -11 volts DC to -3 volts DC in 9 steps.

Rise Time: (N/10): 0.5  $\mu$ sec.; (N/10): 0.5  $\mu$ sec.

Load: Typical, one N-Series Decade or one T-Series flip-flop. (Load information available on request.)

#### OPERATING TEMPERATURE

RANGE: -45°C to +65°C.

SIZE: 1-5/32" wide x 2-3/32" deep x 3-7/8" seated height (including handle). Dimensions are exclusive of external appendage found on external preset and Nixie models.)

## NEW LITERATURE

### Military Components Catalog

This catalog, No. 50, 32 pages, describes U. S. military specifications covering those components which the firm makes. It includes such products as fixed power resistors, adjustable power resistors, precision resistors, rheostats, tantalum capacitors and relays covered by the latest military specifications. The catalog reduces military specifications to the "type" designation: the combination of letters and numbers by which military parts are described and ordered. "Type" designations for each military specification are explained in a graphic manner and the options permitted for each type of component are clearly outlined. The physical and electrical parameters of the style are stated and a sample "type" designation for that style is shown. Symbols and data to complete the sample "type" designation are provided on fold-out master sheets in each section. The books contain summary charts in the introduction to each section which permit a preliminary choice of size and style. It contains dimensional drawings and derating graphs. Write on company letterhead to: Ohmite Manufacturing Co., Dept. ED, 3675 Howard St., Skokie, Ill.

### Magnetic Tape Recorder/Reproducer 239

Bulletin 1576, illustrated, describes the type 5-752 magnetic tape recorder/reproducer. A complete system in a single cabinet, the 5-752 accommodates seven different types of record and reproduces amplifiers for analog, fm or PDM modes of operation, and can be adapted to PCM (digital). Sections of the brochure describe physical and operating features. Photographs and block diagrams are included. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

### Electro Clutch Line 240

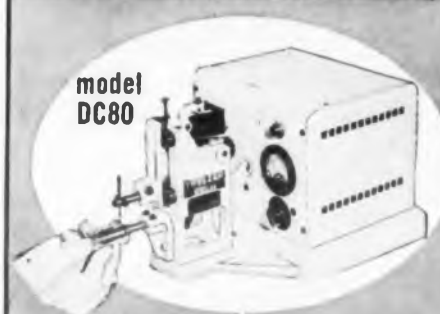
Detailed information on the firm's complete line of electromagnetic clutches, in six series with torque capacities from 1.8 through 13,000 lb-ft, is furnished in this 20-page bulletin. The bulletin, number R-6304-1B, provides design, specification and application material, including photographs, drawings and sketches. The clutches provide instantaneous pushbutton or automatic programming control of shaft-driven machinery in a variety of fields including radar antennas and test equipment. Clutch accessories and components are also described. I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.

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SYNCHRONOUS  
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Please address all inquiries regarding Diall molding compounds to  
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Dept. 14



**Soldering 243**

This technical guide to soldering, titled "Guide To Automatic Soldering," offers data on solder preforms—their selection and use. Also discussed are flux-filled washers for automatic soldering and the process of converting to automatic soldering. "Tips On Soldering," another brochure, deals with the subject of solving soldering problems. The "Flux Finder Guide" brochure is designed to aid the user in finding the right flux for every need. Alpha Metals, Inc., 56 Water St., Jersey City 4, N.J.

**Photoelectric Equipment 244**

Miniaturized electric-eye applications for counting, sorting, monitoring, assembling, and automatic weighing as applied to packaging, printing and general production is described in this 16-page bulletin. The equipment described in bulletin No. 571 ranges from direct or partial cut-off to reflector type units. It contains an expanded section dealing with specific in-plant installations. Technical and specification data includes dimensions, circuitry, speed, monitoring and relays. Photomation Inc., 96 S. Washington Ave., Bergenfield, N.J.

**Telemetry Equipment 245**

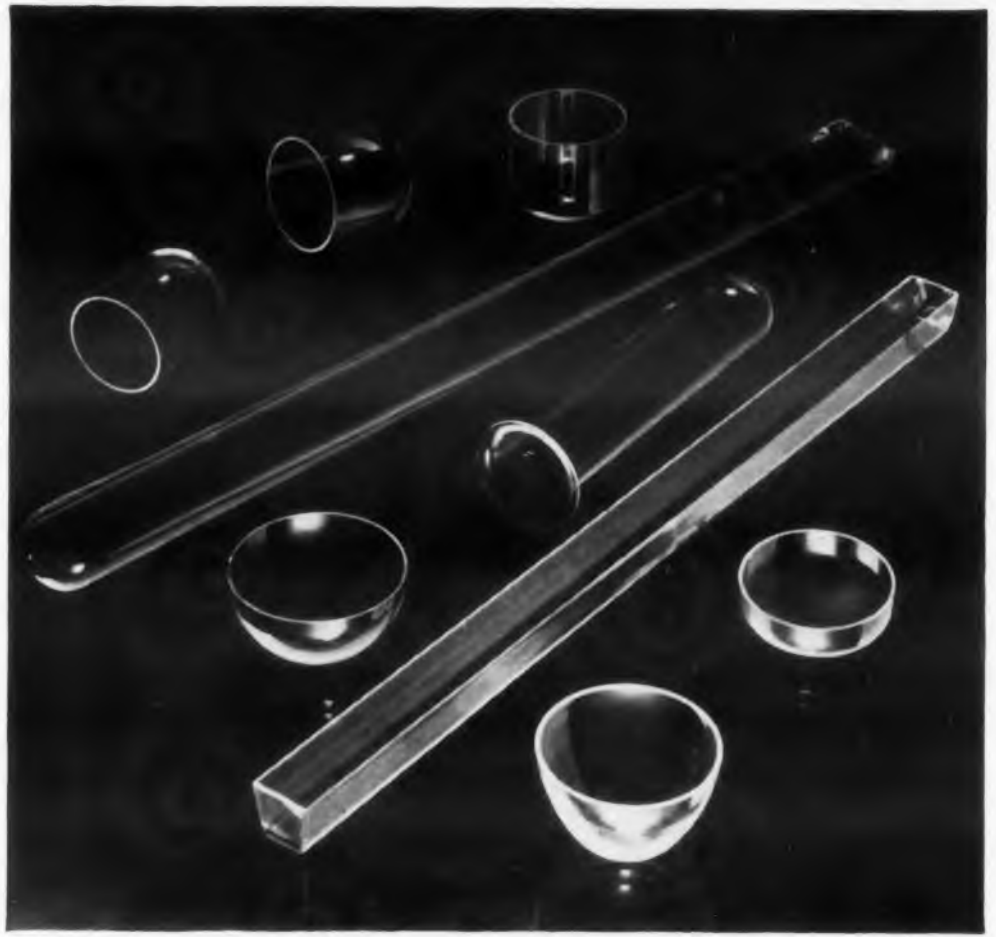
The various components of the firm's ground decommutations system and how they operate are described in an eight-page brochure titled "M-Series Ground Stations for PAM/PDM Decommuration." Basic, recommended systems layouts for telemetry decommutation stations are given along with accessories that may be used with them. Complete system specifications are provided. Applied Science Corp. of Princeton, a division of Electro-Mechanical Research, Inc., Box 44, Princeton, N.J.

**Encapsulated Transformers 246**

This four-page brochure, titled "Encapsulated Transformers," describes performance characteristics and applications of HR/Epseal and Electro-seal transformer construction. Three basic design improvements, which achieve higher reliability, reduced size and weight, and improved cooling, are illustrated. Typical transformer configurations are shown in photographs. Units are designed to custom requirements from microwatt ratings to 250 kva for both commercial and MIL-T-27A, Grade 2 or 5, applications. Electro Engineering Works, 401 Preda St., San Leandro, Calif.

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**HERE'S GOOD NEWS** for anyone in the semi-conductor field making silicon and germanium and using ordinary crucibles or thin wall tubing for zone refining. General Electric offers the industry's most complete line of semi-conductor components of extremely High Purity fused quartz. This enables you to fill all your quartz requirements from a single source—simplifying ordering, stocking and bookkeeping.

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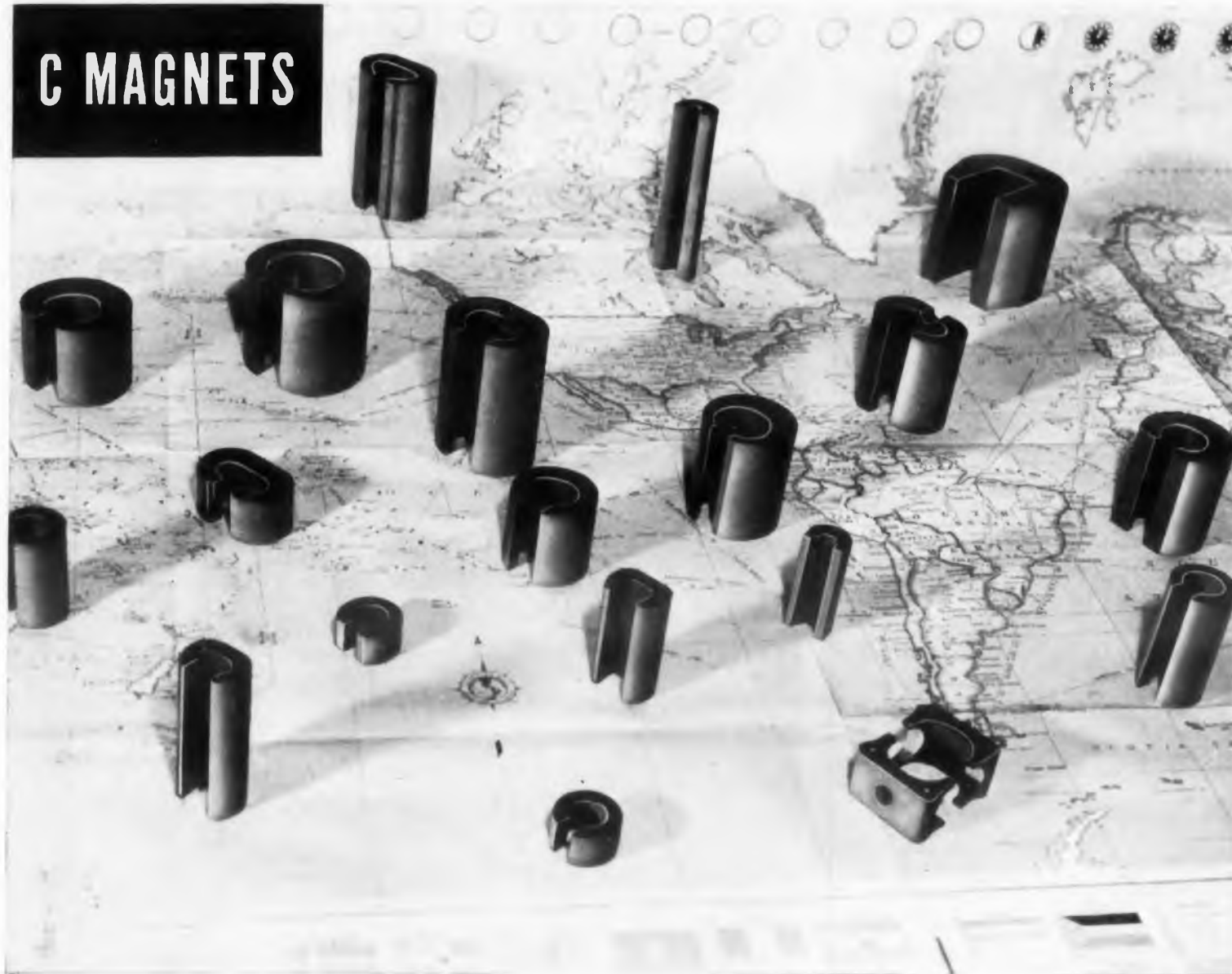
Contains pictures, prices and properties (physical and chemical) on G-E Fused Quartz ingots, plates and discs; tubing and rod; laboratory quartzware; immersion thermocouple tubes and combustion tubes; plus quartz yarn, wool and mat. For your free copy, write: General Electric Co., Lamp Glass Department ED-119, Willoughby Quartz Plant, Willoughby, Ohio. And you can get free engineering assistance just for the asking—when you write.

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magnets available for wave guide applications:

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SPECIALISTS IN MAGNETIC MATERIALS—  
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Laminations Wound Cores

## NEW LITERATURE

### Instrument Standards

This standard, No. C39.1-1959, applies to dc and ac ammeters, voltmeters, wattmeters, varmeters, frequency meters, power-factor meters, and other instruments operating on the same principles but indicating derived quantities. It is the fifth edition of the standard. Special purpose instruments such as ultra-sensitive dc microammeters and thermovoltmeters of the vacuum-couple type are also covered, with suitable exceptions. All these instruments may be panel or switchboard mounted, or they may be portable. The standard does not cover indicating instruments provided with arrangements for curve drawing, contact making. Nor does it cover small instruments of types and sizes where the indications are only approximate. The standard contains 52 pages and includes illustrations of the various types of instruments and a tabulation of detailed requirements. Send \$2.50 to the American Standards Association, Dept. PR 103, 70 E. 45th St., New York 17, N.Y.

### Mercury-Wetted Contact Relays 249

A full line of the firm's mercury-wetted contact relays is illustrated and described in Catalog 201. Relay types are for both single- and multi-element operation, biased with permanent magnets, or adjustable to provide single-side-stable, bi-stable, or chopper characteristics. C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill.

### Test Equipment Carts 250

Four carts for oscilloscopes and other test equipment are described in this one-page data sheet. Model numbers, applications, features, dimensions, weight, and price are given. The carts are made of 14 gage steel and finished with light grey enamel. Photographs are included. Northeastern Engineering, Inc., 25 S. Bedford St., P.O. Box 150, Manchester, N.H.

### Position Indicators 251

Technical details of the series 2600 drum type latitude and longitude precision counters are given in this two-page data sheet. Dimensional drawings and illustrations are included. The counters are completely contained within a movable mask. Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago 14, Ill.

**Tape Wound Cores 252**

Tape wound cores which can be obtained in two new core materials to precise limits are described in this eight-page, illustrated catalog. Core design data is included as well as new case sizes. Bulletin TB-105 contains diagrams, charts and tables. G-I. Electronics, 2921 Admiral Wilson Blvd., Camden 5, N.J.

**Moisture, Corrosion Inhibitor 253**

An inhibitor that displaces and seals out water and moisture, protects metal surfaces against corrosion and lubricates is discussed in this six-page, illustrated folder. Called CRC 2-26, this liquid formula has been developed for manufacturing and maintenance use in electronic equipment. The folder includes an explanation of how CRC 2-26 works, its benefits, and details on its physical specifications. Corrosion Reaction Consultants, Inc., 116 Chestnut St., Philadelphia 6, Pa.

**Microwave Meters and Filters 254**

Precision frequency meters in the 500 to 18,000 mc tuning range and tunable band pass filters with tuning ranges from 960 to 9600 mc are discussed in this 12-page catalog. In addition to photos and graphs, such electrical characteristics as cavity types, frequency response, and insertion loss are covered. Frequency Standards, Div. of Harvard Industries, Inc., P. O. Box 504, Asbury Park, N.J.

**Electronic Equipment 255**

Detailed descriptions and illustrations of electronic equipment for research and industrial uses are covered in this 12-page, two-color book. Included are: dc power supplies, digital readout voltmeters, ac line voltage regulators, and information on custom design and prototype development engineering services offered by the firm. Davenport Manufacturing Co., 2530-32 N. Elston Ave., Chicago 47, Ill.

**Semiconductor, Capacitor Catalog 256**

This eight-page catalog covers the firm's line of diodes and capacitors. Basic specifications and brief descriptions are included in catalog No. U.S.S.-8-59. The catalog is divided into sections, and a page is given to ordering information on solid electrolyte tantalum capacitors. U. S. Semiconductor Products, a Division of Topp Industries, Inc., 3540 W. Osborn Road, Phoenix, Ariz.

# Circuit Design Reliability Problems

**New** tool for the Reliability Engineer . . . the AIL Type 90 is designed to test low frequency (audio, video and computer) circuits by the "extreme values" or "worst case" technique. Circuits may be tested for all combinations of anticipated low and high values for as many as 16 parameters. Up to 1500 tests per minute may be conducted.

Digital read out permits determination of circuit combinations which produce unacceptable performance. The total number of available circuit parameters combined with the total number of parameters successfully tested to their extremes, provide a measure of the reliability factor of the circuit under test.

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## NEW LITERATURE

### Servo Systems

259

How to design, breadboard, and analyze servo systems rapidly is discussed in this six-page report. Photographs illustrate the uses of the servo system simulator. The report explains how the unit can simulate portions of a servo system, simulate complete systems, analyze components, debug prototypes, life-test systems, and perform quality control tests. Servo Corp. of America, 111 New South Road., Hicksville, N.Y.

### Panel Instruments

260

Microminiature panel meters, 1/2-in. in size, are featured in this two-page bulletin. Specifications, photos, a table of standard ranges and approximate resistances, and an outline drawing describe these meters. DeJur-Amsco Corp., Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N.Y.

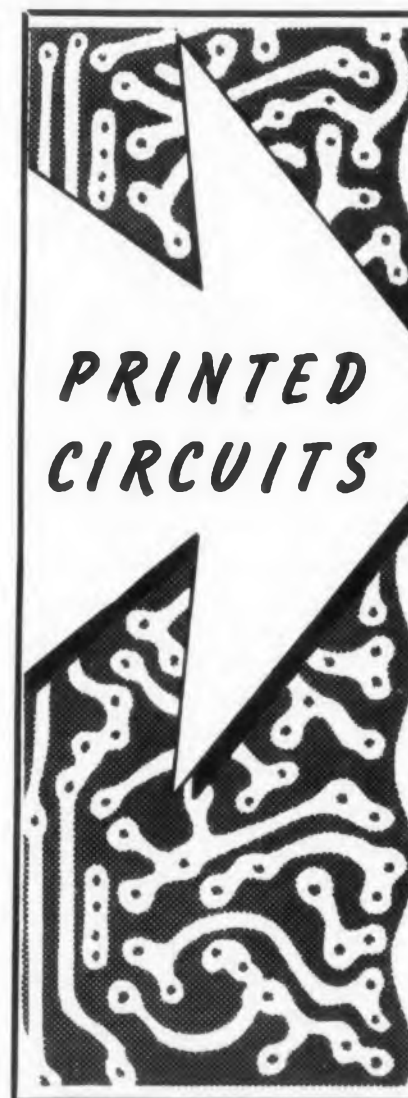
### Terminal Chart

261

Scale drawings of solder terminals with dimensions and materials appear on this 21 x 27 in. wall chart. The solder terminal kit is also included. Cambridge Thermionic Corp., Concord Ave., Cambridge 38, Mass.

### Transistor Manual

This 227-page manual, the fourth edition, contains rewritten information on transistors and their use in electronic circuits. Included in the 20 chapters are data on basic semiconductor theory, transistor construction techniques, biasing, switching characteristics, and circuits. An up-to-date listing of all American JEDEC-registered transistor types with basic specifications and interchangeability information also appears. Send \$1 to General Electric Co., Dept. ED, Charles Bldg., Liverpool, N.Y.



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Write for our booklet... "Some Suggestions on Printed Circuit Layout and Design."

CIRCLE 262 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 25, 1959



## RF and IF Amplifiers 263

Catalog No. 96 provides 22 pages of information on microwave receiver front ends, rf, if, and twt amplifiers, telemetering preamplifiers, noise test sets, and beacons. Information is included on electrical characteristics, mechanical construction, and general applications. A number of new product additions are described, including an X-band low noise microwave mixer-amplifier assembly, a hybrid transistorized amplifier with a ceramic triode input, and a crash locator beacon. Pictorial material is also given. Lel, Inc., 380 Oak St., Copiague, L.I., N.Y.

## Glow Lamps 264

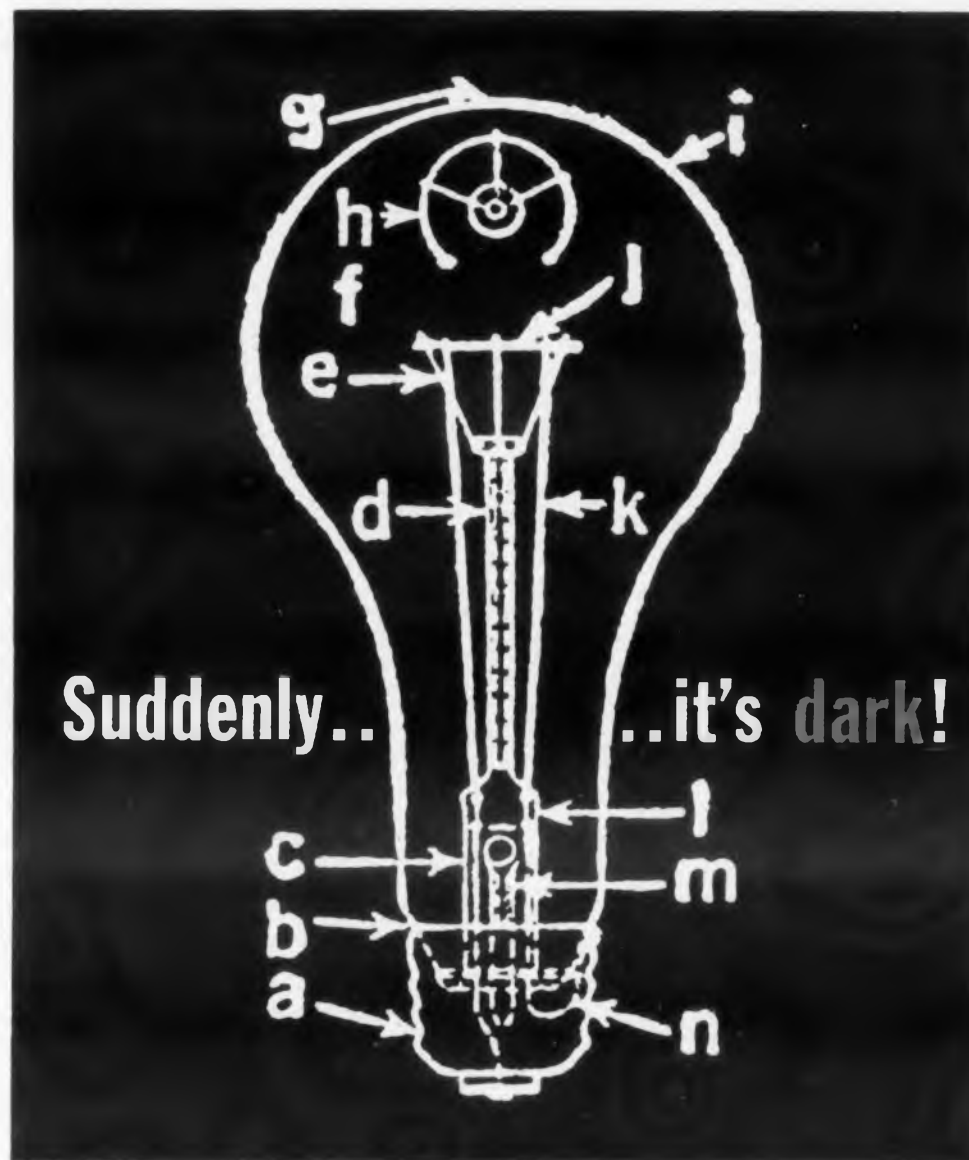
This file folder contains specification sheets on glow lamps for the appliance, electrical and electronic industries. A 3 x 5 in. file card, which summarizes the range of glow lamps and allied devices available from the firm, tears easily from the folder cover for filing purposes. Signalite Inc., Neptune, N.J.

## Telemetering System 265

This four-page, two-color bulletin describes the model TU-1A telemetering system. The system can be applied to pressure vessels, radomes, and moving and rotating equipment. It is fully described as to configuration and operational performance. Photographs are included. Telemetering Corp., P.O. Box 645, Mesa, Ariz.

## Inductors 266

A line of small light-weight toroidal inductors which have high Q values is described in this two-page data sheet. A typical 1-mh inductor operating at 40 kc has a maximum Q of 240. Complete technical specifications, dimensional drawings and ordering instructions are included. Units are supplied with inductance values from 1 mh to 5 h. Designated as series 785, these inductors are fully encapsulated and hermetically sealed and meet MIL-T-27A and MIL-E-5272A specifications. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.



Suddenly... ..it's dark!

A pretty dark situation, indeed—when a *single* electron tube failure can shut down an equipment or entire production line test facility! Use IERC's new set of a, b, c's to help you get improved electronic equipment reliability. **a.** The practice of replacing tube failures in manner and attitude like that of replacing a light bulb is neither protection nor cure against a continuing high rate of electron tube failures! **b.** Downtime, labor replacement costs often add up to 10 times the tube cost! **c.** You can actually increase tube life up to 12 times by specifying and using IERC Heat-dissipating Electron Tube Shields! The full facts, in the form of **d.** complete product literature, **e.** test reports, **f.** engineering data and **g.** tube shield application guides, especially prepared to help you "see the light," are available on request—write today!

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Foreign Manufacturers: Europelec, Paris, France. Garrard Mfg. & Eng. Co., Ltd., Swindon, England.

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### Union Miniature Relays

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The excellent reliability and small size of the Union Miniature Relays have led to their use in traffic control systems, computers, resistance welders, and other equipment.

#### OUTSTANDING FEATURES

**HI-I/O CONTACTS**—Permit high and low load handling in same relay. Dry-circuit contacts available for extremely low-level loads.

**COIL RESISTANCE**—In standard case, from 0.9 to 8750 ohms; in long case, from 1.6 to 13,000 ohms.

**TEMPERATURE RATING**—Class A  $-55$  to  $+85^{\circ}\text{C}$ ; Class B  $-65$  to  $+125^{\circ}\text{C}$ .

**AC OR DC**—Nominal operating voltages from 1.5 to 160 volts, DC; 115 volts, 60 to 400 cps, AC. Built-in rectifiers in AC relays.

**TYPES AND MOUNTINGS**—6PDT or 4PDT; plug-in or solder-lug connections. All usual mountings.

**SPECIALS**—Slow-acting relays if you need a differential between operating time of various relays. Plate-circuit relays—operate on less than 8 milliamperes; double-coil relays—either coil operates relay. Write for complete information.

See us at Eastern Joint Computer Conf. Dec. 1, 2, 3, 1959, Statler Hilton Hotel, Boston, Mass. Booths #1 and #2.

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**UNION SWITCH & SIGNAL**

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY—

PITTSBURGH 18, PENNSYLVANIA

CIRCLE 269 ON READER-SERVICE CARD

## NEW LITERATURE

### Digital Systems 270

"Symbolic Logic, Boolean Algebra and the Design of Digital Systems," a 34-page illustrated booklet, discusses the binary number system and its relationship to dyadic or two-valued logic, the method of expressing the variable functions in terms of two-valued logic, and the means of implementing these functions electronically. A description of the theoretical methods for minimizing a logical function follows. Basic logical circuits are analyzed and implemented. Computer Control Co., Inc., 2251 Barry Ave., Los Angeles 64, Calif.

### Power Supplies 271

Standard and special power supplies are described and illustrated in two-page data sheet 100A. A power supply requirement check list covering any supply problem is included. Burmac Electronics Co., Inc., 142 S. Long Beach Rd., Rockville Centre, N.Y.

### Servo Components 272

Control and torque synchros and resolvers, and data about the firm and its personnel are featured in this illustrated brochure. Photographs, tables, and dimensional diagrams are included. Vernitron Corp., 136 Church St., New York 7, N.Y.

### Silver-Zinc Batteries 273

Design details for over 20 manual and automatically activated silver-zinc primary batteries appear in this six-page brochure. Specification tables show electrical performance, environmental capabilities, physical specifications, energy-to-weight ratios, and automatic activation times. The brochure illustrates batteries featuring rectangular, and cylindrical sector case configurations. Cook Batteries, Sub. of Telecomputing Corp., 3850 Olive St., Denver 7, Colo.

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## With Laboratory Standard JKFS-1100T

# FREQUENCY STANDARDS

### Fully Transistorized, with Double Proportional Control Oven

Today's most advanced design, with each unit aged in and calibrated directly with WWV at Washington, D. C. **Input:** 24 to 32V DC. **Output:** 1V into 50 ohms at 1 MC and 100 KC. **Dimensions:** 6.0"H x 4<sup>1</sup>/<sub>16</sub>"W x 12<sup>1</sup>/<sub>2</sub>"D. **Power Supply Unit:** operates from 115V AC, with 12-20-hour self-contained stand-by batteries. Fully automatic switch-over. Dimensions: 6.0"H x 3<sup>3</sup>/<sub>16</sub>"W x 12<sup>1</sup>/<sub>2</sub>"D. Write for literature on JKFS

## 1100T



### THE JAMES KNIGHTS COMPANY, Sandwich, Illinois

CIRCLE 274 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 25, 1959

## Pulse Control Instruments 275

This illustrated eight-page booklet describes 24 packaged pulse-handling units. A megacycle variable scale counter and a high frequency pulse generator are included in the brochure. Burroughs Corp., Electronic Tube Div., Plainfield, N.J.

## Transistor Chart 276

This revised replacement chart for transistors, two pages, lists types similar or identical to the firm's transistors. Bendix Aviation Corp., Red Bank Div., Long Branch, N.J.

## Electromagnetic Clutches 277

Design, specification and application data for electromagnetic clutches are given in this 20-page bulletin. Operating characteristics, dimensions, torque ratings, speeds, and prices are covered for the six series of clutches. Photographs and drawings illustrate the units. I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.

## Isolators 278

Microwave waveguide ferrite isolators are described in this two-page illustrated bulletin. Performance curves show vswr, isolation, and insertion loss plotted over the isolator's entire frequency range. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y.

## Silicon Power Rectifiers 279

Specifications and a description of silicon power rectifiers, which operate from one to 15 amp, appear in data sheet 71059. The diagram gives dimensions for these 7/16-in. hex stud base diodes. Syntron Co., 283 Lexington Ave., Homer City, Pa.

## Differential DC Amplifier 280

Features of the firm's wide-band low-level differential dc amplifier appear in bulletin 105801, four pages. Photos of the unit and a graph illustrating wide-bandwidth are included. Epsco, Inc., 275 Massachusetts Ave., Cambridge 39, Mass.



## What can you do with a remarkable instrument like this?

We knew we had an outstanding instrument in our product line when this readout device was introduced several years ago. It proved to be ahead of its time during those early days, but now this remarkable precision instrument for displaying data is gaining acceptance in many industries. It's about as big as a candy bar, and it will display, store, or transfer up to 64 different numbers, letters, or symbols without using complicated conversion equipment and "black boxes."

This is an entirely new species of readout device so we had to give it a new name, the Readall\* readout instrument.

We developed the Readall instrument for data display in flight control equipment. We knew the Readall instrument was fine but didn't know just *how* valuable it was. But one of our engineers did. He designed a complete new pipeline control system based on the new instrument. The application was a breakthrough in data handling, and the control system is a big success.

Naturally, we put the Readall instrument

on the market so systems engineers could use it to improve their control systems. We announced the Readall instrument as "... an electro-mechanical, D.C. operated, readout device for displaying characters in accordance with a pre-determined binary code ... a compact, self-contained device ... which can be applied to the output of digital computers, teletype receiving equipment, telemetering systems, or wherever data must be displayed."

Other systems have been developed with separate units for data display, decoding, storing, and electrical readout. These separate units cost more and occupy more room. Market response confirms the need for *one, small, inexpensive* unit that does all three jobs. The Readall instrument serves the purpose.

We'd like to discuss possible applications for the Readall instrument with you. If you want information as to possible applications you have in mind for this remarkable instrument, please fill in the coupon.

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DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY—  
PITTSBURGH 18, PENNSYLVANIA

Union Switch & Signal  
Division of Westinghouse Air Brake Company  
Pittsburgh 18, Pennsylvania

Here is a possible application we have in mind for the Readall instrument:

Send more information about the Readall instrument

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

Company \_\_\_\_\_

Address \_\_\_\_\_

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

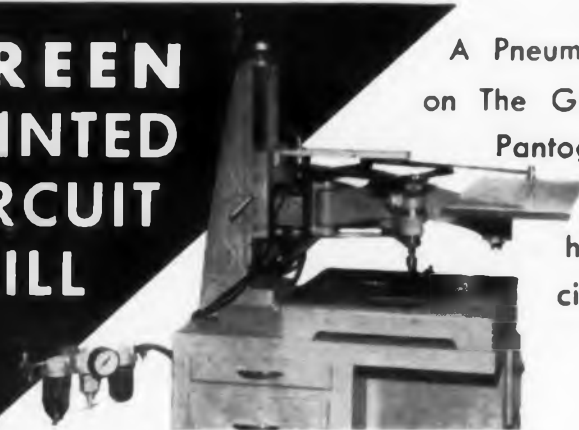
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CIRCLE 282 ON READER-SERVICE CARD

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Formula Number  
**1571**  
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## GREEN PRINTED CIRCUIT DRILL



A Pneumatic Attachment on The Green Model D2 Pantograph Engraver rapidly drills holes in printed circuits by tracing templates.

- Drill as many as 100 holes per minute, Foot switch actuates air powered operation.
- Drill speeds and feeds have independent adjustments, Feed regulated by air pressure.
- Spindle speeds up to 26,000 rpm. Permits use of carbide drills when required.
- D2-201 air attachment includes spindle air cylinder, regulating valve and pressure gauge, foot switch, filter and oiler, ready to operate when connected to compressor.

The Model D2 Heavy Duty Pantograph Engraver features ratios of 2 to 1 to infinity. Unobstructed on three sides to handle large work. Micrometer adjustment for depth of cut. Vertical range 10" adjusting copy table automatically with pantograph.

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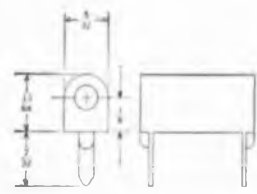
## CHECK THE LOW COST of these new printed circuit test jacks



Patents pending

### Samples on request

Ucinite's new test jack is designed for permanent, soldered assembly to printed circuit boards. Gold-over-silver-plated beryllium copper contacts provide low-resistance contact for repeated insertions of standard .080" diameter test probes. Nylon bodies are available in eleven standard code colors. Uniquely simplified construction affords economical usage in all quantities. Immediate shipments from stock.



For .052 application holes on .400 centers



**The UCINITE COMPANY**  
Division of UNITED-CARR Fastener Corporation  
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CIRCLE 284 ON READER-SERVICE CARD

## NEW LITERATURE

### Relay Control Amplifier

285

A high-gain dc to ac relay control amplifier is described in this four-page bulletin. It gives detailed information on principles of operation, performance ratings, and applications. Illustrations and graphs are included. The amplifier recognizes the polarity of a low-level dc input signal, converts it to ac, and amplifies it to a signal with sufficient strength to actuate its master relay in accordance with that polarity. Thermo Electric Co., Inc., Saddle Brook, N.J.

### Digital Magnetic Tape Recording

286

A 1500 bit per inch packing density for digital magnetic tape recording is described in this 26-page report. It includes theoretical considerations with experimental test results. Information drop-out is examined, and descriptions and diagrams for the implementation of this technique are provided. Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, L.I., N.Y.

### Silicon Power Diodes

287

Silicon power diodes, rated from 25 to 35 amp, are described in Bulletin XSR-310, two pages. Photographs, dimensional data, mechanical construction, and electrical characteristics are included. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

### Permanent Magnets

288

The magnetic and material characteristics of Hyflux Alnico V-7 permanent magnets are covered in this two-page bulletin, No. 350. Use of the magnets in lightweight ground or airborne generators, alternators and recording equipment is described. A demagnetization and energy product graph is included. The Indiana Steel Products Co., Valparaiso, Ind.

### Precision Instrument Components

289

Printed on small size paper to save file space, this 416-page catalog lists over 10,000 items, including gears, shafts, collars, couplings, speed reducers, and differentials. In addition to drawings, specifications and prices, the catalog contains separate technical data, breadboard kit and tool components sections. PIC Design Corp., 477 Atlantic Ave., E. Rockaway, N.Y.



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MAC: Advertising! The blight of contemporary life! Power-mad, money-hungry Gray-Flannelites, dictating to our sub-consciouses.



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MAC: ... and transforming our nation into one giant libido, lusting after material possessions!



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**MICRO-MINIATURE RELAYS**  
As advertised on page 99

Fast delivery at factory prices from



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## JOHNSON MINIATURE CAPACITORS

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### Save valuable space in RF equipment...

Johnson miniature and sub-miniature air variable capacitors are available in a wide range of sizes, types, and capacities—perfect for use in compact RF applications. The 3 types described below have soldered plate construction, oversize bearing, and heavily anchored stator supports to provide extreme rigidity. Inductance path to both stator supports is extremely low with bridge-type stator terminal. Large compression rotor contact provides steady torque—rotor stays "put" where set. Rotor contact and all other metal parts are nickel-plated—steatite insulator is DC-200 treated.

**SUB-MINIATURES**—In addition to the miniature air variables described below, the new Johnson Type "T" and "U" sub-miniature capacitors are also available in production quantities. Write for our new components catalog 978 listing complete specifications.

**TYPE "M"**—Peak voltage 1250 volts on .017" plate spacing; 850 volts on .013" spaced units. Shaft slotted for fast screwdriver adjustment—mounting bushing threaded with flats to prevent turning—mounting nut furnished. Available in production quantities with the following features: locking bearings; 180° stop; various shaft extensions; high torque; silver or other platings. Single section, butterfly, and differential types available.

**TYPE "S"**—Midway in physical size between the Type "M" and "K" capacitors, the Type "S" has a plate spacing of .013" with a peak voltage rating of 850 volts. Other spacings, single hole mounting types, straight shaft, screwdriver shaft, or locking type screwdriver shaft available on special order in production quantities.

**TYPE "K"**—Widely used for many military and commercial applications, the Type "K" has a peak voltage rating of 1000 volts with a plate spacing of .015". Unit is available in production quantities to meet MIL-C-92A specifications—other capacities and variations for specialized military and commercial applications are also available in production quantities.

### New Catalog

For detailed specifications, including engineering drawings, on Johnson miniature and sub-miniature capacitors, as well as other Johnson electronic components, write for your free copy of our new components catalog No. 978.

**E. F. JOHNSON CO.**

1920 Second Avenue S.W. • Waseca, Minn.

CIRCLE 291 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 25, 1959

### Silicon Transistors 292

This two-page bulletin, complete with package photos, lists descriptions, important data and applications of five new silicon transistors. An itemized inventory with operating characteristics of a line of silicon transistors available from stock is also included. Transitron Electronic Corp., 168-182 Albion St., Wakefield, Mass.

### Dielectric Materials 293

Properties of dielectric materials at microwave frequencies over a wide range of dielectric constants and dissipation factors are given on this colorful chart. Emerson & Cuming, Inc., Canton, Mass.

### Thermal Magnetic Circuit 294

Circuit breakers designed for use with computers, data processing equipment, communications and test equipment are described in this data sheet. E-T-A Products Co., 6284 N. Cicero Ave., Chicago 46, Ill.

### Miniature Toroidal Inductors 295

Designed for use with printed circuit boards or stacking on a single screw for chassis mounting, these miniature toroidal inductors are described in illustrated data sheet I 8-2. Specifications, dimensional drawings, and ordering information appear. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

### Transmitter Adapter 296

Features and specifications for the firm's single-sideband high frequency communications transmitter adapter are presented in this four-page brochure. Photos, graphs, and a block diagram illustrate the adapter system. Kahn Research Labs, Inc., 22 Pine St., Freeport, N.Y.

### Coaxial Connectors

This 46-page reference manual is designed to simplify specifying and ordering rf coaxial cable connectors. It provides the numbers assigned by leading connector manufacturers, large users, BuShips, as well as military standards. The manual matches their equivalents with more than 2000 stock items carried by the firm. Write on company letterhead to Gremar Manufacturing Co., Dept. ED, 7 N. Wakefield Ave., Wakefield, Mass.

LEFT: STUD 7/16—11/16  
CENTER: AXIAL LEAD TOP HAT  
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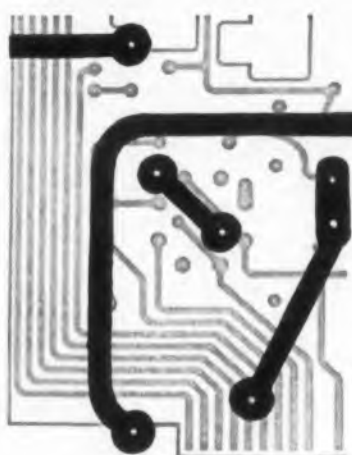
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ORIGINATOR OF THE TAPE METHOD OF DRAFTING

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Saves time . . .  
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CIRCLE 299 ON READER-SERVICE CARD

## NEW LITERATURE

### Spectrum Analyzers 300

This 12-page catalog gives specifications and descriptions for spectrum analyzers, special purpose instruments, accessory instruments, tracing systems, single sideband analyzers, rf-vhf-uhf and microwave analyzers, and telemetering spectrum analyzers and calibrators. Illustrations include photos of the units discussed, graphs, and diagrams. Panoramic Radio Products, Inc., 514 S. Fulton Ave., Mount Vernon, N.Y.

### Silicone Rubber 301

Twelve-page illustrated bulletin CDS-170A describes room temperature vulcanizing silicone rubber compounds and silicone rubber sponge. Suggestions for handling the compounds, curing and viscosity characteristics, and data on primers for bonding applications also appear. General Electric Co., Waterford, N.Y.

### Design Instruments 302

Included in this one-page brochure are photographs and specifications for a transistorized voltmeter, a transistorized signal generator, a vibration meter, a vacuum-tube voltmeter, a dc amplifier, a microsource, and an audio response plotter. Southwestern Industrial Electronics Co., P. O. Box 22187, Houston 27, Tex.

### Copper-Cored Wire 303

Bulletins IND-22 and IND-23, two pages each, describe copper-cored alloy glass sealing wires. In addition to data on specific soft glasses with which the wires are compatible, a comparison of the physical and mechanical properties of solid No. 446 alloy and copper-cored No. 446 alloy also appears. Sizes, dimensional tolerances, weight, and coefficients of expansion are covered. Texas Instruments, Inc., Metals & Controls Div., 34 Forest St., Attleboro, Mass.

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CIRCLE 304 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 25, 1959

### Transistor Dissipation Ratings 305

Eight-page booklet AN-181 has been prepared to help circuit designers determine peak-dissipation values of 39 of the firm's transistor types, which are used in pulse and switching service. A table gives the transistors' maximum permissible collector-junction temperatures, typical thermal time constants, and maximum thermal resistances. Peak dissipation is determined in terms of pulse width, duty cycle, and either ambient or case temperature. Radio Corp. of America, Semiconductor and Materials Div., Somerville, N.J.

### Synthetic Mica 306

This eight-page news bulletin covering developments in the field of high temperature insulation will be published periodically. The inaugural issue features the first of a four-part series on the development of synthetic mica. Abstracts of technical papers delivered by the firm's engineers at the WESCON show and other scientific sessions are included. Mycalex Corp., 125 Clifton Blvd., Clifton, N.J.

### Semiconductors

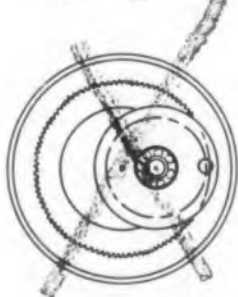
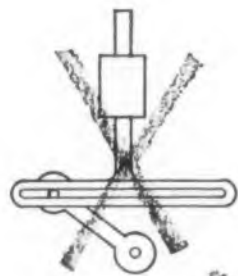
This semiconductor products' handbook HB-10, in loose-leaf form, covers semiconductor devices including transistors and silicon rectifiers. Intended uses, characteristics, operation, maximum ratings, terminal connections, commonly used curves plotted to easily readable scales for solving design problems, and mechanical dimensions are included. For a subscription to this handbook send \$5.00 to Radio Corp. of America, Harrison, N.J.

### Circular Slide-Rule

This pocket-size circular slide-rule is constructed of two durable aluminum discs and a clear plastic indicator. It performs multiplication, division, fractions, squares, square roots, cubes, cube roots, proportions, percentages, areas and circumferences. Send \$4.95 to Edmund Scientific Co., Barrington, N.J.

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You can often save space, weight and money in equipment employing sine-cosine operations by "designing in" Gamewell Sinusoidal Potentiometers. Far lighter and more compact than gears, cams, and other complicated mechanisms, they're widely used in analog computers, data converters, Tacan systems, and radar components. Advanced design produces functions with smoothness and precision unobtainable by other resistive methods. For details and latest catalog, write THE GAMEWELL COMPANY, Dept. 14D, Newton Upper Falls 64, Mass.



#### CONDENSED SPEC OF RVG-30XS-4

Resistance.....16,000 ohms  $\pm$  5%  
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RVG-30XS-4

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—because I-S Beryllium  
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\*AGASTAT is a registered trade mark of Elastic Stop Nut Corp. of America, 1027 Newark Ave., Elizabeth 3, N. J.

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## TRANSISTOR CIRCUITRY ENGINEERING "KNOW HOW" AND PRODUCTION



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The Acme Electric research and engineering staff have a wealth of experience to develop assemblies in this specialized field of manufacturing. A letter outlining your problem will have our prompt attention.

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CIRCLE 363 ON READER-SERVICE CARD

## IDEAS FOR DESIGN

# Single Gate Energizes Many Output Punch Coils

WHEN PUNCHING output data from a logical unit with a device such as a Teletype perforated tape punch, command pulses from the logic unit must be synchronized with the rotation of the motor supplying mechanical power to the punch. These short pulses must also be made to energize the punch coils (in the case of the Teletype punch) for a period of 12 msec, starting at a definite point on the rotation cycle of the motor shaft.

The usual method of accomplishing this is to generate a 12-msec gate for each coil to be energized. For example, a gate is generated individually for the feed coil and each level punch coil of the perforated tape punch. The method described here uses only one gate, which is applied to all of the coil driver circuits. One coil-driver circuit is shown in Fig. 1.

A notched flywheel on the motor shaft, and a magnetic pickup are used to provide timing pulses, Fig. 2. These timing pulses trigger a 12-msec gate circuit. They also permit the logic unit to send out its command pulses for the tape levels and feed, as desired.

The 12-msec gate is applied to each of the tubes V1 in the coil-driver circuits. The tubes V2 in the proper coil-driver circuits then receive command pulses from the logic unit, and the proper coils are activated. The circuit shown acts as an "AND" gate for firing, since both the gate and a command pulse must be present. After firing, however, only the presence of the gate is required to sustain conduction.

The 12-msec gate is applied to the grid of V1. This tube conducts through R1 and the punch or feed coil to which the circuit is connected. The

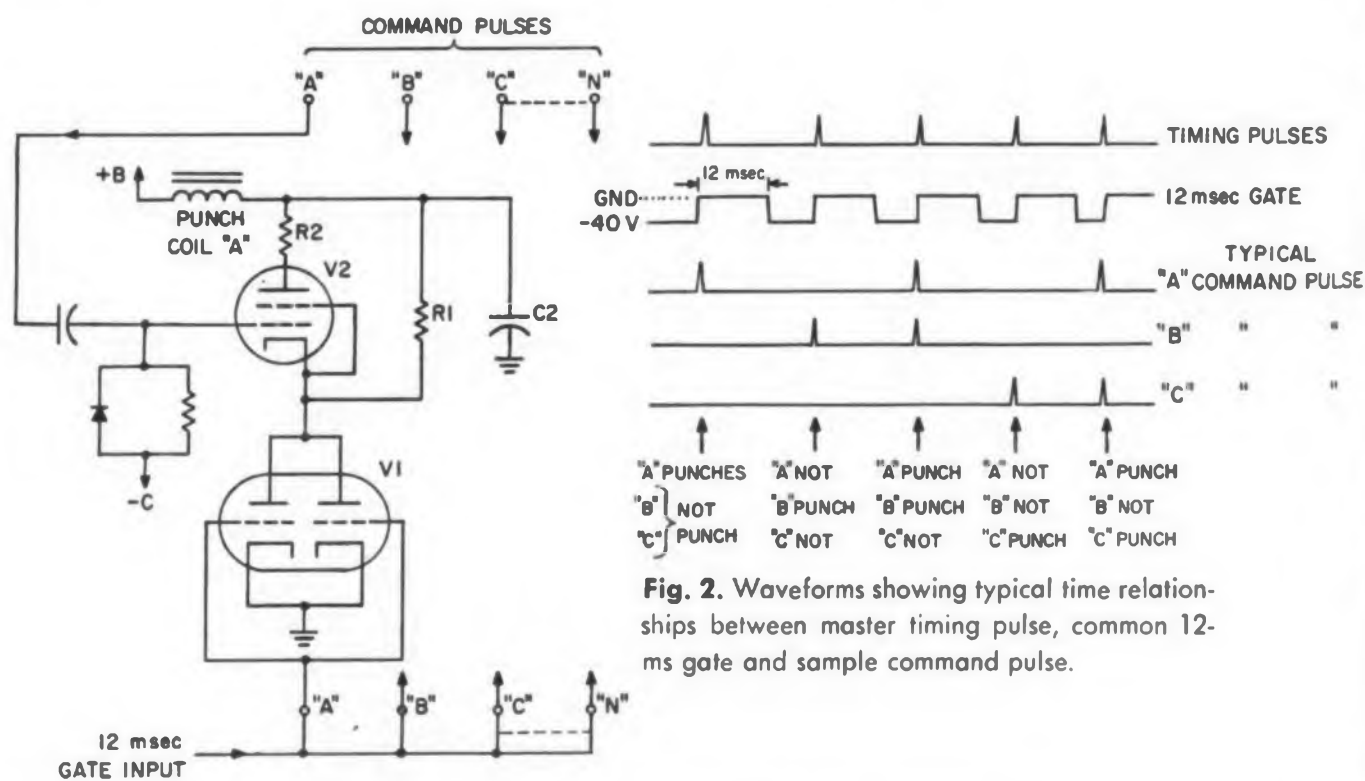


Fig. 1. One of a series of coil-driver circuits which acts as "AND" circuit for command pulse and common 12-ms gate.

Fig. 2. Waveforms showing typical time relationships between master timing pulse, common 12-msec gate and sample command pulse.



current flow is far too low to enable the coil to pull in its armature, since the value of  $R1$  is very high. Essentially all of the  $+B$  voltage is dropped across  $R1$ , applying plate voltage to  $V2$ .

If this particular coil is to be energized during this cycle, the logic unit sends a command pulse to the control grid of  $V2$ .  $V2$  fires, and the circuit is then completed through  $V1$ ,  $V2$ ,  $R2$ , and the coil. The circuit now supplies sufficient current to energize the coil, which pulls in the armature.

Since  $V2$  is now independent of its grid, this circuit will continue to supply current until the end of the 12-ms gate. At this time,  $V1$  is cut off, removing the plate voltage from  $V2$ , and opening the circuit until the next gate is generated.

$C1$  absorbs the inductive kick of the coil when the circuit is suddenly opened. Without  $C1$ , the voltage surge from the coil would prevent  $V1$  and  $V2$  from being cut off.

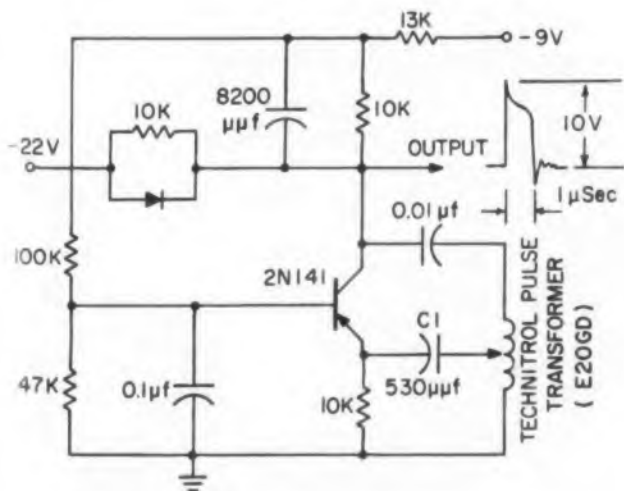
Dan M. Bowers, Project Engineer, Falls Church, Va.

### Inexpensive Transistor Pulsar Simplifies Computer Test

An expensive transistor pulse generator was needed for testing out computer logic to simulate timing pulses or input information. The object was to avoid tying up expensive pulse generators for this simple task.

The circuit illustrated was developed to fill this need. The compact unit can plug in a spare socket in any rack, and couple into any circuitry under test. The output is a one- $\mu$ sec pulse. Repetition rate can be varied up to 50 kc by using a variable capacitor for  $C1$ .

Walter D. Scott, Technical Engineer, RCA, Los Angeles, Calif.

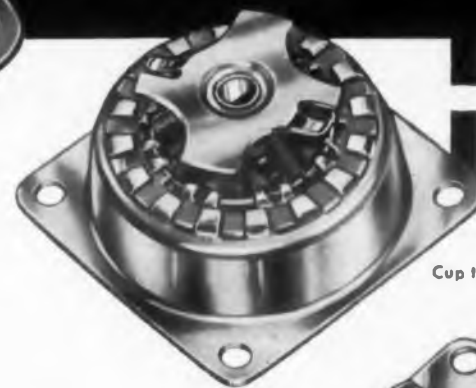


Compact pulse generator frees expensive pulse generators from routine computer test applications.

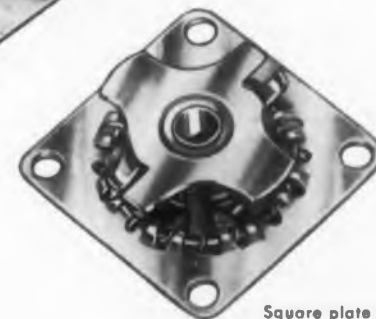


Cup type, size 3 . . . . 10 lbs.

## Ucinite EQUIFLEX vibration isolators



Cup type, size 1 . . . . 1/2 lb.



Square plate type,  
Size 1 . . . . 1/4 lb.

Standard Equiflex mountings come in two basic types . . . the Square Plate and the Circular Cup. Both types are available in three different sizes . . . size 1 for light loads or small equipment, size 2 for medium loads or medium duty equipment, size 3 for heavy loads or heavy duty equipment.

Equiflex mountings withstand 100 hour salt spray tests, take 15G shocks without damage and will keep equipment captive up to 30Gs. Extra-damped mountings are available in which each multiple coil spring is shrouded with polyethylene or Teflon tubing.

Equiflex vibration isolators can be supplied to cover load ranges from 1/4 to 35 lbs.

- Greatly prolonged service life.
- Wide temperature range.
- Controlled damping.
- Can be loaded in any direction or position.
- Absence of drift or permanent set.
- Equiflex action or 1:1 ratio of radial and axial spring rates.
- Integral single unit assembly with safety washers included and attached.



## The UCINITE COMPANY

Division of United-Carr Fastener Corp., Newtonville 60, Mass.

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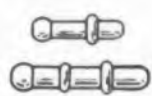
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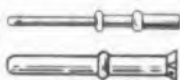
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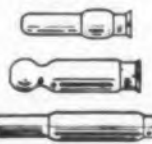
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CONTACTS



also PRINTED CIRCUIT  
MINIATURE PARTS

Contact pins, terminals, jacks or any small tubular parts. Maximum 1/4" diameter x 1 1/4" length.

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## IDEAS FOR DESIGN

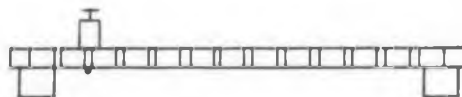
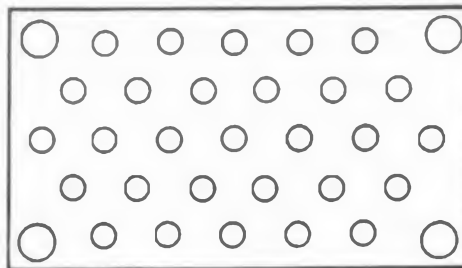
### Perforated Metal Chassis Eliminates Costly Hole-Drilling

When using metal breadboard chassis, hole-drilling can be costly and time-consuming. Drilling can be eliminated completely by using perforated metal plate and stand-offs.

The plate is chosen so that the hole size is compatible with the stand-offs. A ceramic base mount can be used to get the plate up off the table. Perforated plate can also be obtained with holes that are the size of transistor sockets, so that a bank of transistors can be made without drilling a single hole.

Joseph W. Verzino, Design Engineer, G.E. (HMED), Court St., Syracuse, N.Y.

BASE MOUNTS



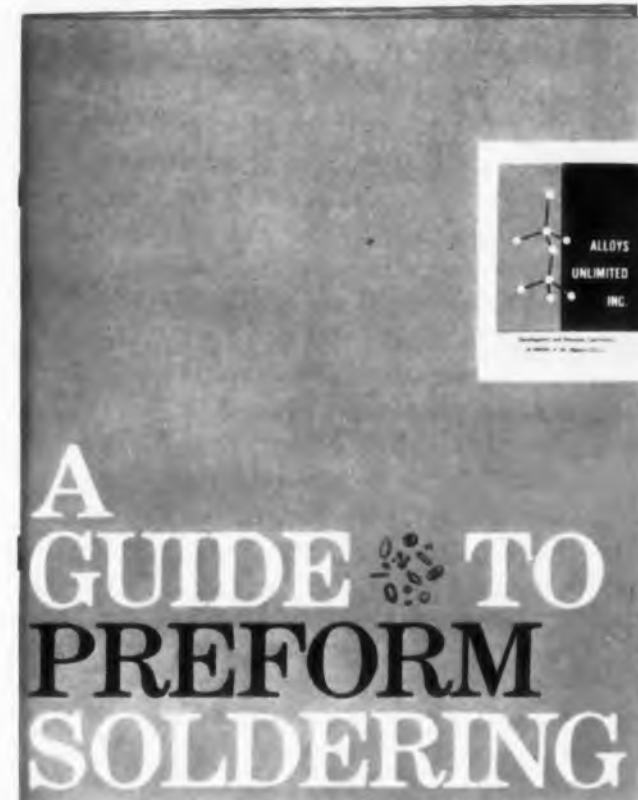
Perforated metal plate serves as a versatile chassis material when used with stand-offs.

### Series Connection Allows Use of Germanium Transistors in HV Circuits

Series connecting transistors allow operation with higher voltage inputs than the voltage rating of the individual transistors. This extends the economy of germanium transistors into circuits normally thought to require use of their high-priced silicon brothers.

One application called for operation when the full input voltage into a transistorized power supply may be dropped by the series regulating transistor. Such a condition could occur when the output is short-circuited, and when the full input voltage at its highest input level will be impressed on the series transistors.

Under these conditions a current-limiting network will insure that no current is flowing



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ELECTRONIC DESIGN • November 25, 1959

through the transistors. However, they will still have to support the input voltage. The application also specified that the input may contain transient spikes of short duration but high enough to exceed the voltage rating of a single transistor.

The availability of germanium transistors for higher voltage operation is limited. The rating of these transistors for voltage depends on the emitter to base bias. This in turn varies under transient conditions. (ELECTRONIC DESIGN, July 22, 1959, p 28)

To design for a proper voltage rating of the power supply while utilizing the most economical and readily available transistors, a series string is designed as shown in Fig. 1.  $R_1$ ,  $R_2$ , and  $R_3$  are

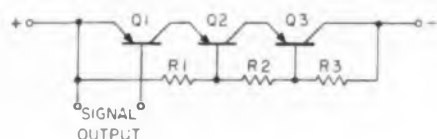


Fig. 1. Series string of transistors enables low-voltage rated transistors to accommodate high voltage input.

equal resistors forming a voltage divider across the transistors. They drop the same voltage as the transistors do.

Signal is applied to the base-emitter circuit of  $Q_1$ . Current flowing through  $Q_1$  biases  $Q_2$  and  $Q_3$  through their respective resistors  $R_2$  and  $R_3$ . A reduced voltage absorbed by  $Q_1$  causes the base emitter voltage of  $Q_2$  to increase and reduce its emitter-to-collector voltage. The same applies to  $Q_3$ . Thus, equal voltage division is obtained

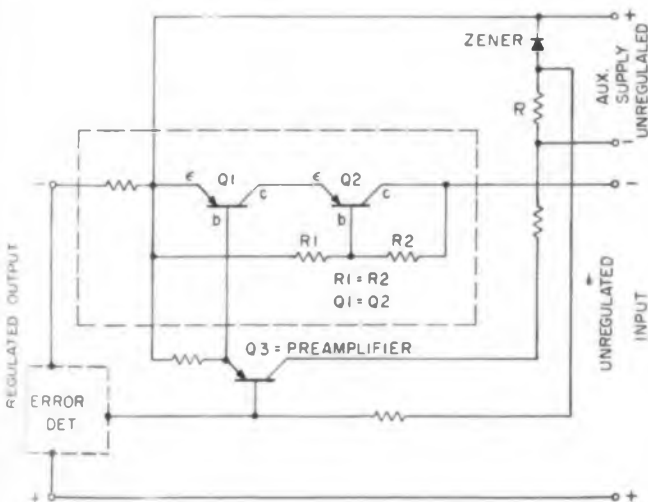


Fig. 2. A transistorized power supply designed around series connected transistors.

between  $Q_1$ ,  $Q_2$  and  $Q_3$ . A circuit indicating how this was incorporated into the power supplies is shown in Fig. 2.

Baruch Berman, Chief Engineer, Avion Div. C.F. Paramus, N.J.

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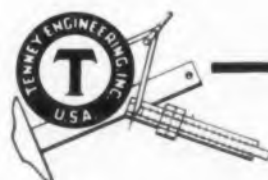


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4C1	6.3 CT	8	1500	115	SM3	100 C	16.50
4C2	6.3 CT	1.2	1500	115	SM2	100 C	16.50
4C3	6.3 CT	6.75	1500	110 115 120	2	100 C	26.50
4C4	6.3	4.9	1500	115	3	90 C	23.70
4C5	6.3 CT	7.2	1500	115	35	120 C	27.50
4C6	6.3	7	1500	120	35	80 C	26.80
4C7	6.3 CT	7	1500	120	4	100 C	11.90
4C8	6.3	13.7	1500	115	4	90 C	31.90
4C9	6.3 CT	12.3	1500	115	5	100 C	29.50
4C10	28 CT	0.6	1500	115	SM1	100 C	21.00
4C11	6.3	2.8	1500	115	3	100 C	29.50
4C26	6.3 CT	2	1500	115	SM1	100 C	21.00
4C27	6.3 CT	3	1500	115	1A	100 C	21.80
4C28	6.3 CT	5	1500	115	2	100 C	22.60
4C29	5.0 CT	3	2500	115	SM1	100 C	21.00
4C30	5.0 CT	6	2500	115	2	100 C	22.60

POWER

4C12	14.1	7	1500	115	3	100 C	22.50
4C13	21	9	1500	115	4	65 C	25.00
4C14	26	0.5	1500	115	SM1	55 C	20.50
4C15	26 CT	1.5	1500	115	3	65 C	21.20
4C16	28 CT	0.75	1500	115	2	65 C	31.80
4C17	52 CT	.192	1500	115	SM1	100 C	22.75
4C18	90 CT	4.5	1500	115	9	100 C	41.00
4C19	115	0.5	1500	115	SM2	100 C	16.80
4C20	105 115 125	0.4	1500	105 115 125	2	90 C	24.30
4C21	115	2.63	1500	115	8	100 C	35.00
4C22	134	0.25	1500	115	SM1	120 C	19.30
4C23	26 CT	3	1500	115	4	100 C	25.50
4C24	26 CT	4	1500	115	6	100 C	29.40
4C25	52 CT	7	1500	115	5	100 C	28.10

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	L	W	H	F	G		
SM3	1	1-1/4	1-3/16	1	Note 1	0.06	Note 1
SM2	1-1/2	1-1/4	1-11/16	1	Note 1	0.10	Note 1
SM1	1-1/2	1-1/2	1-11/16	1-1/8	Note 1	0.16	Note 1
1A	1-13/16	1-7/8	1-13/16	1-1/4	1-7/16	0.25	Note 2
2	1-11/16	1-17/32	1-13/16	1-5/32	1-1/8	0.25	Note 2
3	2	1-15/16	2-1/8	1-9/32	1-1/4	0.40	Note 2
35	2-5/16	1-13/16	2-1/8	1-9/32	1-7/16	0.45	Note 2
4	2-5/16	2-3/8	2-3/16	1-17/32	1-11/16	0.70	Note 2
5	2-3/4	2-3/8	2-7/8	1-17/32	2-3/16	0.90	Note 2
6	2-3/4	2-5/8	3-1/8	1-17/32	2-3/16	1.50	Note 2
7	3	2-7/8	3-3/8	1-25/32	2-1/2	2.00	Note 2
8	3-3/8	2-7/8	3-3/8	1-25/32	2-1/2	2.50	Note 2
83	3-3/4	3-1/4	3-3/8	2-1/4	3	3.25	Note 3
86	3-3/4	3-3/4	3-3/8	2-3/4	3-1/8	4.25	Note 3
9	4-1/16	3-3/8	3-7/8	2-3/16	3-1/2	5.00	Note 3
10	4-1/2	3-15/16	3-15/16	2-3/4	3-1/8	6.00	Note 3

Note 1—SM series are two hole mounting with holes on center line. #4-40 Pem nuts are fastened to the bracket.

Note 2—#6-32 Pem nuts on bracket are standard.

Note 3—#8-32 Pem nuts on bracket are standard.

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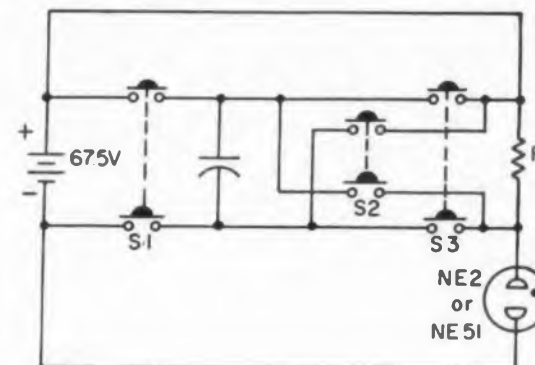
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## IDEAS FOR DESIGN

### Capacitor and Switches Provide Inexpensive Memory for Lamp



Inexpensive memory is provided for neon lamp by 67.5-v source, capacitor and three switches.

A memory for a pilot lamp can be provided at minimum cost by use of a 67.5-v battery or dc source, a capacitor and momentary contact switches. The circuit illustrates the basic principle involved.

In this circuit, use is made of the difference between the starting and sustaining voltages of a neon lamp. The 67.5-v source is adequate to sustain the discharge in the neon lamp once it has started, but is not adequate to start the discharge

The capacitor which is charged from the 67.5-v source through switch S1 supplies a pulse when discharged through switch S2. This charge adds to the 67.5-v source, and thus starts the discharge. Now the 67.5-v source is adequate to sustain the discharge and the neon lamp will remain lit, until it is extinguished.

To extinguish the lamp, the capacitor is again charged through S1. Discharging the capacitor through S3 subtracts from the 67.5-v source voltage, and drives the voltage below that which is necessary to sustain the discharge. Thus the lamp is extinguished. Actual switch arrangements can be altered to suit the application.

Jack Koff, Engineer, Farrand Optical Co., New York 70, N.Y.

### Measure Open-Loop Gain With the Loop Closed

In order to insure stability of a feedback amplifier, it becomes necessary to check the open-loop gain and phase response. In the case of a high-gain amplifier, this becomes quite difficult since noise alone might possibly cause saturation.

The open-loop gain phase response may be made with the loop closed and thereby eliminate

the difficulties inherent in the open-loop measurement. The method is shown in the illustrations.

By definition,  $\beta$  is the ratio of feedback voltage to input voltage.

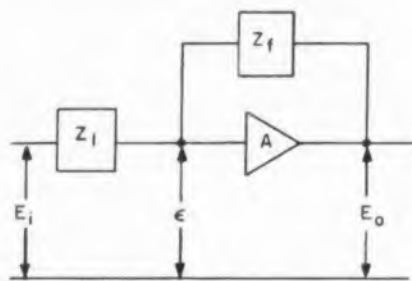


Fig. 1. Conventional feedback amplifier configuration does not permit measurement of open-loop gain.

From Fig. 1,

$$\beta = \frac{Z_f}{Z_f + Z_i}$$

Define  $\epsilon'$  as the voltage at the junction of the input and feedback impedances, with the input to the amplifier open and the output shorted, as in Fig. 2

$$\epsilon' = E_i \frac{Z_f}{Z_f + Z_i}$$

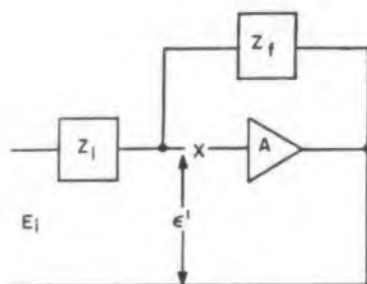


Fig. 2. Two-circuit changer permits open-loop gain measurement without danger of saturation.

By derivation,

$$\epsilon = \frac{E_i Z_f}{Z_f + (A+1) Z_i}$$

Dividing and simplifying yields the expression

$$\frac{\epsilon'}{\epsilon} = 1 + A\beta$$

or

$$A\beta = \frac{\epsilon'}{\epsilon} - 1$$

$A$  and  $\beta$  are both frequency dependent. Therefore any constant amplitude ac signal of varying frequency can be applied at  $E_i$  so that the amplifier output does not overload. The voltages  $\epsilon$  and  $\epsilon'$  are then measured for amplitude and phase. When one is subtracted from this ratio, the open loop response of the amplifier is obtained.

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**Polarity:** Pos/Neg terminals are above ground and isolated from AC input.  
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## IDEAS FOR DESIGN

### Multivibrator Design Shortcut

A common practice in designing saturating flip-flops is to first define the collector and emitter resistors ( $R_c$  and  $R_e$ ) in terms of the load requirements of the circuit. Subsequent calculations of the cross-coupling networks may be simplified by determining the maximum value of  $R_2$  in this manner.

$$\text{Assume: } V_e \approx \frac{V_s R_e}{R_c + R_e}$$

$$V_{c\text{ on}} \approx V_e$$

$$\text{Then: } V_{b\text{ off}} \approx V_e \frac{R_2}{R_1 + R_2} + I_{co} \frac{R_1 R_2}{R_1 + R_2}$$

For proper temperature stabilization  $V_{b\text{ off}}$  must be less than  $V_e$  when  $I_{co}$  reaches its maximum value. Therefore

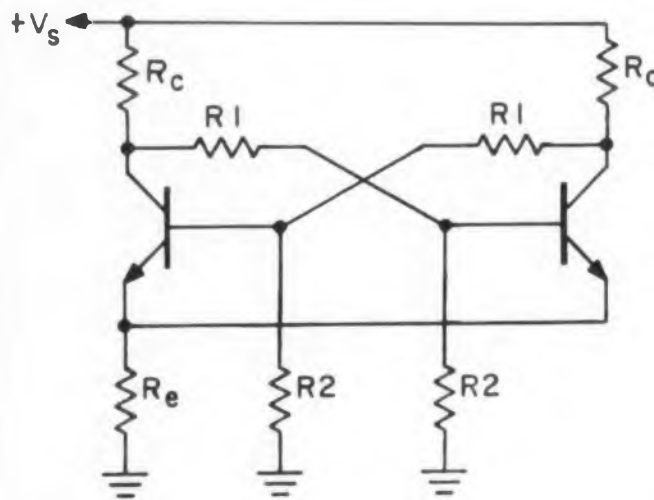
$$V_e \frac{R_2}{R_1 + R_2} + I_{co\text{ max}} \frac{R_1 R_2}{R_1 + R_2} < V_e$$

$$V_e R_2 + I_{co\text{ max}} R_1 R_2 < V_e R_1 + V_e R_2$$

$$V_e R_2 + I_{co\text{ max}} R_1 R_2 < V_e R_1 + V_e R_2$$

$$I_{co\text{ max}} R_1 R_2 < V_e R_1$$

$$R_2 < \frac{V_e}{I_{co\text{ max}}}$$



Cross coupling network calculations are simplified in multivibrator circuit.

This relationship quickly determines an approximate value for  $R_2$  and the required value of  $R_1$  may then be calculated using the minimum value of  $H_{fe}$ .

In this discussion, only dc was involved. Hence compensating capacitors were not included in the schematic.

Thomas L. Thompson, Cook Research Labs., A Division of Cook Electric Co., Chicago, Ill.

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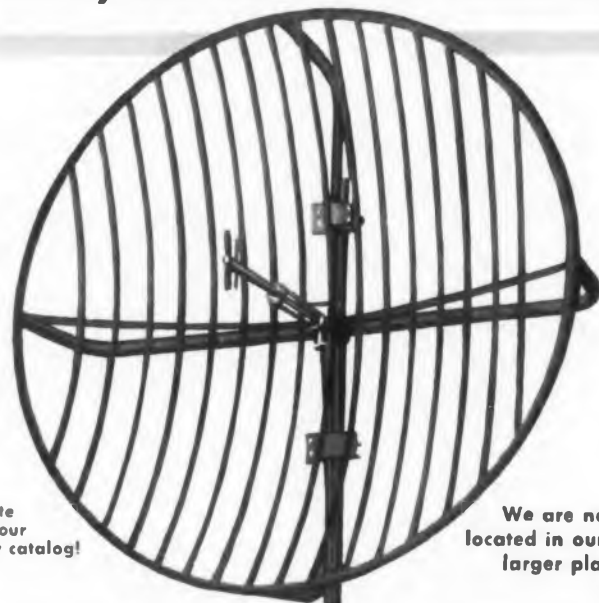
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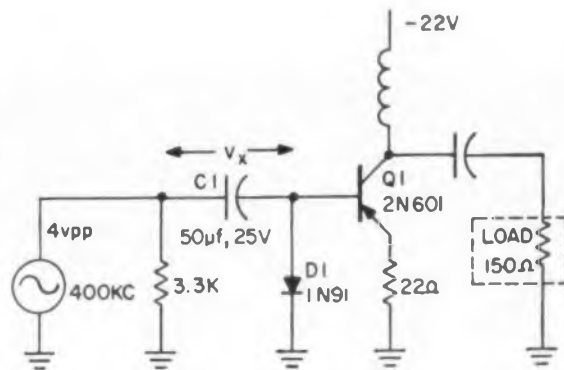
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## Transistor Runs Pseudo Class A In Power Driver

A medium power driver amplifier was needed to supply approximately 500 mw at 400 kc to a single-ended load. The design of a transformer-coupled push-pull stage was considered. However, it was felt that the job could be done with a single, medium-power rc coupled transistor amplifier operating pseudo "class-A". Such a circuit would be acceptable if the objectionable standby power, usually associated with class A operation, could be eliminated.

The solution chosen uses a 750-mw transistor in a signal-biased linear mode of operation. With this arrangement, collector dissipation decreases with signal level and becomes negligible under zero signal conditions. The circuit shown illustrates the method.



Eliminating standby power allows pseudo class A operation of transistor in power supply circuit.

Under zero signal conditions,  $Q1$  is cut off and the collector current is maintained at a small value by the reverse leakage path afforded by diode  $D1$  and the emitter degeneration resistor. When signal is applied, capacitor  $C1$  charges through  $D1$  to a positive voltage  $V_x$  as shown. This voltage biases the transistor into a quasilinear operating range for the particular average level of applied signal.

Performance of the amplifier is as follows:

Frequency	= 400 kc
$P_{DC}$ (required dc power)	= 1.3 w
$P_o$ (into 150 $\Omega$ load)	= 530 mw
$P_{in}$ (into eff. 800 $\Omega$ $R_{in}$ )	= 4.8 mw
$G_p$	= 20.5 db
Efficiency	= 41%
Stand-by power	= 54 mw
Total harmonic distortion	= 11%

Donald W. Boensel, Member of Technical Staff, Space Electronics, Glendale, Calif.

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1310N	SAME AS MODEL 1310	IN-LINE (NIXIE)	YES
1321	000.0 TO 120.0 V DC, 1 TO 100,000 MMF	VERTICAL	NO
1321N	SAME AS MODEL 1321	IN-LINE (NIXIE)	YES

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319R	1, 10, 100, 1000	YES	YES	NO	NO
319	1, 10, 100, 1000	YES	NO	NO	NO
318RA	1, 10, 100	YES	NO	YES	YES
318R	1, 10, 100	YES	YES	NO	NO
318	1, 10, 100	YES	NO	NO	NO



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## IDEAS FOR DESIGN

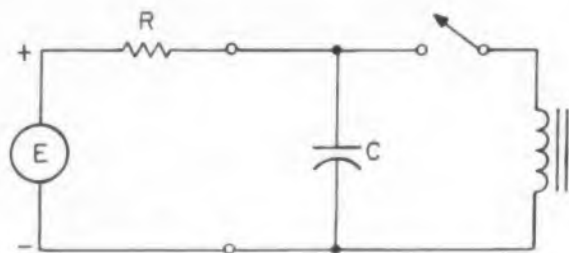
### Capacitor Supplies Solenoid Pull-in Energy

A high-impedance source may be adequate to hold a solenoid once it is pulled in but not adequate for pull-in. A capacitor can often be used to advantage as shown to avoid replacing the power supply with a lower impedance source.

The energy for pull-in may be obtained by charging the capacitor across the high impedance line to full open circuit voltage. When the solenoid switch is closed, the capacitor discharges through the solenoid. This charge provides the initial burst of energy needed to operate the solenoid. As the surge decays, the normal supply takes over.

The capacitor will recharge when the switch is opened and will be ready for the next cycle. The rate of operation and the size of the capacitor are dependent upon the other circuit parameters.

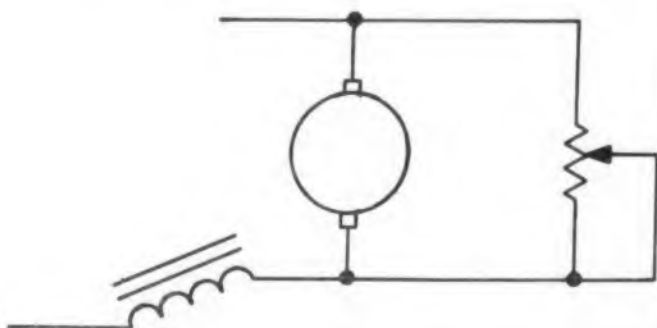
Arthur Goldschmidt, Electronics Engineer, Moorestown, N.J.



Capacitor charge enables high-impedance source to pull in solenoid.

### Speed and Direction Control of A Universal Motor

A simple method for remote, 2-wire, speed and direction control can make a small universal motor much more valuable in some applications. Here is



Simple rewiring and advanced brushes provides speed and direction control for universal motor.

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The 120B offers unique performance advantages over mercury and competing electronic generators. The 2.5 millimicrosecond rise time feature is ahead of the field and offers a new tool for fast, high resolution work. Two independently variable outputs add to its flexibility, as does the wide range of frequencies provided (10 cps to 10 Megacycles). Available also are an advanced scope triggering pulse and

a fast, flexible gating input for complex pulse-time and pulse-amplitude selection.

### SPECIFICATIONS

**RISE TIME (10% to 90%)**  
Less than 2.5 millimicroseconds

**PULSE WIDTH**  
2.5 to 25 millimicroseconds

**REPETITION RATE (External or Internal)**  
10 cps to 10 Mc

**OUTPUTS**  
(Two Independent Output Channels)  
Amplitude, 0 to -8 volts (also 0 to +8)  
Impedance, 93 ohms

### TRIGGER OUTPUT

Positive 15 volt pulse

### CONNECTORS

All BNC type

### TRIGGER ADVANCE

120 millimicroseconds

### EXTERNAL DRIVE

Delay, 50 millimicroseconds  
Amplitude Required, 3 volts rms

### ELECTRONIC GATE

Gating Time, less than 100 millimicroseconds  
Amplitude Required, positive 20 volts

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ELECTRONIC DESIGN • November 25, 1959



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The 201C makes both DC and AC measurements to  $10^{-15}$  ampere in the low current region. Excellent DC stability, fast response, low noise and high sensitivity make it an outstanding instrument. 16 ranges,  $10^{-6}$  to  $3 \times 10^{-15}$  ampere, and response to 40 microseconds give it exceptional flexibility.

**EH****ELECTROMETER  
MULTIMETER**

Model No. 215

Excellent stability  $30\mu\text{v/volt}$  line change; high input impedance  $10^{15}\Omega$ ; good sensitivity  $200\mu\text{v}$ ; large band pass 5 Kc. Uses — via external R, C, or E: millivoltmeter, 10 mv to 10 v scales, fast response; ammeter,  $< 10^{-14}$  amps; ohmmeter,  $> 10^{16}$  ohms; current integrator,  $< 10^{-13}$  coulomb.

one method of accomplishing this modification that will fit most applications.

Advance the brushes ahead of the field-pole center by 45 degrees. If the brushes are then short-circuited, the motor will run in the reverse direction as a repulsion-induction motor. Thus, by running two leads from the brushes to the remote location, and connecting them to a variable resistor, speed control is obtained as the resistor is varied, going from full-speed in one direction to full-speed in the other.

Unless the motor is designed for this service, an ordinary motor will run hot. However, this is adequate for light or intermittent duty.

Robert A. LeMassena, Senior Engineer, Minneapolis-Honeywell, Heiland Division, Denver 22, Colo.

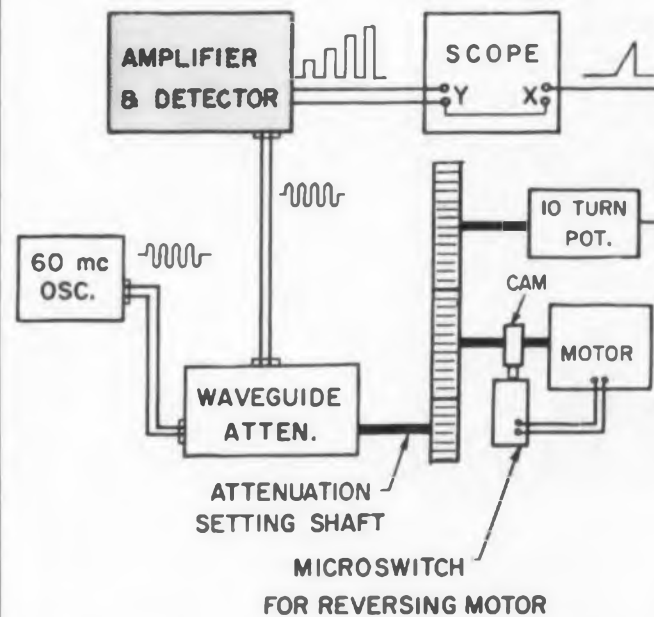
**Motor Drive  
Helps Check Wide Range Amplifier**

The motorized arrangement shown in the diagram was used to check the amplitude response of a 60 mc logarithmic amplifier over a 60 db dynamic range. Suitably modified, the arrangement can be used to check other instruments over other ranges.

The 60 mc pulsed oscillator supplies a test signal which is fed to the waveguide attenuator. The decibel output of the attenuator is proportional to the position of the shaft which drives it. This shaft is driven by a small motor which also drives a 10-turn helical potentiometer which supplies the sweep voltage for the scope.

The amplifier is assumed perfect when the top of its output pulses form a straight diagonal line.

D. Renkowitz, Engineer, Airborne Instruments Lab., Garden City, N.Y.



Simple arrangement checks response of wide-range logarithmic amplifier.

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## PATENTS

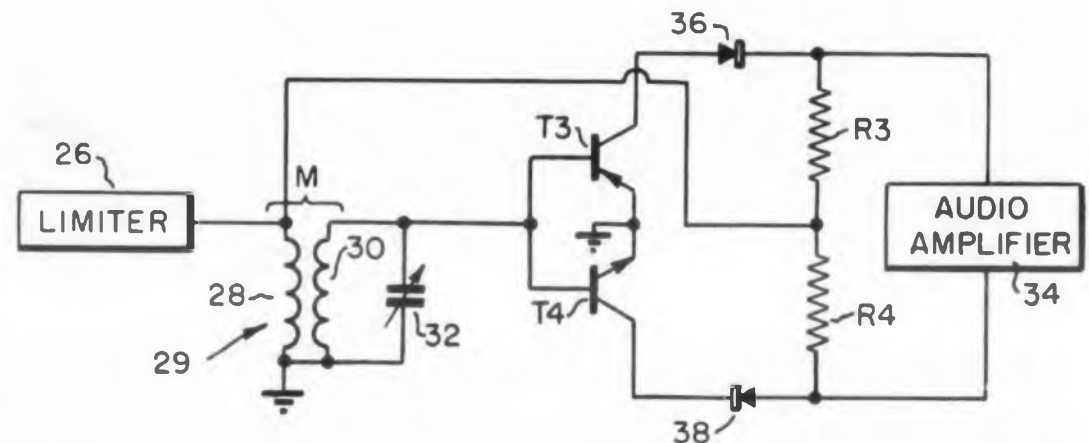
### Phase Shift Detector

Patent No. 2,901,612. Leo E. Dwork, Chang Huang. (Assigned to Sylvania Electric Products, Inc.)

An fm discriminator comprises complementary symmetry transistors which produce a resultant output linearly related to phase shift, essentially the deviation off resonance.

The pnp transistor *T3* and npn tran-

sistor *T4* are connected with the emitters and bases in common with diodes 36 and 38 to prevent collector current flow when the emitter to base is cut off. At resonance, the input signals are shifted 90 deg in phase; below resonance the shift is less than 90 deg and above resonance the shift is greater than 90 deg. Due to the symmetrical arrangement of the complementary transistors, the voltage developed across the load increases with frequency.



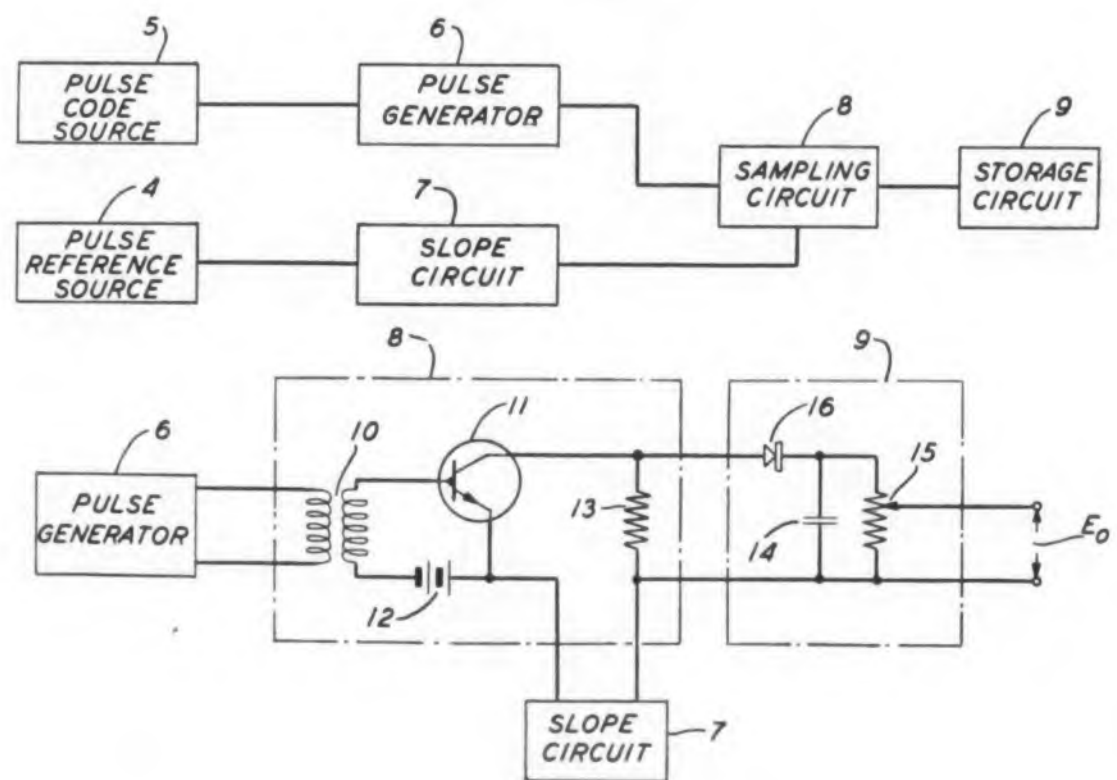
### Sampling Circuit

Patent No. 2,900,507. Samuel C. Rogers. (Assigned to Bell Telephone Labs, Inc.)

The pulse position demodulator develops a dc voltage proportional to the time separation of two pulses.

Slope circuit 7 generates a linear voltage waveform triggered by pulse reference source 4; no current flows through

resistor 13, however, since battery 12 initially sets pnp transistor 11 beyond cut off. Later, pulse code source 5 triggers generator 6 to drive the transistor to saturated conduction and capacitor 14 charges during the pulse time to the instantaneous value of the linear voltage waveform. Subsequent discharge of the capacitor is determined by leakage resistor 15.



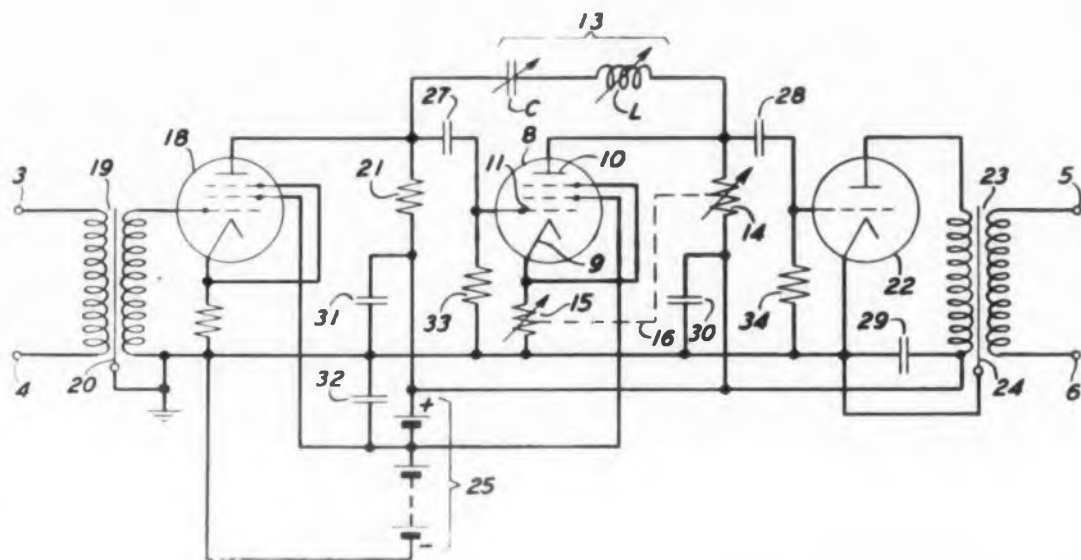
### Delay Network

Patent No. 2,890,333. Manvel K. Zinn.  
(Assigned to Bell Telephone Labs., Inc.)

The circuit shown in the figure is an all-pass network, since there is no loss at any frequency; the delay varies directly with change of adjustable resistance.

Tubes 18 and 22 isolate phase adjuster

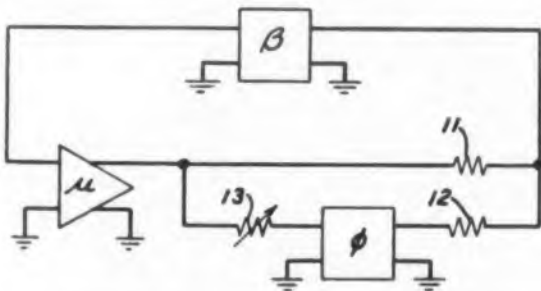
stage 8 which is characterized by a series LC between output and input and coupled resistors 15 and 14 which respectively adjust the tube transconductance and output impedance reciprocally. When the resistors track, the delay varies as resistor 14. The height and shape of the delay characteristic may be varied further by making L and C variable.



### Variable-Frequency Oscillator

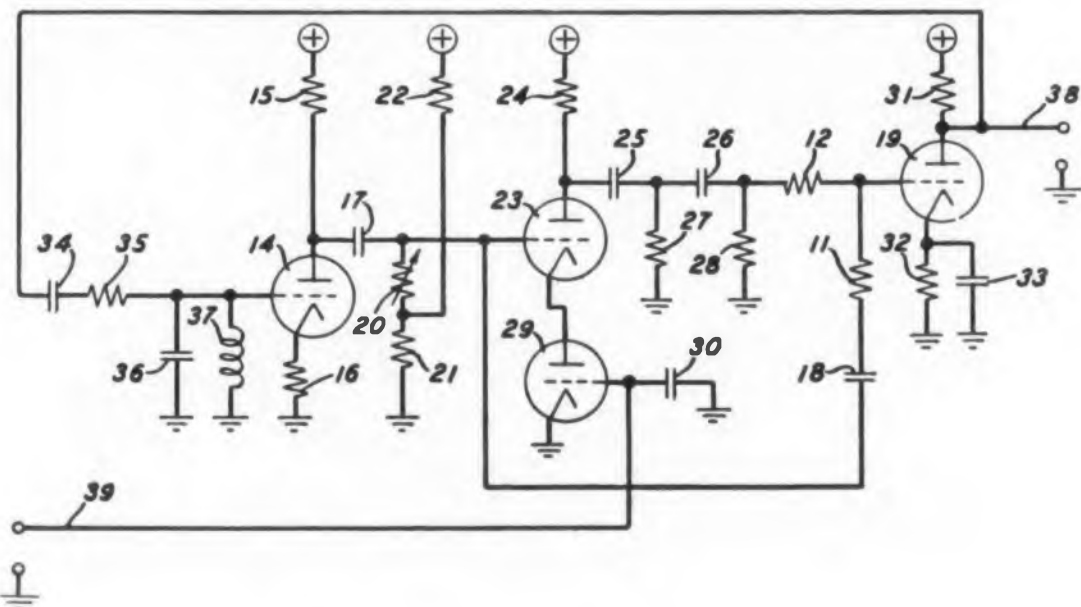
Patent No. 2,902,656. Robert O. Soffel.  
(Assigned to Bell Telephone Labs., Inc.)

The oscillator is made variable by means of an adjustable phase shifter in the feedback network. This constitutes an improvement over the conventional reactance tube devices.



Amplifier 14 is tuned by the L-C tank in the grid-cathode circuit and oscillations are produced by feedback through capacitor 18 in series with amplifier 19. The frequency of oscillation may be changed by resistor 20 in conjunction with capacitor 17 and resistor 21.

The feedback path contains an additional phase shifter comprising the internal resistance of tube 23, capacitors 25 and 26, and resistors 27 and 28. A control signal applied to terminal 39 changes the internal resistance of tube 23, shifting the phase of the feedback voltage; the frequency of oscillation changes to maintain zero phase shift at the grid of tube 14.



Corles Perkins, Chief of Flight Control Systems  
Honeywell Aeronautical Division

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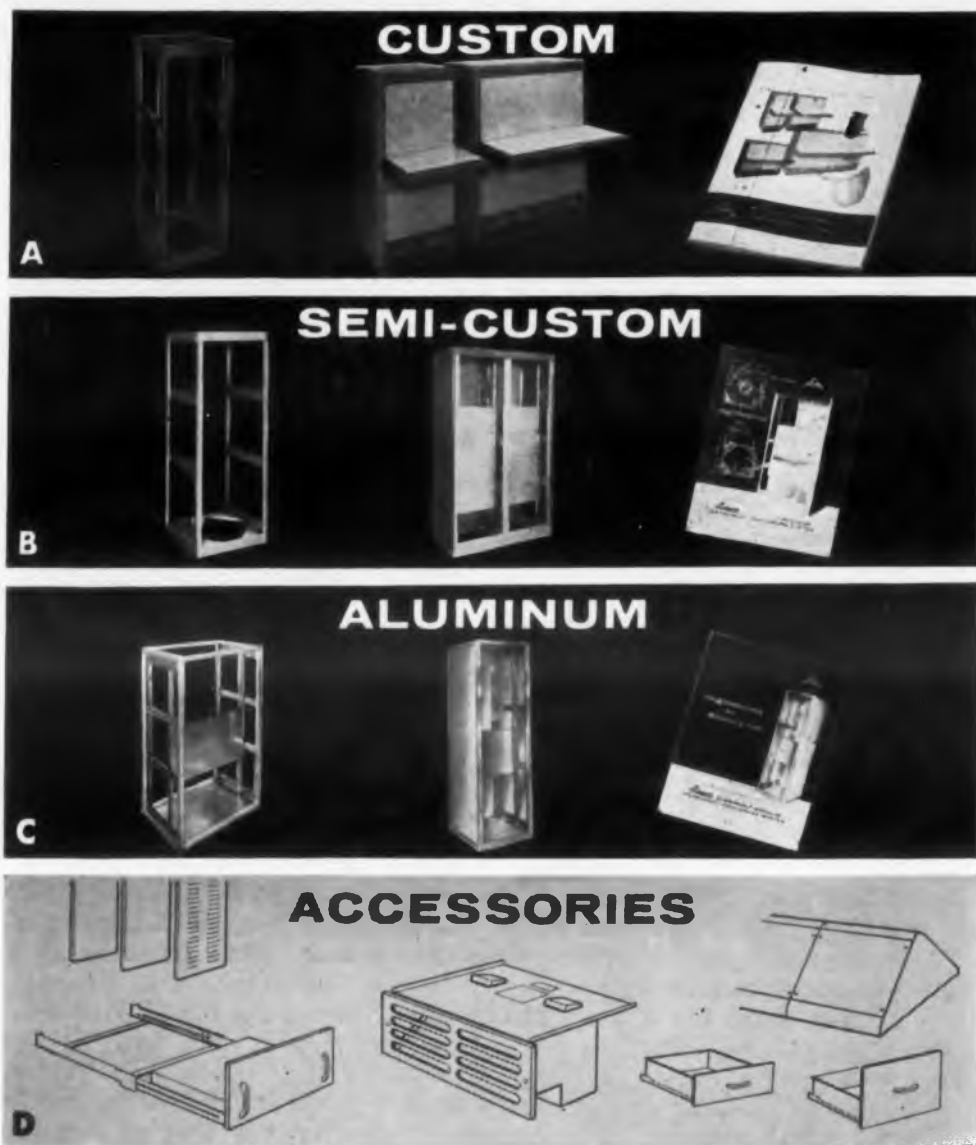


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## PATENTS

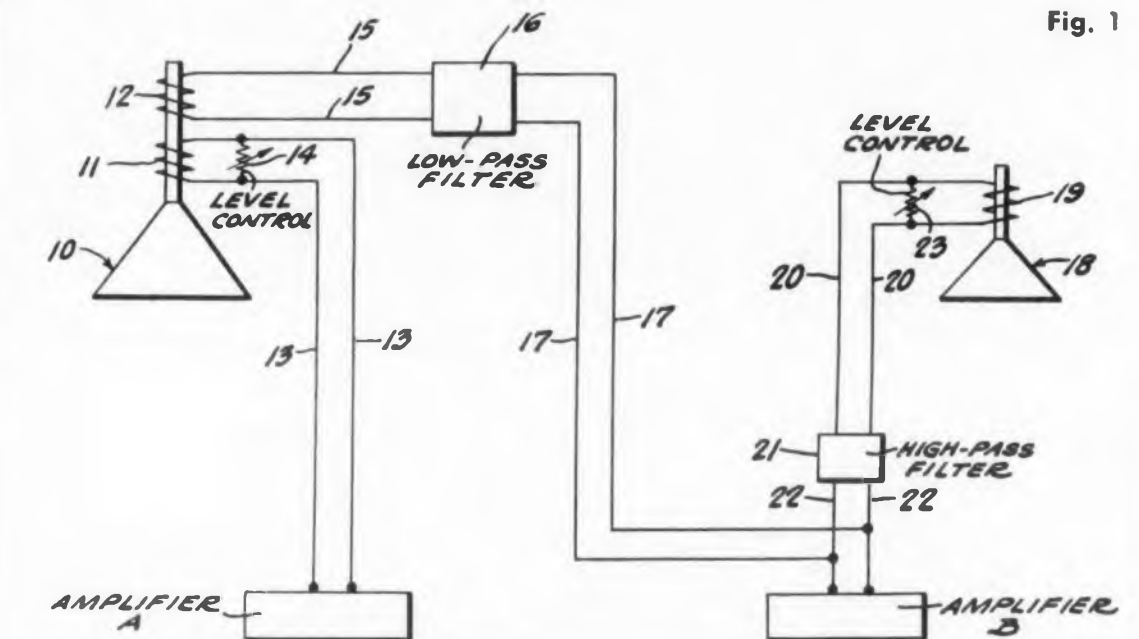
### Stereophonic Sound Propagation System

Patent No. 2,904,632. Sidney E. Levy. (Assigned to University Loudspeakers, Inc.)

Since, in a stereo system, only the higher frequencies are directive, a low cost system has been devised which uses one high quality speaker with one or more

cheap middle and high frequency reproducers.

Two systems are illustrated. In Fig. 1, speaker 10 reproduces the full range of amplifier A and the low-pass filter 16 energizes a separate voice coil 12 with signal from amplifier B; speaker 18 reproduces the high-frequency output of amplifier B. In Fig. 2, the two separate coils 25 and 26 are energized by the low frequencies delivered by amplifiers A and B and each



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Oscillator 1246	40Kc to 50 Mc
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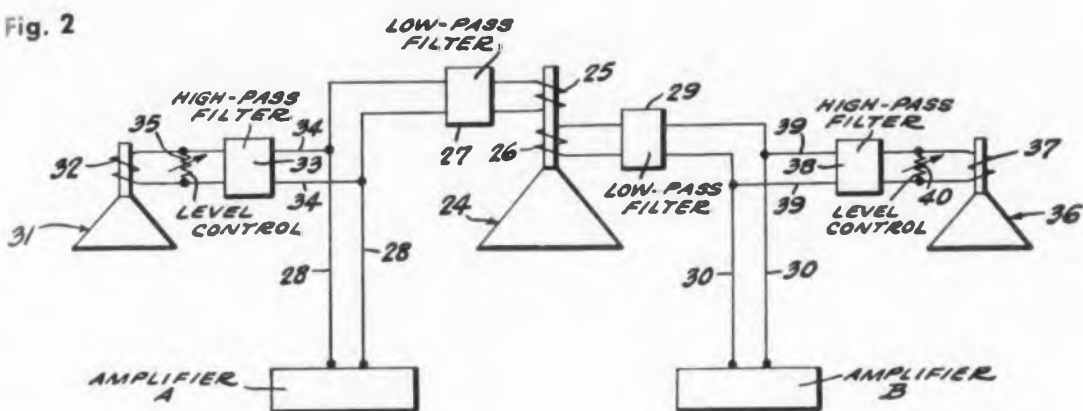
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repro-  
 Fig 1,  
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additional speaker is controlled by an amplifier exclusively at the higher frequencies. It is obvious that speaker 24 might

otherwise be a full-range reproducer of the outputs of the amplifiers in a more expensive system.

Fig. 2



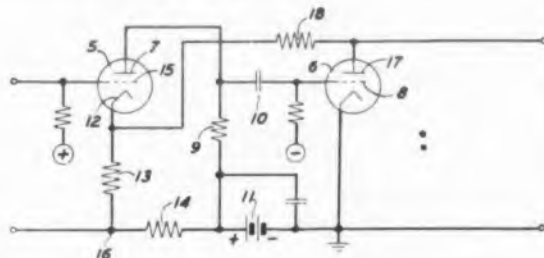
### Broadband Balanced Amplifier

Patent No. 2,904,643. Hugh P. Kelly and Robert L. Nichols. (Assigned to Bell Telephone Laboratories.)

In an RC feedback circuit, the amplifier is frequency-sensitive since the capacitive reactance is high for low frequencies. The invention is a circuit arrangement which provides dc coupling of the degenerative feedback.

A simple embodiment is shown. Uniquely the plate supply of amplifier 6

is fed through resistor 13 in the cathode of the driver amplifier 5. The sense of the feedback through the common resistor 13 is negative and the connection is direct without a coupling capacitor.



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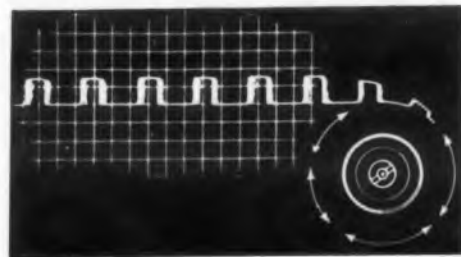
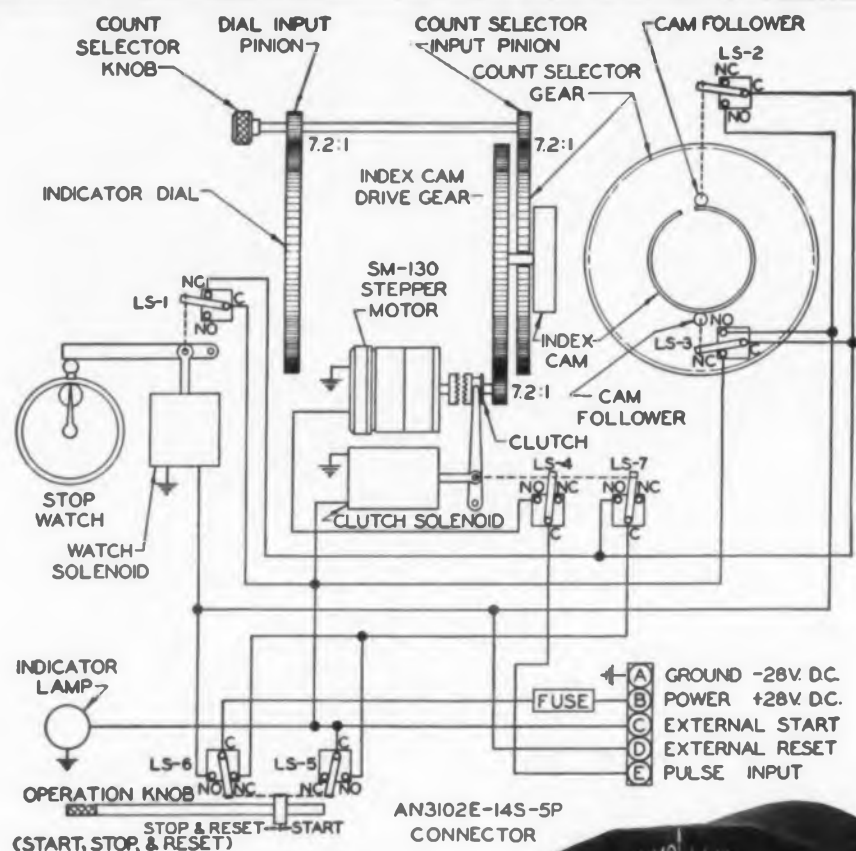
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# STEPPER AUTOMATIC PULSE TIMER



Model K-165

This Automatic Pulse Timer mounts in a standard  $3\frac{1}{8}$ " mounting. The initial usage of the Automatic Pulse Timer was for a difficult instrumentation problem encountered on test aircraft—timing the pulses from a fuel flow transducer and thus determining specific fuel consumption. It successfully replaced a complex and unreliable method.

The Automatic Pulse Timer incorporates an uni-directional Stepper Motor along with complimentary gears, cams, solenoids, switches, an indicator light and—for an accurate independent time base—a stop watch. It is designed to visually record the lapsed time of an occurrence of a specific number of electrical impulses. The Pulse Timer can count pre-selected quantity of 2 to 60 pulses, having a uniform or variable rate up to 25 pulses per second.

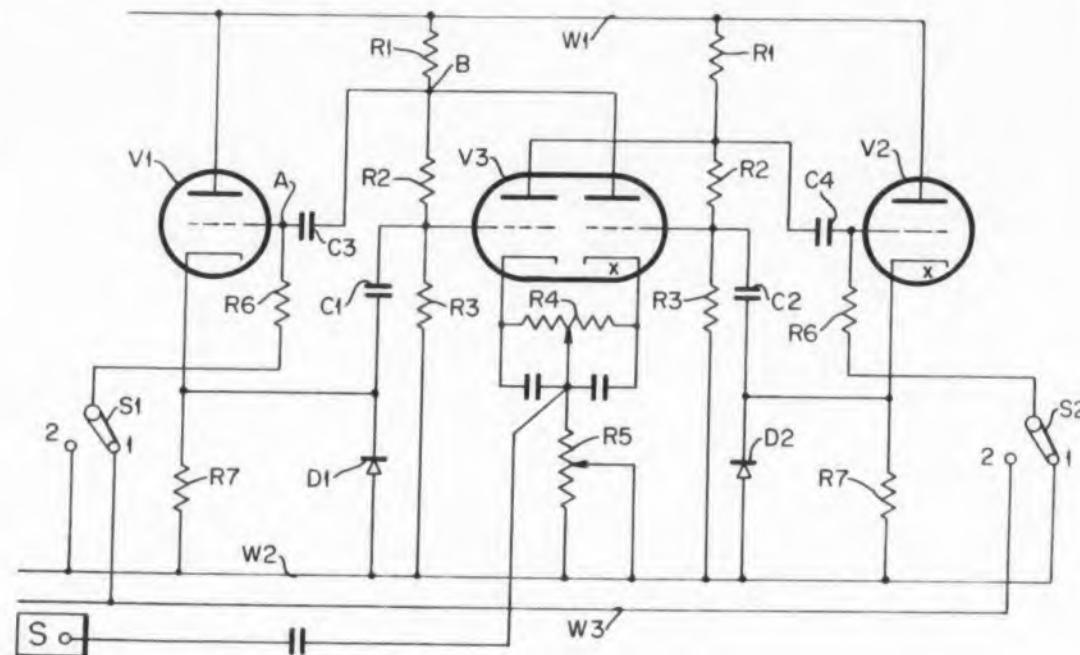
In this application the combined accuracy of the fuel flow transmitter and the automatic pulse timer is better than 1%, and of this the timer contributes essentially no error. When the broad input requirements are available, the unit can be used for timing pulses regardless of the source from which they may originate.

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Subsidiary of California Eastern Aviation, Inc.  
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## PATENTS



### Polystable Trigger Circuit

Patent No. 2,901,608. Robert C. Paulsen and Arthur H. Dickinson. (Assigned to IBM Corp.)

A modified Eccles-Jordan trigger circuit permits polystable switching which can easily be reversed. The circuit is suffi-

ciently stable for data processing applications.

Let the manual switches be set to position 1 as shown and let  $W_3$  return to a negative bias supply. In this condition, triode  $x$  of  $V_3$  is conducting, tube  $V_1$  is cut off and tube  $V_2$  conducts slightly. A negative pulse from source  $S$  causes the

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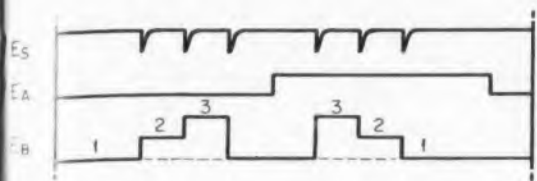
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AMERICAN ELECTRICAL HEATER COMPANY

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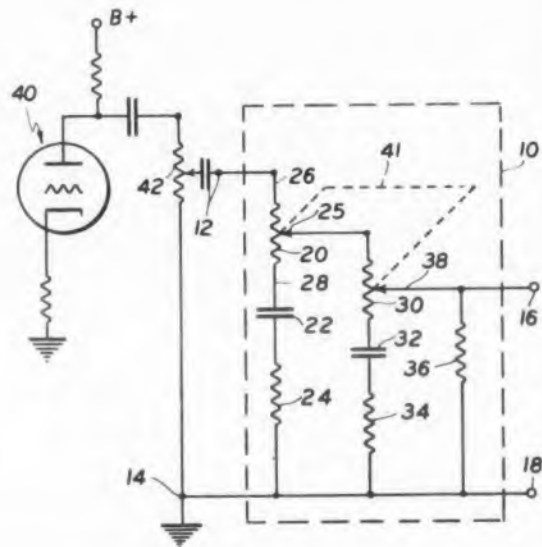
left section of  $V_3$  to conduct making section  $x$  conduct less; the positive pulse at  $B$  drives  $V_1$  to conduct weakly since its grid ties back to the negative supply  $W_3$ . A second negative pulse from source  $S$  drives the left section of  $V_3$  harder and feedback through capacitor  $C_1$  causes this side to saturate with section  $x$  of  $V_3$  cutoff. A third negative pulse from source  $S$  causes no change in the left section of  $V_3$  but section  $x$  conducts hard and the feedback from  $V_2$  through capacitor  $C_2$  causes section  $x$  to saturate as the left section is driven to cutoff. The waveform at terminal  $B$ ,  $E_B$ , reverses as the switches are shifted to position 2.

#### Tone Compensated Loudness Control

Patent No. 2,900,609. Michael H. Estowski. (Assigned to V-M Corp.)

A voltage divider comprising an adjustable resistor 20 in series with capacitor 22 and resistor 24 produces uniform hearing loudness over the audio fre-

quency spectrum according to the Fletcher-Munson curves. Essentially, for all power levels, the circuit attenuates the midfrequencies to the level of the high and low frequency components. In the specified design, the reactance capacitor 22 at 20 cps is selected to equal the resistance of potentiometer 20. At midfrequency, say 1500 cps, resistor 24 is chosen to match the reactance of capacitor 22. The circuit consists of the ganged dual arms so that the Fletcher-Munson curves are matched more precisely.

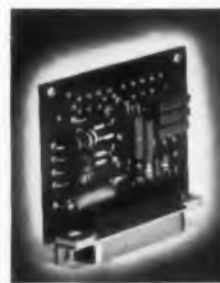


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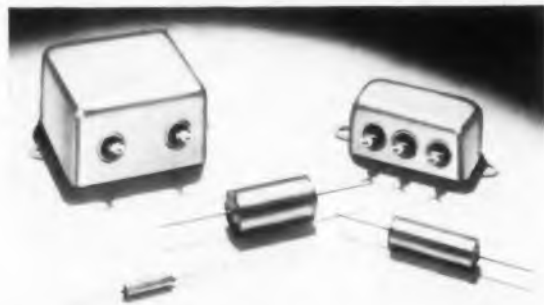
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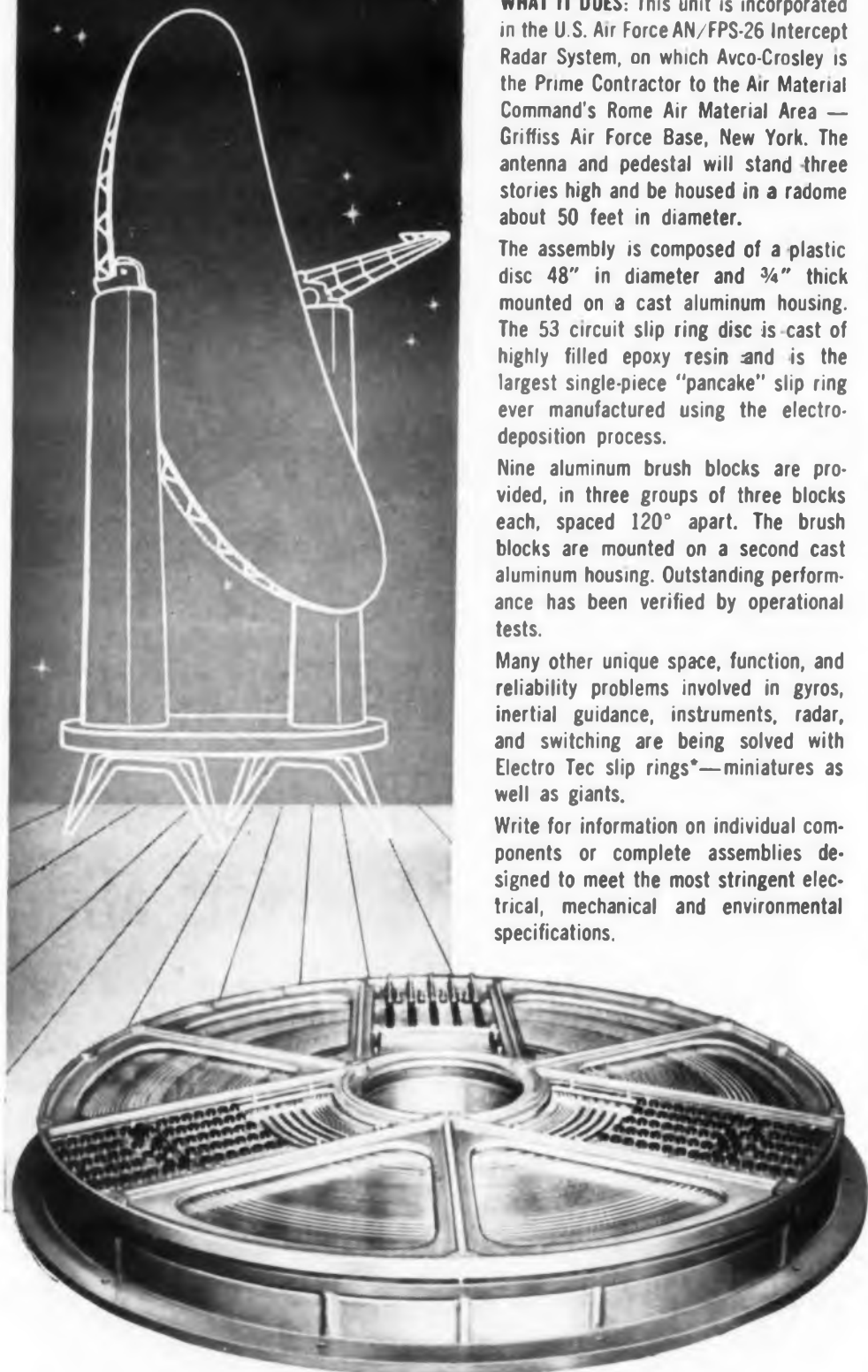
**WHAT IT DOES:** This unit is incorporated in the U.S. Air Force AN/FPS-26 Intercept Radar System, on which Avco-Crosley is the Prime Contractor to the Air Material Command's Rome Air Material Area — Griffiss Air Force Base, New York. The antenna and pedestal will stand three stories high and be housed in a radome about 50 feet in diameter.

The assembly is composed of a plastic disc 48" in diameter and  $\frac{3}{4}$ " thick mounted on a cast aluminum housing. The 53 circuit slip ring disc is cast of highly filled epoxy resin and is the largest single-piece "pancake" slip ring ever manufactured using the electro-deposition process.

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\*Pat. No. 2,696,570 and other patents pending.

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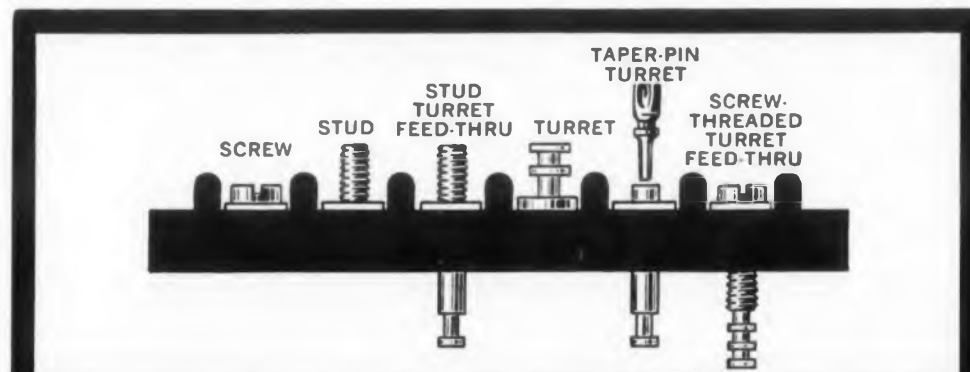
## BOOKS

**Fourier's Series And Spherical Harmonics**  
*William Elwood Byerly, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 287 pp, \$1.75*

The development of functions, series and their differential equations is concretely explained in great detail; throughout the text, theory is applied to practical problems which are fully and lucidly worked out. In addition, the reader is given 190 problems to solve, many with helpful hints as to method. An appendix includes 6 tables of surface zonal harmonics, hyperbolic functions, and Bessel's function. As a handbook, reference and lucid exposition of fundamental methods, there is no duplicate for this book in such areas as mathematical physics, wave mechanics, and advanced engineering including communications technology, aero-

dynamics, radar, acoustics, etc.

Partial contents: Development in Sine Series; Legendre's Coefficients; Bessel's Functions; Development in Trigonometric Series; in Cosine Series; Fourier's Integral Obtained; Convergence of Fourier's Series; Graphical Presentation of Successive Approximations to a Sine Series; Conditions Under Which a Function Can Be Expressed as a Fourier's Integral; Solutions of Problems in Physics; Logarithmic Potential; One Dimensional Flow of Heat; Disturbance Along an Infinite Stretched Elastic String; Flow of Heat in a Sphere; Nodal Lines in a Square Drumhead; Polar Coordinates; Conduction of Heat in Space; Zonal Harmonics; Problems in Potential; Tesseral Harmonics; Development in Spherical Harmonic Series by Aid of Laplacians; Differ-



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entiation. Along an Axis; Nomenclature Justified; Bessel's Functions of nth order; Stationary Temperatures in Cylindrical Shell; Laplace's Equation in Curvilinear Coordinates; Ellipsoidal Harmonics; much more.

#### Microwave Measurements for the Technician

Ralph W. Ritchie, Wm. C. Brown Co., 135 S. Locust St., Dubuque, Iowa, \$3.50

Purpose of this book is to provide a comprehensive, simplified manual on basic microwave measuring techniques. Subjects covered include: "Operation of Microwave Test Bench," which includes tuning, frequency measurement and power measurement, "Standing Wave Ratio Measurement," "Use of Smith Chart," "Measurement on Directional Couplers," "Measurements on Klystrons," and "Attenuation Measurements."

A "how-to" book, it will be especially helpful to electronics engineers and technicians assigned to microwave measurements, with little or no previous indoctrination in the field.

#### Welding of Plastics

J. A. Neumann and F. J. Bockhoff, Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 288 pp, \$7.25

Here is a comprehensive treatment of all phases of this subject ranging from initial design procedures to final detailed fabrication methods. Various physical and chemical properties of individual plastics presently used for welded construction are completely covered with regard to their use in chemical and allied processing. All presently known techniques of welding are covered in detail and many step-by-step procedures with photographs are included. In addition, the book contains one of the most complete corrosion resistance tables yet published, plus a concise guide for the choice of an appropriate plastic construction material. An entire chapter is devoted solely to design considerations as they specifically affect welded construction. Testing and evaluation are also given separate treatment.

This book is of substantial help to engineers and manufacturers who are interested in present and potential applications of plastics in the process industries.

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Capacitance.....	500 mmfd. to 500 mfd.	50 mmfd. to 10 mfd.
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## SMI REPORTER

Engineering notes from the

By STANLEY M. INGERSOLL, Capabilities Engineer



#### REPORT NO. 1

A new advance in pressure switching is embodied in our TR 2065. Through the use of solid state switching circuits\*, SMI has developed a pressure switch which is extremely accurate and highly reliable. This new unit supplies a switch closure or opening on either an increasing or decreasing pressure and is ideally suited to applications where severe environments of temperature, vibration and shock are encountered.

For example, exhaustive tests of a 500 PSI unit have shown that it will not chatter when subjected to 50G's vibration when the pressure input is only 0.2% away from the switch point.

Essentially the TR 2065 is an SMI Bourdon Tube Pressure Transducer coupled with unique solid state switching circuits. The result is a pressure switch which is friction free and contains no moving parts in contact.

**Principles of Operation** As switching pressure is applied to the interior of the helically twisted Bourdon Tube, the tube rotates the armature attached to its end. The armature is positioned in a miniature, balanced, inductive bridge. A solid state electronic circuit receives the signal from the bridge and performs an extremely reliable switching function using minute amounts of energy, due to the elimination of friction and the minimizing of inertial forces.

Additional switch points may be added to the TR 2065 without adding more pressure sensing elements. Thus, as the number of operations increases, the size, weight and cost per switching point decreases.

#### Switch Point

#### Dynamic Stability:

Less than 0.25% of full scale when subjected to 60G's shock (10 m.s.) and vibration and 100G's shock

#### Vibration:

(10-55 cps 0.2" SA) (55-2000 cps 60g)

#### Hysteresis

0.1% of the pressure cycle experienced by the tube

#### Temperature:

(zero shift) 0.005% per °F (scale factor) 0.001% °F

#### Long Term Drift

0.2% per year (approx.)

#### On-Off Differential

0.1% or better

#### Repeatability

0.1% of full scale

#### Typical Specifications



Pressure Switch, Type TR 2065.

**What are your needs?** If your immediate or future applications call for pressure switching, write or wire for complete information. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

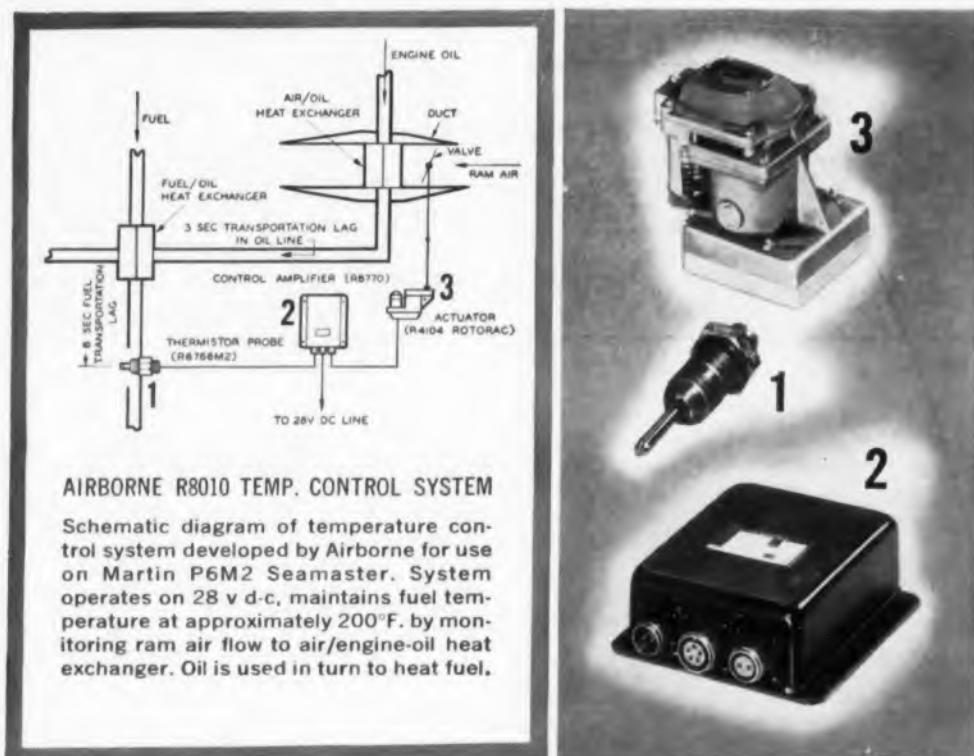
\*Patent applied for



**SERVOMECHANISMS, INC.**

Los Angeles Division  
12500 Aviation Boulevard  
Hawthorne, California

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**AIRBORNE R8010 TEMP. CONTROL SYSTEM**

Schematic diagram of temperature control system developed by Airborne for use on Martin P6M2 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

An integral part of each main engine installation on the Martin P6M2 Seamaster is an Airborne R-8010 custom-engineered temperature control system. By regulating air flow through a heat exchanger, this system maintains supply line fuel at 180-220°F.

As developed for the P6M2, the R-8010 system consists of a thermistor probe, a control amplifier and a rotary actuator. The probe (mounted in an MS10057-12 fitting) is in direct contact with the temperature-regulated fuel and presents to the control box a resistance which is proportional to fuel temperature. In response, the control box energizes the actuator to change the setting of a ram air intake valve, thus regulating volume of air flow through an air/fuel heat exchanger. This sensing and response continues until prescribed fuel temperature

is attained, at which point the system reaches a state of electrical balance.

A fail-safe feature is also provided. In the event of power failure, a magnetic clutch in the actuator is released, permitting the air valve to be pushed open by the force of the ram air.

This application\* on the P6M2 illustrates only one of many possible adaptations of the Airborne R-8010 system for temperature control functions on aircraft, missiles and related equipment—cabin temperature control, engine temperature control, temperature regulation of fuel, oil, electronic cooling packages, etc. If you have requirements in these areas, we will be happy to make a proposal. Contact any of our offices.

\*Described in detail in new Bulletin PS-4A, available on request.



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## BOOKS

### Algebraic Theories

Leonard E. Dickson, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 276 pp, \$1.50

This book develops theories centering around matrices, invariants, and groups, which are among the most important concepts in mathematics. All important theories are studied with rigorous, detailed proofs. This volume provides courses in higher algebra, the Galois theory of algebraic equations, finite linear groups, including Klein's "icosahedron" and theory of equations of the fifth degree, and algebraic invariants. Higher algebra is fully treated, including matrices, linear transformations, elementary divisors and invariant factors, and quadratic, bilinear, and Hermitian forms, whether taken singly or in pairs. The results are classical with due attention given to questions of rationality. Elementary divisors and invariant factors are introduced in a simple, natural way in connection with the classi-

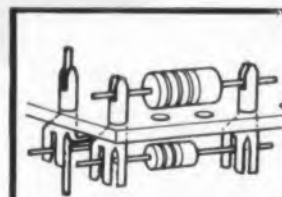
cal form, and a rational, canonical form of linear transformations. These topics are developed more lucidly than usual, and in close connection with their most frequent mathematical applications.

Chapter titles: Introduction to Algebraic Invariants; Further Theory of Covariants of Binary Forms; Matrices, Bilinear Forms, Linear Equations; Quadratic and Hermitian Forms, Symmetric and Hermitian Bilinear Forms; Theory of Linear Transformations, Invariant Factors, Elementary Divisors; Pairs of Bilinear, Quadratic, and Hermitian Forms, First Principles of Groups of Substitutions; Fields, Reducible, Irreducible Functions; Group of an Equation for a Given Field; Equations Solvable by Radicals; Constructions with Ruler and Compasses; Reduction of Equations to Normal Forms; Groups of Regular Solids; Quintic Equations; Representations of a Finite Group as a Linear Group; Group Characters.

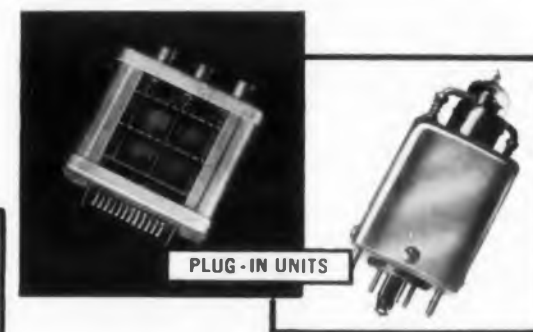
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### Modern Electronic Components

W. A. Dummer, *Philosophical Library*, 15 E. 40th St., New York 16, N. Y., \$15.00

Users of components will appreciate this book in which all the characteristics of the commonly-used components are given. Components are now used under arduous environmental conditions and several chapters have been written to cover those aspects in detail.

The bibliography at the end of the main chapters has been carefully chosen to provide a comprehensive, although brief, summary of the literature.

The information in this book will help the user to an understanding of the basic characteristics of components and enable him to choose the best component for his particular purpose.

### Nomography

Alexander S. Levens, *John Wiley & Sons*, 440 Fourth Ave., New York 16, N. Y., 296 pp., \$8.50

Nomography is considered one of the clearest expositions of the basic theory and construction of charts involving straight line scales, curved scales, and

combinations of the two. This 1959 edition recognizes that from the launching of a satellite to the more mundane realm of food technology, nomographs are apt to be called to the rescue. Statistics, electronics, ballistics, heat transfer, radioactivity, medicine, the physical and biological sciences, engineering, and business are only a few of the fields in which nomographs are constructed today.

This second edition of "Nomography" has three new chapters on circular nomograms, projective transformations, and the relationship between concurrency (Cartesian) and alignment nomographs with applications to experimental data. Three earlier chapters have been expanded to include: methods for designing nomographs for four variables without the need of a turning axis; material on nomograms which consist of two curved scales and a straight line scale, and three curved scales; and a more extensive treatment of the use of determinants. Professor Levens has also simplified the mathematical developments for the various type forms throughout the book, and introduced many new problems and examples, in addition to other up-to-date material.



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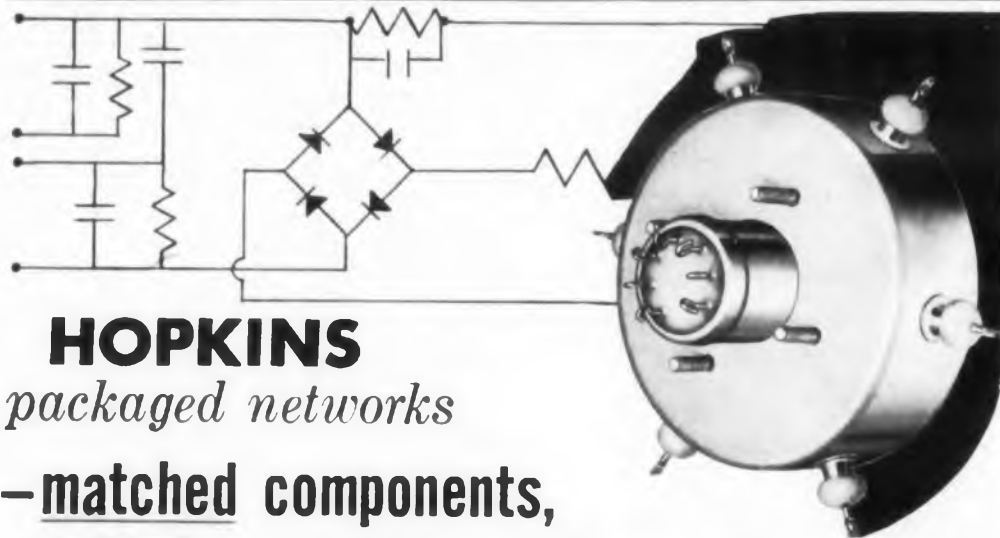


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## BOOKS

### Group Theory in Quantum Mechanics

Dr. Volker Heine, Pergamon Press, Inc.,  
122 E. 55th Street, New York 22, N.Y.,  
370 pp. \$10.00.

This book gives an elementary introduction to the use of group theory in quantum mechanics together with an account of the simpler applications in all branches of physics and chemistry. Throughout, there is an emphasis on applications.

The book introduces the three main uses of group theory in quantum mechanics: firstly, to label energy levels and the corresponding eigenstates; secondly, to discuss qualitatively the splitting of energy levels as one starts from an approximate Hamiltonian and adds correction terms; and thirdly, to aid in the evaluation of matrix elements of all kinds, and in particular to provide general selection rules for the non-zero ones.

The level of the text is that of a course for research students in physics and chemistry, such as is now offered in many universities. A previous course in quantum theory is assumed, but the matrix

algebra required is included as an appendix.

The view adopted throughout is that group theory is not simply a specialized tool for solving a few of the more difficult and intricate problems in quantum theory. In advanced quantum mechanics, practically all general statements that can be made about a complicated system depend on its symmetry properties, and the use of group representations is a systematic, unified way of thinking about and exploiting these symmetries. For this reason simple results are included for which one could easily produce ad hoc proofs from first principles.

A series of examples is appended to each section. Some of these are simple drills in the concepts introduced in the section; others, particularly in later chapters, indicate extensions of the theory and further applications. Chapter headings include: Symmetry Transformations, Quantum Theory of a Free Atom, Representations of Finite Groups, Further Aspects of the Theory of Free Atoms and Ions, Structure and Vibrations of Molecules, Solid State Physics, Nuclear Physics, and Relativistic Quantum Mechanics.

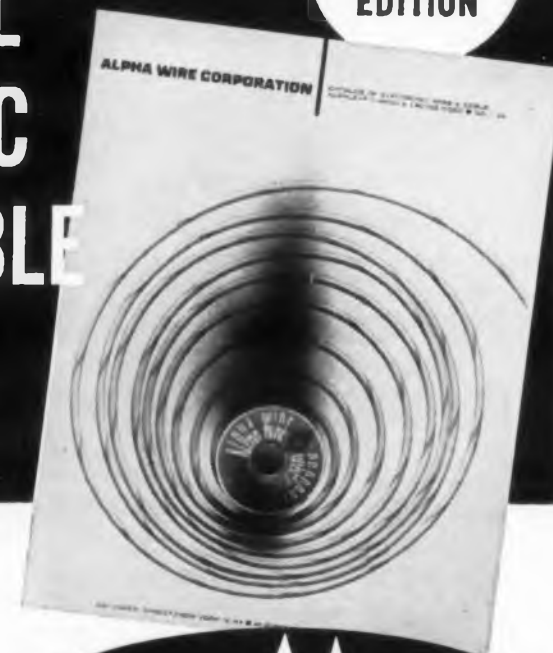
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**Metropolitan Miami Manufacturers**  
*Dade County Development Dept., 345  
 N.E. Second Avenue, Miami 32, Fla.,  
 \$3.50*

A new 1959 directory, listing 2403 individual manufacturing plants in Metropolitan Miami, is now in distribution. It is the second part of a comprehensive printed factual effort by Dade County devoted to presenting the economic attributes of Metropolitan Miami to interested national management. Part I is the "Economic Survey of Metropolitan Miami" which appeared in January 1959.

The new directory lists manufacturing plants of the area alphabetically by name as well as by product under the Standard Industrial Classification format. It affords market researchers, particularly, a far wider range of professionally geared information by inclusion of:

- name, address, postal zone, telephone number;
- top firm officer identified by name and title and whether owner, partner or otherwise;
- type of product and product trade name by SIC classification;
- total number of square feet floor space occupied by plant;

- Census Tract location of each plant;
- areas of relative market importance emphasizing major geographical distribution of local sales.

**Physical And Engineering Properties Of Materials For Nuclear Fuel Elements**

*Dr. Henry H. Hausner, Sylvania-Corning Nuclear Corp., Bayside, L. I., N. Y., 55 pp, \$1.00*

This is a compendium of physical and engineering data about elements, alloys, compounds and other materials of particular interest to those engaged in the design, fabrication and use of nuclear fuel and control elements. It serves admirably its intended purpose of supplying information not yet widely available in conventional reference sources.

Eighty tables are presented: the first contains thermal-neutron cross sections of 50 commonly available elements; succeeding ones give various physical and thermal properties of uranium, uranium alloys, thorium, plutonium, ceramics, zirconium and zircaloy-2, aluminum, stainless steel, graphite, and other high-temperature materials.

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 Separate Anodes

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 Voltage Range: 3 to 250 volts

Type SMTUCP  
 Dual Common Positive  
 Separate Cathodes

These dual section common anode constructed capacitors have cathodes which are electrically separated and isolated. Unique construction with "floating" cathodes makes these ideal for coupling, filter and bypass circuits for "above ground" applications.

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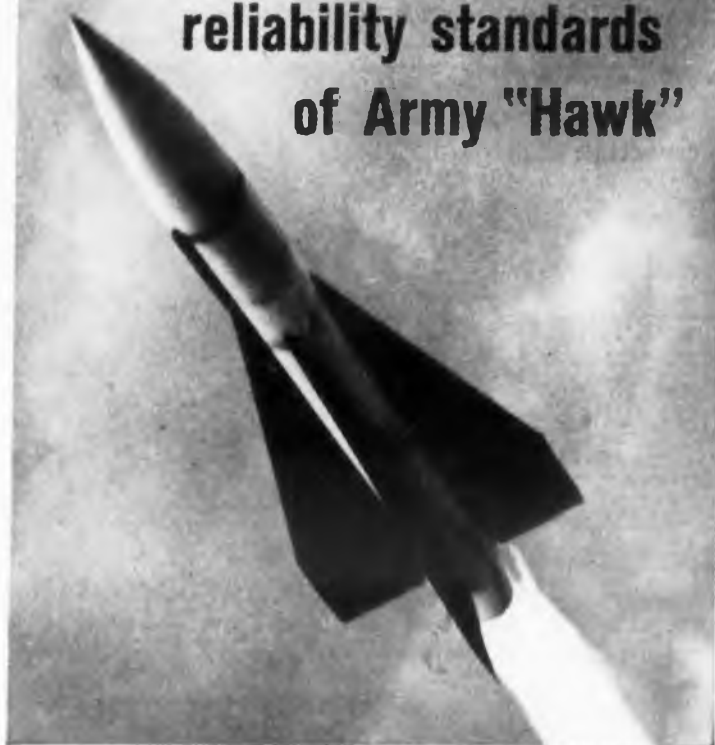


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## RUSSIAN TRANSLATIONS

J. George Adashko

# Novel LC Filter Using Mutual Inductance

**T**HE FILTER shown in Fig. 1 is designed to suppress one frequency, and to take advantage of LC elements even at very low frequencies. In this filter, the parallel circuit II and the resistor R serve as a voltage divider.

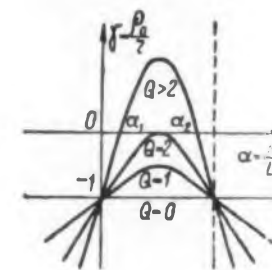
The resonant-frequency voltage is divided in the ratio of the Q of circuit II and the resistance R. Since, in real circuits, Q is finite and decreases with the frequency, this leads to filtering of the resonant frequency.

The losses in circuit II, which cause the low Q of the circuit and the poor filtering effect, can be compensated by coil L<sub>1</sub>, inductively coupled with L<sub>2</sub>. This increases the power drain (the filter input resistance is decreased), but greatly increases the equivalent Q of circuit II.

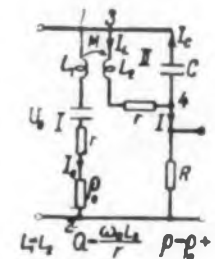
A circuit with greatly enhanced Q results in a filter that has all the advantages of LC filters over RC filters (low losses and steep slopes), even at frequencies of several cycles.

In addition, by varying the parameters of the

circuit of Fig. 1 it is possible to obtain either a high-pass or low-pass filter without increasing the number of elements. If circuits I and II are pretuned, the filter has only one tuning element—the resistance  $\rho_0$  with which the losses in circuit II



**Fig. 1.** This LC filter drains more power than simpler LC filters, but it provides sharper filtering.



**Fig. 2.** Conditions for infinite  $Z_K$ .

### Russians Reveal New Patent Regulations

In an unsigned article "New Regulations for Inventions and Efficiency Suggestions," in the journal *Vestnik Svyazi (Communications Herald)* of July 1959, the Russians revealed new pay scales for inventiveness. Their "Regulations for Discoveries, Inventions, and Efficiency Suggestions" and "Instructions on Remuneration for Discoveries, Inventions, and Efficiency Suggestions" became effective on May 1, 1959.

The new regulations and instructions differ from previous ones in that they provide for increased bonuses to inventors and efficiency experts. The minimum compensation is set at 200 rubles for an

invention and 100 rubles for efficiency suggestions which don't result in any saving. (The official exchange rate is about four rubles per dollar; tourist rate is ten for one).

Compensation is paid to the inventor even if his invention relates to the field in which he works.

The article in which this information appears was abstracted in the Central Intelligence Agency's *Scientific Information Report* of September 4, 1959. This semi-monthly publication is distributed by the U.S. Department of Commerce, Office of Technical Services, Washington 25, D.C. Annual subscriptions cost \$28.00. Single copies \$2.75.

are compensated.

The resonant impedance  $Z_K$  of the parallel circuit  $II$  (between points 3 and 4) can be determined with Kirchoff's equations as follows:

$$1. u_0 = I_0 \left( \rho + i \omega L_1 + \frac{1}{i \omega C} \right) + i \omega M I_L$$

$$2. 0 = I_L (r + i \omega L_2) + I_C \frac{1}{i \omega C} + I_0 i \omega M$$

$$3. I_L = I + I_C$$

$$4. u_0 = I R - I_C \frac{1}{i \omega C}$$

$$5. Z_K = \frac{u_0}{I} - R$$

After solving for  $u_0/I$  and after suitable transformation, one obtains

$$Z_K = \frac{R \frac{M}{\rho} + L + i \omega_0 \left( \frac{M^2}{\rho} - \frac{r}{\omega_0^2} \right)}{M^2 - ML + CL \rho r} \rho L$$

This impedance vanishes when

$$M = \frac{L}{2} \pm \sqrt{\frac{L^2}{4} - \frac{r \rho}{\omega_0^2}}$$

i.e., it is necessary to have

$$\rho = \frac{\omega_0^2 M}{r} (L - M) = r Q^2 \frac{M}{L} \left( 1 - \frac{M}{L} \right)$$

Since  $\rho = \rho_0 + r$ ,  $\rho$  and  $M$  must satisfy additional conditions if  $Z_K$  is to be infinite.

Since  $M/L = \alpha$ , and  $\rho_0/r = \gamma$ ,

$$\gamma = Q^2 \alpha (1 - \alpha) - 1$$

This condition is represented graphically in Fig. 2.

The points  $\alpha_1$  and  $\alpha_2$  can be defined:

$$\alpha_{1,2} = \frac{1}{2} \pm \sqrt{\frac{1}{4} - \frac{1}{Q^2}}$$

Thus, knowing the  $Q$  of the initial circuit, it is possible to choose  $\rho_0$  and  $M$  so as to ensure normal operation of the filter. Such a circuit can be successfully used in many circuits. It readily yields an attenuation of  $10^4$  to  $10^6$  at frequencies from 100 cps to several tens of kilocycles. The fronts are steeper than in an ordinary  $LCR$  circuit.

The principle of compensation of the losses in tuned circuits by increasing the power drain and using inductive coupling is applicable also to more complex filter circuits.

This article is abstracted from *Electronic Filter with Mutual Inductance in the July 1959 issue of Radiotekhnika.*

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FREQUENCY CALIBRATION	$\pm 3$ percent plus 10 cps
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VOLTAGE ACCURACY	$\pm 5$ percent
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## GERMAN ABSTRACTS

E. Brenne

### Double RC Integrator

THE INTEGRATOR circuit shown in Fig. 1 has R-C branches on both grid and plate side of the tube. For this circuit, the complex transfer function is

$$\frac{V_2}{V_1} = -gm \frac{R_2}{j\omega R_1 C_1} \cdot \frac{1 + \frac{1}{R_2/R_0 + j\omega R_2 C_2}}{1 + \frac{1}{j\omega R_1 C_1}}$$

if  $R_1 C_1 = R_2 C_2$  and if  $R_2/R_0 < \omega R_2 C_2$  the integration of periodic functions can be performed with high precision and greater simplicity than the Miller integrator requires. In Fig. 2, the phase and amplitude errors are shown as functions of frequency, for  $R_2/R_0 = 2/3$ , in comparison to the

### Multilayer Microwave Terminations

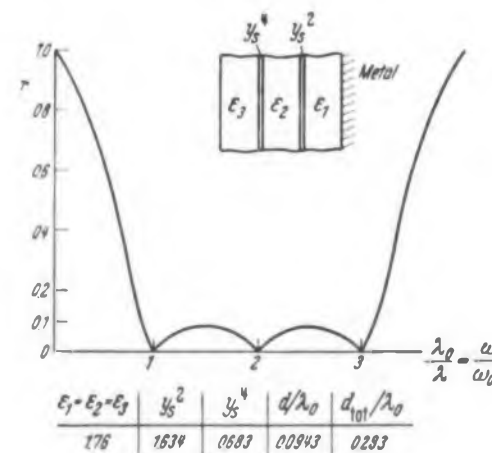


Fig. 1. Reflection factor as a function of normalized frequency for a five layer structure. The symbols  $y_a$  refer to the normalized admittance of the metal foils and the superscripts 2 and 4 refer to their position in the structure relative to the metal wall.



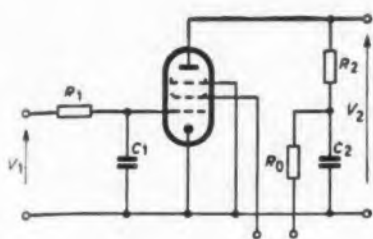


Fig. 1. Double RC integrator.

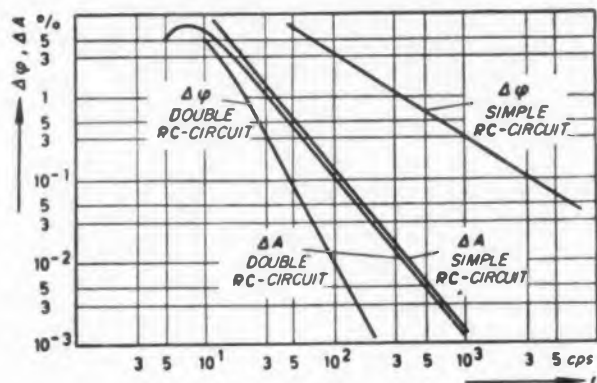


Fig. 2. Amplitude and phase error as functions of frequency for the simple and the double RC integrators.

performance of the simple R-C element.

Abstracted from an article by W. Berger, F. Hoevelmann and H. J. Koessler, *Elektronische Rundschau*, Vol. 13, No. 9, September 1959, pp. 336-338.

THE USE of multiple resonant structures for reflectionless broadband absorbers of microwave energy offers considerable broadbanding possibilities. Such structures consist of layers of nominally lossless dielectrics alternating with conducting foil in front of a metal wall. A structure is designed on the basis of transmission line equations (normal incidence).

For simplicity in computation, it is assumed

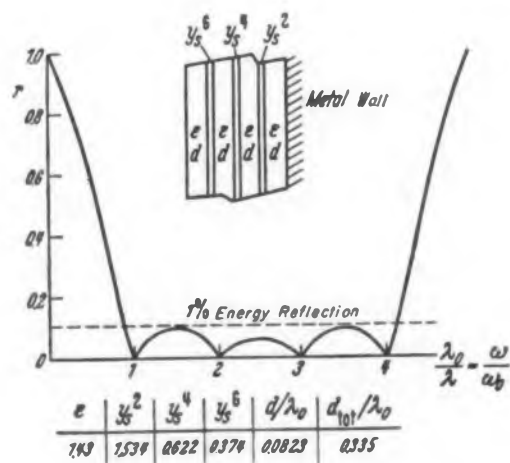


Fig. 2. Reflection characteristics of a seven layer structure. As in Fig. 1,  $y_n$  is the normalized admittance of the metal foil in the  $n$ th position from the metal wall.

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## GERMAN ABSTRACTS

that all dielectric layers have the same geometrical and optical properties, i.e. the same dielectric constant. The five-layer structure shown in Fig. 1 has the reflection characteristics indicated. A seven-layer structure has the 4:1 band shown in Fig. 2. For 15 deg and 45 deg angle of incidence, the experimental curve shown in Fig. 3 for a seven-layer structure shows good agreement with Fig. 2.

Abstracted from an article by H. J. Schmitt, *Zeitschrift fuer Angewandte Physik*, Vol. 11, No. 9, September 1959, pp. 335-339.

## High-Frequency Crystal

FOR MEASUREMENT of the properties of silicon mono-crystals, an axial current is fed to the crystal rod by means of two solder contacts and the resulting voltage is measured between two closely-spaced point contacts on the rod. The use of solder contacts has the disadvantage of producing surface dirt which results in lowering the resistance and the charge carrier lifetime. If solder contacts are avoided by use of pressure contacts, metal traces result which cannot be neglected for high resistance samples.

The use of high-frequency techniques makes it possible to use contact-free circuits by use of inductive coupling for low-resistance materials and capacitive coupling for high-resistance materials. In addition, the sample may be protected from surface dirt by wrapping in protective foil.

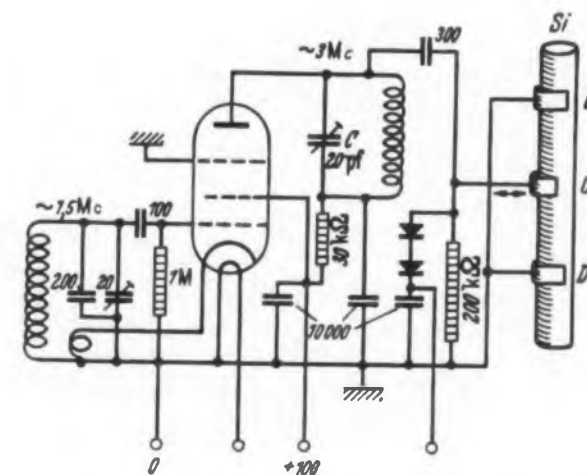


Fig. 1. Circuit of a 3 mc apparatus for resistance measurement in the 1000 to 30,000 ohm-cm region.

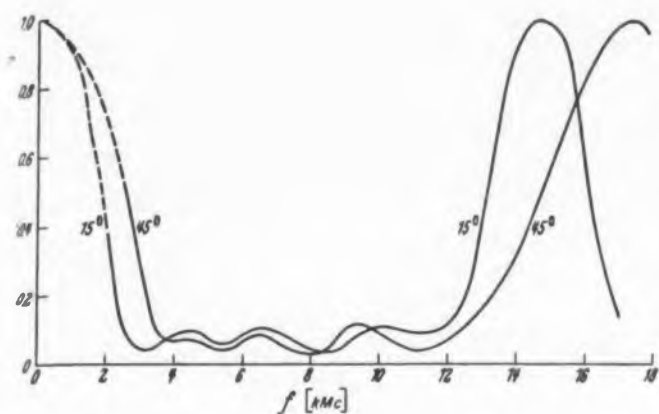


Fig. 3. Measured reflection factor as a function of frequency for a seven-layer absorber for two angles of incidence.

## Measurement of Silicon Parameters

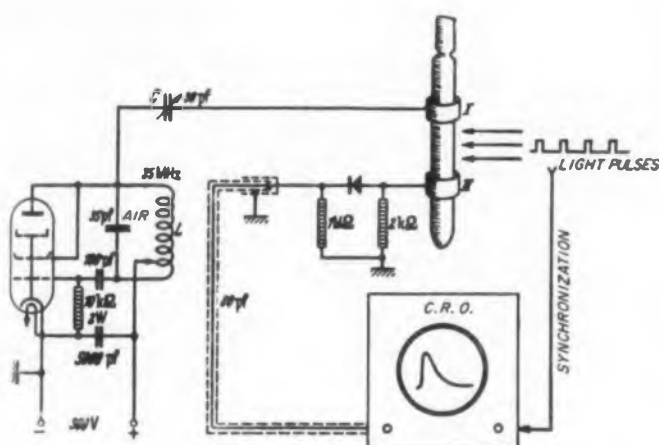


Fig. 2. Circuit for lifetime measurement.

For resistance measurement of samples whose resistivity is between 1000 and 30,000 ohm-cm, a circuit which has been used successfully is the 3 mc circuit shown in Fig. 1. In the tuned circuit, the capacitive coupling of the silicon rod to the tank is at points marked B, C and D.

For measurement of charge-carrier lifetime, the modulated light method may be adopted to the high frequency method shown in the 35 mc circuit of Fig. 2 where capacitive coupling is at points I and II.

In each application cited, the results obtained by the high frequency method agree well with standard values.

Abstracted from two articles by W. Keller, *Zeitschrift fuer Angewandte Physik*, Vol. II, No. 9, September 1959, pp 346-352. Dr. Keller notes that I. R. Weingarten and M. Rothberg in the U.S. have presented a high frequency method to the *Electrochemical Society* on Apr. 29, 1958.



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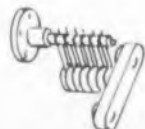
Information on these new relays may be obtained by writing to the address below.



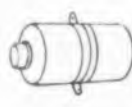
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## REPORT BRIEFS

### Vibrations

Some of the environmental problems in equipment design for military applications are outlined, and the need for power spectrum analysis of vibrations shown. Various systems for frequency analysis, including swept filter and fixed types, are discussed. An ideal fixed filter system meeting certain necessary specifications on response to simple inputs is proposed. This system is commercially unavailable. *Line Power Spectrum Analyzer For Mechanical Vibrations*, Frank Amoroso, Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass. May 1958, 76 pp, Microfilm \$4.50, Photocopy \$12.30. Order PB 140853 from Library of Congress, Washington 25, D.C.

### Silicone Insulated Cables

A comparison of the dielectric breakdown results of gas flame exposed Class E and Class T insulated cable specimens indicates that the dielectric strength of specimens vibrated for 15 min at a frequency of 20 cps and an amplitude of 1/16 in. is not significantly different from the dielectric strength of similar specimens which had not been vibrated. *Dielectric Strength Of Silicone Insulated Cables After Exposure To Flame and Vibration*, Material Laboratory, New York Naval Shipyard, Brooklyn, N.Y. 23 July 1958, 9 pp, Microfilm \$1.80, Photocopy \$1.80. Order PB 139527 from Library of Congress, Washington 25, D.C.

### Magnetron Research

The results cover the following: (1) comparison of experimental results with various design equations and a set of simplified design equations; discussion of the cause of upper current or diode cut-off and a means for avoiding it; discussion of the cause of minimum current cut-off and pulsing and methods for its reduction; measurements of cathode back-heating and one method for protecting the hot cathode; and various anode structures and their performance; (2) a method for voltage tuning magnetrons; (3) the use of a magnetron as a reactance for frequency modulating another oscillating magnetron; and (4) the use of a magnetron as an amplifier or controlled oscillator thereby permitting stable external frequency control and therefore, either amplitude or frequency modulation. *C. W. Magnetron Research*, D. A. Wilbur and R. B. Nelson, General Electric Research Laboratories, Schenectady, N.Y. 1 Apr. 1950, 174 pp, Microfilm \$8.10, Photocopy \$27.30. Order PB 137249 from Library of Congress, Washington 25, D.C.

## Networks

If a network contains a variable parameter  $x$  (capacitance, or  $g_m$  of a vacuum tube, etc.) the polynomials of the driving-point and transfer functions describing the network have coefficients which are linear functions of  $x$ . The roots of the polynomials are also functions of  $x$ . Since the locations of the poles and zeros of these network functions are important in both analysis and synthesis of the network, it is desirable to know quantitatively the tendency for a root to vary with the parameter  $x$ . A measure of this tendency to vary is provided by the sensitivity function  $S = dp/dx$ , where  $p$  is a root of a polynomial. Properties and theorems pertaining to this sensitivity function are given in this work. *Pole-Zero Sensitivity In Network Functions*, Franklin F. Kuo, Electrical Engineering Research Laboratory, University of Illinois, Urbana, Ill. 1 May 1958, 84 pp. Microfilm \$4.80, Photocopy \$13.80. Order PB 137069 from Library of Congress, Washington 25, D.C.

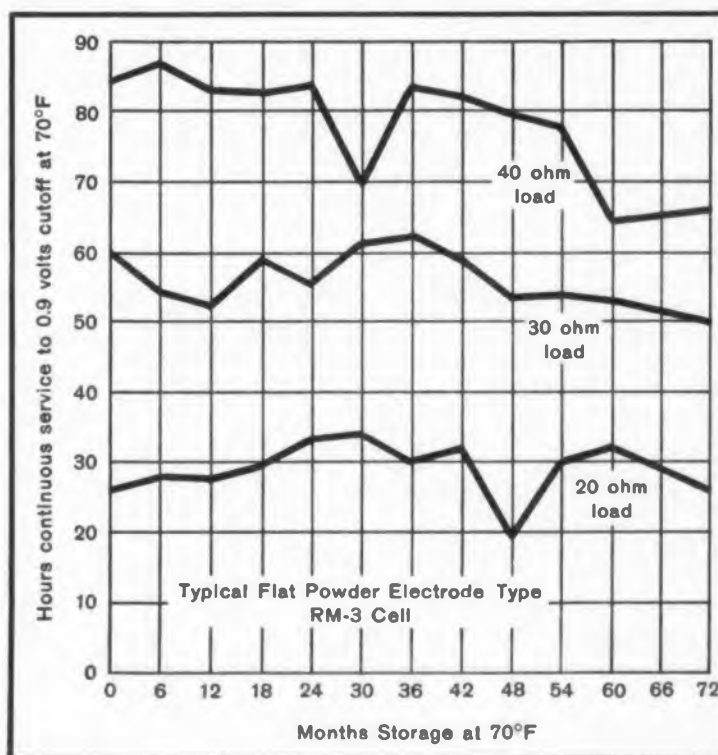
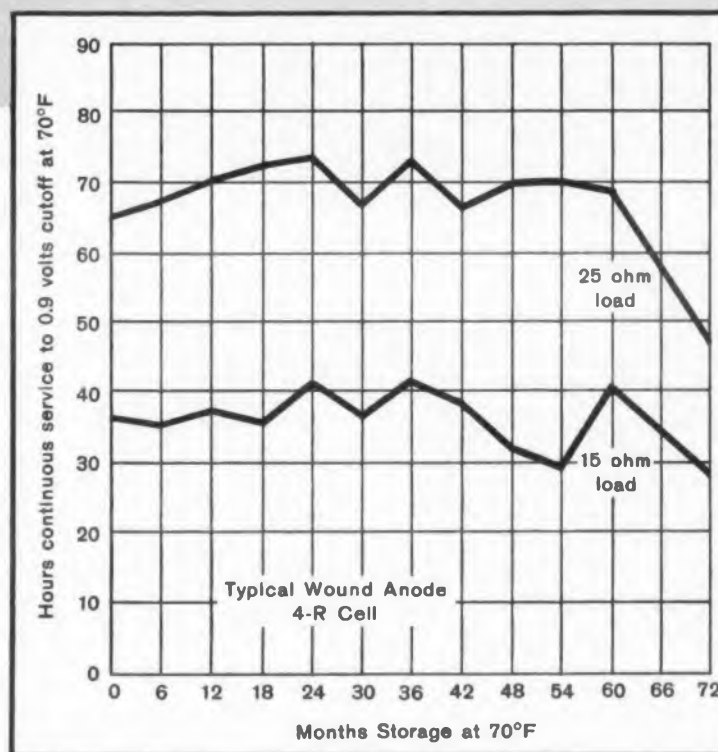
## Designing Video Interstages

This study presents a method of designing interstages for transistor video amplifiers. The transistors are represented by the hybrid- $\pi$  equivalent circuit. The problem of designing interstages is shown equivalent to the problem of synthesizing a transfer impedance function proportional to the stage gain where the resulting interstage network must have certain specified terminating impedances. These terminating impedances represent the effects of the transistors. The interstage synthesis technique developed emphasizes the importance of the interstage using a limited number of elements and providing a satisfactory gain-bandwidth product. *Interstages for Transistor Video Amplifiers*, J. J. Spilker, Stanford Electronics Laboratory, Stanford University, Calif., Apr. 1958, 139 pp. Microfilm \$6.90, Photocopy \$21.30. Order PB 139459 from Library of Congress, Washington 25, D. C.

## Microwave Resonant Cavities

This report describes the design and testing of two types of resonant microwave cavities operating near 9435 mc in which the end plates are replaced by terminations which leave the cross-sections of these cavities essentially unobstructed. *Design of Open-Ended Microwave Resonant Cavities*, Donald C. Thorn, Electrical Engineering Research Laboratory, University of Texas, Austin, Tex., Aug. 1958, 23 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 142035 from Library of Congress, Washington 25, D. C.

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SILICON	11.0	.00078	81
SILICON	16.0	.00065	78
GERMANIUM	1.6	.00091	426
GERMANIUM	3.4	.00067	268

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## REPORT BRIEFS

### Designing Crystal Filters

A set of convenient insertion loss equations is derived, which is applicable to the design of multisection, reactive, symmetric filters. Specific network designs for quartz crystal bandpass filters with sharp cut-off characteristics, and more than 60 db attenuation in the stop bands, are presented for two categories of fractional bandwidths: (1) less than or equal to 0.4 per cent; (2) equal to or larger than 1.5 per cent. Several network structures for each of these two categories are worked out and the corresponding insertion loss characteristics are plotted. Element values are given for a filter with a 6 db bandwidth of 40 kc with respect to a center frequency of 11.5 mc. A design for a filter with a bandwidth of 400 kc with respect to a center frequency of 24 mc is included. This design makes full allowance for the effects of coil dissipation. In an appendix, a general approach is outlined to the formation of lattice-type filters with 4, 6, and 8 peaks of infinite attenuation (i.e., zeros of transmission) and with image impedances suitable for (1) quartz crystal-capacitor-inductor filters with a constant- $k$  image impedance. Recent design progress is announced, which took place subsequent to the close of the first quarter and promises to lead to a very satisfactory filter design in the fractional-bandwidth region between 0.4 per cent and 1.5 per cent. *High Frequency Crystal Filters, Leo Strock, Hughes Aircraft Co., Culver City, Calif., 1957, 84 pp, Microfilm \$4.80, Photocopy \$13.80. Order PB 142388 from Library of Congress, Washington 25, D. C.*

### Crystal Oscillator Circuits

Performance information for the cathode coupled and grounded grid oscillators for the 10 to 75 mc frequency range is reported. Reference circuits and their performance as a function of frequency have been established. Effects of component variation have been determined, and shown to be adequately described by the normalized curves developed for higher frequency operation. Initial problems of frequency and crystal voltage correlation have been resolved. These are shown to be caused by the effect of the plate-to-cathode capacitance. Correction is obtained by the addition of an inductor in series with the crystal in the feedback path. The design information for the grounded grid circuit in this frequency range has been found to be essentially an extension of the results obtained in the higher frequency range. A discussion of the problems encountered



Dislocation density. Knapic silicon monocrystals. Crystal diameter 1/10" to 3/8"—None; 3/8" to 3/4"—less than 10 per sq. cm.; 3/4" to 1-1/4"—less than 100 per sq. cm.; 1-1/2" to 2" less than 1000 per sq. cm.



with the cathode coupled circuit is given. However, its performance at the lower frequencies is compared with that at the higher frequency range and differences are noted. Temperature characteristics and oscillator output harmonic content measurements for the two series resonant circuits in the 75 to 150 mc frequency range are reported. Extension of the antiresonant circuit design information to 20 mc has been completed for the Colpitts circuit, and work on the electron coupled Colpitts is in progress. The previously developed design information is shown to be useful to 20 mc without any loss of accuracy over that originally specified. *A Study of Crystal Oscillator Circuits*, H. E. Gruen and A. O. Plait, *Armour Research Foundation, Chicago, Ill., Feb.-May 1957, 35 pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 142400 from Library of Congress, Washington 25, D. C.*

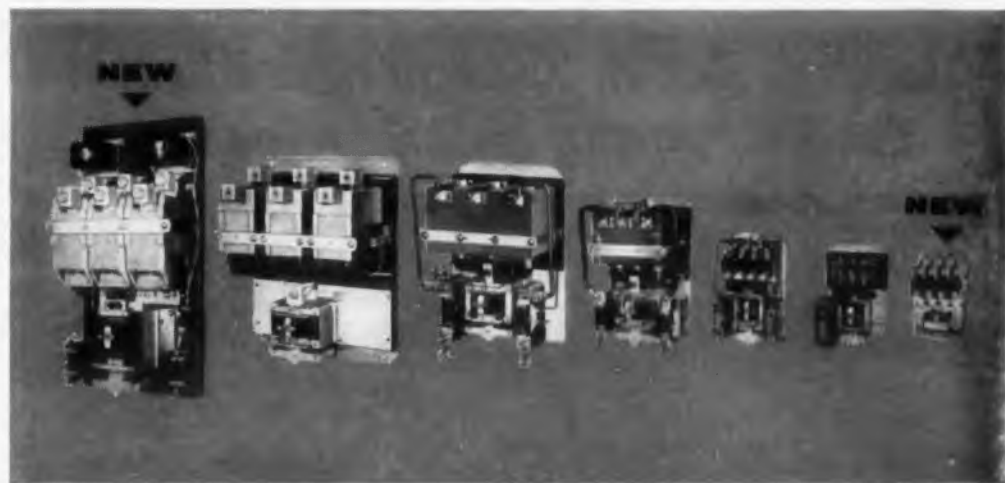
### Traveling Wave Tubes

This report refines the conventional MacLaurin's series representation for audio amplifiers to include the frequency sensitivity of microwave devices and uses the condition of linear combinations of input frequencies to predict the response. An apparatus suitable for measuring the frequencies and relative amplitudes from X-band to uhf frequencies is discussed and the procedure used in measuring intermodulation in the X-259 B traveling wave tube is presented. The indications obtained are that terms of the MacLaurin's series up to and including the 15th term are significant in the region of saturation, which presents the possibility that 240 new frequencies were produced in varying amplitudes. *Intermodulation in Traveling Wave Tubes*, James E. Green, *Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, Mar. 1959, 64 pp, Microfilm \$3.90, Photocopy \$10.80. Order PB 140926 from Library of Congress, Washington 25, D. C.*

### UHF Amplifiers

This report will present the synthesis considerations, design procedures, and constructional features of uhf amplifiers described in Technical Report No. 11, "A 400 Mc I-F Amplifier," June, 1952. The reader is referred to this report, which serves as an introduction to the present report and indicates the results that can be obtained. *The Synthesis and Design of Grounded-Grid Suggested-Triples at UHF*, Donald O. Pederson, *Electronic Research Laboratory, Stanford University, California, Sept. 1952, 60 pp, Microfilm \$3.60, Photocopy \$9.30. Order PB 142433 from Library of Congress, Washington 25, D. C.*

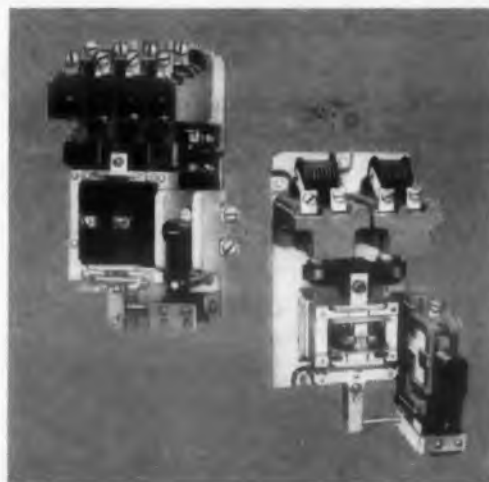
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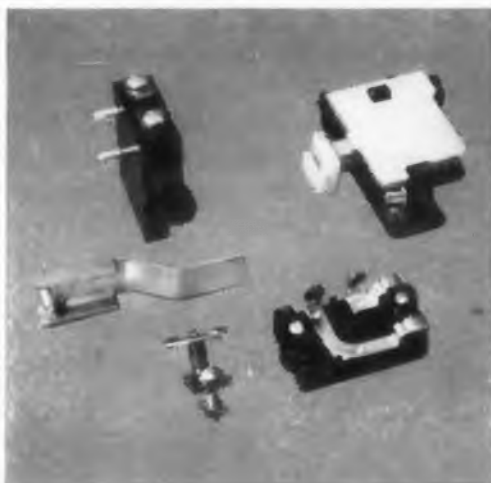
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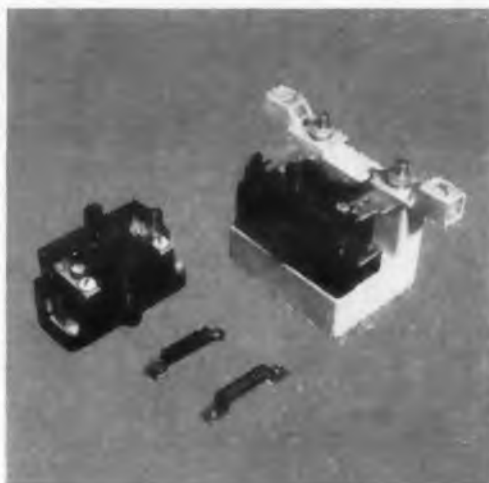
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Construction Styles:	Basic No.	Type Winding	Shape
	101	Inserted Tabs	Flat
	103	Extended Foil	Flat
	106	Inserted Tabs	Round
	107	Extended Foil	Round

**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	IR 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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## REPORT BRIEFS

### Ceramic Capacitors

Techniques have been developed to measure temperature coefficients of capacitors to an increased degree of accuracy. Capacitance increments due to temperature variations can be measured to  $0.0001 \mu\text{f}$  or one per cent, whichever is greater, with the exception of a very small range of capacitors. A test-panel sample holder was developed with a maximum contributing error of  $0.00001 \mu\text{f}$  per deg C change over a  $225 \text{ deg C}$  total temperature variation. A switching mechanism to allow measurement of one hundred samples in a day was devised, utilizing statistical techniques to reduce resettability errors as small as desired. A capacitance sensitive device in the form of a variable oscillator and standard increment capacitors were designed and developed for detecting and recording  $0.0001 \mu\text{f}$  capacitance changes. A discussion of the specifications of temperature coefficients of capacitors and recommendations for their amendment are included. Details concerning the construction of a temperature coefficient test set and measurement techniques are also given. *Design Study Toward Development of A Test Set to Measure Temperature Characteristics of Ceramic Capacitors*, Joseph Seton Smith, New York University, College of Engineering, N.Y., 1951, 87 pp, Microfilm \$4.80, Photocopy \$13.80. Order PB 142176 from Library of Congress, Washington 25, D. C.

### Detection of Signals in Noise

A detection criterion is formulated which leads to the design of detectors on the basis of much less a priori information. These non-parametric detectors are proposed as possible alternatives to the detectors studied in those situations where little a priori information is available. A concept known as asymptotic relative efficiency is employed to compare nonparametric detectors with some of the detectors investigated in the past. Using this criterion the efficiency of nonparametric detectors is found to be quite high. The application of the nonparametric detection criterion to the detection of nonstationary signals in noise is discussed. Nonparametric detectors are shown to possess certain advantages in detecting such signals. *Nonparametric Methods For The Detection of Signals In Noise*, Jack Capon, Columbia University, School of Engineering, New York, Mar. 1959, 234 pp, Microfilm \$10.20, Photocopy \$36.30. Order PB 142327 from Library of Congress, Washington 25, D. C.



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### Design of Radomes

This report considers radome design requirements and construction and the manner in which absorption losses affect radome performance. Equations for lossy radomes are given, and a number of transmission curves are computed for lossy sandwich panels. The report also contains the design procedure for lossy high-incidence radomes, methods for obtaining optimum core thickness for maximum transmission, and a discussion of the effects of dimensional tolerances on transmission. *Electrical Design of Lossy High-Incidence Radomes*, S. Wolin, Aeronautical Electronic and Electrical Laboratory, Naval Air Development Center, Johnville, Pa., Jul. 1950, 139 pp, Microfilm \$6.90, Photocopy \$21.30. Order PB 142015 from Library of Congress, Washington 25, D. C.

### Power Distributed Amplifier

This report presents the results of an investigation by the Electronic Defense Group into means of increasing the frequency capabilities of power distributed amplifiers. The design, physical construction, and electrical characteristics of a 6-tube 4X150A distributed amplifier and a 6-tube 4X250B distributed amplifier are described. These amplifiers demonstrate experimentally the validity of the theory of distributed amplifiers using dummy constant- $k$  line sections between tubes. The amplifiers have upper cut-off frequencies in the neighborhood of 450 mc and useful output power capabilities. The output power capability is, however, a function of the duty cycle at which the amplifier is operated. *The Design and Measured Characteristics of 450 Mc Power Distributed Amplifier*, D. Hamburg, Michigan University Research Institute, Ann Arbor, Mich., Jul. 1957, 31 pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 139442 from Library of Congress, Washington 25, D. C.

### Silicone Insulated Cables

Representative specimens of electric cables utilizing silicone compounds as primary insulation were subjected to laboratory conditions simulating a fairly severe shipboard fire and subsequent extinction with salt water fog. A majority of the specimens sustained their rated operating voltage throughout the period of exposure to fire and subsequent salt water fog. *Effect of Combined Fire and Water on Silicone Insulated Cables*, A. M. Deleeuw, Material Laboratory, New York Naval Shipyard, Brooklyn, N.Y., Feb. 1959, 9 pp, \$0.50. Order PB 151751 from OTS, Washington 25, D. C.

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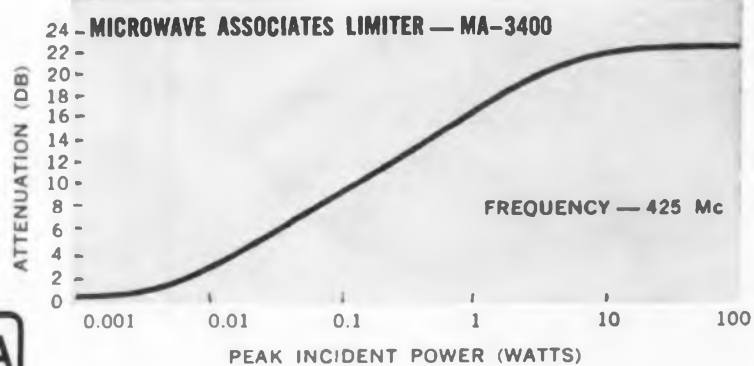
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Low Level Insertion Loss	0.3 db	0.5 db
Peak Power	400 watts	200 watts
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High Level Insertion Loss	20 db	20 db



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ELECTRONIC DESIGN • November 25, 1959



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## LETTERS

### 1000 Times Too Good

Dear Sir:

We would like to bring to your attention a mistake in the article, "Packaged Switching Circuits Designed for On-Site Processing", which appeared in the September 30, 1959, issue of *ELECTRONIC DESIGN*. The first sentence in paragraph three should be corrected to read: "So far, seven logical components have been developed, all operating at 50-kc pulse repetition rates.", not 50-mc.

James A. Cunningham  
Data Processing Systems Division  
U. S. Department of Commerce  
Washington 25, D. C.

### Inside-Out Twin-T Useful Despite Upside-Down Symbol

Dear Sir:

Referring to Mr. Howden's article "Inside-Out Twin-T Varies Rejection Frequency" (*ED*, Oct. 14, 1959, p. 198), may I point out an error, undoubtedly a misprint.

In the third column, at three separate locations,  $\omega_c$  should be  $\omega_{oc}$ . This is required to make the results dimensionally correct.

Thank you for an interesting and useful article. We have already made use of it in our equipment as a feedback network.

Paul I. Wolf, Engineer  
Medico-Technological Research Dept.  
St. Barnabas Hospital  
714 9th Ave., South  
Minneapolis 4, Minn.

### Difference of Opinion on Exclusive "Or" Circuit

Dear Sir:

We agree that Mr. Maki's circuit, published in your "Ideas for Design" in July 22nd issue, performs an Exclusive Or function for two inputs  $(\bar{A} + \bar{B}) \cdot (A + B)$ . However, it does not perform the Exclusive Or function for more than two inputs.

For example, the Exclusive Or function for

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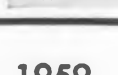
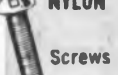
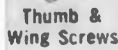
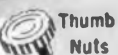
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three inputs takes the form  $(\bar{A} + \bar{B} + C) \cdot (A + \bar{B} + \bar{C}) \cdot (\bar{A} + B + \bar{C}) \cdot (A + B + C)$ . This reads that the Exclusive Or function is true when one (1) or three (3) inputs are present (logical 1's). In general, the Exclusive Or function for  $N$  variables (inputs) is true when an odd number of variables are in the logical "1" state. This property of the  $N$ -input Exclusive Or circuit makes it extremely useful in performing parity checks in digital computers.

N. P. Breault, Assoc. Engineer  
E. F. Morris, Assoc. Engineer  
International Business Machines Corp.  
Poughkeepsie, N. Y.

### Floating Decimal Points Again

Dear Sir:

Although the editing of the article, "Building Block Circuits for Transistorized Digital Computers," *ED*, September 2, was in general very satisfactory, there were two obvious errors:

a) page 20, column 3, par. 5, line 2: "25 v" should have read "2.5 v" and

b) page 21, column 1, par. 1, line 5: "+70" should have read "-70."

You may be interested to know that several engineers have expressed interest in the "Monostable Multivibrator Featuring Quick Recovery."

Frederick C. Hallberg  
John M. Hovey  
Harold H. Levy  
U. S. Naval Research Laboratory  
Washington, D. C.

### Improper Credit Given

Dear Sir:

On page 11 of the October 14, 1959 issue of your excellent magazine there appeared a picture of a plating thickness gage. The caption implies that it was developed at or by the National Bureau of Standards.

Actually this gage was developed at Boeing Airplane Co., Seattle, Wash. To measure rhodium plating thickness (on printed circuits) to a few millionths of an inch, the principle of beta particle backscattering is used, this part of the gage having been developed in the Radioisotopes and Nuclear Instrumentation Group of the Nuclear Physics Unit at Boeing Aero-Space Division. The picture shows Mr. Don Frazer of Boeing Manufacturing Research Group, using the gage.

We were happy to see the gage in print, though, even with the wrong information.

David L. Dye, Ph.D.  
Boeing Airplane Co.  
Seattle 24, Wash.

▶ Our apologies to the Boeing gentlemen.



## Servo-type 6 KVA AUTOMATIC VOLTAGE REGULATOR

- ★ High Accuracy — Holds Line Voltage Constant to  $\pm 0.25\%$
- ★ High Speed of Response — 10 or 20 Volts per Second
- ★ Output Independent of Load
- ★ Output Voltage Variable  $\pm 10\%$
- ★ Handles Line Variations up to either 10% or 20%
- ★ NO Waveform Distortion or Power Factor Restrictions
- ★ No Relays... No Chattering
- ★ Withstands Short-Period Overloads up to 500 Amperes

Type 1570-AL (115 volts, 60c): \$490

Type 1570-AH (230 volts, 60c): \$510

A number of other models are described in the NEW Line Voltage Regulator Bulletin. Write for your copy.

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  - Effects of rare metals in soldering
  - Effective soldering of joints requiring high creep strength
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**A. L. Simberg**, Supervisor  
Personnel Research & Development  
AC Spark Plug Div.  
General Motors Corp.  
Flint, Mich.



# Blocks to Creativity

## II Cultural Barriers

This is the second of three articles on obstacles to creativity. The first article (*ED*, Nov. 11, 1959) discussed perceptual blocks. The third article will consider emotional blocks.

A. L. Simberg, instructor and lecturer in creative thinking, is not averse to taking his own advice. When he entered the field of personnel research, he found a paucity of standard tests to spot creative talent. Whereupon he undertook to create his own. He became co-author of the "AC Test of Creative Ability," a paper-and-pencil examination of idea fluency and flexibility.

The 36-year-old specialist, who holds an MA in psychology, has lectured on creativity before the Industrial Education Institute, American Management Assoc., Society of Automotive Engineers, and at several colleges and other professional societies.

**S**OCIETY lays down rules of behavior, thought and action. If the individual does not obey these, he is considered a nonconformist. But conformity and creativity do not go hand in hand.

Conformity requires that the young engineer act in a certain way merely because it is customary. Creativity requires that the present way be challenged, investigated and, if necessary, changed.

Cultural blocks to creativity are among the most difficult to eliminate. We have a whole force of blocks to contend with, resulting from years of training in the home and in school. Add to this the difficulty of a new, young engineer in a company challenging the parties in power, perhaps getting off to a wrong start, and it is obvious why engineering changes are not easily brought about.

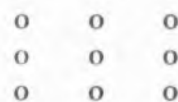
It requires a certain courage to create, an attitude that enables the engineer to strike off in new directions. Let us investigate more closely some of the blocks we term cultural.

■ *The desire to conform to an adopted pattern.*

Most people do not like to be different; it is not a very comfortable feeling. However, many of our routine actions are really not necessary for conformity. They are the patterns of behavior that, for one reason or another, we have developed ourselves. These patterns can be eliminated only by our own effort. The human mind is fascinating in that it is able to develop patterns where none existed. The mind seems able to "correct" our perceptions, to organize them into the meaningful objects we know.

For example, try the problem of the nine dots below (solution at end of article). The task is to join these nine dots by four straight, continuous

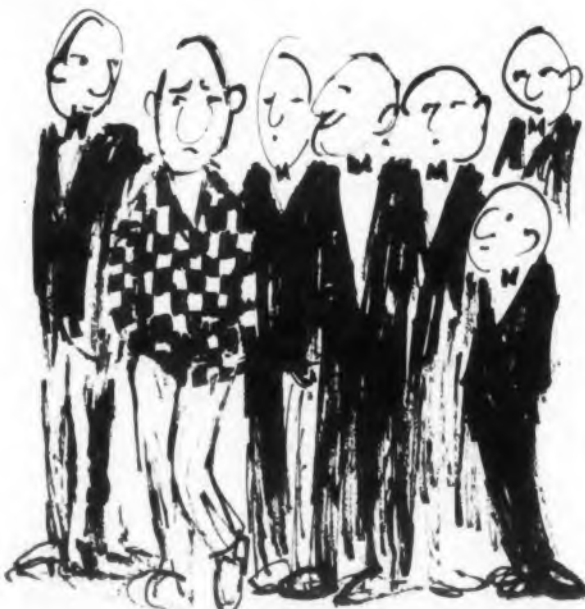
lines (do not raise pencil from paper).



■ *We must be practical and economical above all; so often judgment comes into play too quickly.*

Our lives are composed of a series of paradoxes. On the one hand, we are taught to be practical, thrifty, etc., while on the other our teachers are the first to admit that "it takes money to make money."

Our chief engineer gives us the assignment of developing a new product. He tells us that he wants something that is really "practical" but yet it must be startlingly different. Unfortunately what often happens is that at the sound of the word "practical," our imaginations cease to function.



Would it not be just as simple to start with the "startlingly different" idea and engineer this back to practicality? Learn to try to shoot for the single great idea at the outset. Take your chance on the "one in a million shot." You can always come back to reality by stages, either because of cost, processing problems, etc.

Our minds seem to function either imaginatively (creatively) or judiciously (using judgment). When we are using judgment—deciding, placing values upon something, etc.—we cannot also be creative.

Lest it be thought that judgment is of no value, let me hasten to add that it is of the utmost importance. But it has its place, and this, is after, not during the time when we are trying to find ideas!

■ *It is considered impolite to be too inquisitive and unwise to doubt.*

People who are inquisitive are often considered "nosy." In business language they are often told

It is considered impolite to be too inquisitive.



Most people do not like to be different.

# VERY SCALE



**OPENINGS NOW  
ON PROGRAM 412L**  
(Air Weapons Control System)

The Heavy Military Electronics Department of G.E. has been awarded responsibilities for Systems Management, Systems Integration and Systems Engineering of AWCS 412L—a Universal Electronic Control System to meet the vast problem of Air Defense outside the continental United States.

Designed for both fixed and mobile applications, 412L will be an ultra flexible system. It can be used to defend a single airfield or—by linking control sites together—provide air control for an area the size of Alaska. By integrating capabilities of several countries, it can operate as the air defense system for an entire continent.

In addition to its prime function of Systems Management, HMED will design, develop and produce the Data Processing and Display Subsystem, which is the heart of 412L.

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Programs in:**

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Now HMED offers able engineers an opportunity to get full exposure to this field of the future—to learn, grow and develop their capacities for systems thinking, by working with men who have been in-at-the-beginning of major systems design and integration programs.\*

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At HMED you are joining an organization providing professional people with an outstanding combination of CAREER STABILITY plus INDIVIDUAL PROGRESS. In the last few years this G. E. department has *doubled* its dollar business volume; *tripled* its engineering laboratory and office space; *quadrupled* the number of its supervisors and managers, from 26 to 101, with 90% promoted from within; *quintupled* its professional engineering staff.

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- COMMUNICATIONS ENGINEERS**—To work with Propagation consultant in frequency choice versus sight configuration, and design of optimum communication and sight configuration. (BS in EE and 3 years' experience necessary)
- RADAR SYSTEMS ENGINEERS**—To integrate varied data acquisition equipment into complex electronic control systems. (Advanced EE degree preferred with minimum 3 years' experience)
- TELECOMMUNICATIONS ENGINEERS**—To design and develop advanced communications subsystems of ground electronic control system complex. (EE degree and 5 years' experience)
- PROPAGATION CONSULTANTS**—To assist in the design, development and management of radar and communications subsystems as applicable to an air defense system. (Advanced degree in EE or Physics with 5 years' experience)
- RADAR RECEIVER & VIDEO PROCESSING ENGINEERS**—To establish receiver design criteria for optimum system performance in varied environments, particularly ECM. (Advanced EE degree or equivalent and minimum 5 years' experience)
- ECM SPECIALISTS**—To provide threat models and consultation to design and management engineers. (Advanced degree in EE and 3-5 years' experience)
- ANTENNA AND MICROWAVE ENGINEERS**—To establish antenna design and sighting philosophies for optimized detection system performance. (Advanced EE degree and 5 years' experience)
- RADAR DESIGN ENGINEERS**—To work on advanced designs and development of receivers utilizing parametric amplifiers. (BSEE and 2-4 years' experience)
- PERSONNEL SELECTION AND TRAINING SPECIALISTS**—To prepare job evaluations, manning structures for complex military systems, and forecast training aid needs. (PhD or EdD required)
- EQUIPMENT EVALUATION SPECIALISTS**—To solve man-machine problems, evaluate alternative components, displays, or techniques and devise simulators. (PhD in Experimental Psychology)
- CABLING ENGINEERS**—To resolve varied problems in grounding and associated shielding problems of complex electronics equipments. (EE degree with minimum 2 years' experience)
- LOGIC DESIGNERS**—To organize and perform logic designs of a high speed digital computer. (Degree in EE, Math or Physics with minimum 4 years' experience)
- CIRCUIT DESIGN ENGINEERS (DISPLAY)**—To analyze equipment and circuit design requirements in data utilization and display subsystems. (Electrical Engineering degree with minimum 5 years' experience required)
- SYSTEMS ANALYSTS**—To conduct system analysis programs and feasibility studies which lead to the conception and development of new systems, subsystems, and equipments of advanced design and function. (Advanced degree in EE, Math or Physics preferred with 3 years' previous experience)
- TECHNICAL WRITERS**—To organize, write and publish progress and planning reports. (Engineering degree preferred with previous technical writing and editing experience in advanced electronics)

Dear Mr. Callender: Please send me an application form and additional information on the positions I have checked off above.

I am a graduate engineer with \_\_\_\_\_ degree (s) and \_\_\_\_\_ years experience.

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ ZONE \_\_\_\_\_

STATE \_\_\_\_\_

Mr. George B. Callender, Div. 76-SMU  
HEAVY MILITARY ELECTRONICS DEPT.

**GENERAL  ELECTRIC**

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# SEMICONDUCTOR SCIENTISTS!



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Raytheon has more than 100 openings in every phase of semiconductor design, development and production. And every one of these jobs will pay more than a quarter of a million dollars during the next two decades. Whether you have a smattering of knowledge about semiconductors or are steeped in semiconductor facts, there's a good job for you at Raytheon. Now is the perfect time to find the right spot with the best future for you. Airmail your resume to:

Joseph McGovern

Semiconductor Division, Raytheon Co.,  
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### Opportunities like these:

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A broad background in physics and chemistry, semiconductor experience plus the ability to derive knowledge from all scientific fields, will help this development engineer advance his career. Problems include work in solid state circuits, high frequency and high power devices, semiconductor surfaces, electrode processes and solid state diffusion.

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To work on the design and development of automatic test equipment of transistors and diodes. Draw electronic schematics and do design work. An excellent position for an engineer with a BS in EE who has the potential to eventually assume full design engineering duties on automatic test equipment. Good starting salary, full benefits.

#### Process Engineer

Develop and specify production processes. Analyze and rectify manufacturing problems. Improve processes with respect to quality, yield and cost reduction. Act as consultant on production and quality control. BS with basic coverage in chemistry, physics and mathematics. Full benefits, good salary.

#### Product Engineer

Design, development, pilot production and evaluation of advanced semiconductor devices and circuit-paks for market samples. BS in physics, metallurgy, chemistry or electrical engineering. Minimum of one to three years' experience in semiconductor product development engineering or directly related industrial experience.



If you know SEMICONDUCTORS

You ought to know RAYTHEON

CIRCLE 901 ON CAREER INQUIRY FORM

### cultural delegation

that the matter is "out of the realm of your immediate responsibility."

The engineer who accepts this code literally, who fails to question methods, processes, materials and personnel, will remain noncreative. Usually if a person is properly approached, he is happy to answer any questions. Not many managements expect complete obedience to the established procedures merely because they are "policy."

Harlow Curtice, former president of General Motors, wrote last year:

"Men of science and engineering . . . possess what I have called the inquiring mind. This type of mind is never satisfied with things as they are. It is always seeking ways to make things better and do things better. It assumes that everything and anything can be improved."

To worry about the cultural taboo on asking questions is to deprive yourself of needed information. It could mean the difference between solving a problem and not solving it.

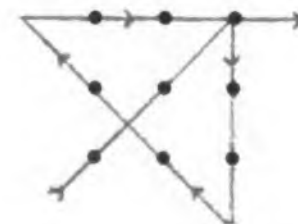
■ **Over-emphasis on competition or on co-operation.**

One other seeming paradox in our society is that of competition or co-operation. We usually think of these as opposites, while in reality they may be considered in another way. An over-emphasis on co-operation may very well mean that the engineer must temper his creative ideas to fit in with the current thinking of the organization for which he works. This situation may be true in some companies. However, in many others there is no such barrier, except that within the engineer himself.

Competition in itself implies that one is working against someone else. An over-emphasis on competing will lead the engineer to lose sight of his primary goal, that of solving the problem at hand rather than trying to "beat someone else to it."

Emphasis on competition or cooperation tends on the whole to make technical people rely less on their initiative, resources and creativity. They feel they are either in a race against someone else or must co-operate to keep their jobs. Either attitude, on an all-or-nothing basis, leads to stagnation of ideas. ■ ■

Solution to problem:



After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

24

(Please print with a soft pencil or type.)

Name \_\_\_\_\_ Telephone \_\_\_\_\_

Home Address \_\_\_\_\_ City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

Date of Birth \_\_\_\_\_ Place of Birth \_\_\_\_\_ Citizenship \_\_\_\_\_

Position Desired \_\_\_\_\_

*Educational History*

College	Dates	Degree	Major	Honors

Recent Special Training \_\_\_\_\_

*Employment History*

Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience \_\_\_\_\_

Professional Societies \_\_\_\_\_

Published Articles \_\_\_\_\_

Minimum Salary Requirements (Optional) \_\_\_\_\_

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924  
 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

## Advancement Your Goal?

## Use New Form To Speed Action

ELECTRONIC DESIGN's new Career Inquiry Service form is designed to help engineers advertise themselves. This new service speeds applicants to the jobs they seek. It is the first such service offered in the electronics field and is receiving high praise from personnel managers.

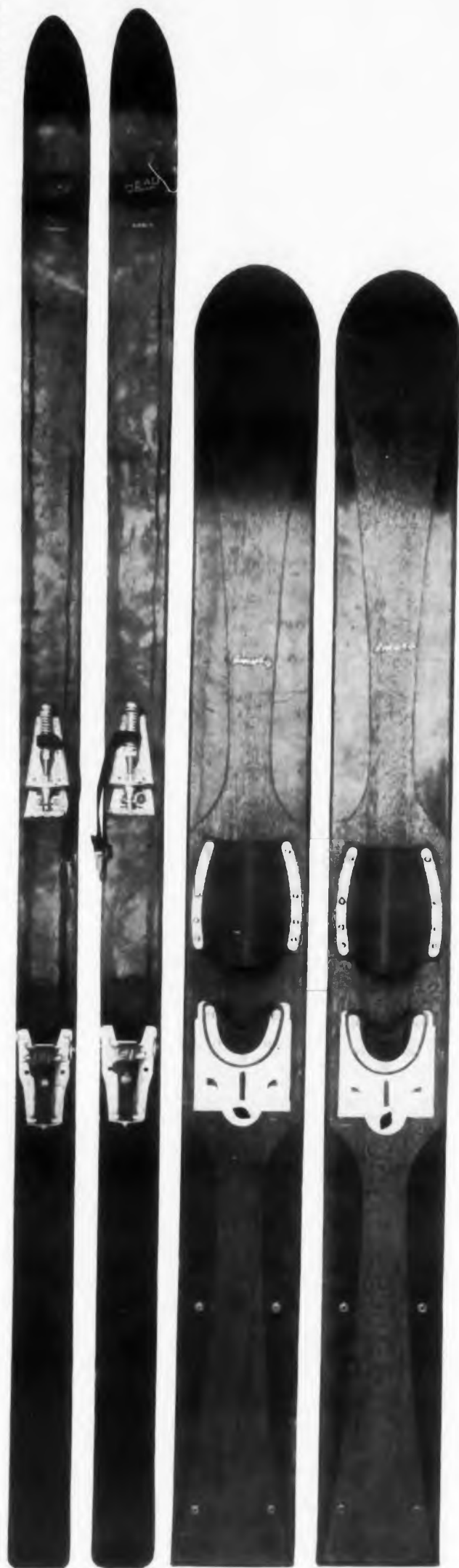
To present your qualifications immediately to the personnel managers of companies that interest you, simply fill in the attached standardized short resume.

Study the employment opportunity ads in this section, and circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN's Reader Service Department will act as your private secretary and type neat, duplicate copies of your standardized resume and send them to all companies you may select . . . the same day the resume is received. (ELECTRONIC DESIGN will detach the circle number portion of the form so that no company will know how many numbers you circled.)

The standardized resume will permit personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you directly. In the past much time has been lost through personnel-manager requests for resumes from applicants who proved ineligible.

MAIL CAREER INQUIRY SERVICE FORM TO READER SERVICE, ELECTRONIC DESIGN, 830 THIRD AVE., NEW YORK 22, N. Y.



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Located in Binghamton, in the heart of Upstate New York's all-season vacationland, Link's activities are steadily expanding. New positions exist for men with productive experience in several fields:

- *Advanced circuit development*
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Link Aviation, Inc., is engaged in projects whose scope far exceeds its long-standing reputation for flight-simulation equipment. Engineers are stimulated by this diversity. And they like the recognition given them, in such forms as excellent salaries, exceptional insurance and retirement plans, and tuition-free advanced university courses.

If you want to progress in this direction contact us at once.

Write to: Mr. A. M. Darrah  
Link Aviation, Inc.  
Binghamton, New York



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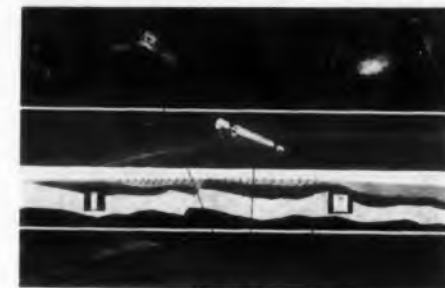
A subsidiary of General Precision Equipment Corporation

CIRCLE 902 ON CAREER INQUIRY FORM



## CAREER OPPORTUNITIES BROCHURES

### Space Electronics Corporation



Space Electronics Corporation has presented in this eight-page illustrated brochure its past and present achievements and future aims in conducting advanced and practical research and development on electronic problems associated with missile and space technology. The company's scope of activities includes: systems analysis, instrumentation, communications, computing equipment, ground checkout equipment and guidance components. An 8-page tip-in is devoted to the experiences and capabilities of SEC's management and staff. An organization chart and a graph depicting staff and business growth are given.

Space Electronics Corp., Dept ED, 930 Air Way, Glendale 1, Calif.

CIRCLE 870 ON READER-SERVICE CARD

### Westinghouse

#### CAREER OPPORTUNITIES WITH WESTINGHOUSE



SEMICONDUCTORS  
YOUNGWOOD, PENNA.

The activity at Westinghouse in Youngwood, Pa., is devoted exclusively to the design, development and production of semiconductor devices. The Advanced Development Section is charged with the development of materials and devices up to the pilot plant stage. The company's 6-page brochure and pitch letter describe briefly the section's prime interests and aims. Facilities, on-the-job photos, and living conditions within the Youngwood, Pa., community are illustrated and outlined.

R. G. Snyder, Industrial Relations, Semiconductor Dept., Westinghouse Electric Corp., Dept. ED, Youngwood, Pa.

CIRCLE 871 ON READER-SERVICE CARD



## YOUR CAREER

### NEWS AND NOTES

*Engineers and scientists* may not always agree on what makes them happy on the job. But the majority of 622 interviewed recently had little hesitation about disclosing what made them unhappy: it was company management.

Seventy-two per cent of those responding to the survey accused management of misusing their talents; 80 per cent complained they were underpaid compared with other groups; 75 per cent felt hemmed in by corporate pressures and unable to work in the most creative way; 67 per cent believed that "pull," not necessarily knowledge, was the key to success in management.

The survey, conducted by Opinion Research Corp. of Princeton, N.J., covered six big corporations in electrical equipment and electronics, aviation, chemicals, drugs, petroleum and rubber. The opinions of 105 managers at the corporations were also recorded.

Half of the professionals who were surveyed held advanced degrees, a third had doctorates and many were lauded by their managers as "presently or potentially most valuable" to their corporations.

"*Management's push for profits* sharply conflicts with the scientists' and engineers' quest for perfection," Opinion Research concluded in a report on the survey. "Companies have put forth increasing money and effort to motivate and satisfy their technical people without much evident success."

The research organization noted this split in motivation between management and science-engineering personnel: managers obtain satisfaction from being identified with a successful company, but scientists and engineers want recognition based on individual contributions. Managers who were interviewed agreed that the scientific intellect required a different type of recognition from management's, but the survey found that "little has been done to fill this need."

Typical of differences between the two groups were these examples uncovered by the survey:

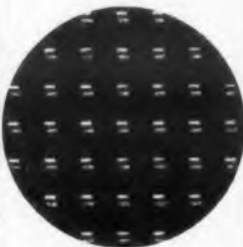
Engineers said: Budgets, production timetables, demands for immediate results are stifling scientific goals.

A manager replied: Research freedom like this "is actually a form of laziness; the place for such freedom is in academic institutions, not competitive industry."

A scientist: "The company only pays lip service to the idea and policy that a scientist can advance in stature, pay, recognition and prestige without getting into administrative work. Without

(continued on page 182)

CAREER  
OPPORTUNITIES  
AT TI



## DEVICE DEVELOPMENT ENGINEER



26,000 TI transistors will be produced from the thin slices of germanium crystal seen in the container above being inserted into a diffusion furnace. In circle at left, precisely separated on single slice (magnified 10 times) are 37 of more than 1,000 transistor hearts per slice.

### your future: a challenging opportunity with an industry leader

Now take advantage of maximum professional growth at Texas Instruments by participating in development of the most advanced semiconductor-component devices. Working with the newest facilities, take part in:

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- **SURFACE STUDIES** Surface reactions and surface energy phenomena on silicon and germanium.
- **ADVANCED COMPONENT DESIGN** Development of new components by studies of deposition of thin films, electrolytic studies such as anodic oxidation rates and film structures.
- **NUCLEAR RADIATION** experiments on semiconductor materials and devices.

With TI... receive liberal company-paid benefits, including profit sharing (last year 15% of base salary) ... enjoy premium living in a moderate climate with excellent neighborhoods, schools and shopping facilities ... work in a plant selected as one of the 10 outstanding U. S. industrial buildings of 1958.

Interviews will be held in your area soon. If you have an *Electrical Engineering* degree and/or knowledge of transistor circuitry, please send a resume to

C. A. Besio, Dept. 200-ED

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CIRCLE 903 ON CAREER INQUIRY FORM



## Catalog Information

### ... Right at Your Finger Tips

Here is a valuable new information service to augment your data files. Manufacturer's catalogs are now being accepted for binding, directly in *Electronic Design*. The catalogs may be easily removed, or if you wish, filed with the magazine (all catalogs will be listed in the semi-annual index of articles).

This unique service is one more step in providing our readers with the latest, complete, product information obtainable in a single reference source. Up-to-the-minute product data can break design bottlenecks, create additional time for more important work, speed the completion of your project.

If there is a particular type of product for which you would like to have information on a regular basis, let us know about it, we will relay your requests to the appropriate manufacturer.

### How to Request Additional Catalogs

If you need extra catalogs for other engineering groups or for central files, use the appropriate Reader-Service number to request additional copies.



CIRCLE 800 ON READER-SERVICE CARD

## CAREER NEWS

(continued from page 181)

getting out of actual research, there appears to be nowhere to go after about 10 years of service."

Most managers: Knowledge and not "politics" determines who will get ahead.

*There was general agreement*, however, on the contribution of science and technology to this country's high standard of living. Thirty-two per cent of the engineers and scientists said they were "mainly responsible" for the rising standard, and 79 per cent of the managers agreed.

But most engineers and scientists appeared to doubt that the public was aware of their key roles in national progress. Asked to name those "well thought of" in the community, 56 per cent of the engineers and scientists listed management; only 9 per cent cited themselves.

Opinion Research recommended that companies explore ways to mold managerial policies without losing sight of the special needs of scientific and technical personnel. It urged that a dose of realism be injected into the college training and job recruitment of engineers and scientists to offset any disillusionment on entering the world of business.

"It's time to call a halt to over-promising, to building unrealistic hopes for a life very much like an extension of graduate school," the research organization said.

• • •

Seven new employment offices for engineers and technical personnel have been opened in strategic parts of the United States by AC Spark Plug, the electronics division of General Motors.

The offices—at New York City, Dayton, Boston, Detroit, Washington, Dallas and Los Angeles—will seek top-flight personnel for AC Spark Plug operations in Milwaukee, Boston and Los Angeles. The company is developing inertial guidance for the Titan ICBM and holds other advanced research contracts. It also produces inertial guidance for Thor and Mace missiles.

Directors of the new job recruiting program and addresses of the area employment offices are as follows:

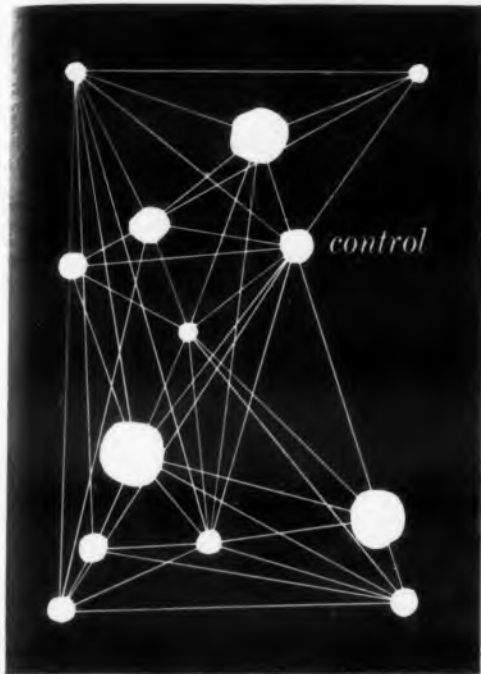
New York City—Richard Klann; Franklin National Bank Building, 600 Old Country Rd., Garden City, L.I., N.Y. (PI 1-8955).

Dayton—William B. Clark; Talbott Tower, Suite 1005, 118 W. First St., Dayton, Ohio (BA 8-9522).

Boston—Thomas S. Crutcher; 59 Park, Beverly, Mass. (WA 7-1474).

Detroit—John P. Donovan Jr.; Room 204, Tech Center Service Section, Box 56, North End Station, Detroit (JE 9-5000).

(continued on page 184)



## careers in control of space

For 74 years, Minneapolis Honeywell has pioneered and led the development and production of advanced automatic controls. Today, with work in this area more demanding and more rewarding, new opportunities exist for engineers.

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AERONAUTICAL DIVISION

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To explore professional opportunities in other Honeywell operations coast to coast, send your application in confidence to H. D. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

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## CAREER NEWS

*(Continued from page 182)*

Washington—Earl W. Sherburne; 1625 First St. N.W., Washington, D.C. (EX 3-1133).

Dallas—Gerald Raasch; Rice Building, 5641 Yale Blvd., Dallas, Tex. (EM 1-5813).

Los Angeles—James Kronner; 950 N. Sepulveda, El Segundo, Calif. (EA 2-5750).

*Engineers are often thought of as more interested in "things" than people. The General Electric Engineers Assoc. of Syracuse, N.Y., aims to counteract that belief. One of its goals for the coming year is to heighten the work of its Civic Activities Committee.*

Under the chairmanship of Richard Charles, the committee sees its job as a dual one: to serve the community and to educate it to the role of engineers as professionals.

"We want the community to know us not as transient technical people interested only in ourselves, but rather as permanent residents gifted with an ability to analyze community operations, appreciate community problems and actively participate in helping to solve them," Mr. Charles was quoted in the association's publication, *The Engineer*.

Among activities that the committee is undertaking is repair work for a Talking Book Project for the blind, installation of a public address system at a meeting place used by the blind, help in maintaining portable polio respirators in the Syracuse area and a role in metropolitan development.

### ENGINEER-IMPROVEMENT COURSES AND SEMINARS

*Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographic areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.*

#### National Courses

**UCLA Engineering and Management Course,  
January 25-February 4**

A course for the professional development of managers and designers, will be held at the University of California, Los Angeles. The 10-day program will offer a choice of 22 subjects to fit the

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Now under development at IBM are new and unusual electronic computing systems that will greatly strengthen man's control of his environment. In one project, for example, advances in acoustics, oceanography, and information theory are being coordinated to yield a data system that will sentinel the ocean's depths. Another group is applying a computer's logic and computational capabilities to analyze, correlate, and identify input signals to data acquisition systems. In the late development stage is an extremely high-speed, large-capacity computing system which will automatically handle the large volume of detailed records and communications required by a nationwide sales operation. To staff such efforts, scientists, mathematicians, and engineers of vision are needed.

IBM's rapid expansion provides many opportunities for you to advance—either through technical achievement or engineering administration. You may work independently or with a small team, and you can choose your assignments from a broad range of research and development areas. Specialists of many different backgrounds are available to assist you in your work. This is an excellent opportunity for a scientific or engineering career that combines maximum growth potential with job stability.

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& statistics  
Applied physics  
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Component engineering  
Computer analysis  
Cryogenics  
Flight test analysis  
Human factors  
Inertial guidance  
Information retrieval  
Logical design  
Magnetics  
Microwaves  
Operations research  
Programming  
Radar circuitry  
Transistor circuit design

**QUALIFICATIONS:** B.S. or advanced degree in Electrical or Mechanical Engineering, Physics or Mathematics—and proven ability to assume a high degree of technical responsibility in your assignments.

#### TYPICAL ASSIGNMENTS

Planning and logical design of solid state computers, input-output systems, and peripheral equipment. Knowledge of digital systems required with experience in transistor circuitry and switching techniques.

Analysis of ferrite "memory" and buffer systems and design of new high-speed configurations, including drive and addressing circuitry, for advanced solid state data processing systems. Familiarity with digital computer systems and magnetic core "memory" design.

Solutions of real-time control problems with digital techniques; mathematical analysis of navigation and fire control systems, ray tracings, and signal cross-correlations.

Application of information theory to signal processing. Familiarity with signal cross-correlation techniques, statistical data processing, sampled-data control theory, analog-digital data processing techniques, signal propagation, and beam formation. Naval experience required in at least one of these specialties: sonar, fire control, ASW, navigational systems, signal processing.

Investigation of new computer applications and techniques, based on observation and analysis of customer needs; establishment of broad systems concepts, assisting in both logic and machine design. Experience required in digital computer applications, technical organization of a medium or large machine installation.

Circuit design of advanced data processing systems and input-output equipment, working closely with logic designers. Experience required in design of arithmetical control and switching circuitry to reduce logic diagrams to component counts for cost-estimating development.

Application of transistor-diode logic to develop advanced circuitry; review of new circuits for possible use in digital control systems, defining basic techniques for improving performance characteristics.

Laboratory facilities are located in Endicott, Poughkeepsie, Kingston, Owego, and Yorktown Heights, N. Y.; Lexington, Ky.; and San Jose, California.

For details, write, outlining background and interests, to:

Mr. R. E. Rodgers, Dept. 555K4  
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New York 22, N. Y.

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He's a top liaison man too, able to work smoothly with management, project engineers, test engineers, and others to insure that specifications are current and accurately reflect contractual requirements. And he's constantly negotiating specifications with customers and subcontractors. He knows how to *lead* too, supervising engineers working on lower level specifications.

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Mr. Walter N. Wells, Professional Personnel,  
Missile Systems Division, Raytheon Company,  
520 Winter Street, Waltham 54, Massachusetts.

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Foremost is opportunity. For here a man is encouraged to use all of his creative talents to their fullest. He works on projects that spark vision, that inspire imagination. He works with men who recognize and respect his abilities . . . a calibre of men that he cannot help but admire.

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- Selective signaling
- Transistor applications
- Crystal engineering
- Sales engineering
- Design of VHF & UHF FM communications in portable or subminiature development
- Microwave field engineers
- Transistor switching circuit design
- Logic circuit design
- T.V. circuit design engineering
- Home radio design
- New product design
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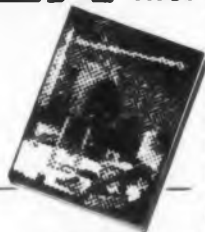
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## CAREER COURSES

needs of both executives of large industries or of middle-level personnel from small companies. Emphasis will be on the principles and techniques which form a systematic approach to management, and on the quantitative methods which supply the facts for such an approach. Information on registration and living accommodations may be obtained from Reno R. Cole, College of Engineering, University of California, Los Angeles 24, Calif.

### Training Course In Value Engineering and Analysis, IEI, November 30

This five-day course, which will be held in Boston, starting Nov. 30, has been developed by the Industrial Education Institute, in cooperation with the Materials Handling Institute. The program, covering all phases of the subject, has been designed especially for men responsible for product design, procurement and manufacturing in industry and government.

Value Engineering and Analysis is a technique developed for reducing product cost. It is concentrated effort to improve the value of any product by eliminating unnecessary costs in product design, manufacture and procurement.

The five-day training will combine formal instruction, guest lectures, informal discussion, demonstration, case study and problem solving. Through specially developed work projects, the participants will learn "by doing" by value analyzing a wide variety of products. Through the free exchange of information with men with similar responsibilities and problems, the registrants will pick up new functional design and procurement techniques they can apply to their own products.

The members of the "faculty have been drawn from industry, government and education. They include L. S. Miles, Manager of Value Services, General Electric Co.; Rear Admiral A. G. Mumma (USN Ret.), Vice President, Engineering, Worthington Corp.; Rear Admiral R. S. Mandelkorn, (USN Ret.), Chairman of Value Engineering Committee, Electronic Industries Association; Vincent de P. Goubeau, Vice President, Materials, Radio Corp. of America; Frederick S. Sherwin, Manager, Value Analysis Service, Raytheon Co.; Don Otis, Controller, Electric Typewriter Div., IBM Corp.; Bernard W. Eades, Manager, Value Engineering, Stromberg-Carlson Co., and President of the Society of American Value Engineers; Raymond J. Spenard, Value Analysis Education, U. S. Army Ordnance; Morgan D. Roderick, Office of Value Engineering, Bureau of Ships, U. S. Navy; Louis J. De Rose, Executive Director, Materials Management Institute, and others. Further details and



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registration information may be obtained from the Registrar, Industrial Education Institute, 25 Huntington Ave., Boston 16, Mass.

## One-Day Seminars

### Plastics Engineers One-Day Seminar, Washington, D.C.

The Baltimore-Washington Section of the Society of Plastics Engineers, Inc., in conjunction with the Prevention of Deterioration Center of the National Academy of Sciences, has scheduled a Regional Technical Conference entitled "Stability of Plastics." Dr. Herman Mark, Director, Polymer Research Institute, Polytechnic Institute of Brooklyn, will preside as moderator of the program.

The objective of the conference is to present a program covering current concepts of mechanisms governing natural and synthetic polymer stability and degradation. Degradation under the conditions of mechanical processing, ultraviolet or other radiational exposure, elevated temperatures, and enzymatic attack will be among the topics covered by well-known contributors to these fields. While papers will report results of original investigations, each author will present a brief survey of the current theories of the mechanism of polymer degradation under the influences of the various factors enumerated above. The conference will be held December 1, in the auditorium of the National Academy of Sciences Building, 2101 Constitution Ave., Washington, D.C.

## PAPER DEADLINES

Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

**December 15:** Deadline for abstracts of 150-200 words for the 1960 Electronic Components Conference scheduled for May 10-12 in Washington, D. C. Please send in triplicate to: *Gilbert B. Devey, Technical Program Chairman, Sprague Electric Co., North Adams, Mass.*

**January 15:** Deadline for 100 word abstracts in triplicate and 500 word summaries in triplicate for the 1960 IRE Professional Group On Microwave Theory And Techniques to be held May 9-11 at the Hotel del Coronado in Coronado, Calif. Papers to be presented should deal with microwave components, systems and physics. Send all material to: *Dr. David B. Medved, Chairman, Technical Program Committee, 1960 Dynamics Corp., Mail Zone 6-172, P. O. Box 1950, PGMTT Symposium, Convair, A Div. of General San Diego, Calif.*



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