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SIDELIGHTS OF THIS ISSUE

News that the American Institute of Electrical Engineers and Institute of Radio Engineers contemplate a merger (see p 7) was welcome, if not exactly surprising.

The gradual marriage of interest between the two societies was evident at the fall general meeting of the AIEE in Detroit. More than half of the technical papers delivered were strictly electronic. Several sessions, including one on adaptive communications (see p 8), were concerned with the frontiers of the electronic art. One complete symposium — the Electronic Designer's — was on switching circuit theory and logical design — drew a distinguished audience of computer designers, who appeared to be only remotely connected with other activities at the meeting.

The coming merger talks found favor at the AIEE meeting. Heard at the convention were such remarks as: "If the merger goes through, technical developments will probably be a lot easier to keep up with."

Among the many decisions facing the committee planning the consolidation is that of a name for the combined group. We are confident the more than 150,000 members of the new society will not have to refer to their organization as the AIEEE.
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Details of the 120B's electrical capabilities are given in the specs below. You may particularly wish to note such features as direct reading calibration, "times-5" sweep expander, linear integrator for accurate sweeps and built-in amplifier calibrator. Also the slow sweep speeds for mechanical or medical work, and fast sweeps for transient measurements.

Many engineers who have tested the new 120B feel it is perhaps the easiest-to-use, most widely versatile, and highest value commercial 450 KC scope ever offered. Why not confirm their opinions with a test on your own bench.

Further, the 120B has automatic triggering which ends trigger adjustment and insures a bright, clear baseline even without a sync signal. For manual level adjustment 10 to -10 volts, a panel control overrides the automatic trigger.

The 120B is also a boon physically. The front panel reads easily, and controls are where you expect them—simple, logical. When the trace strays, a push-button finds it instantly. The whole arrangement is such that, in an engineer's hands, the instrument is quick and sure; yet it is readily understood and used by non-technical personnel.

Finally, Model 120B is either a sleek, modern bench instrument or (with a handful of hardware supplied) a precision fit rack mount unit. Access to the inside is instantaneous, and the top cover contains a complete adjustment guide.

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- **Trigger Point:** Zero crossing, negative slope of external sync signals, zero crossing, positive or negative slope of vertical deflection signals. Front panel control locks out automatic and permits trigger point to be set between -1.0 to ±10 v.

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- **Bandwidth:** DC coupled: dc to 450 KC; ac coupled: 2 cps to 450 KC.
- **Sensitivity:** 10 mv/cm to 100 v/cm. 4 calibrated steps with attenuator accuracy of ±3%, 10 mv/cm, 100 mv/cm, 1 v/cm, 10 v/cm. Vernier for continuous adjustment of sensitivity between steps and extends 10 v/cm step to at least 100 v/cm.
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- **Sensitivity:** 0.1 v/cm to 100 v/cm. 3 calibrated steps, accurate within ±5%, 0.1 v/cm, 1 v/cm, 10 v/cm. Vernier for continuous adjustment of sensitivity between steps and extends 10 v/cm step to at least 100 v/cm.
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More Switching, High-Frequency Barriers Fall

Electron Devices Meeting Told of Transistor Advances; Gains in GaAs Solar Cells, Microwave and Data Units Noted

Robert Hovind
Chief News Editor

SOLID-STATE devices for faster switching or higher frequency operation were prominent among developments unveiled at the Electron Devices Meeting in Washington, Oct. 26-28. New advances in microwave, data-handling, and energy-source devices also were introduced to the industry.

Some of the more important developments for the design engineer were:

- Producing planar-silicon transistors, capable of operating to over 2 Gc, and of switching with less than 2-nsec propagation-delay time.
- Mesa-type switching transistors for switching rates up to 100 mc in saturated circuits.
- Gallium arsenide solar cells with efficiencies up to 13 per cent.
- A multiposition core river using electron-beam-switched silicon diodes in place of transistors.
- A new type 1.5-megawatt magnetron said to have four times the frequency stability of present types.
- A microspot cathode-ray tube capable of displaying 92 million picture elements on a 5-in. face.
- Gallium antimonide (GaSb) tunnel diodes with $f_{max}$ up to 10 Gc, said to have half the shot noise constant of equivalent germanium devices.
- Cryosistor—a three-terminal field-effect-controlled fast germanium switch for operation at liquid-helium temperatures.

Lead Areas Larger Than Active Regions In New Gc-Operating Silicon Transistors

Gigacycle silicon transistors, reported by Fairchild Semiconductor Corp., are designed

Verdict on Tunnel Diodes: Useful, But Can't Replace Transistors

Design philosophy held much attention as the new devices unveiled at the Electron Devices Meeting.

A definitive statement on the status of the tunnel diode was presented by E. O. Johnson of RCA Laboratories, Princeton, N. J. "They will never replace transistors," as some believed when they were first developed, Mr. Johnson said. The greatest interest in tunnel diodes at present, he said, is for microwave and special applications.

In microwaves, tunnel diodes offer higher gain at higher frequencies than transistors, with the added factor of low-noise characteristics. Mr. Johnson thinks that when the devices are integrated in distributed-circuit structures, to minimize serious inductance effects, they will reach frequencies of 100 Gc, compared with an expected 10-Gc limit for transistors. Present limits of about 10 mw for the tunnel diode at 2 Gc should be pushed to about 1 w in the gigacycle region, he predicted. Aside from the microwave use, special applications cited for the devices were in pulse discriminators, scalers, pulse calibrators and coincidence detectors. In these applications low-noise and high-speed characteristics offered by tunnel diodes are of particular advantage.

Another important use is in down converters because of the inherent low noise of the devices in this application. Initial work attempted to get optimum values for all parameters at once, but resulted in poor stability. Excellent stability has been achieved, however, by sacrificing gain and operating at unity gain factor while biasing in the positive $R$ region of the $I^2V$ characteristic toward the origin and pumping hard toward the negative $R$ region of the curve.

Tunnel-diode down converters are being used in place of crystal mixers. The mixers gave about 7-db insertion loss and 8-db noise compared to no insertion loss and 1- to 2-db noise with the new tunnel diode devices, Mr. Johnson said.

Interest in tunnel diodes for computer logic is dwindling, Mr. Johnson commented, because of the difficulty in fanning out for more than two or three levels due to the low gain of the devices. Tolerance of all elements in these circuits must be held to 1 or 2 per cent to achieve this. Although the tunnel diode is a simpler device than the transistor, this tolerance is a tough requirement to meet. The relatively low cost of transistors, especially now makes them more attractive for this application. The tunnel diode will be used, however, in small, fast computer memories because of their high-speed capability and low noise, allowing design for low power.

An additional important advantage cited for the tunnel diode in comparison with the transistor was its ability to operate in and to survive high radiation conditions.
Array of gallium-arsenide solar cells converts light energy from lamp to drive small electric motor and wheel.

Comparison of efficiency of gallium arsenide solar cells and silicon units shows advantages claimed for GaAs cells.

so that areas where leads can be attached are larger than the actual active areas. This is said to make production simpler and is expected to result in devices cheaper than many existing types that have poorer characteristics. Measurements at 1 Gc with 625 mw into one of these devices showed 50 mw out, according to Fairchild. The 2-msec time was obtained by dividing total delay time through an 11-stage ring counter by 11, Fairchild reported.

Germanium epitaxial maser-type switches reported by Texas Instruments Inc., are said to have a unity-gain frequency of 1.5 to 4 Gc.

Gallium-arsenide solar cells developed by RCA's Semiconductor Div., are said to have considerably higher radiation tolerance than silicon cells. Efficiency is said to decrease less with temperature for GaAs than for Si types.

On the ground, or high in the sky, Raytheon's line of rugged diode rectifiers gives dependable arc-free operation.

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Metal-Amplifier Paper
Hastily Withdrawn

Disclosure of a complete metal-metal oxide thin-film amplifier was held back at the meeting by the last-minute withdrawal of a paper by L. E. Godzicki, D. F. Foote and I. Weiman of Electro-Optical Systems Inc. because of patent considerations.

Operation of a metal-metal oxide amplifier using a germanium collector—the Metal Interface Amplifier—was previously reported by Philco Corp. (see ED, June 7, p 24; June 21, p 18). An energy-level structure similar to that of the junction between metal oxide and germanium in the MIA is said to be achieved in the Electro-Optical device by substitution of a metal-metal oxide-metal sandwich for the germanium. Thus, a five-layer device with triode-like characteristics was said to have been achieved. Tantalum, niobium and aluminum with oxides, were said to have been used.

This work is being done under an Air Force contract.
Ray Tube Dept. Unusual features include a spiral anode that doubles the effective length of the neck; use of a grainless thin-film phosphor; and a special microgun to generate an electron-focus whose brightness is said to exceed that of the cathode by a factor of 10.

GaSb tunnel diodes described by Micro State Electronics Corp. are said to be available now with \( f_{m} \) up to 4 Gc. Cutoff frequencies of 6 to 10 Gc have been achieved in the laboratory, the company said, and future plans are to make devices for use at up to 30 Gc.

Operation of the Cryosistor is based on impact ionization of impurities in germanium at liquid-helium temperatures. Impact ionization between two contacts on a germanium wafer is controlled by a reverse-bias rectifier junction situated between the two contacts. Short voltage pulses applied to the junction can switch the device in or out of breakdown in a few nanoseconds. Many Cryosistors can be put on a single germanium wafer, according to its developer, Ivars Melngailis of MIT's Lincoln Laboratory. His initial work on the device was done at Carnegie Institute of Technology.

IRE, AIEE Consider Consolidation By '63

Merger talks have been launched by the two largest engineering societies in the world—the American Institute of Electrical Engineers and the Institute of Radio Engineers.

The proposed new organization would involve 150,000 engineers, scientists, educators and industrialists. A resolution approving a merger study by a special committee, was adopted by the IRE board of directors in New York and by the AIEE board in Detroit at the close of the fall general meeting of the AIEE.

The committee, which also was asked to prepare a constitution and bylaws, is to submit a report to the societies by Feb. 15, 1962. If approved, the merger proposal would be put to a vote of the members by Jan. 1, 1963.

The AIEE was organized in 1884 and has about 70,000 members in the United States and Canada. The IRE, organized in 1912, has 91,000 members all over the world. About 6,000 persons belong to both societies.
Canadians Simulate Adaptive Communications System

Test Design, With Variable Data Rate, Demonstrates Ability To Control Symbol Error; Others Pursue Similar Projects

Alan Corneretto
News Editor

An adaptive communication system, designed to transfer digital data at a variable rate, has been simulated with digital modules. The performance of the system correlates with predictions and indicates that an on-the-air system would be able to maintain a constant error rate despite channel fluctuations, according to scientists of the Defense Telecommunications Research Establishment, Ottawa.

In the Canadian system, phase-modulated sequences of binary digits are transmitted with a variable degree of redundancy to a receiver, in which the incoming sequence is compared with a local stored copy of the transmitter sequence. After accuracy of the received message is determined, the data rate is modified by changing, through a feedback channel, the amount of redundancy needed to maintain a desired error rate.

The project is one of many by various organizations to apply the adaptive concept and the developments of feedback theory to communications links. The project was described by Prof. G. S. Glinski of the University of Ottawa at the recent fall general meeting of the AIEE. Adaptive communications studies, he said, fall into two large classes: unidirectional open-loop systems and bidirectional closed-loop systems.

The adaptive-filter systems, under study at General Electric and other organizations, are examples of open-loop systems. So are designs that include matched filters, comb filters, integrators and correlators, Prof. Glinski said.

Closed-Loop Adaptation Due to Feedback Channel

In closed-loop systems adaption is achieved through a feedback channel. This channel is used either to improve error performance at a fixed data rate or to vary data rate in compensation for changing channel conditions. A system called Janet, developed several years ago at the Canadian Telecommunications Research Establishment, is an example of a variable-rate system using predecision feedback, in which the feedback channel is used to supply data on the communications channel.

The new Canadian system and two designs under study at the Radio Corp. of America use postdecision feedback to supply information on the results of individual receiver decisions. The Canadian system and a proposed RCA system, described a year ago at the National Communications Symposium, use the feedback information to modify data rate. The other RCA project, described at the Detroit AIEE meeting, is based on using feedback information to vary transmitted energy as needed.

The transmitter of the variable-rate system discussed at Detroit (by N. G. Davies of the Canadian defense agency), contains a binary-sequence generator that feeds an encoder. Combined message symbols and binary sequences go to a phase-modulated transmitter. The sequence generator, encoder and a timer are standard digital modules.

The generator is designed to produce a continuous stream of binary digits that occur with about equal probability and have a repetition period that is long compared with the period of a message symbol. This causes the bandwidth of the phase-modulated signal to approximate the digit rate of the binary-sequence generator.

High Symbol Rates Mean Few Sequence Digits

When the transmitter is operating at high message-symbol-transmission rates—which in the breadboarded equipment range from 100 to 500 kilobits per sec—a small number of sequence digits is transmitted for each message symbol. At lower rates, the number of sequence digits per symbol increases. The period of the sequence digits, rather than the period of message symbols, determines the

Feedback-type adaptive communication systems fall into two classes—predecision, in which channel data is supplied to the transmitter, and postdecision, in which the results of individual receiver decisions are supplied. Both types are closed-loop, two-directional systems. Open-loop systems use filtering to achieve adaptation.
Receiver of a breadboarded postdecision feedback adaptive communication system, in which the feedback channel carries information that varies the amount of redundancy in the transmitted signal to assure a desired error rate despite changing channel conditions. Incoming digit sequences are compared with stored sequences to determine the accuracy of reception.

transmission bandwidth. Encoding does not change the bandwidth-determining characteristics of the transmitted waveform, Mr. Davies reports.

At the receiver, the signal is detected, fully clipped and applied to a digital comparator, where it is matched digit by digit with a binary sequence generated by a local sequence generator. After the number of digit coincidences in a message symbol are counted, a decision is made on the most probable transmitted symbol.

The incoming signal is spotted by a phase-sensitive detector, whose coherent phase reference is supplied by the signal itself. This is done by squaring the input signal to remove the phase modulation, using narrowband filtering and dividing the frequency by two. The filter is a very narrow-band phase-locked loop able to track changes in frequency caused by Doppler shifts and frequency instability.

The basic parameters of the breadboarded system are a digit period of 10 μsec and a bandwidth of 100 kc. Transmission was over a few inches of wire and the system did not include a channel for feedback control of the data rate. This feature is to be added to the system, as will synchronization noise. The system was tested with noise-free sync for the transmitter and receiver sequences.

Measurements of the probability of error per message symbol over various signal-to-interference ratios show that for each reduction of the symbol rate by a factor of 2, the required signal power is reduced by 2. When the signal-to-noise ratio is high, messages can be transmitted at a high rate; when the ratio falls, the message rate can be reduced correspondingly to maintain a constant probability of error. Though the reduction in message rate causes no corre-
what every engineer knows about constant-current power supplies... How do you check the peak inverse voltage rating of a solid state junction? the breakdown voltage of a reference diode at a specified current? the dynamic impedance of a reference diode? and the many other parameters that are so easily checked with constant-current power supplies?

It's an easy matter to convert some voltage-regulated power supplies to current-regulated operation. At least it's easy with an E/M® Regatron Programmable Power Supply. But for true constant-current performance, there's no substitute for a power supply specifically designed for constant-current operation.

Take Electronic Measurements' Model C638A shown here. It's an easy matter to set the current control to any value desired—from a few microamperes up to 100 mA—manually or programmably. And there's no juggling with makeshift, extra circuitry. Then you can adjust the voltage compliance to any value from 0 to 1500 V. There's no fear that the voltage may be too great or not enough; the voltage control sets the upper limit.

Here are some additional features of the C638A: Output impedance is 10¹ megohms at 0.5 μA to 0.5 megohms at 100 mA. Above 2.2 μA, regulation is better than 0.15%, line or load. Ripple is less than 0.01%±1 μA rms. A modulation input is provided.

But to get back to the point, to check the peak inverse voltage rating of a solid state junction, simply set the output current control of an E/M Constant-Current Power Supply at the specified current. Connect the output to the junction, turn the power supply on, and measure the voltage drop across the junction. What could be easier? And other measurements can be made almost as easily.

For a complete discussion of constant-current power supplies with ratings up to 1A, ask for Specification Sheet 3072B. It lists all the models and specifications, too.

NEWS

Canadians Simulate...

(continued from page 9)

sponding changes in the transmitted signal bandwidth, the period of the receiver counters must be increased.

At lower values of message-symbol rates, an acceptable probability of error can be achieved when the signal power is considerably below the noise power, according to Mr. Davies.

W. L. Hatton, co-author of the paper describing the system, reports that the experimental data link is simple, yet lends itself well to combining with other communications techniques such as novel coding procedures and spread-spectrum methods.

Similarly, the variable-bandwidth system under development at RCA's Applied Research Laboratory, Camden, N. J.—though intended mainly for tropospheric-scatter communications—is said to be practical for other types of systems where received signal statistics vary in Rayleigh fashion.

Usable Current Obtained From Bio-Power Devices

Conversion of "life-energy" into usable electric power has gone far beyond the test-tube stage, according to a company that has had such conversion devices—known as bio-power units—in operation for more than a year.

Military secrecy has prevented the developer, Magna Products, Inc., Santa Fe Springs, Calif., from giving more than a bare outline of the project. But the company, a subsidiary of Thompson Ramo Wooldridge, Inc., hinted that bio-power devices are feasible and even competitive with some conventional systems.

The company has tested three types of bio-power units: a bio-battery, in which millions of bacteria, consuming minerals and organic matter found in sea water, produce an electrical potential; a bio-fuel cell, utilizing organic matter and air; and a bio-solar cell, which uses photosynthetic organisms that convert solar energy directly into electricity.

Magna Products declined to give an efficiency level for the solar cell, but predicted that its rating might eventually outstrip that of any known device.

Bio-power units already are generating...
ALL-NEW MADT TRANSISTORS

Wide Range of Parameters Plus Choice of Package Tailored to Meet Your Actual Circuit Requirements

Sprague now offers a complete new line of ultra-high-speed switching transistors. For greater design flexibility, these Micro-Alloy Diffused-Base Transistors provide interchangeability of packages (identical specifications are available in either the TO-9 or TO-18 case).

Here are some key parameters:

<table>
<thead>
<tr>
<th>Type No.</th>
<th>JEDEC Case</th>
<th>Max Icbo (ma)</th>
<th>Min. BvCEO (volts)</th>
<th>Min. BvCEO (volts)</th>
<th>Min. hfe</th>
<th>Typ. Fr (mc)</th>
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<td>15</td>
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<td>9</td>
<td>15</td>
<td>15</td>
<td>40</td>
<td>450</td>
</tr>
</tbody>
</table>

THIS NEW FAMILY OF SWITCHES OFFERS:
- High BVCEO Ratings
- Excellent Frequency
- Low Saturation Voltage
- Low Storage Time
- Close Parameter Control
- Low Output Capacitance

For application engineering assistance, write Product Marketing Section, Transistor Division, Sprague Electric Co., Concord, N.H.


Bacteria culture in the battery cells produces electricity, as illustrated by Dr. Gilson H. Rohrback, president of Magna Products, Inc., Santa Fe Springs, Calif.

enough power to operate radio beacons, signal lights and other apparatus at sea, Magna Products said.

Dr. Gilson H. Rohrback, president of the company, evolved the basic concepts of the bio-power devices. The company encountered the phenomenon while doing basic research on the causes of corrosion in oil wells and ocean-water pipelines.

Huge Antenna Takes Shape

Radar and radio explorations of the solar system will be made with this 70-ton, 150-ft steel and aluminum parabolic antenna. The dish, covering nearly a half acre, will be linked to a 20-55-mc radio transmitter. The transmitter's 1,000,000-w input will give the dish a 300-400-kw radar probe. The radio telescope was erected on the Stanford University campus.
Electronics to Test Leg-Brace Forces

Strain Gages, Relays Rigged Up by NYU Researchers
In Quest of Better Mechanical Aids for Handicapped

Electronic techniques will play a major role in a research project on braces and artificial legs for the handicapped. The objective of the studies, to be conducted in a special laboratory now being outfitted at the orthotics section of New York University's Research Div., New York, is the analysis and eventual improvement of brace construction.

In the past, according to Dr. Edward Peizer, who heads the NYU research program, braces for the legs and lower body have been built by skilled craftsmen on the basis of experience and common sense. Experimental data on such factors as the forces involved in walking, the effects of varying brace construction, and pressures at body-brace interfaces have not been available.

As a start in this direction, an NYU group including engineers, doctors and prosthetic-device specialists, will analyze eight specific problems in this field. One of these, for example, is the difficulty paralytics wearing short leg braces have in maintaining balance while walking, particularly at the moment of heel-strike. Transmission of forces applied to the calf through the calf-band will be studied, as will the effects on knee stability of redirecting these forces.

A special leg brace fitted with an array of strain gages has been developed by the
Force plate used to analyze the forces involved in walking consists of a walking plate supported by four strain-gage-instrumented columns. Lower diagrams show how the torque-measuring gages are connected in bridge to sense the magnitude of the turning torque exerted by a person stepping at any point on the walking plate.

NYU researchers. By mounting the gages with varying orientations on the side-bars of the brace, and arranging them in Wheatstone-bridge circuits, the forces involved in walking can be analyzed from ink-recorded records.

Another tool being used by the group is known as the force plate. A plate upon which a test subject steps is supported by four symmetrically placed columns, each supplied with 12 strain gages. Again, Wheatstone-bridge circuits are used to obtain information on direction and magnitude of the force applied in the step. The diagram illustrates the bridge arrangement used to measure the twisting torque applied to the force plate when a subject steps on it. Similar bridge arrangements are used to measure other components of the force.

Another instrument devised by the group is a tilt table. A test subject stands on a tilt-board with each foot pressing three contacts that hold relays fastened in an open position underneath the board. The square tilt-board is attached to a long plank that has a wire attached at the opposite end. A motor-pulley system is used to pull the wire and gradually tilt the board until the subject loses his balance, thus allowing relay closure. By testing various types of braces with different force distributions with this tilting system, the researchers hope to find optimum configurations for good balance.

The special needs of this project could be met by some of the following types of devices, according to Elliot Dembner, chief engineer for the program:

- Wafer-type pressure transducers for
KINTEL’s Model 121A/A non-inverting DC amplifier has fixed gains of 0, +1, +10, +20, +30, +50, +100, +200, +300, +500, and +1000. A variable gain control adjusts any fixed gain from x1 to x2.2. A gain calibration control gives ±2.5% adjustment for each gain other than ±1.

With this new instrument, you can amplify accurately all low-level signals from DC to beyond 200 kc for the reliable measurement of strain, temperature, flow, vibration, displacement, or other physical phenomena. The 121A/A has the same dimensions, fits the same cabinets and modules as other KINTEL DC amplifiers.

For more information on this new, more usable DC amplifier, write to KINTEL. Engineering representatives in all major cities.

**ADDITONAL SPECIFICATION NOTES:**

The Model 121A/A is a non-inverting (positive input produces a positive output), wideband, DC amplifier. Amplification is accurate within 0.1% for all gains other than ±1 (gain accuracy is 0.2% at ±1), linear within 0.005% for outputs up to ±15 volts DC with load impedances of 200 ohms or more. The amplifier provides up to 100 ma = DC or peak AC into loads of 100 ohms or less. Input impedance is greater than 10 megohms; output impedance is less than 0.3 ohm. Frequency response is flat within 0.25% to 2 kc, within 4% to 10 kc, within 3 db to 200 kc. Drift is less than ±2.0 volts equivalent input for over 40 hours at ±1000 gain. Amplifier recovers from 100% overload in 0.4 second, is undamaged by sustained, direct short across output terminals. Price $1000.

**NEWS**

**Leg Braces . . .**

(continued from p 13)

- Wireless data transmitters so that test subjects do not have to carry a bundle of wires with them.
- More sensitive strain gauges (semiconductor types are being investigated) to eliminate the need for amplifiers.
- A small, light triaxial accelerometer that could be used in force and motion studies of walking.

The NYU group hopes eventually to move into studies of some of the advanced areas currently being opened up in the medical-electronics field. Research in the potential variations within muscles and the electrical activity of the nerves suggests two important studies with paralytics or amputees. One possibility is the use of generated electrical signals to control the muscles of a person whose nerves are not functioning properly. The second possibility is the use of nerve signals in amplified form to control the operation of artificial limbs.

The entire NYU research program is coordinated by Dr. Sidney Fishman, under the sponsorship of the Easter Seal Research Foundation and the Office of Vocational Rehabilitation, Dept. of Health, Education and Welfare. Laboratory facilities and special equipment are being made available by the Veterans Administration.

**Fifty Navy Vessels To Use Improved Echo Depth Sounder**

Fifty Navy vessels soon will be outfitted with an improved electronic echo depth sounder, known as the DE-714-715.

The depth sounders, developed by Raytheon Co., Newton, Mass., give shipmasters instantaneous readings of the depth of water on a flashing-light indicator. The units also provide a simultaneous continuous graph of the ocean or harbor floor for navigation purposes.

Receiver sensitivity is varied automatically within the depth sounders to provide accurate readings from less than 2 ft to more than 780 fathoms.
Digital Programmer Operates With Accuracy of 0.1 Per Cent

A solid-state digital programmer, with accuracy of better than 0.1 per cent, has been developed as part of an arming and fusing system for future atomic weapons.

The all-electronic programmer, developed by Tempo Instrument, Inc., Hicksville, L. I., N. Y., consists of two identical, independent programmer channels. Each channel has a four-stage, adjustable timing program accurate to better than 0.1 per cent under extreme conditions, such as: -65°F to +165°F; ±5.5 V dc; 50 g at 2,000 cps (vibration); and 100 g (shock and acceleration).

The circuits for each channel are contained on five printed-circuit disks. Each disk is potted in rigid polyurethane foam to encapsulate all components. The potted disks are bolted together and interconnected. The entire assembly is mounted in an outer shell and the volume between is filled with silicone rubber.

All timing errors observed during testing were reported far below the 100-msec allowed by the specification and directly reflected oscillator accuracy. The greatest error occurring during temperature tests was 27 msec at a preset fusing time of 109.9 sec. This represents an accuracy of 0.024 per cent for the longest time required.

Development of the timing programmer was under the direction of the Special Weapons Group of the Army Ordnance Corps' Picatinny Arsenal, Dover, N. J.

Thermal Problems Under Attack

Electronic heat-transfer devices will be tested and developed in this new research laboratory, set up by the Birtcher Corp. Industrial Div., Monterey Park, Calif. The facility is equipped with environmental chambers to simulate internal and external ambients and flow patterns. It contains also calibrating equipment for direct measurement of thermal problems, in which the transistor's own junction will act as a thermocouple to measure heat transfer.

SHOCKING NEWS FROM EIMAC: there's now a 250-watt tetrode that can withstand shock of 90G for 11 milliseconds and vibration from 20-750 cps at 10G, with maximum rated voltages applied! It's Eimac's 4CX250R (shown 1½ times actual size). This new tube in the 4CX250B family is electrically equivalent to Eimac's 7580. The difference: the 4CX250R is ruggedized for extreme environments—as are other members of the family. And what a difference! Call your Eimac representative or write: Power Grid Tube Marketing, Eitel-McCullough, Inc., San Carlos, Calif.
NOW! a 3 amp glass diode

- takes voltage spikes to 5,000 volts
- conducts 1.5 amps at 150°C
- withstands 10 watts continuous overload
  — all without heat sinks

THE DIODE DESIGN THAT ELIMINATES FAILURE!

FORWARD CURRENT CHARACTERISTICS
The large capacitor filter in this bridge rectifier circuit causes 10 amp surges to flow every half cycle. The heat generated in the junction of the Unitrode is quickly dissipated through the terminal pins, bonded throughout the full area of both faces of the silicon. There is no whisker to burn out. The original condition of the diffused silicon surface, in contact only with pure inert hard glass, is preserved. To add a safety factor, all materials are stable to over 600°C.

INVERSE VOLTAGE CHARACTERISTICS
In this circuit, a .05µf condenser charged to 3000V discharges into the diode in the inverse direction. With no degradation, the Unitrode conducts current in the zener (breakdown) region until the transient voltage drops to the 600V level. Heat due to zener currents and voltage concentrations, is immediately dissipated across the wafer and out through the pins. Elimination of internal voids prevents arcing.

HIGH TEMPERATURE OPERATION
A Unitrode rated at 3 amps at 25°C will conduct 1.5 amps at 150°C, 300ma at 250°C, and will withstand 25 amp surges at 150°C, because of the high temperature materials used and the high thermal conductivity of the package. Since all materials have the same low coefficient of expansion, Unitrodes easily withstand thermal shock from −195°C to +300°C. No heat sinks are required. Unitrodes need only the thermal mounting of a 2 watt resistor.

RATINGS

<table>
<thead>
<tr>
<th>Single diodes:</th>
<th>10 milliamperes to 3 amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 volts to 800 volts</td>
<td></td>
</tr>
</tbody>
</table>

Miniature potted assemblies:
- Full wave rectifiers and bridges
- 50 volts to 5000 volts
- Selected matched pairs and quads for bridge and ring modulators
- 1 milliamperes to 50 milliamperes

Stacks (strings):
- 1000 volts to 20,000 volts
- Storage and operating temperature: −185°C to +300°C

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CIRCLE 15 ON READER-SERVICE CARD

NEWS

SIGNIFICANT BITS

Important Industry News Written
For Fast Scanning by Engineers

Research spending in the United States will amount to almost $16 billion next year, according to George W. James, economist for the Battelle Memorial Institute, Columbus, Ohio. The total for 1960, he said, was $11 billion, and that for 1950 only $3 billion. Mr. James estimated that 1962 spending would include: government research, $10 billion; industry, $5.5 billion; and universities and foundations, $350 million.

Tough nonmagnetic and corrosion-resistant alloys have been developed by Navy scientists. The alloys, named Nitinol, are based on the intermetallic compound TiNi (a combination of titanium and nickel). Nitinol can be hardened to 62 Rockwell “C.” The new alloys are expected to find uses in aircraft and space components by virtue of their low density, toughness and strength over a wide temperature range. They are easy to weld, according to reports from the Magnetic Materials Div. of the Naval Ordnance Laboratory, Silver Spring, Md.

Regional instrumentation centers for biological and medical research have been promised limited federal assistance. The National Institutes of Health will support development of such centers, beginning next year. The proposed centers, which would include electronic data-processing equipment, could serve scattered research laboratories, the U. S. agency pointed out.

Modular arithmetic for computers promises to speed multiplications, additions and subtractions by eliminating the carry term used in conventional binary arithmetic. The
idea behind the use of this approach by
the computer group at Lockheed Missiles &
Space Co. is based on a 2,000-year-old Chi-
inese theorem on remainders, recently revived
in a Czech scientific journal by a Czech
mathematician. Harvard's Howard Aiken, a
Lockheed consultant, picked up the idea and
suggested its application.

Design work on a high-powered vlf radio
transmitter for fleet communications in the
Pacific has been awarded to the Navy to Con-
tinental Electronics Manufacturing Co., of
Dallas, a subsidiary of Ling-Temco-Vought,
Inc. The facility, destined for Australia, will
be similar to the Navy's most powerful radio
station—a 2-million-w transmitter in Cutler,
Me.

Ground-based optical techniques for detec-
tion of nuclear explosions in space will be
developed by Geophysics Corp. of America,
Bedford, Mass., under an Air Force contract.
The proposed technique is based on obser-
vation of the scattering of sunlight by the de-
bris which results from the nuclear blast.

An undisclosed number of advanced video
magnetic tape recorders will be made by Amp-
pex Corp., Redwood City, Calif., under a
$500,000 contract from Bell Telephone Labo-
raries. The recorders are for the Army's
Nike-Zeus anti-missile program, for which
Bell Laboratories has systems-design respon-
sibility. Western Electric Co. is prime con-
tractor.

The post of assistant secretary of commerce
for science and technology probably will be
created by the next session of Congress. An
administration request for such a position was
killed by the House of Representatives during
the last session.

Craftsmanship produces enduring quality
For over three centuries, the Stradivarius has provided unmatched violin qual-
ity, reflecting the integrity of its maker. Similarly, companies today achieve
their goals—or fall short—through varying degrees of quality and integrity.
Bendix® Electrical Connectors, made by the Scintilla Division, are recognized
by their users as products of the highest quality—with no premium in cost.
If connector quality interests you, write us at Sidney, N. Y.

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Canadian Affiliate: Aviation Electric, Ltd., 300 Laurier St., Montreal 9, Quebe. Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.
CIRCLE 16 ON READER-SERVICE CARD
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Leach crystal can relays give you big performance in small packages in every standard relay configuration. Standard, Half-Size, Sensitive and Magnetic Latch in 0.20 inch grid spacing and “lazy S” header. Each type is capable of switching loads from low level to 2 amp in aerospace and electronic control applications. Bulletin CC-861.

Optical Electronics To Highlight NEREM

Talks Set on Light Modulation, Demodulation and Harmonics

Developments that ride the boundary between electronics and optics will be prominent among topics for discussion at the 15th Northeast Electronics Research and Engineering Meeting (NEREM), to be held next week in Boston.

Microwave modulation of light through use of the Pockels electro-optic effect is scheduled to be described by I. P. Kaminow, Bell Telephone Laboratories, Inc., Holmdel, N. J. At Bell Laboratories, an experimental modulator, using potassium dihydrogen phosphate crystals (KDP), has been operated in a pulsed mode at 9.25 Gc as part of an effort to develop optical communication systems.

According to Mr. Kaminow, about 2 kw are required to produce a peak phase retardation of 1.9 radians. To achieve modulation, the KDP crystal is placed in a microwave cavity where the forward wave component of the cavity standing wave in effect causes the crystal to rotate the polarization vectors of light passing through it. The light first passes through a polarizer; after modulation, it passes through an analyzer.

Microwave-Modulated Light Demodulated With Photoconductors and Phototubes

A method of demodulation of microwave-modulated light from optical masers through the use of semiconductor photodetectors and microwave phototubes will be described by A. E. Siegman of Stanford University, Palo Alto, Calif.

At Stanford, the output from a ruby laser was fired at an improvised phototube consisting of a 2-4 Gc traveling-wave tube whose cathode was visible through the glass envelope. Photocurrent pulses of from 1 µA to 500 µA were measured at the cathode and strong outputs were obtained at intervals from 1.8 to 4.2 Gc. The microwave signals were coherent and nearly monochromatic.

Mr. Siegman also plans to discuss a novel microwave-disriminator phototube for demodulating frequency-modulated coherent light.

A third optical technique, the generation
of optical harmonics is scheduled to be described by researchers of the University of Michigan, Ann Arbor. By focusing a beam from a pulsed ruby optical maser inside crystalline quartz, the Michigan investigators achieved a second harmonic of the fundamental laser beam. The laser produced about 3 joules of light in a 1-mc pulse at 6,943 A. Detectable amounts of the optical second harmonic were present at about 3,472 A.

In addition to quartz crystals, the researchers have found that KDP, ADP, and triglycerin sulphate also are effective in producing harmonics.

The meeting will be held at Boston's Commonwealth Armory; the headquarters hotel is the Somerset. About 15,000 persons are expected to participate. NEREM this year will offer about 400 exhibits and some 90 technical papers. Among scheduled speakers are J. A. Volpe, the governor of Massachusetts and J. L. Burns, president of Radio Corp. of America, and Charles H. Townes, new provost of Massachusetts Institute of Technology.

Test Transformer Unveiled

Tests for corona starts, flashover, dielectric breakdown voltage and related electrical properties will be performed by this high-voltage transformer. The equipment was installed by Ceramaseal, Inc., New Lebanon Center, N.Y., as a service for purchasers of bushings and terminals, and for its own research. The equipment includes a Peschel Electronics 150-kv (rms) test transformer and cathode-ray oscilloscope-type corona detector. Transformer and detection circuits are inside a copper-screen enclosure to reduce interference effects.

New low-cost Transient Control makes silicon rectifiers reliable by clipping voltage spikes

The new Ledex Transient Control guarantees positive dependability of 200 PIV silicon rectifiers. It's a non-polarized device that automatically clips voltage spikes by providing a low resistance shunt for all potentials above 200 volts—on the AC or DC side. It draws no current in normal operation.

As shown in the actual scope shots above, the control will repeatedly clip transients or reverse voltages to a safe level of 200. To the design engineer, it is a guarantee that the maximum voltage will go no higher than 200. Compact, light, and economical, the new development puts low-cost 200 PIV diodes in a reliability class of their own.

While the device is mainly intended for protection of 115 VAC silicon rectifier circuits, it can also be designed to clip spikes and protect other semi-conductor circuits at lower or higher control voltages.

NEW LEDEX TRANSIENT CONTROL is small (3/4" dia. by 1 1/2" long), lightweight (3/4 oz.) low cost ($1.60 to $2.05 in small quantities). Part No. A-46500-001 has 200 volt control and 2" leads.

NEW LEDEX SILICON BRIDGE RECTIFIER is protected by a built-in Ledex Transient Control. Voltage spikes are automatically clipped at 200. The rectifier is sealed in epoxy resin and meets the general requirements of MIL-E-5400 on insulation, terminals, vibration, shock, sand and dust, fungus and salt atmosphere. Operating temperature is -65°C to +120°C. Part No. A-46501-001 is rated as follows: 115 volt AC input, 100 volt DC output, maximum surge 50 amp for 8 msec. $6.80 to $8.15 in small quantities.

VALUE ANALYSIS RECTIFIER TRANSIENT CONTROL KIT consists of Transient Control, Silicon Rectifier with built-in Control and outline for evaluation tests to compare costs and reliability with your present circuits, Part No. A-47600-001. $11.00 per kit.

Other Ledex products are ready to go to work as compact solutions to your actuating, stepping or circuit switching applications.

FOR LITERATURE, clip this ad. check boxes above, attach to your letterhead and mail to Ledex Inc., Dayton 2, Ohio; Marsland Engineering, Ltd., Kitchener, Ont.; NSF Ltd., 31 Alfred Place, London, Eng.; AEMGP, 115 Ave. Clement, Boulogne, France.

CIRCLE 18 ON READER-SERVICE CARD
DEFENSE R&D BEING SHIFTED TO GOVERNMENT LABS

The administration is quietly beginning to divert electronic research and design from private contractors to government laboratories under military management and supervision.

This is no wholesale reversal of the Eisenhower policy of farming out such R&D work to industry and "nonprofit" companies. But a trend to in-house laboratory work has been discernible as a result of a directive from Secretary of Defense Robert S. MacNamara. The secretary expressed "profound concern" over Pentagon R&D policy.

A drive to beef up government R&D facilities has been signalled by Dr. Harold Brown, the Pentagon's research and engineering director. In what had been billed as merely a pep talk for personnel at the Anacostia Naval Research Laboratory, Dr. Brown spelled out some of the Kennedy administration's thoughts. Rarely has a high defense official spoken with such candor outside the Pentagon corridors about a subject that has long disturbed military scientists.

Dr. Brown told the Anacostia weapons developers that he is aware of "bad" morale at such government installations. He said the causes of bitterness and frustration—lack of recognition, poor Pentagon management and low pay—now are recognized officially, and that the Pentagon intends to do something to eliminate them.

The weapons research chief did not promise that all of the 100-odd in-house defense establishments would be upgraded immediately at the expense of outside contract work. The speech acknowledged valid arguments for both types of research, but made the weightier case for the Defense Dept's own shops.

Dr. Brown said that in view of urgent needs, most of the Pentagon's billion-dollar spending program had properly been contracted to private industry—which includes 350 small companies set up during the Eisenhower years to perform government services. But he also promised that the Pentagon is going to have strong laboratories of its own, staffed by first-rate (and better paid) workers who will do their jobs with a new feeling of importance—and provide expert supervision over projects farmed out to industry.

SHOWDOWN DUE IN FIGHT ON PATENT RIGHTS

A smoldering controversy over conflicting patent policies of federal agencies is heading for a showdown in the next session of Congress. Inventors who claim rights to patents developed under government contracts may get some legislative breaks.

Emilio Q. Daddario (D-Conn.), chairman of the House Space Subcommittee on Patents, predicts the panel will endorse his bill to relax patent practices of the National Aeronautics and Space Administration (See ED, Oct. 11, p 20). NASA now is required by law to retain title to most patents resulting from farmed-out re-
search. Final hearings on the Daddario bill are set for December—just before Congress comes back.

"We cannot hobble the inventive power of our industry," Daddario told the National Association of Manufacturers' patents committee at a luncheon meeting marking the 125th anniversary of the U.S. patent system. "We must encourage initiative and the useful contributions that all in the free world can make."

**The effect of government restrictions** on the rights of researchers, Rep. Daddario said, is "to retard the interest of American enterprise to invent—and particularly to deter small business from entering into research contracts with the U.S. government."

On the Senate side, John L. McClellan (D-Ark.), chairman of the Judiciary Subcommittee on Patents, says it is high time for action: "If the government is to have a consistent policy, the Congress will have to decide whether ownership of these inventions should reside in the contractor or the government."

The McClellan subcommittee is drafting a unified patent-policy bill. The subcommittee began to move after issuing a report on patent practices of the Defense Dept. Unlike NASA, Defense permits most contractors to retain commercial rights to inventions, although royalty-free licenses go to the government.

**ELECTRONIC DEVICE READS FOR THE BLIND**

After four years of work, the Veterans Administration and researchers at the Mauch Research Laboratories, Inc., Dayton, and Battelle Memorial Institute, Columbus, Ohio, have come up with machines that enable the blind to read without Braille. Demonstrated at a VA press conference, the electronic gadgets are designed to translate written characters into sounds of actual words or into a special musical alphabet. Dr. Robert E. Stuart of the VA expressed "cautious optimism" about developmental prospects. He said it may be many years before a compact, low-cost aural reading aid is available.

**PROMISING REPORT CARD ON TEACHING MACHINES**

There is no technical reason why digital computers cannot equal or surpass capabilities of classroom teachers, J. E. Coulson of System Development Corp. argued at a three-day Washington symposium, co-sponsored by the Office of Naval Research.

Properly programmed machines of the future will be as informed, flexible, sophisticated, subtle and responsive to individual needs of students as skilled instructors themselves, Mr. Coulson said. He conceded that such devices are as far beyond present prototype teaching machines as computers are beyond adding machines.

But Mr. Coulson predicted the machines will be used not only to take the roll, give tests and grade papers but also to argue Greek philosophy, teach idiomatic languages, pose complex mathematical questions and answer them—and still not be taxed beyond their educational capacities.

**CAPITAL CAPSULES**

The Army has tracked down the culprit responsible for a $7.4-million excess supply order in Europe. It was a calculating machine whose wires got crossed. The Diamond Ordnance Fuze Laboratory has developed an automatic sensing device as part of the trigger for anti-missile warheads.
Transportable Electronics
Built For Rugged Treatment

Mobility has become a primary concept in the design of electronic systems for national defense. Tight packaging techniques, ruggedized design approaches, and human engineering are some of the major considerations that must be used by the design engineer working on equipment to be built for air-drops or movement over rugged terrain. Here are some examples of the systems being readied for possible military needs.

A fifth-wheel, odometer-type ground navigator for mobile missiles has passed road tests successfully. A Chrysler Corp. fifth-wheel odometer was hitched to an inertial-reference system made by Kearfott Div. of General Precision, Inc., Little Falls, N. J. Technicians are shown during the road tests, run at 50 mph over varied terrain. The passive navigator is designed to fix launching positions for inertially guided mobile missiles.

Air-transportable terminal station, above, and mobile field subscriber station, left, are part of the Army's Strategic Army Communication (STARCOM) network. A family of three sideband-type systems, varying in power and channel capacity, were built for the Army by Adler Electronics, Inc., New Rochelle, N. Y. The AN/TSC-18, 19 and 20 provide, respectively, ranges of 7,000, 5,000; and 2,500 miles. The AN/TSC-18 and 19 each provide 3 voice and 16 teletype channels, and the remaining system has 1 voice and 3 teletype channels. Facsimile equipment in all three versions of the system allow sending of photographs. Spare parts for the Army's fixed communications equipment can be used with the new transportable systems. World-wide communications would be possible with the STARCOM net from remote areas without fixed communications.
NEW PRODUCT
Solder BANTAM
Miniature Round Connector

BURNDY now has available to the industry its BANTAM miniature round connector which conforms to the requirements of MIL-C-0026482A (WEP). These connectors are supplied with a variety of insert configurations in nine shell sizes. Number 16 and 20 size contacts are supplied depending on the insert configurations.

The miniature solder BANTAM mates with, or replaces, all connectors which conform to MIL-C-0026482A (WEP).

BANTAM plug and receptacles feature the TRI-LOK bayonet coupling, a positive coupling which can be quickly disconnected. They are vibration resistant and moisture-proof with the required temperature range of -67 to +257 degrees F. They provide an interfacial seal per the military spec and the need for safety wiring is eliminated by the positive locking bayonet coupling. Polarized inserts and a five point key and keyway eliminate the possibility of misrating.

BANTAM contacts are machined of high conductivity copper alloy and the sockets feature closed-entry, making them probe-proof. Extra heavy gold silver plating provides high conductivity and extra protection against corrosion. In addition, plating of contacts provides hard gold mating with soft gold, adding durability and minimizing galling. Special plating can be provided.

Solder BANTAM shells are fabricated of a high strength aluminum alloy. The standard finish is cadmium plate, type II, class C, per QQ-P-416, with olive drab iridite finish. Other finish plating can be provided.

For further information consult:

BURNDY, Norwalk, Connect.

BURNDY has developed the Coaxial Feed-Thru HYFEN to provide a new solderless, quick-disconnect, single feed-thru connector using proven coax HYFEN® contacts. Installed cost lower than most BNC type panel connectors, the new BURNDY series offers maximum mounting configurations requiring a minimum of components.

Features: • connected with standard HYFEN installation tooling. • made of tough, lightweight plastic (Polystyrene TMDA 2122) with molded-in ferrules for positive contact retention. • receptacle shells are available with either flange or nut mountings. • plastic shells will prevent electrolytic corrosion.

For full details and complete technical specifications, contact OMATON DIVISION

BURNDY
NORWALK, CONNECT. BICC-BURNDY Ltd. Prescot, Lancs., England In Europe: Malines, Belgium TORONTO, CANADA 21 ON READER-SERVICE CARD
ELECTRONIC DESIGN • November 8, 1961
another
advance
in
vibration/shock/noise control

BTR®
Elastomeric
Mountings

the answer to high reliability for sensitive
instruments, guidance systems, electronic equipment

Are you concerned with high reliability for equipment with low vibration/shock tolerance? Is your application on aircraft, missiles, space craft or ground support equipment?

Then here's the vibration isolator that gives you everything you need.

LORD BTR (Broad Temperature Range) Elastomeric Mountings cushion high G shock loads, isolate vibration to 2000 cps, give all-attitude protection, limit resonant amplification to approximately three or less. And this performance is unaffected by extreme environments and temperatures from -65° to +300° F. Size for size, ounce for ounce, they pack more load-carrying and energy-storage capacity than any other isolator.

Performance has been repeatedly proved on the most difficult applications. Even ultra-sensitive inertial guidance systems on operational ICBM's are now protected by standard production BTR Mountings.

Utilize this advance in vibration/shock/noise control to achieve higher reliability for your project.

Information on BTR Elastomeric Mountings is contained in Bulletin 301, available from your nearest LORD Field Engineering Office or the Home Office, Erie, Pa.

NEWS

Radiometer to Investigate Re-Entry Plasma Sheath

Hot ionized gases (plasmas), that form about the body of a space craft re-entering the atmosphere, are creating a communications problem. Radio signals over a wide frequency range are severely attenuated by the plasmas.

To investigate this phenomenon, the Air Force Cambridge Research Laboratories, Hanscom Field, Mass., will send sensitive radiometers aloft on re-entry vehicles.

The radiometers are miniature, transistorized, crystal radio receivers capable of detecting the very small plasma noise. The Dieterle radiometer compares the plasma noise to a reference-noise source within the receiver.

The radiometer was designed to operate over a wide range of frequencies by changing only the rf components. The first package will operate at 2,000 mc with an input bandwidth of 200 mc and a switching rate of 1,000 cps.

Oil-Pipe Mill Automated

This fully automatic pipe-weighing, measuring and identification system processes heavy oil-field pipe at the rate of one piece every 18 to 36 sec. The system, developed by Baldwin-Lima-Hamilton Corp's Industrial Equipment Div., Eddystone, Pa., handles pipe up to 10-3/4 in. in diam and 50 ft 2 in. in length. According to BLH, the system enables one part-time attendant to do the work of a crew of four to eight men.

ELECTRONIC DESIGN • November 8, 1961
Reservations Network
For TWA to Cover Globe

Trans World Airlines has ordered the first intercontinental electronic airline reservation system. The first link—to Europe—is scheduled for operation within 15 months. Eventually, all TWA offices will be connected.

Called Teleflite, the new system, developed by Teleregister Corp., Stamford, Conn., will transact in seconds the reservations that used to require 45 min to 2 hr.

One of the design features, which lends speed to the data transmission, is a communications terminal that permits teletype messages to be introduced into the computer directly from the communications lines instead of having to go through a paper-tape loop.

Reservations messages from overseas will come into the Teleflite center via teletype. There will be no manual handling of the messages once they are transmitted.

Two real-time computers will process and respond to all in-puts the moment they are received. Two core memories will store 32,000 decimal digits. Initially there will be four drums, each storing over 1,000,000 bits.

The TWA Teleflite system has been designed by Teleregister on a building-block concept. This permits gradual expansion of storage and processing capabilities to keep pace with increasing traffic.

Designers Use Blackboards

An engineering method, called the Panoramic Design Technique, is said to cut engineering, design and drafting costs from 33 to 50 per cent. Engineers put their designs directly on wall-size blackboards and record them photographically. A project shown in its entirety permits engineers to see how their portion of a design fits the whole pattern. The technique was developed by TAB Engineers, Inc., Chicago.

The combination of a high figure of merit (Q) and high maximum working voltage (MWV) in conjunction with high performance PSI transistors make these devices ideally suited for harmonic power generation. Note the examples of high efficiency circuits shown above.

These ten new High-Q Varicap types, all available on prompt delivery schedules, give the designer a wide selection of electrical characteristics—capacitance from 6.5 to 47pf, Q values from 50 to 124 and working voltages from 25 to 100V.

The High-Q Varicap frequency multiplier concept and its associated circuitry is original with PSI ... another example of why it will pay you to “look first to PSI”!

For complete specifications, prices and delivery, phone, wire or write a PSI field office near you.

Pacific Semiconductors, Inc.

Varicap is the registered trademark of silicon voltage-variable capacitors manufactured by Pacific Semiconductors, Inc.

CIRCLE 24 ON READER-SERVICE CARD
Reliability is built into these Type TO-5 transistor headers by using Carpenter VacuMeltrol NICOSEAL alloy for leads and eyelets. NICOSEAL matches commercially hard glasses to provide a stress-free or matched type seal for dependable transistor performance in computers, communication equipment and other precise instrumentation.

Matching metal to glass is a Carpenter specialty

In glass sealing alloys, Carpenter offers transistor and other electrical and electronic manufacturers the widest range available from any producer.

Excellent deep drawing on strip and better machinability on bar and wire items are extra benefits you get with Carpenter's broad selectivity. Grain size and orientation—directional physical properties—are precisely controlled to eliminate "orange peel" and "earing", and assure you uniform working and performance characteristics on every order.

Nicoseal (above) is just one of many Carpenter alloys designed to match hard and soft glasses for specific glass sealing problems. All are covered in a new, 34-page technical booklet, "Electronic Alloys Simplified", now available through your Carpenter representative or from The Carpenter Steel Company, 145 W. Bern Street, Reading, Pa.

Carpenter steel

You can make it consistently better with Carpenter Specialty Steels for specialists

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Export Dept., Port Washington, N.Y.—“CARSTEELCO”
Alloy Tube Division, Union, N. J.
Webb Wire Division, North Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.

CIRCLE 25 ON READER-SERVICE CARD

NEWS

Designers' Datebook

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<td>7th Annual Conference on Magnetism and Magnetic Materials; Hotel Westward Ho; IRE, AIEE, AI Phys., ONR, AIME.</td>
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<td>Phoenix</td>
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<tr>
<td>Boston</td>
<td>Electrically Exploded Wires Conference; Kemmorne Hotel; Air Force Cambridge Research Laboratories.</td>
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<td>14</td>
<td>Electronics Systems Reliability Symposium; Linda Hall Library Auditorium.</td>
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<tr>
<td>Kansas City</td>
<td>14-16</td>
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<tr>
<td>Boston</td>
<td>NEREM Northeast Electronics Research and Engineering Meeting; Somerset Hotel and Commonwealth Armory; IRE.</td>
</tr>
<tr>
<td>26-Dec. 1</td>
<td>New York</td>
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<tr>
<td>New York</td>
<td>Mechanical Engineers' Winter Meeting; Statler-Hilton Hotel; ASME.</td>
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<tr>
<td>30-Dec. 1</td>
<td>Minneapolis</td>
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<td>Minneapolis</td>
<td>12th National Conference on Vehicular Communications, Radison Hotel; PGVC.</td>
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December

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<tr>
<th>12-14</th>
<th>Eastern Joint Computer Conference; Sheraton Park Hotel; IRE, AIEE, ACM.</th>
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<tr>
<td>Denver</td>
<td>26-31 Annual Meeting and Exposition of Science and Industry; Hilton Hotel; AAAS.</td>
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Two Comb-Filter Systems To Detect Tracking Beacons

Two comb-filter spectrographic systems, to be developed by Itek Electro-Products Co., Cambridge, Mass., will be used in Bell Telephone Laboratories' space-communication program.

The comb-filter systems will be installed in the Rumford, Me., ground station and will detect the tracking beacon of the first commercial communications satellite, to be launched next April. The systems will survey a frequency spectrum supplied by a receiver, detect any Doppler returns and identify their frequency within a few cycles.
ALLEN-BRADLEY TYPE TR RESISTORS
are STANDARD for today's miniaturized hearing aids

Because of the engineering ingenuity of the manufacturers, hearing aids have become so tiny they are hardly noticeable—since the principal objection to wearing a hearing aid has been overcome, ever increasing thousands are enjoying this remarkable contribution to the joy of hearing.

Allen-Bradley is proud to play a part in this important development. The extremely tiny Type TR fixed resistor (actually smaller than a grain of rice) is used by virtually every hearing aid manufacturer to help achieve today's amazing miniaturization—without sacrificing reliability!

Tiny as they are, these miniature resistors—made by Allen-Bradley's exclusive hot molding process—have never experienced catastrophic failure in service. They are remarkably "uniform" to their resistance rating. Therefore, you are only fair to yourself—and your customers—when you insist on the reliability of the A-B Type TR resistors.

For complete details, please send for Technical Bulletin 5001, and Publication 6024 which also includes information on other A-B space-saving electronic components.

SOME OF THE MANUFACTURERS OF HEARING AIDS WHO RELY ON A-B TYPE TR RESISTORS

American Sound Products, Inc.
Audivox, Inc.
Beltone Hearing Aid Company
Busse Electronics Company
Dahlberg Company
Dictograph Products, Inc.
Electro Acoustic Research Labs., Ltd.
Gem Ear Phone Co., Inc.
Hahlens Wideex, Inc.
Johnston Hearing Aid & Electronics, Inc.
Maico Electronics, Inc.
The Microtone Company
E. A. Myers & Sons, Inc.
Otonon Listener Corp.
Qualitone Company, Inc.
Sonotone Corp.
Telex, Inc.
Unex Laboratories
Vari Electronics, Inc.

ALLEN-BRADLEY
Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.
Non-Linear Systems, Inc. designs first digital voltmeter to satisfy critical standards for missile work

Resistor Failures UNHEARD OF

...naturally, NLS uses ALLEN-BRADLEY hot molded resistors

To satisfy the high standards of consistent accuracy and reliability demanded for missile and weapons checkout, Non-Linear Systems, Inc., developed this digital voltmeter. It uses scores of Allen-Bradley fixed resistors. (For example, the latest Series 20 unit, shown above, contains about 1,000 in each instrument.) "In the selection of A-B resistors," says NLS, "quality and availability have never been a problem."

A-B resistors have such consistently uniform electrical characteristics that their performance can be accurately predicted over long periods of time under various operating conditions... with complete freedom from catastrophic failure while in service! The hot molding process used exclusively by A-B is the reason for this uniformity and reliability.

To obtain this same measure of superior performance for your equipment, always insist on Allen-Bradley quality fixed resistors available in various types. For full details, send today for your copy of Technical Bulletin 5000 or Publication 6024. Write to: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS
Marconi TV System Ordered By University of California

Experiments with a 4.5-in. image orthicon TV camera have been so successful at the University of California, Berkeley, that the college will expand educational TV facilities.

An 80-seat classroom has been set aside as a TV teaching laboratory; in addition, a number of lecture courses will be video-taped for subsequent playback.

A year ago, using a Marconi Mark IV camera and Zoomar lens, the university began televising various instructional activities and events around the campus. The Marconi camera televised physics lectures. Through a hook-up with the San Francisco TV-broadcast service, the lectures also could be seen by the public.

The order for installation was obtained by the Ampex Corp. of Redwood City, Calif., sole authorized distributors in the United States of Marconi broadcasting equipment.

Space Power Unit Tested

A nuclear thermoelectric power system, which uses the spontaneous decay of curium 242 to produce heat, will be used in space studies. The model shown by a researcher of Westinghouse Corp.'s Aerospace Dept., Lima, Ohio, is designed to produce 50 to 60 kw for three months on the moon's surface. During operation the high-junction temperature is 1,050 F, while the cold-junction temperature is 450 F. The curved shields are waste-heat radiators. Heat is transferred to the generator by liquid sodium potassium.

---

75 V 60 V 50 V

—the "Peaks" you want in High-Voltage SOLID TANTALUM CAPACITORS

Only KEMET can offer you the widest selection of dependable high-voltage solid tantalum capacitors. Topping the list is KEMET's new 75-volt type—the highest rated working voltage unit of its kind available today—by a margin of 50%!

KEMET's complete J-Series and N-Series comprise voltages of 60 and 50—ranging downward through 35, 20, 15, 10, and 6 volts—providing standard E.I.A. values with ±5%, ±10%, and ±20% tolerances.

J-Series capacitance values range from .0047 to 330 microfarads; operating temperatures from -55 to +125°C. N-Series capacitance values range from .0024 to 160 microfarads; operating temperatures from -55 to +105°C.

"KEMET" solid tantalum capacitors are designed, manufactured, and tested to serve the most demanding industrial/military applications. All are hermetically sealed in corrosion-resistant metal cans, with solderable and weldable leads. Four J-Series case sizes meet or exceed the performance requirements of MIL-C-38635A/2.

For utmost reliability in solid tantalum capacitors—high or low voltage—specify "KEMET". Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

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"Kemet" and "Union Carbide" are registered trade-marks for products of KEMET COMPANY

CIRCLE 26 ON READER-SERVICE CARD

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Write for technical data on the complete line of "KEMET" Solid Tantalum Capacitors

---

CIRCLE 27 ON READER-SERVICE CARD
90% lower $t_{gs}...25$ nsec max.
70% lower $V_{CE(sat)}...0.45$ V max.
50% lower $C_{ob}...18$ $\mu$F max.

...with new Sylvania...SILICON epitaxial mesas

- 2N1958 - 2N1959 (compared with conventional mesa types 2N696, 2N697)

Sylvania 2N1958 and 2N1959...first 2-watt transistors to handle 500 mA of collector current in a total switching time of 110 nsec.

Exclusively epitaxial! Now ALL Sylvania Silicon Mesa transistors are produced by the epitaxial process. Exceptional Sylvania knowledge of solid state physics combined with extraordinarily automated processing and testing techniques continue to advance the state of the art. The new Sylvania 2N1958 and 2N1959—improved 2N696 and 2N697 conventional Silicon Mesa types—are dynamic evidence of the benefits offered design engineers by (1) epitaxial techniques and (2) transistors quantity-produced by Sylvania for switching and amplifier circuitry operating in the nsec range.

Sylvania 2N1958 and 2N1959 Epitaxial Silicon Mesa transistors are now available from your Sylvania Franchised Semiconductor Distributor and your Sylvania Sales Engineer. For tech data write to Semiconductor Division, Sylvania Electric Products Inc., Dept. 185, 1100 Main Street, Buffalo 9, New York.

Curves compare storage time ($t_s$) and saturation voltage $V_{CE(sat)}$ of 2N696, 2N697 and Sylvania-originated 2N1958 and 2N1959. Note significant improvements offered by Sylvania epitaxial mesas 2N1958, 2N1959.

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**SYLVANIA**

**NEWS**

**Computer's Memory Drum Floats on Helium Film**

A new approach to the memory-drum concept—use of a 150-micro-in.-thick film of helium as a bearing—has made possible a smaller, more reliable digital computer for space-vehicle guidance.

The gas-bearing drum is said to eliminate mechanical wear of metal suspension systems and decreases the head-to-drum clearance from 0.001 in. in earlier models to 0.00015 in. The latter feature raises the memory capacity.

The computer (L-70) was developed by Librascope Div. of General Precision, Inc., Glendale, Calif. It is a follow-on design of Librascope's Centaur guidance computer and, at 19 lb, weighs only half as much as its parent model.

The gas-bearing drum, permitting more accurate location of magnetic heads, made possible recording tracks on 0.045-in. centers. This gives 70 tracks within 3.7 in.

In its original application, the L-70 memory drum has a capacity of 112,000 bits.

Another feature of the L-70 is an output module that weighs only 8 oz and measures 2-1/2 x 2-1/2 x 1 in. It has fewer components, a simplified gear train and increased thermal efficiency. Standard accuracy of the model was given as 0.1 per cent.

The L-70's amplifier is 50 per cent smaller than previous models. Heat sinks are eliminated by improved thermal efficiency. Tachometer feedback for servo damping also has been eliminated, by utilizing integral feedback within the amplifier.

Close-up view of L-70 flight-guidance computer, weighing 19 lb, and with helium memory-drum bearing.

ELECTRONIC DESIGN • November 8, 1961
Bank Uses ‘TV Scooter’

Key equipment in a closed-circuit television system is a TV scooter. The scooter moves on tracks in front of files at the Pioneer Bank and Trust Co., Shreveport, La. The scooter transmits TV pictures to monitors in branch banks, where the teller or customer requesting information sees it on his screen. The system is manufactured by Dage Div. of Thompson Ramo Wooldridge, Inc., Michigan City, Ind.

Computer Accessory Gives Voice Replies to Queries

Voice replies to queries fed into a computer are given by a new alpha-numeric computer input/output device.

The unit, dubbed Unicall, transmits complete messages (up to 40 alpha-numeric digits) in about 2 sec over long-distance telephone lines. Voice-reply transmission (from magnetic drums at the computer site) begins within a half-second of receipt of a Unicall query.

Remington Rand UNIVAC Div. of Sperry Rand Corp., New York City, developed Unicall. It is engineered for use with UNIVAC real-time computing systems. The company expects Unicall to facilitate reporting of changes in inventory, production, distribution and sales.

Unicall units will rent for about $30 per month. The price is about $1,350 per set.

Manufacturers of Precision Resistors

CIRCLE 29 ON READER-SERVICE CARD

MEPCO, INC
Morristown, New Jersey

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>MEPCO</th>
<th>MEPCO</th>
<th>MEPCO</th>
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</thead>
<tbody>
<tr>
<td>EC25A</td>
<td>500K 1%</td>
<td>EC25A</td>
</tr>
</tbody>
</table>

MEPCO’s new miniature 1/4 W Carbon Film resistors were specifically designed to break the cost and space barrier in printed circuit applications.

Having both leads extending from one end and available in three different lead spacing arrangements, these Carbon Film Resistors for vertical mounting offer advantages never before available.

**Write or call today** for samples and literature.
New Bourns Precision Potentiometer Resolves the Quality-Price Dilemma!

Here is military reliability in a competitively priced industrial potentiometer. Bourns wirewound 10-turn Model 3500 measures just 17/16" in diameter by 1" long—shorter by 1/2" than units available elsewhere—yet has a resistance element 20% longer than that of comparable potentiometers.

Fully meeting military requirements for steady-state humidity, Model 3500 can also be provided at a 10% premium to meet the cycling humidity specs of MIL-STD-202, Method 106. It's the only 10-turn potentiometer guaranteed to meet this spec. Its published characteristics incorporate wide safety margins. Reliability insurance is provided by the exclusive Bourns Silverweld® bond between terminal and resistance wire. Virtually indestructible under thermal or mechanical stress, this termination eliminates a chief cause of potentiometer failure. In addition, a special close-tolerance rotor almost completely does away with backlash.

Model 3500 is also subjected to the rigorous double-check of Bourns' exclusive Reliability Assurance Program. In short, every possible step is taken to ensure that the performance you specify is the performance you get. Write for complete data.

<table>
<thead>
<tr>
<th>Resistances</th>
<th>500Ω to 125K, 0.25% std. (to 250K spl.)</th>
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<tbody>
<tr>
<td>Linearity</td>
<td>±0.25% std.</td>
</tr>
<tr>
<td>Power rating</td>
<td>2W at 70°C</td>
</tr>
<tr>
<td>Operating temp.</td>
<td>−65° to +125°C</td>
</tr>
<tr>
<td>Mech. life</td>
<td>2,000,000 shaft revolutions</td>
</tr>
</tbody>
</table>

**INTER-OFFICE MEMORANDUM**

To: John Miller—Design Engineer

From: Paul Hammond—Reliability Engineer

John,
you'll like this one—
reliable and inexpensive!

Paul

---

**NEWS**

**Digital-Data System Tracks Pollution in Ohio River**

A digital-data system will be used to monitor the water quality of the Ohio River.

Data from about 40 points along the Ohio River are obtained on demand or automatically in preselected sequence and transmitted by telegraph to a central recording station in Cincinnati. The system, developed by Datex Corp., Monrovia, Calif., transcribes the telemetered signals from the monitors in a permanent typewritten tabular form and also makes a punched-tape record for computer processing.

The entire system was designed by the Ohio River Valley Sanitation Commission. It is expected to yield clues to the behavior of the river and the performance of waste-control facilities installed to curb pollution.

The automatic system will replace a manually operated data network.

**Field-Emission Theory Confirmed By Experiment**

Experiments have verified the theory of emission of electrons from metals at low temperatures—or in the field-emission region.

Previous work had confirmed the theory of thermionic and transition emission, but until recent tests at the National Bureau of Standards the field-emission theory had not been experimentally verified.

A high field, on the order of 10⁷ v/cm², and temperatures from about 4.2 to 400 K were used in the NBS tests. Liquid helium

This specially designed tube was used at the National Bureau of Standards for experimental verification of the field emission of electrons from metals.
was used to cool the vacuum tube containing the tungsten tip, attached to a tantalum loop. The loop was used as a thermometer for the experiment.

A resistance-temperature curve was determined by calibration at several constant-temperature points. Various temperatures were obtained by resistance heating of the loop. A field was applied to the emitter and a nulling circuit was used to measure the current variation with changes in temperature. The theoretical expectation that the current increment would vary with the square of the absolute temperature was confirmed by the experiment.

The investigation also showed that the field at the emitter surface can be calculated from the slope of the emission current versus temperature squared curve.

One effect that was not observed during the experiment was that of the elimination of the energy band gap as a result of a superconducting-to-normal transition. This had been expected in an experiment with a niobium emitter.

Failure to verify this effect suggests that the surface of the emitter either was not superconducting or that superconductivity at the surface might have been quenched by the applied field.

DEW Line System Extended

America's DEW (Distant Early Warning) system, which stretches 6,000 miles from the Aleutians to Iceland, has extended its network with the addition of the 7-station DEW East segment. Dye-2 above, is one of the Greenland icecap sites in the 1,200-mile DEW East link. The self-sufficient building houses a rotating antenna, top center. The circular structures, left and right, house 30-ft dish-type antennas. Western Electric Co., Inc., New York City, is the prime industrial contractor.

"FRIGID MIDGET" for electronic systems

Model: 144029-010
Actual Size: 9" x 9 1/2" x 8"

COOLING SYSTEM ... and the customer receives perfection in miniature, assured performance ... plus single-source responsibility from Pesco — the only manufacturer that produces all its own micro-matched components for electronic cooling packages. Designed by a creative team of Pesco engineers, this compact package features a liquid flow rate of 1 gpm ... high heat transfer of 2 1/2 KW at 212° F and 50,000 feet altitude ... liquid temperature range from -65° to -212° F ... plus built-in thermal bypass for low temperature operation requiring no cooling. It is particularly adaptable to electronic systems utilizing liquid-cooled power tubes in either airborne or ground installation where space and weight are of critical importance. For customized cooling packages engineered to meet your environmental requirements, contact the Pesco Sales Office nearest you or write today to ...
WESTON SWITCHBOARD INSTRUMENTS SOLVE PROBLEMS OF RANGE, ACCURACY, SPACE

Models and types available for every application

Weston Switchboard Instruments provide basic accuracies of ±1% full scale, and can be made to meet more exacting requirements. They are supplied in groups of matching units in a wide variety of models and ranges.

All models are available with internal illumination, or with clear plastic fronts for exceptional visibility. "In-line" pointers and scales eliminate reading errors caused by parallax. For even more precise measurement, they can be supplied with knife-edge pointers and mirror scales.

Model 610 Group is supplied with 4 x 4.5" Bakelite cases. Scales are 3.5" long. CORMAG® mechanisms permit mounting on magnetic or non-magnetic panels without special adjustment. These instruments are ideal for compact installations where one operator controls a large number of circuits.

Model 921 Group consists of 5.75 x 6" instruments with 5.21 scales. Rugged steel cases provide shielding against external magnetic fields. This group is particularly suitable where good readability under adverse conditions is required.

Call your Weston representative for details on how these instruments can be adapted to your most critical specifications, or write for Catalog 01-200. Daystrom, Incorporated, Weston Instruments Division, Newark 12, New Jersey. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.

NEWS

Simulated Flights Give Lift to Minuteman Tests

The Minuteman's recent successful flights were a foregone conclusion in the miniature "missile-test-range" laboratory at Autonetics, Div. of North American Aviation, Inc.

With equipment coded to simulate the many functions of a missile, program tape is run through a typical mission profile. By this direct simulation, using elements of the actual flight-control and guidance equipment of the Minuteman, scientists at Autonetics can locate a defect and thereby prevent costly disaster.

The direct simulator facility is a digital-oriented system. In addition to the Minuteman airborne digital computer, Autonetics' VERDAN airborne-type digital computers have been incorporated into the unit, along with simulation components.

When the command to "launch" is given, the VERDAN computer "flies" the simulated Minuteman from liftoff to thrust termination down the Atlantic missile-range path followed by the actual missile. Digital telemetry data needed for analysis of the test are gathered by tape recorders.

The exact duration of a Minuteman flight is used in the simulated runs.

Hi-Fi Was Never Like This

Looking like a hi-fi fan's dream, this enormous acoustic testing facility at the Litchfield Park, Ariz., plant of Goodyear Aircraft Corp. will be used to test the destructive qualities of sound vibrations. The Goodyear noise-maker can duplicate sounds ranging from 37 to 10,000 cps. Shown are some of the 48 circular "woofers" and 64 trumpet-shaped mid-range speakers, which constitute "tweeters" because they are of the highest range employed in the installation.
Titan Guidance Improved

Technicians at Cape Canaveral, Fla., load an inertial-guidance package into a Titan ICBM missile. The new system has gone through several successful in-flight tests. Among the innovations of the guidance package are a fluid temperature-control system, welded electrical connections and beryllium gyroscopes. The guidance system was developed by AC Spark Plug Div. of General Motors Corp., Milwaukee.

Mechanical Arm for Industry

This 900-lb vehicular mechanical-arm is operated from a portable control station having an on-off push button for power regulation. Lever switches control the speed of each of six manipulator motions. Called Little Ranger by its developers, General Mills, Inc., Minneapolis, the system is said to operate at temperatures ranging from −30 F to +120 F. TV cameras and an intercom system can be installed.

New Zener-like characteristic of the improved Vickers Captivolt lets you build maximum surge protection into your silicon rectifier circuits... eliminates costly de-rating

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Sperry adds high-power pulsed TWT's to list of tubes available in 30 days

In a move to simplify design problems in present and future radar systems, Sperry Electronic Tube Division of Sperry Rand Corporation has added two high-power pulsed traveling wave tubes to the list of advanced microwave tubes available in 30 days.

The two tubes covered by the announcement—the STL-114 and the STC-152—operate in L and C bands, respectively. They are typical of a line of pulsed TWT's ranging from P through V bands which Sperry offers on a firm delivery date basis.

EASY RADAR APPLICATION
Sperry's pulsed TWT's are admirably suited to the demands of application in phased array radars, height finders, search, ECM, and other radar applications. Widely varied in-system experience has proved that their reliability, long life, high power, high gain, and extreme broad band operation make them ideal for radar use.

Design features of this tube family minimize the necessity for system adjustments in the field. Among these features are broadband response, constant voltage operation, and short circuit stability.

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These pulsed TWT's, produced at Sperry's Great Neck, N. Y., facility, have compiled an impressive record of in-system experience. Such experience has proved that their resistance to shock and vibration damage, their inherent indifference to ambient conditions, and their mounting flexibility make them ideal for ground or airborne application.

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Among Sperry's other interesting activities in pulsed TWT's is the extension of capability into the V Band—26.5 to 40.0 kMc. Although these efforts are largely classified, inquiries are invited from those who have the necessary clearance and need to know.

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CIRCLE 35 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961
Feast Above, Famine Below

While hundreds of engineers in the space sciences attended the mammoth Space Flight Report to the Nation in New York's Coliseum recently, another technical meeting took place in the near-by New Yorker Hotel. But a handful of audio engineers, a group of scientists—mostly from Columbia University's Hudson Laboratories—presented a series of papers covering some of the fundamentals of underwater acoustics. The juxtaposition of this session of the annual Audio Society meeting and the space exhibition was rather startling.

The drama of space exploration naturally overshadows that of the study of the oceans and their sound-propagating characteristics. But drama alone is not a reliable index to relative importance.

At the space meeting, speakers ticked off countless planned, proposed or imagined missions into the beyond. Imagination rode free-rein in some of these presentations. Systems were proposed that assumed a succession of breakthroughs.

This approach is necessary as we prepare to engineer for a completely new and hostile environment. It is too early to say what reward might await us in space, but the military implications and scientific interests drive us onward.

By contrast, the potential reward and the problems of the study of sound in the undersea are clearly defined. The reward is the long-range detection and surveillance of undersea craft, possibly bent on our destruction. The Soviet's emphasis on its submarine fleet is a major military threat to the United States.

In the Navy's Project Artemis these scientists accomplished the detection of sound at a range of 12,000 miles. The interpretation of received sound signals, however, is still a mysterious art.

A start has been made on analysis of these echoes, but the problems are tremendous. New techniques are needed for generation and reception of the sound. New approaches are necessary to process the data received; it often takes months to analyze information gathered in a few hours.

These problems are based on an immediate need. It is evident that the application of more talent and the expansion of undersea scientific programs, would speed solutions. And yet we seem willing to push much harder for the more glamorous, but as yet more distant, space rewards.

It is a tremendous task, with billions of dollars at stake, to choose from a myriad of technical proposals those that offer the greatest rewards, and that have the greatest probability of success. In the by-play of emotions and propaganda spectacles, such as we have witnessed in the past half-decade, it is increasingly important to probe deeply into these matters and to base decisions on real, existing needs—rather than hoopla and holler.

Robert C. Haavind
Low-Frequency Instability
In Cascaded Emitter Followers

Oscillation is often a severe problem encountered with cascaded emitter followers. Equivalent circuits are developed for low-frequency and high-frequency conditions and techniques for predicting instability as well as remedial action are outlined for single and multistage amplifiers.

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Cascaded emitter followers, used in current amplifier designs, can be stabilized by two general approaches developed from a source and input-impedance concept. One technique involves the addition of series resistance to cancel the negative resistance component; with the other method, resonance is made to occur outside the negative resistance range. The phenomenon of low-frequency oscillation in emitter-follower stages is analyzed on the basis of a simple equivalent circuit; test setups and resultant data are presented to illustrate the correlation between calculated and experimental results.

Equivalent Circuit of a Single-Stage Emitter Follower

The equivalent circuit used for the analysis is shown in Fig. 1. From this circuit, the following approximate expressions for voltage gain and input and output impedances are derived:

\[ A_v = \frac{1}{1 + \frac{r_b}{Z_L} (1 - \alpha)} \]  

(1)

\[ Z_{in} = r_b + \frac{r_v + Z_L}{1 - \alpha} \]  

(2)

\[ Z_{out} = r_b + (r_v + Z_L) (1 - \alpha) \]  

(3)

where the approximation is that \( Z_g \), \( r_b \), and \( r_v \) are assumed negligible compared to \( r_c \). For the purpose of the single-stage case, \( Z_g \) and \( Z_L \) are defined as follows:

\[ Z_g = R_g + j \omega L_g \]  

(4)

\[ Z_L = \frac{R_L}{1 + j \omega R_c C_L} \]  

(5)

Substituting these and the other frequency variants, the input impedance can be expressed as:

\[ Z_{in} = R_i - jX_i \]  

(6)

where the real part may be written

\[ R_i = r_b + \frac{R_L}{\lambda_0} \left[ \frac{r_v + r_c}{1 + \omega^2 T^2 (1 + \omega^2 R_c C_L)} \right] \]

\[ + \frac{(\lambda_0 + \omega^2 T^2) r_v}{\lambda_0 + \omega^2 T^2} \]

(7)

where \( \lambda_0 = 1 - \alpha_c \).

The second term contains a negative term, \( \alpha_c R_c C_L / T \), and if this is sufficiently larger than one, the whole expression will be negative for a range of frequencies. Fig. 2 shows a typical polar plot of the impedance of an emitter follower.

It is apparent that if this circuit is driven from an inductive source with insufficient damping, it will oscillate at a frequency determined by the source inductance and the reactive component of \( Z_{in} \), provided that this frequency is within a range of sufficient neg-
ative resistance (above \( w_1 \) in Fig. 2).

To prove this mathematically, the expression for the voltage gain is expanded in terms of frequency. The equation then takes on the form (using Laplace transforms)

\[
A(S) = \frac{R_1 (1 + ST)}{K_1S^3 + K_2S^2 + K_3S + K_4} \tag{8}
\]

where:

\[
\begin{align*}
K_1 &= TR_1 C_L L_e \\
K_2 &= T L_e + R_L C_L \left[ T(R_e + r_b) + \lambda L_e \right] \\
K_3 &= T(R_L + R_e + r_b) + \lambda_0 \\
&\quad \left[ L_e + (R_e + r_b) R_L C_L \right] \tag{9} \\
K_4 &= R_L + \lambda_0 (R_e + r_b)
\end{align*}
\]

A linear amplifier is stable if its transfer function has no poles in the right hand half of the S-plane. In Eq. 8 this is equivalent to the denominator not having roots with positive real parts. To test for this condition, the Routh's Criterion can be used. According to this criterion, the equation has as many roots with positive real parts as there are sign changes in the first column of the following array:

| \( S^3 \) | \( K_1 \) | \( K_2 \) | \( K_3 \) | \( K_4 \) |
| \( S^2 \) | \( K_1 \) | \( K_2 \) | \( K_3 \) | \( K_4 \) |
| \( S^1 \) | \( K_2K_3 - K_1K_4 \) | 0 | \( K_1 \) |
| \( S^0 \) | \( K_4 \) | 0 |

Since \( K_1, K_2, K_3, \) and \( K_4 \) are all real and positive, the only way a sign change can occur is if \( K_2K_3 < K_1K_4 < 0 \). This inequality defines the conditions for instability. The same expression as an equation defines the border between stable and unstable operation.

\[
K_2K_3 - K_1K_4 = 0 \tag{10}
\]

The locus of the solutions to this equation in

\( L_e \) and \( C_L \) is of the form shown in Fig. 3.

Any point in this figure corresponds to a particular combination of values for \( L_e \) and \( C_L \). Points inside the closed curve correspond to combinations which result in unstable operation, and points outside correspond to stable operation; the curve itself defines the borderline between the two cases.

If some other parameter, such as \( r_b \), is varied, the area of the enclosed curve will decrease for increasing \( r_b \) and vice versa. This is merely another way of saying that if \( r_b \) increases, the range of sufficient negative resistance decreases, which reduces the range of values of \( L_e \) and \( C_L \) for which the amplifier will oscillate.

Analysis and Test Data
For a Single-Stage Amplifier

This analysis was performed on a typical amplifier using a 2N553 transistor, and the results checked by measurements of its performance. The calculated data were obtained by computer solution of Eq. 10.

Fig. 5 shows the resulting plots and Fig. 4 a schematic of the circuit used to obtain the experimental data. The values of the transistor parameters were known only to a low degree of precision (from measurements and published data).

The values substituted in Eq. 10 were

\[
\begin{align*}
& r_b = 100 \Omega, T = 1.9 \times 10^7 \sec, \alpha_0 = 0.988 \\
& R_e = 10K, C_L \text{ and } L_e \text{ variable.}
\end{align*}
\]

The calculated curve agrees reasonably well with the experimental data.

Extending Analysis to Multistage Amplifier Design

The analysis of single-stage circuits can now be extended to multistage amplifiers.

To establish the equivalence between the two cases, first consider the first stage as the source for the second. Then, the output impedance of the first stage is the effective source impedance driving the second stage.

When evaluated in terms of frequency, the expression for \( Z_{out} \) becomes

\[
Z_{out} = \frac{r_e + (r_h + R_3) (\lambda_0 + \omega T^2)}{j\omega T \alpha_0 (r_b + R_2)} \tag{11}
\]

which is the form \( R_0 + j\omega L_0 \) (for small values of \( \omega T \)) where

\[
\begin{align*}
R_0 &= r_e + \alpha_0 (r_b + R_2) \\
L_0 &= \alpha_0 T (r_b + R_2)
\end{align*}
\]

This approximation is quite good for values of \( \omega T \) up to 0.1, as can be seen from Fig. 6,
Fig. 7. Locus of instability for a two-stage emitter-follower circuit.

which shows a polar plot of the actual output impedance compared to one of $R_o + j\omega L_o$.

Thus, the driving stage in a two-stage emitter-follower amplifier acts as an inductive source for the second stage. Also, a third stage would provide capacitive loading for the second stage, making the combination potentially unstable without any apparent reactive components.

Fig. 7 shows the locus of instability curves for a two-stage circuit. The experimental results were obtained from a circuit as shown in Fig. 8. The analytical results were obtained by using an equivalent circuit for each

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stage, as shown in Fig. 1. One curve corresponds to a driver stage with \( \beta = 200 \) and the other one to a driver with \( \beta = 160 \).

As indicated by Eq. 11, varying \( R_s \) in this case has the same effect as varying \( L_g \) in the single-stage case, and varying \( \beta \) has the inverse effect of varying \( r_s \) in the single-stage case.

Remedial Action to Stabilize The Emitter Follower

On the basis of this analysis, remedial action can be recommended. Returning again to the source and input-impedance concept, it appears that there are two approaches toward stabilizing the circuit. One consists of cancelling the negative resistance by adding positive resistance in series, and the other one consists of arranging for resonance to fall outside the negative resistance range.

There are several ways of mechanizing the first approach; the most obvious, of course, is to insert an actual resistance between the stages. Another way is to select the parameters \( a, R_s, C_t, \) and \( T \) in Eq. 7 so that \( aRC \ll T \). This is overdesigning appreciably, since it results in a total series resistance of \( r_s + aR_e \) in the input circuit instead of one which is just greater than zero.

A third way is to use feedback around the driver stage to increase its output impedance and, specifically, the resistive component thereof. The circuit in Fig. 9 illustrates this technique.

The effective input voltage to the emitter follower, \( e_i \), becomes

\[
e_i = \frac{e_z \cdot Z_{n1}}{Z_{n1} + Z_i \cdot Z_{n1} \cdot (K + 1) + Z_i} \tag{12}
\]

Based on this equation, the equivalent circuit in Fig. 10 can be drawn to represent the input circuit to the emitter follower.

Letting \( Z_i = R_s \) and \( Z_0 = 1/j\omega C_t \), the resulting output impedance

\[
Z_{out} = r_s + j\omega T \left( r_s + \frac{R_e \cdot R_1 \cdot C_t}{1 + j\omega T} \right)
\]

which for \( \omega = 10^3, T = 10^{-4}, \beta = 100 \) becomes

\[
Z_{out} = r_s - 0.01 \cdot r_s + 10^4 R_e \cdot C_t + j(0.1r_s + 10^4 R_e \cdot C_t) \tag{14}
\]

According to this typical example, the amount of damping can easily be controlled by manipulation of \( R_s, R_e, \) and \( C_t \).

A way to mechanize the second approach...
is to shunt the source of the first stage with a capacitance. This also results in an increased output resistance, but its chief effect is in reducing the reactive component, even to the point of making it negative. The output impedance in this case becomes

\[
Z_{out} = r_e + \frac{(\lambda_h + \omega^2 T^2)(r_b + R_e) + \omega^2 R_e C_g (\alpha_0 T + \lambda_h) C_g}{1 + \omega^2 [R_e C_g (1 + \omega^2 T^2) + T^2]}
\]

\[
+ j \omega T \alpha_0 \frac{r_b (1 + \omega^2 R_e C_g) + R_e [1 - \frac{R_e C_g}{\alpha_0 T} (\omega^2 T^2 + \lambda_h)]}{1 + \omega^2 [R_e C_g (1 + \omega^2 T^2) + T^2]}
\]

Letting the reactive part equal zero and solving for \(C_g\)

\[
C_{g_{eff}} = \frac{\lambda_h + \omega^2 T^2 \left[2 \lambda_h + \omega^2 T^2 - \frac{4 r_b (r_e + R_e)}{R_e^2}\right] + \lambda_h'}{2 \omega^2 T r_b}
\]

\(\lambda_h\) which corresponds to decreasing \(\beta\). Also, the reactive part, \(\omega^2 C_g\), decreases with decreasing \(T\), which corresponds to increasing alpha-cutoff frequency. Thus, the transistors should be so selected that the driving stages have low betas and higher alpha-cutoff frequencies than the succeeding stages.

**Evaluating the Effects of Various Stabilization Techniques**

Selecting a technique of stabilization among those presented will in general be dictated by considerations of frequency response and gain. Inserting series resistance between the stages lowers the voltage gain somewhat and causes large dc offsets if the steady-state current is appreciable; however, it has only a slight effect on the frequency response.

Using the feedback technique also reduces the voltage gain but does not produce the dc effects mentioned. Its effects on frequency response, however, are somewhat complex and, since it is a feedback system, should be designed carefully so as not to introduce another source of instability.

Shunting the source with capacitance results in a reduced high frequency response, but in an easily predictable fashion, which makes it suitable for use in amplifiers which are part of a feedback loop. Shunting the load with capacitance has about the same effect, but differs in the value of capacitance required, which is greater by a factor roughly equal to the current gain than that required across the source.

Stabilization by selection of transistor parameters restricts gain and frequency response to the extent the gain-bandwidth product is limited in the first stage.

All these methods result in degraded performance in some form or another. To allow for this it is necessary to overdesign somewhat; the gain-bandwidth product, in particular, must be higher than if no stabilization were required.

**Example of Stabilization Techniques In a Typical Design Problem**

An example of a circuit using two of the discussed techniques is shown in Fig. 11. This is part of a voltage regulator where four emitter followers are required to provide the necessary current gain. This four-stage circuit is stabilized by means of a capacitance shunting the input to the first stage and a feed-back capacitance between collector and base of the second stage. The first capacitor \(C_1\) is solved for by Eq. 16. By sub-
stituting the following values in Eq. 16

\[ \lambda_0 = 0.008 \text{ (min)} \quad 0.014 \text{ (max)} \]
\[ T = 2.5 \times 10^5 \times 1 \times 10^{-7} \]
\[ r_s = 30 \text{ \Omega} \]
\[ R_o = 4,000 \text{ \Omega} \]

we obtain maximum 0.0015 \text{ uf} < C_i < 0.17 \text{ uf}
using the maximum values of \( \lambda_0 \) and \( T \) and
0.013 \text{ uf} < C_i < 10 \text{ uf} using the minimum values
of \( \lambda_0 \) and \( T \). Thus, the range for \( C_i \) is
0.013 \text{ uf} < C_i < 0.17 \text{ uf}. A value of 0.1 \text{ uf} was
chosen as being roughly in the center of the range.

To find the value of the feedback capacitor,
solve for \( R_i C_i \) in the expression

\[ \frac{R_i R_o C_i}{1 + \omega^2 T^2 \beta^2} = R_o \] (17)

This expression results from setting the real
part of the equation for \( Z_{\text{out}} \) (Eq. 13) equal
to \( R_o \), which is the required value of resistance
in the input circuit of the following stage. Resistance \( r_s \) is assumed to be so small
as to be negligible.

The worst-case values for \( T \) and \( \beta \) are
\[ T = 0.8 \times 10^{-7} \]
\[ \beta = 40 \]

The maximum value of \( R_o \) was found to be
between 10 and 100 ohms at \( \omega = 10^6 \). These
values were obtained by measurements; they
could also be found by computing \( R_i \) versus
\( \omega \) in Eq. 7. The output impedance of the pre-
vious stage is assumed to be largely resistive
(because of the capacitance across the input)
and is roughly equal to the \( r_s \) of the
transistor, which is typically about 3 ohms.

Substituting the following values in Eq. 17:
\[ T = 0.8 \times 10^{-7}, \beta = 40, R_s = 3, R_o = 100 \text{ ohms}, \]
\[ \omega = 10^6 \text{ and solving for } R_i C_i \]
\[ R_i C_i \approx 4.4 \times 10^4 \]

\( R_i \) is 400 ohms as dictated by other consider-
ations, which would make \( C_i = 1 \text{ \mu f} \). By ex-
tensive testing, it was found that an optimum
value for \( C_i \) was about 0.1 \text{ \mu f}. This large
discrepancy is apparently due to the assump-
tion that \( Z_{\text{out}} \) of the previous stage consists
merely of \( r_s \). Better results would be obtained
if Eq. 15 were used to calculate \( Z_{\text{out}} \) for the
appropriate value of \( \omega \).

Acknowledgements
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Reference
1. Heule & Walsh, "The Application of Transistors to
Computers", Proc. IRE (June, 1958.)
Gold-Plated Leads Can Cause Cold-Soldered Joints

Gold-plated leads have been overrated, says the author. It has been assumed that they enhance the reliability of a soldered joint but in some cases the gold-plating actually causes cold-soldered joints by dissolving into the solder bath and raising the solder's melting point. He believes that copper-nickel or copper-bronze-nickel-zinc alloy leads without plating are best for soldered joints.

![Fig. 1. Gold-plating causes cold-solder joints because it dissolves in the solder and raises the solder's melting point. Here 60/40 solder has been flowed onto a gold-clad nickel wire (from the right) with a 600°F soldering iron. The heavy 0.002-in. thick gold cladding has alloyed with the solder, freezing it, and caused the "cold-solder" look.](image1)

![Fig. 2. A collar of gold-tin-lead alloy was formed above the solder level when this gold-clad nickel wire was dipped for 5 sec in a 450°F 60/40 solder bath. The gold was removed from the immersed (right hand) end of the wire during the formation of this collar.](image2)

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With the increased stress on reliability, the materials used for the leads of the many small electrical parts which are soldered into printed-circuit boards or to terminals, are becoming critical. As a result, there has been a tendency to go somewhat blindly to exotic coatings for the leads. The purpose of this article is to show that merely specifying gold-plating on the leads can just as well be a step away from reliability as a step toward it.

Basically, it is necessary for the leads to be clean and easily soldered so that the soldering operation can be accomplished with only rosin flux and reasonably low temperatures to avoid damage to printed-circuit boards or other connections. In an attempt to provide reliable and easily soldered leads, several manufacturers have adopted gold-plated or gold-clad leads, basing this choice on the well-established fact that gold remains easily solderable, even after long storage. Gold-plated lead wire does not solve the problem, however, because the gold dissolves very readily in melted solder; and if the underlying metal is not solderable, a poor connection can result. (See Fig. 1.)

Gold-plated copper or brass lead wires probably will be satisfactory, because even if the gold is dissolved by the solder, the underlying metal is solderable using (activated) rosin flux.

An exception to this condition will occur if heavily gold-clad leads are used. There is enough gold on this type of wire to form an alloy of gold-tin-lead, with a melting point so high that it will not flow; and a "cold-soldered" joint will be formed.

Gold dissolves in melted solder and raises the freezing point of the solder. Thus, when only a small quantity of solder is used, it may be necessary to use a soldering iron having a temperature of 800°F, or even higher, to flow the solder properly. High temperatures are undesirable for several reasons:

- Soldering iron tips erode rapidly.
- Small-diameter wires of copper or bronze dissolve rapidly in solder.
- Laminated insulating boards and component parts are damaged.

Fig. 2 shows the result (in 5 sec) if a gold-clad nickel lead is immersed with slight agitation in tin-lead (60/40) solder at 450°F. The gold has been removed from the immersed area, and a collar of gold-tin-lead alloy formed on the wire lead above the solder level. A 1-sec dip of a heavily gold-plated nickel lead, however, was too short to permit the gold to alloy, but would also be too fast for practical wave, or dip, soldering.

Most printed-circuit soldering is done at low temperatures in wave-soldering or dip-soldering machines. But even a small amount of gold will quickly "contaminate" the solder, making it sluggish, so that the printed circuits will not be properly soldered. The gold which was dissolved from the leads by the solder remains in the solder pot; and there is no economically feasible method of removing the gold from the solder.

Gold-Plated Nickel-Wire Leads Not Solderable

Leads which are made of nickel wire, as is the case on tantalum capacitors, are not solderable if gold-plated. The gold dissolves and leaves the nickel lead exposed, and it is unsolderable with rosin flux.

If a moderately active flux is used, such as hydrazine mono-hydrobromide, nickel can be properly solder-alloyed. ("Solder-alloyed" describes the union between solder and another metal whereby it becomes difficult to separate...
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IN POWER SAMPLING, flat coupling full range eliminates coupling corrections; you have, again, the convenience of one unit for both incident and reflected power, plus high power handling ability, low SWR and low insertion loss making practical a permanent monitoring installation in transmission lines.

SPECIFICATIONS Model 760D, 250 to 1,000 MC, mean coupling 20 ± ½ db, coupling variation ± ½ db, minimum directivity 35 db, primary SWR (max.) 1.20, secondary SWR (max.) 1.25, power capacity 50 w CW, 10 kw peak, Type N connectors, price, $200.00. Model 761D, 1 to 4 GC, same except directivity > 30 db, primary SWR 1.25, secondary SWR 1.30, price, $185.00.

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Electronics Design - November 8, 1961
High-Density Electronic Packaging—Thermal Design

Components in tightly packed microminiature electronic assemblies are extremely susceptible to thermal damage. To achieve the high reliability demanded of High-Density Packages, thermal characteristics of components must be ascertained and proper heat transfer techniques applied.

The design steps involved in achieving proper thermal performance during initial assembly analysis, rather than last-minute haste, are outlined. Previous articles relating to HDEP have appeared April 12, May 10, May 24, and July 19.

Charles Kadlec
Samuel Francis
The Sippican Corp.
Marion, Mass.

CLOSED control of component temperature is an important consideration for tightly packed assemblies specified for high-reliability systems. High-Density Electronic Packaging (HDEP) increases the heat-dissipation density and the intercomponent heat transfer; high power dissipation components must be kept within rated operating temperature to minimize failures.

Heat Transfer by Conduction
Key to Successful Thermal Design

It has always been recognized that individual component temperatures, rather than cold-plate or exhaust-air temperatures, are the important factors in system reliability since failures occur at the component level. However, actual calculation of individual component temperatures has been generally considered too complex and time consuming, especially in conventional designs where components are exposed to the ambient gas and the heat is removed primarily by natural or forced convection. In HDEP, the components are encapsulated in epoxy compounds of known thermal characteristics. The heat is removed from the components by conduction, which is not affected by changes in altitude or surface conditions. Simple shapes and simple heat exchangers are used in the design of the heat path from the circuit module to the outside heat sink. This results in economy of fabrication and relative ease of thermal analysis, using well-known heat transfer equations and empirical data (refer to the material listed in the Bibliography for detailed explanation of heat transfer theory and data on heat exchangers). Even transient temperatures may be evaluated analytically, with a minimum of approximations and adequate accuracy, using graphical or numerical methods.

As a result, the thermal performance of the design can be predicted and excessive component temperatures can be eliminated at the design stage. This step is in agreement with high reliability design thinking.

To further aid in the thermal design, a procedure has been developed which helps to quickly identify those components which require the most careful analysis, as well as those components which are unlikely to cause trouble. The procedure, based on the flow of information shown schematically in Fig. 1, consists of a preliminary analysis of the operational requirements, the thermal environment and the components. The operational requirements and the thermal environment are combined to determine the worst situation from the thermal point of view. The components are analyzed to determine their rating (maximum allowable surface temperature vs dissipation) required by the specified system reliability. Then, the circuit is analyzed to obtain the maximum dissipation for each component. The maximum operating surface temperature is thus determined for each component and finally, thermal design, to maintain the components below their maximum temperatures under the worst combination of thermal environment and required operation, can proceed in detail.

Operational Requirements of a Typical High Density Package Assembly

The following operational requirements should be listed:

1. Storage (nonoperating)
2. Ground operation (test and equipment calibration)
3. In-flight operation
   a. Transient (short-term)
   b. Steady-state (long-term)

The distinction between transient and steady-state operation is made on the basis of the anticipated thermal time constant of the package which is usually a few minutes to an hour. The thermal time constant can be evaluated at this stage from the proposed weight, size, and dissipation of the package (the dissipation will indicate how good a thermal path there must be to the environment; in general, the higher the dissipation, the shorter the time constant).

Last, the required warm-up time, if any, should be determined. Equipment which requires rapid warm-up from low temperatures may require heaters and complex tem-
perature control equipment.

Analysis of the Thermal Environment: The purpose of this analysis is to determine the most important means of heat removal that the package will use. Sometimes this is obvious, as when cooling fluid or gas is supplied, but more often a decision must be made.

The following means are available to remove the heat dissipated by the circuitry:
- Conduction to the mounting structure.
- Free convection to the surrounding atmosphere.
- Forced convection to a fluid or gas supplied to the package.
- Evaporation of a fluid either supplied to the package or stored.
- Radiation to the surrounding equipment or the surrounding space.

Of the above, conduction, free convection, and radiation will always be present to some extent, and may either remove heat from the package or add to the heat dissipated by the package. For example, a package may be cooled by forced convection to a lower temperature than the ambient air, in which case heat is added from the air. This will increase the amount of heat which must be removed by the cooling fluid.

To reach a decision regarding the primary means of heat removal, the expected characteristics of all the available means should be listed for all types of required operation. The important characteristics are:

- Conduction—maximum and minimum temperature of the mounting structure.
- Free Convection—maximum and minimum temperature and density of the ambient air. It should also be ascertained that the sides of the package are not in close proximity to some other equipment. This would seriously impair free convection.
- Forced Convection—maximum and minimum temperature and pressure of the cooling fluid or gas, and the available pressure drop across the package.
- Evaporation—amount of fluid available and the maximum and minimum ambient pressure.

Radiation—maximum and minimum temperature of the surroundings and their emissivity.

Any of the above may change with time, sometimes very quickly. Such conditions must be carefully described to avoid designing for a situation that actually will not exist; for example, the skin of a missile reaches very high temperatures a few seconds after launch, but the equipment mounted to it on the inside, because of its thermal time constant, is able to operate for several minutes at relatively low temperatures.

MIL-E-5400D describes the standard environment for airborne military equipment and is often used in specifications in lieu of a detailed description of the thermal environment. Another possible source of information is the specification for testing of the equipment, which usually includes a test simulating the extremes of the expected thermal environment.

Preliminary Thermal Design: At this point, the general package layout, compatible with the selected means of cooling, is established. The various methods that have been used to remove the heat from the circuit modules are shown in Fig. 2. The designs are such that each circuit module has one or more sides in contact with a metallic foil or plate (called the "cooling foil") which is in turn connected to either the mounting structure or the side of a heat exchanger. The cooling foils are made of soft aluminum which deforms under the compressive load applied by the bolt and thereby provides a good thermal contact with the circuit module. Aluminum is used because it is the best heat conductor on a weight basis (copper and silver are better on a volumetric

Fig. 2. Various methods of removing heat from a circuit module involve the transfer of heat through a plate or foil to a heat exchanger.
basis). This statement is verified by the relationship of thermal conductivity and density for aluminum vs copper:

$$\frac{K_{al}}{\rho_{al}} = 0.795 \text{ BTU-ft}^2 \text{ hr-F-lb} \rho_{al}  > \frac{K_{cu}}{\rho_{cu}}$$

$$= 0.402 \text{ BTU-ft}^2 \text{ hr-F-lb}$$

The thickness of the cooling foil is important because it determines the temperature gradient in the foil. For example, assume that a circuit module dissipates a total of 0.5 w and has a cooling foil 0.020 in. thick attached to one of its sides which has the dimensions of 2.5 x 1.5 sq in. The temperature distribution can be evaluated using the equation for a flat plate with uniformly distributed heat sources which implies that the heat input from the circuit module is uniform. The maximum temperature difference along the length of the cooling foil is given by:

$$\Delta t_{max} = \frac{\dot{q} L}{2K}$$

where

$$\Delta t = \text{max temperature difference along length of cooling foil}$$

$$\dot{q} = \text{heat dissipation per unit volume of cooling foil}$$

$$L = \text{length of cooling foil}$$

$$K = \text{thermal conductivity of aluminum, } 100 \frac{\text{BTU}}{\text{hr-ft}^2\text{-F/ft}}$$

Substituting the given values and converting to a consistent set of units:

$$\Delta t_{max} = \frac{(3.413)(0.5)}{(2.5)(1.5)(0.020)^2} = 8.5 \text{ F}$$

This is an acceptable value. Now consider a different circuit module, dissipating 0.75 w and having a cooling foil 0.02 in. thick attached to one of its sides which is 3.5 x 1 sq in. The maximum temperature difference for this cooling foil is:

$$\Delta t_{max} = \frac{(3.413)(0.75)}{(3.5)(1)(0.020)^2} = 26.9 \text{ F}$$

This is probably too high and the thickness of the cooling foil must be increased or the dimensions of the circuit module changed.

The rest of the heat path is analyzed similarly. The resistance at the interfaces of metal parts can be estimated from available information on "contact coefficients". When this is done, the temperature gradients along the path are added to give the total temperature difference from the heat sink to the cooling foils (see Fig. 3).

The temperature of the cooling foil thus evaluated will be used to determine how the components should be distributed among the circuit modules.

To evaluate the temperature of the cooling foils under transient conditions, a theoretical model of the thermal path is drawn (see Fig. 4). Then, by either numerical or graphical methods, such as the Schmidt plot, the temperature vs time of the cooling foil can be obtained with a good accuracy. Fig. 5 shows the results for a package mounted to the inside of a missile skin.

To prevent excessive temperatures at the end of the required operating time, the package must have an adequate thermal capacity. The addition of mass for this purpose is not desirable, from the point of view of both weight and efficiency. The specific heat of most materials is about 0.25 BTU lb-F, but the addition of a material which will change phase at a temperature below the maximum allowable component temperatures is a very good solution. One such material is a stearic acid compound which melts at about 85 C. The heat of fusion of this compound is in the order of 70 BTU/lb. In one application, a small copper container was built and filled with such a compound. The components (mostly Zener diodes) were cemented to the container and the whole assembly encapsulated as a circuit module. The components will operate at 85 C as long as some of the compound is melting.

*Available from the Armour Industrial Chemical Co. as "Armid C".*

**TABLE 1. Thermal Characteristics of Several Encapsulating Compounds**

<table>
<thead>
<tr>
<th>Materials</th>
<th>Specific Gravity</th>
<th>Thermal Conductivity BTU/hr ft²/F/in</th>
<th>Volume Resistivity ohm-cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eccofoam</td>
<td>0.37</td>
<td>0.36</td>
<td>1 x 10⁶</td>
</tr>
<tr>
<td>Hi K 625D (1)</td>
<td>0.8</td>
<td>0.8</td>
<td>1 x 10⁶</td>
</tr>
<tr>
<td>Stycast 1095 (1)</td>
<td>1.4</td>
<td>3.1</td>
<td>1 x 10⁶</td>
</tr>
<tr>
<td>Stycast 1231 (1)</td>
<td>2.5</td>
<td>12.3</td>
<td>1 x 10⁴</td>
</tr>
<tr>
<td>P33 (2)</td>
<td>2.8</td>
<td>1.100</td>
<td>2.8 x 10⁶</td>
</tr>
<tr>
<td>Aluminum</td>
<td>3.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

References:
Preparation of a List Containing Component Thermal Characteristics

Before an intelligent breakdown of the system into modules can be made, it is essential that each component be listed with its pertinent thermal characteristics:

1. The rating (maximum surface temperature vs dissipation) obtained from reliability considerations.
2. The maximum dissipation obtained from an analysis or test of the circuit.
3. The dimensions of the component, obtained from the manufacturer or by actual measurement.

While this type of information is normally collected for component specifications, this is generally so late as to preclude its effective use in design. Rigorous, persistent pursuit of this information before design commences is essential.

Arrangement of Components For Optimum Thermal Design

The heat transfer inside an encapsulated circuit module occurs by conduction from the components and their leads to the encapsulating compound. The purpose of the thermal design is to provide a sufficient thermal path between each component and the cooling foil. To do this as efficiently as possible, components that require the same thermal path should be placed in the same circuit module. Naturally, other requirements, such as the electrical logic interconnections, often conflict with such an arrangement and a compromise must be selected.

The thermal path required by each component is calculated from the information already tabulated on the component lists. The equation which describes one-dimensional conduction is rearranged as follows:

\[
\frac{Q}{(\Delta t)(A)} = \frac{K}{X}
\]

where

- \(Q\) = maximum dissipation of the component
- \(\Delta t\) = difference between the maximum allowable surface temperature of the component and the estimated temperature of the cooling foil
- \(A\) = cross-sectional area of the component perpendicular to its leads
- \(X\) = required thermal path

If components with the same value of \(K/X\) are placed in the same circuit module, they will operate at the same proportion of their maximum allowable surface temperature if no lateral heat transfer takes place. Lateral heat transfer will occur if there are temperature differences between adjacent components. Therefore, it is desirable to arrange the components in the circuit module in a way which minimizes the temperature difference between adjacent components. For example, the component which has the highest allowable surface temperature is placed at the center of the circuit module and the other components are arranged toward the outside of the module in order of decreasing allowable surface temperature.

The value of \(K/X\) for each component is tabulated on the component lists to give the layout designer a quick reference of the thermal requirements of each component.

After the components have been allocated to the various circuit modules, the type of cooling method for the whole circuit module is determined. There are two possible approaches for cooling modules:

1. Selection of encapsulating compound.
2. Use of metallic conductors.

For the first case, an encapsulating compound is chosen which has an adequate thermal conductivity. As seen from Table 1, the weight of the encapsulating compound increases with increased thermal conductivity, so that appreciable weight savings can be achieved by careful selection of the final compound.

The second option, metallic heat conductors, is usually employed when it is impossible to remove component heat by encapsulation in a potting compound having the highest available thermal conductivity. Metallic heat conductors are also useful in the case where a component with a high thermal path requirement (high value of \(K/X\)) must be placed in a circuit module having components with much lower thermal path requirements (see Fig. 6).

The actual operating component temperatures are evaluated after a preliminary layout of the circuit module has been made and an encapsulating compound has been chosen. Knowledge of the internal construction of a component helps in estimating the amount of heat which will be removed by the leads (usually about 50 per cent). The leads, being connected to metallic conductors in close proximity to the cooling foil, provide a low-resistance path from the point of attachment to the component. The remainder of the heat will be conducted in three dimensions by the surrounding encapsulant. An evaluation of the effective cross-sectional area in the axial direction is made according to the spacing shown by the preliminary layout. The temperature difference is then calculated using this area, the amount of heat not removed by the leads, the thermal conductivity of the encapsulant, and an average distance along the axis of the component.

The results of this calculation will show whether or not the selected encapsulant is adequate. It may be found at this point that metallic heat conductors are preferable to a highly filled epoxy encapsulant, or that a rearrangement of the components results in a more satisfactory thermal design.

The final recheck of component temperatures is usually confined to those components whose location was a compromise due to other requirements and to those components whose performance was predicted to be marginal and thus subject to failure.

Bibliography

Cited References

General Reference Literature
Go-no-go testing, particularly when many different voltage levels must be monitored, can call for a lot of complicated and expensive equipment. In this article, authors Gile (left) and Newbigging describe a circuit which can be used in just about anyone's check-out equipment.

**Fig. 1.** Reactron monitoring circuit consists of two regenerative, complementary transistor trigger circuits.

**William W. Gile and David F. Newbigging**
Seismological Laboratory
California Institute of Technology
Pasadena, Calif.

**IDEALLY,** electronic equipment used for go-no-go testing should be accurate, fast and inexpensive. In our work with such testing, we designed a monitoring circuit which, compared with commercially available units, could perform just as accurately, had a faster speed of response, and cost considerably (up to 90 per cent) less. The design, which we call the "reactron" circuit, may be applied to monitor any signal that can be transduced to a varying dc level.

Basically, the circuit acts as a high and low-level voltage comparator. That is, if the applied signal goes above or below any pre-selected levels for a duration of 0.1 µsec or longer, the device will "trigger." This in turn may operate a relay, light a lamp, initiate a command function, etc.

Major specifications of the reactron are listed in the table. The circuit, Fig. 1, consists primarily of two complementary npn-pnp monostable, highly regenerative, trigger circuits. In Fig. 2 the circuit is shown laid out on a modular plug-in card.

The primary factors that influenced the selection of the transistor types were:

1. **High Beta.** This was desired for high regeneration within the trigger circuit.

2. **Low $I_{bc}.$** This characteristic allows the device an operating temperature gradient without excessive trigger-point level changes.

3. **Conduction Hysteresis.** Of the many types of transistors evaluated, several exhibited a nonrepeatable gain factor when going from cut-off to low conduction. Since the repeatability of...
Table 1. Specifications for Reactron* Monitoring Circuit.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger point accuracy</td>
<td>That of the reference ±35 μV</td>
</tr>
<tr>
<td>Thermal drift</td>
<td>Less than 30 μV per deg C</td>
</tr>
<tr>
<td>Response</td>
<td>Will trigger at any pulse, transient, or level change greater than the preset limits, that last longer than 100 μsec.</td>
</tr>
<tr>
<td>Stabilization time</td>
<td>10 min</td>
</tr>
<tr>
<td>Input impedance (dc)</td>
<td>Greater than 10 meg.</td>
</tr>
<tr>
<td>Input impedance (ac)</td>
<td>Varies as a function of amplitude and frequency. Always greater than 2.5 K.</td>
</tr>
<tr>
<td>Input trigger range (upper and lower limits)</td>
<td>Adjustable within ±2.0 vdc of the signal to be monitored.</td>
</tr>
<tr>
<td>Input signal range</td>
<td>No practical limits</td>
</tr>
<tr>
<td>Cost</td>
<td>Under $150.00</td>
</tr>
</tbody>
</table>

The trigger point is a function of the repeatability of the transistor gain factor, this had to be considered.

The operation of both the npn and pnp sections of the circuit is identical except for polarity. Thus, a description of the circuit's operation can be concerned mainly with the pnp side.

The input transistor Q1 is biased to cut-off by feedback through resistor R8. The "reaction" transistor Q2 is biased slightly into saturation via feedback through R4. The negative-going trigger point is selected by adjusting potentiometers R2 and R7. Potentiometer R7 acts as a coarse adjustment and is returned to the collector supply. This supply furnishes an emitter potential 0.5 v more positive than the desired negative-level trigger point. This gradient compensates for the emitter-base voltage drop across Q1.

Monitor Can Be Set
To Trigger At Any Levels

Suppose that the desired voltage to be monitored was +10,000 vdc and the trigger points were to be +10.020 and +9.980. Pin "E", the collector supply for the negative sensing side, would be returned to a voltage supply that was 20. ±2 vdc more negative than the input signal. This supply would then be -10. ±2 vdc. The positive-sensing-

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side collector supply pin, "L", would be returned to a supply that was 20. ±2 vdc more positive than the input signal, or, in this case, +30. ±2 vdc.

Since the emitter potentials of Q1 and Q2 must be of approximately the same magnitude as the signal to be monitored, the returns of potentiometers R7 and R14 would be connected to the +30. ±2 vdc supply (for monitoring the +10.0 vdc level). Trigger-point adjustment would be made by connecting the desired trigger level potential to pin "A" and adjusting potentiometers R2 and R7. The fine adjustment potentiometer R2 is a 20-turn carbon trimpot. This was selected to provide infinite resolution.

The circuit is reset manually by SW-1. In the case of a high-speed transient that causes the circuit to "set", return of the signal voltage to the "normal" level will not reset the circuit. Reset is accomplished by selecting the ratio of resistors R5 to R3 and R8 to R4. Transistors Q3 and Q6 are standard "normally off" and "normally on" light drivers. Since the collector voltages at points "E" and "L" are determined indirectly by the signal to be monitored, the light drivers must be biased off regardless of the voltage level feeding resistors R6 and R20. This is done by inserting bias resistors at points "F" and "M" and connecting them to positive or negative supplies determined by the respective collector-voltage swings.

Let us illustrate how these connections are made by again considering the +10.0 vdc signal condition. The collector swing on Q2 will be approximately from +10.0 vdc during conduction to -10.0 vdc during triggering. In this case, no external bias resistor on pin "F" would be needed. The "normal" state would reverse-bias Q3 and the "triggered" state would cause sufficient current flow through R6 for conduction.

On the positive-sensing side the collector swing of Q5 would be from +10.0 vdc to +30.0 vdc. A resistor must be inserted at point "M" and returned to a negative supply to provide turn-on current for Q6.

If we were to return this resistor to the -10.0 vdc supply, we could determine its value by making a Thevenin equivalent for the base of Q6. Thus we would find that the nonconducting state is represented by a voltage of +7.56 vdc through a 5-K resistor. If a reverse bias of +1.0 vdc rather than +7.56 vdc is desired, the resistor to be connected to the -10.0 vdc supply would be 8.40 K.

Making a Thevenin equivalent of the base of Q6 during conduction yields a circuit which has -1.97 vdc through 3.8 K, or a base current in Q6 of 0.635 ma. This is sufficient to cause Q6 to saturate. In actual practice the nearest standard resistor value is selected and used.

Current Feedback Produces High Dynamic Input Impedance

An interesting feature of the circuit is its extremely high dynamic input impedance. This is the result of current feedback through resistors R8 and R15. Transistors Q2 and Q5 are biased at borderline saturation. Thus there exists a collector potential on both Q2 and Q5 when they are in the conducting state (Vc, sat). These opposite polarity potentials cancel when coupled through R1 and R12, resulting in zero signal current flow at the optimum level. As the input signal shifts toward either of the trigger points, the reaction transistor (Q2 or Q5) senses that polarity shift and begins to come out of saturation. This results in feedback, through R8 or R15, of a potential that is the same as the input swing. This feedback is not cancelled by the reaction transistor opposite to the input swing due to its relative position on the saturation curve. The
over result and that they dependent approximate

The mathematics of design are primarily dependent upon the type of transistors used. They follow the normal "flip-flop" technique with but one exception. It has been found that if the collector resistors are kept to the approximate ratio of 50:1 and the biasing resistors approximately 12:1 (see $R_3$, $R_5$, and $R_4$, $R_8$), extreme stability results. The normal procedure in design would be to select the collector load of the reaction transistor ($Q_2$ or $Q_5$) to be of optimum value for the current desired. Its value is then multiplied by 50 to find the load for $Q_1$ or $Q_4$. The value of $R_4$ or $R_{17}$, the base feedback resistors, would then be: $R_b = R_{17} (\beta - 50)$ where beta is greater than 50. The opposite feedback resistor ($R_8$ or $R_{15}$) would then be $R_{fb} = 12 (R_b)$ and $R_{fb} = 12 (R_b)$.

The above empirical description will satisfy the circuit condition for high-impedance loading (light drivers, etc.); for heavier loads the normal precautions must be taken. The emitter potentiometers must be small enough to stabilize the operating point. Normally, this condition will be met if:

$$R_1 = 0.25 (R_b) \text{ and } R_2 = 10 (R_b)$$

Two Supplies Are Sufficient For Multiple Signal Monitoring

In making use of the reactron some choice is allowed in selecting the respective collector supplies. It has been found that many different signal levels may be monitored with the use of only two supplies. One console, designed for the Missuteman Missile monitored approximately 60 signals derived from a telemetry package during vibration testing. All of the input signals were within the 0 to 50 mV range. Some signal limits were as close as ±10 mV. Under these conditions it was possible to connect all 60 reactors to only two supplies. (Also included within the console was circuitry for transducing frequencies, pulses, sine and square wave amplitudes, temperatures, etc. to dc voltages that can be monitored). This, of course, indicates the versatility of the circuit.

Another example of the reactron may be seen in Fig. 3. This circuit was designed for a lunar exploration seismometer levelling device presently being developed by the California Institute of Technology. The design is still based on reactron monitoring; however, this circuit provides an input time constant delay, automatic discharge of the time constant and automatic reset.

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| DC OUTPUT VOLTAGE: | 120-235 V DC or 325-525 V DC |
| DC OUTPUT CURRENT (MA): | 200, 400 or 800 |
| LINE AND LOAD REGULATION COMBINED: | = (0.1% + .05 V) |
| RIPPLE: | 2 millivolts RMS |
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PRODUCT FEATURE

Army (ARGMA) application of Becon connectors: In this case the connectors are screw fastened to the top and bottom boards but adapter strips permit the smaller boards to be plugged in. Only disadvantage noted by this user was the weight of the connectors.

Board-to-Board Connector Creates Package Flexibility

NEW arrangements for assemblies of printed-circuit boards are permitted by a recently developed combined connector-mounting device. The “Becon” connector, which is being offered by the Brown Engineering Co., P. O. Box 917, Huntsville, Ala., was conceived at the National Aeronautics and Space Administration’s Marshall Space Flight Center, also in Huntsville. The Becon has flown on a successful Juno-II satellite boost and is being used on the large Saturn rocket. However, a Marshall Center engineer cautioned ELECTRONIC DESIGN that time has not permitted reliability histories to be fully developed.

The manner in which this new connector increases a designer’s freedom is symbolized on this issue’s cover. As the cross sections indicate, the connector is but a block of dialyl phthalate plastic into which have been molded grooves to carry the contact fingers and tapped bushings for the hold-down screws. The contacts are springs of beryllium copper ribbons, gold plated.

When a printed-circuit board is screwed down onto this connector, the protruding contacts are compressed (with some wiping action) against the mating conductors on the boards. A virtue of this simple type of connection is that it can be placed anywhere on the board. The designer is not limited to inserting one end of the board into a connector or soldering board.

Thus the board arrangement patterns can be as regular as most conventional arrangements or very irregular, as long as the boards are either parallel or at right angles to each other. For example, the combined electrical and mechanical interconnection ability of the Becon could be used, first with the 180-
The 1.200-in. high by 1.600-in. wide 180-deg version can be used for stacking in parallel planes.

The 0.375-in. sq. 3.5-in. long 90-deg version is for joining boards at right angles.

deg types to stack the boards one on top of the other in parallel planes. Then the 90-deg types could be used to right-angle smaller boards off the main boards.

Prices for the connectors start at $3.74 each for the 10-contact, 90-deg; $5.46 for the 20-contact 90-deg; and $7.38 for the 10-contact 180-deg. These are for sample quantities up to nine connectors and the prices have the usual decrease with quantity. Availability is from stock for quantities of fewer than 150 units and within 30 days for larger quantities.

For more information on these connectors turn to the Reader-Service Card and circle 250.

Norden Miniature All-Attitude Inertial Platform uses four Inland torque motors, one for each gimbal axis.

Norden specifies these Inland d-c torque motors because of their compact pancake shape, low-power input and direct torquing. In addition to providing the obvious weight and space reduction, Inland's direct drive positioning eliminates gear train problems such as backlash.

Norden engineers say, "The linearity of the Inland torquers is excellent over a wide range so that precession rates may be accurately established. The torquer fixed field is carefully stabilized so that the torque gradients will be constant over long periods of time."

Inland d-c pancake torque motors with high torque-to-inertia ratios and linearity of output provide all the advantages of direct gearless servo positioning in a complete line over the full range of 0.1 to 3,000 pound-feet.

### COMPARE THESE TYPICAL INLAND TORQUER RATINGS

<table>
<thead>
<tr>
<th></th>
<th>T-1321-A</th>
<th>T-2136-A</th>
<th>T-2108-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak torque, oz.</td>
<td>20.0</td>
<td>25.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Volts at peak torque, stalled at 250°C</td>
<td>48.0</td>
<td>26.0</td>
<td>25.6</td>
</tr>
<tr>
<td>Amps at peak torque</td>
<td>1.21</td>
<td>1.6</td>
<td>1.24</td>
</tr>
<tr>
<td>Total friction, oz. in</td>
<td>0.5</td>
<td>0.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Rotor Inertia, oz. in sec²</td>
<td>.001</td>
<td>.007</td>
<td>.011</td>
</tr>
<tr>
<td>Weight, oz.</td>
<td>5.0</td>
<td>9.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Dimensions (inches)—O.D.</td>
<td>1.937</td>
<td>2.81</td>
<td>2.81</td>
</tr>
<tr>
<td>I.D.</td>
<td>.625</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Thickness</td>
<td>.50</td>
<td>.63</td>
<td>1.00</td>
</tr>
</tbody>
</table>

For complete catalog with engineering data, outline drawings and specifications on these and other Inland d-c pancake torquers, write Inland Motor Corporation of Virginia, Northampton, Massachusetts., Dept. 3-8.
In all phases of planning for high-alumina ceramic-to-metal seals you can rely on Alite for the “know-how” and “do-how” required to produce highest quality for critical applications.

From design to finished part, every manufacturing step — including formulating, firing, metalizing and testing — is handled within our own plant and carefully supervised to assure strict adherence to specifications, utmost uniformity and reliability.

To simplify design problems and speed delivery, Alite terminals, feed-throughs and cable end seals are available in over 100 standard sizes.

ABOUT 1,000 times more light-sensitive than photovoltaic cells, these photoconductive cells are designed for light-dependent control applications. They are available in four basic sizes: a “Compactron” type; a 9-pin type in a conventional tube envelope; a medium size and a miniature type, each with flying leads.

The “Compactron” type and the two smaller cells are end-illuminated while the fourth is side-illuminated. The units, manufactured by the Receiving Tube Dept. of General Electric, Owensboro, Ky., are hermetically sealed to protect the photoconductive material from moisture.

The “Compactron” type Z-2946 and the conventional-tube envelope type 7427 are all-glass while the medium-size cell Z-2963 and the miniature Z-2755-1 are of metal-to-glass construction. All the cells operate over a range of 1,400 A. The wavelength of maximum response is 5,500 A which is the center of the visible light spectrum.

Both the “Compactron” type and the 7427 have essentially the same ratings. Power dissipation is about 100 mw; max current is 50 ma and max applied voltage is 350 V.

The “Compactron” envelope, because it is bottom-evacuated, lends itself to the end-illumination design. Its 12-pin feature provides extra tie points, socket adaptability and ruggedness. Seated height is less than 1 in. It can be used for street-lighting control and other area or residential-lighting applications. The seated height of the 7427 is 2.25 in.

The medium-size cell was developed for cfr picture-brightness and contrast control. Its power dissipation is about 250 mw, max current is 20 ma and max applied voltage is 250 V. The outside diam is a little more
Cells For Industrial Use

than 0.6 in. and height, excluding leads, is about 0.3 in.

The miniature cell is 0.37 in. in diam and 0.22 in. in height, excluding leads. Power dissipation is 50 mw; max current is 2 ma and max applied voltage is 3 V. Among the applications are camera-aperture controls and toys.

Factory life-test results for the units are impressive. During life-tests of 20 lots of 7427s, totaling 200 units and 100,000 hours of device operation, there were no failures. All 200 tubes were checked for dark current, light current and 350-v breakdown periodically during the test periods. Variations in these characteristics were negligible.

Among the uses for photoconductive cells are in anemometers, blood-pressure gages, card sorters, computer-logic circuits, radiation detectors and crt brightness controls.

Prices to original-equipment manufacturers are 85 cents for type Z-2963 and 80 cents for type Z-2755-1. Prices for the larger cells are in the $1 to $2 range. The 7427 is available from distributors, the other three are available in sample quantities. For more information on these photo-conductive cells turn to the Reader-Service Card and circle 251.

Measures wide range of waveforms with

1/4% ACCURACY

For highly accurate voltage measurements, the uncertainty introduced by waveform distortion limits the use of average and peak-responding instruments. The Model 350 is a 0.25% accurate true rms-responding instrument designed to overcome this limitation. It provides the engineer with a rugged, reliable and easy-to-use laboratory or production line instrument. It will measure a periodic waveform in which the ratio of peak voltage to rms is not over 2.

The method of measurement with the Model 350 is similar to balancing a bridge: four knobs are set for minimum indication and the unknown voltage is read directly from a 4 to 5 digit NIXIE® in-line readout. The precision exceeds the stated accuracy by 5 to 10 times.

Price: $720.

SPECIFICATIONS

Voltage Range . . . . 0.1 V to 1199.9 V
Accuracy . . . . 5%, 100 cps to 10 kc. 0.1 V to 300 V. ½% outside these limits
Frequency Range . . . . 50 cps to 20 kc
Max Crest Factor . . . . 2
Input Impedance . . . . 2 MΩ shunted by 15 pf to 45 pf

Write for brochure giving many more details

BALLANTINE LABORATORIES INC.
Boonton, New Jersey

CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS. REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM WE HAVE A LARGE LINE. WITH ADDITIONS EACH YEAR ALSO AC-DC AND DC-AC INVERTERS, CALIBRATORS, CALIBRATED WIDE BAND AMPLIFIER, DIRECT READING CAPACITANCE METER. OTHER ACCESSORIES.

ASK OUR LABORATORY VOLTAGE STANDARDS TO 100 KW.

CIRCLE 46 ON READER-SERVICE CARD
SCR Trigger Provides High Stability Firing

Designed specifically for industrial controlled-rectifier firing circuits, the SCR trigger is a silicon transistor which exhibits a negative resistance characteristic when a predetermined emitter-to-base firing voltage is exceeded. This characteristic is stable over a temperature range of -65 to +140 C. Rated rms power dissipation is 250 mw; max rms emitter current is 50 ma. Permissible emitter reverse voltage is 30 v max and interbase voltage is 35 v max. Units are encased in a TO-18 package.

International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.

P&A: $3 ea. 1 to 99; from stock.

Semiconductor Networks Measure 1/4 x 1/8 x 1/32 In.

The series 51 includes six different digital circuit modules which will handle 90% of the circuit functions of digital equipments, particularly for military computers, programmers and other information processing application functions. Each silicon network is contained in an hermetically sealed package measuring 1/4 x 1/8 x 1/32 in. Produced to meet the requirements of military applications, they have design compatibility with present-day digital circuitry and operate over a temperature range of -55 to +125 C. The SN 510 flip-flop and the SN 512 and 514 NOR/NAND gates have power drain of 2 mw while the power drain of the emitter-follower units SN 511 and 513 is about 8 mw for Vd of 3 v.

Texas Instruments Inc., Dept. ED, 13500 N. Central Expressway, Dallas, Tex.

P&A: $50 to 265 for quantities of 1,000; immediate.

Vaneaxial Blowers Have 2-In. Diameter

Up to 50 cfm at 2.1 H20 back pressure is produced by vaneaxial blowers designated VAX-2-MC. Maximum length of the unit is 1-1/2 in.; diameter is 2 in. The blower motor can be wound for 115 v ac, 1- or 3-phase, 400 cph or 200 v ac, 3-phase 400 cph. Maximum power for the 3-phase version is 45 w at 65 cfm free air delivery. The unit weighs 5 oz and is designed to meet appropriate MIL specifications for environmental protection.


P&A: factory price; some from stock.
Silicon Controlled Rectifiers Have In-Line Configuration

Newly developed packaging techniques allow miniaturization with no loss of sensitivity, cutoff characteristics or inherent reliability, in silicon controlled rectifiers types 3F15 through 3G200. Both conventional outline and new in-line configuration for welded modules and printed circuits are available with 2-ma triggering, dc ratings to 200 v and 350 ma with pulse capability to 10 amp.


P&A: from $25.50 ea in lots of 100; immediate.

Operational Amplifier Has No Choppers Or Modulators

A miniaturized plug-in, the P65 differential operational amplifier is designed primarily for instrumenting, controlling and computing. Containing no choppers or modulators, it has a direct-coupled input circuit with a differential input range of ±10 v and a common-mode rejection of about 10,000 to 1. Output range is ±1.1 ma at ±11 v. High temperature characteristics of silicon transistors used in the P65 provide an operating range of -20 to + 85 C.


P&A: $95; immediate delivery is possible for small quantities.

KEPCO "ABC" POWER SUPPLY

Its small, lightweight design makes the Kepco "ABC" Power Supply equally at home on the test bench for R & D, rack-mounted as a system element, and chassis-mounted as a modular component.

Its precise, versatile capability makes it compatible with stringent and varied applications:
- Line/Load Regulation: 0.05% □ Stability: 0.05% or 6mv, whichever is greater □ Ripple: 0.5mv RMS □ Input: 105-125v ac, 50-440 cps □ Constant Current □ Remote Programming at 1000 ohms per volt □ Remote error sensing: to maintain regulation at the load □ Automatic overload protection □ Adjustable current limiting.

Its Low Price is achieved by efficient design without sacrifice in quality and reliability.

KEPCO "ABC" POWER SUPPLY

<table>
<thead>
<tr>
<th>MODEL</th>
<th>DC OUTPUT RANGE</th>
<th>VOLTS</th>
<th>CURRENT</th>
<th>Dimensions</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC 30-0.3</td>
<td>0-30</td>
<td>0-300 ma</td>
<td>4½&quot; x 8½&quot; x 5½&quot;</td>
<td>$99.00</td>
<td></td>
</tr>
<tr>
<td>ABC 40-0.5</td>
<td>0-40</td>
<td>0-500 ma</td>
<td>4½&quot; x 8½&quot; x 9½&quot;</td>
<td>$139.00</td>
<td></td>
</tr>
<tr>
<td>ABC 7.5-2</td>
<td>0-7.5</td>
<td>0-2 amp</td>
<td>4½&quot; x 8½&quot; x 9½&quot;</td>
<td>$139.00</td>
<td></td>
</tr>
<tr>
<td>ABC 15-1</td>
<td>0-15</td>
<td>0-1 amp</td>
<td>4½&quot; x 8½&quot; x 9½&quot;</td>
<td>$139.00</td>
<td></td>
</tr>
</tbody>
</table>

For meter: Add suffix "M" to Model No. and $20.00 to price. Rack Adapter, Model RA-4 (for 2 units), RA-5 (for 1 unit) available at $15.00 each.

WRITE FOR COMPLETE SPECIFICATIONS.
SIZE 5 COMPONENTS
FOR SERVO SYSTEM MINIATURIZATION

A complete family of Size 5 components for every servo system function is now available from Kearfott. Stainless steel housings, shafts and bearings protect the units against environmental extremes and contribute to stability under shock, vibration, and temperature fluctuations. - Standard 26-v, 400 cps excitation.
- Operating temperature range -55°C to +125°C.

CHARACTERISTICS

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>VOLTAGE (400 cps)</th>
<th>NULL (mv)</th>
<th>ERROR (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CJO 0555 100</td>
<td>26</td>
<td>454</td>
<td>34</td>
</tr>
<tr>
<td>Control Transformer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low CJO 0555 900</td>
<td>11.8</td>
<td>1.765</td>
<td>34</td>
</tr>
<tr>
<td>High CJO 0555 900</td>
<td>11.8</td>
<td>1.765</td>
<td>34</td>
</tr>
<tr>
<td>Differential</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CJO 0555 100</td>
<td>11.8</td>
<td>1.154</td>
<td>34</td>
</tr>
<tr>
<td>Resolver</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low CJO 0585 100</td>
<td>26</td>
<td>1.0</td>
<td>34</td>
</tr>
<tr>
<td>High CJO 0585 100</td>
<td>26</td>
<td>1.0</td>
<td>34</td>
</tr>
</tbody>
</table>

SERVO MOTORS

<table>
<thead>
<tr>
<th>MOTOR GENERATORS</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No-Load Speed</td>
<td>900 rpm</td>
<td>9000 rpm</td>
<td></td>
</tr>
<tr>
<td>Stall Torque</td>
<td>0.10 in oz</td>
<td>10 in oz</td>
<td></td>
</tr>
<tr>
<td>Rotor Moment of Inertia</td>
<td>0.175 gm^-1 cm</td>
<td>0.175 gm^-1 cm</td>
<td>10</td>
</tr>
<tr>
<td>Voltage a1/p2 (400 cps)</td>
<td>7/26</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Power / oz</td>
<td>1.5 w</td>
<td>1.5 w</td>
<td>1.5 w</td>
</tr>
<tr>
<td>Voltage (400 CPS)</td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Voltage (1000 RPM)</td>
<td>0.1 v</td>
<td>0.1 v</td>
<td>0.5 v</td>
</tr>
<tr>
<td>Volt / 1000 RPM</td>
<td>1.3 mv</td>
<td>1.0 mv</td>
<td>0.0 mv</td>
</tr>
</tbody>
</table>

Size 5 gearheads range in reduction ratios from 20:1 to 1019:1 for servomotors and motor tachometers above. In addition to Size 5 clutches, brakes, and brake-clutches, Size 6 are available.

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.
Little Falls, New Jersey

CIRCLE 48 ON READER-SERVICE CARD

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---

1. **X-BAND MONO PULSE ANTENNA** utilizes the principle of multiple modes in waveguide. It features extremely deep nulls (50 dB) and a very compact configuration.

2. **PARABOLIC ANTENNAS** of conventional design for X-Band and Ku-Band are also available in the Kearfott line.

3. **HORN ANTENNA** This dielectric lens horn antenna is phase compensated to give optimum patterns and side lobe levels.

4. **X-BAND PLANAR ARRAY ANTENNA** consists of a phased array of waveguide slot radiators. The pattern consists of two conical beams at a carefully controlled angle with respect to vertical.

5. **K-space BAND CONICAL SCANNING ANTENNA** achieves a high rate of electrical scanning through use of a tri-slot device that gives 3 electrical scans for each mechanical scan. Compactly designed, it provides extremely close control (less than .1 dB) over the cross over.

---

**KEARFOTT MICROWAVE ANTENNAS**

---

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

---

CIRCLE 49 ON READER-SERVICE CARD

---

59
Efficient conversion of microwave power has been accomplished with a variety of new varactor frequency multipliers developed at the Waveguide Systems Division of Microwave Associates, Inc.

We have produced microwave power of several watts at UHF frequencies, several hundred milliwatts at X-band frequencies, and tens of milliwatts at Ka-band frequencies. The curve above indicates more accurately the power levels achieved by these Microwave Associates units. They employed doublers and triplers.

Efficiencies of these units range from 80—90% in the UHF region and from 20—30% at X-band. At present, the highest efficiencies are achieved at relatively narrow bandwidths (1%/ 2%). However, our capabilities are rapidly improving efficiencies for broader band operation. An example of a fixed-tuned broadband unit is a “tripler” which provides an output of 10 milliwatts over a 14%/ range at X-band.

Because of their efficiency and simplicity, these frequency multipliers are of considerable interest to systems engineers designing radar exciter circuits, low-power transmitters, stable local oscillator and paramp pump sources, and other circuits which require high frequency stability and exceptionally long life. These varactor multiplier circuits are generally passive, requiring neither tuning nor external bias voltage.

Our progress in producing efficient microwave power with all-solid-state techniques is related to performance of the most advanced high-power epitaxial varactors with significantly lower losses. The capabilities of Microwave Associates’ Semiconductor Division in producing such varactors is a most positive asset. As this article is being printed, the multiplier performances shown here have already been exceeded.

We are also developing chains of these frequency multipliers to provide adequate amounts of power when driven by transistor oscillators. Efficiencies of these multiplier chains (RF output/DC input) are as good or better than equivalent klystron sources. Compactness and all-solid-state reliability are equally important benefits.

If you have an application for efficient varactor frequency multiplication or would like to discuss the very latest capabilities of these units, please write to Mr. Herbert Cox, Waveguide Systems Division. We’ll be pleased to send you a new article on Varactor Frequency Multiplication by Mr. M. E. Hines.
AC Power Supply

Output power is 160 va, 1 phase ±0.7 power factor load, with output voltage of 0 to 130 v. Full power output voltage is 100-130 v and basic amplifier response is 45 to 5,000 cps. Regulation vs line is ±0.5% for ±5% line at full power and ±1% for ±10% line at 3/4 power. Recovery time is zero. Model 161A has input of 115 v ac, 1 phase, 60 cps.

Behlman-Invar Electronics Corp., Dept. ED, 1723 Cloverfield Blvd., Santa Monica, Calif.
Price: $420.00 fob Santa Monica.

Remote Control

For motor-driven variable autotransformers, voltage on type 1590-A is indicated on a quasi-rms panel meter. Correction rate of the system depends upon the size of the driven autotransformer and can reach 60 v per sec for small units. Tracking accuracy is ±2% of the line voltage.

Price: $95.00 fob West Concord.

Push-Button Switch

Available with from one to ten stations. Model TP 8800 has snap-action contact with rating of 5 amp at 120-250 v ac (30 v dc rating, 3 amp inductive, 5 amp resistive). The switch has full interlock and lock out design which prevents the user from engaging more than one push-button at a time.

American Monarch Corp., Dept. ED, 2801 37th Ave. N.E., Minneapolis 18, Minn.
Price: $50.00.

new twist in extreme temperature wire and cable

SILICONE RUBBER!

Synkote" Silicone Rubber insulated wire and cable is the answer for extreme temperature applications. It combines some of the best physical and electrical properties of rubber and plastics in one insulation. Flexible even after long exposure to temperatures from −130°F to +500°F, ozone and corona resistant, non-flammable, high dielectric strength and insulation resistance, low dissipation factor and dielectric constant, good tensile strength and elongation. Can be manufactured in watertight constructions. Ideal for outstanding performance under difficult operating conditions—in aircraft, missiles, electronic equipment, motor and transformer leads, high tension ignition leads. Synkote" Silicone Rubber insulated wire and cable—a new twist you should know more about! Write today.

ELECTRONIC DESIGN • November 8, 1961
NEW PRODUCTS

Slip Clutch

Adjustable from 0 to 50 oz.-in. MCS series is designed to meet MIL-E-5272 C and is comprised of a stainless steel spur gear, Delrin bearing and clutch plate, steel spring and anodized aluminum hub and clamp. Axial position of the clamp sets the torque and locks unit to the shaft.

Northfield Precision Instrument Corp., Dept. ED, 4400 Austin Blvd., Island Park, N. Y.

P&A: $22.00; stock.

Time Delay Relay

Model 591 can be used as a delay timer, or a remote time adjustment. Weighing 9 oz, this 2 x 2-1/4 x 3-1/8 in. unit operates on 105 to 125 v ac, 60 to 1,200 cps. with dc units available. Time intervals range from 0.003 to 300 sec (factory set), with 5 amp contacts on this 3pdt relay.

G. C. Wilson & Co., Dept. ED, P. O. Box 5525, Huntington, W. Va.

Cathode Ray Tube

Dual-gun, 12-in. ETC type M1030 tube provides tracking accuracy over a 10-in. diam useful area with a maximum error of 0.070 in. With additional electrodes providing further electrical correction, accuracy can be improved to approximately 0.050 in. max.

VHF Variable Capacitors

Capacities are 1.3 pf min, 32.0 pf max. Standard, butterfly and differential capacitors are available with silicone-treated steatite bases, soldered nickel-plated brass rotor and stator assemblies, and lock-type bearing configurations for extreme shock conditions. These units, which test at 880 v rms, 60 cps, meet or exceed MIL specifications.

Hammarlund Manufacturing Co., Inc., Dept. ED, 460 W. 34th St., New York 1, N. Y.
Availability: stock.

Gold-Tin Alloy

Eutectic, Aculoy 280C, a homogeneous Au90-Sn20 alloy has automatically interspersed elements. Precision squares, rectangles, disks and washers up to 1.5 in. diam and 0.001 in. to 0.015 in. finished gauge, have a melting point of 280 C. Alloy is suitable for electrode attachment in semiconductor devices.

Accurate Specialties Co., Inc., Dept. ED, 345 Lodi St., Hackensack, N. J.

High-Capacity Switch

Rated at 22 amp at 125, 250 or 480 v ac, 1.4 hp at 125 v ac or 1.7 hp at 250 v ac, type BM-1R-A2 has spst circuitry and is available with spst. The switch has 0.001 max differential travel and 0.005 min overtravel. The unit carries UL listing and CSA certification.

Price: $2 ea., 1 to 9.

CIRCLE 53 ON READER-SERVICE CARD

MONSANTO SILICON

can give you the profitable combination of
CONSISTENT REPRODUCIBILITY • UNIFORM
HIGH PURITY • HIGHER YIELDS

Single crystal MONSANTO SILICON — float-zone-refined with parameters precision-tailored to customers' specifications — assures these advantages:

- Extremely flat vertical and horizontal resistivity profiles
- Excellent crystal structure — no slippage or lineage
- Boron level in n type crystals less than 0.25 ppb — for minimum compensation effect
- Uniform radial and vertical dislocation density
- Low oxygen content — less than 1 x 10^16 atoms per cc.
- Uniformly tight diameter control

Grow your own! Find out how Monsanto micropure polycrystalline silicon can help boost your ingot yield. Boron content guaranteed less than 0.25 parts per billion (typically less than 0.15 ppb).

MONSANTO SILICON is being produced in this modern multi-million dollar plant — backed by a 60-year tradition of "tailoring" materials to critical specifications.
Here, too — and at other R&D facilities — Monsanto Scientists and Technologists are developing promising new semiconductor materials and processing advances — including new poly and single crystal intermetallics. We cordially invite your inquiries.

MONSANTO CHEMICAL COMPANY
Inorganic Chemicals Division
Electronic Chemicals Dept. 4213
St. Louis 66, Missouri

Please send me: □ Monsanto mono- and polycrystalline silicon specifications. □ Information about new intermetallics.

NAME

COMPANY

STREET

CITY ZONE STATE
At Dev Tek, Inc.

RIGID PERSHING MISSILE SPECS ARE MET WITH AUTRONEX ACID GOLD PLATING PROCESS*

Dev Tek, Inc., Orlando, Florida, uses the patented Autronex Acid Gold Process to plate circuit conductors. According to Mr. A. F. Goldsby, Dev Tek President, Autronex Acid Gold permits compliance with the rigid ABMA-428 specifications for a hard bright coat of gold alloy 100-150 millionths thick covering all circuit conductors.

Dev Tek is one of the very few manufacturers of electronic components qualified to meet the ABMA Huntsville Specification ABMA-428 and PDS-1C for printed circuits and encapsulated assemblies, as used in the highly reliable new Pershing Missile. The specifications require close control over processes and raw material so that reliability is assured for each part that goes into the missile.

Dev Tek controls the gold bath closely which gives an easy-to-solder-to surface which readily yields the desired ABMA PDS-1C solder joint characteristics of the exacting Pershing workmanship standard.

SEL-REX makes the world's largest selection of processes and systems which take the guesswork out of plating with precious metals. Baths are simply maintained with scientific precision by additions of pre-measured salts or solutions. Your assurance of consistent quality results from one batch to the next.

An internationally based network of sales and service technicians is at your beck and call to make sure you get the optimum results built into every SEL-REX PROCESS.

Complete technical literature free on request. Specify precious metal(s) and your application.

*Patented processes for plating with Gold, Rhodium, Platinum, Palladium, Silver, and to produce "custom alloys" for your particular requirements.

SEL-REX CORPORATION
NUTLEY 10, NEW JERSEY

The World's Largest Selling Precious Metal Plating Processes

CIRCLE 54 ON READER-SERVICE CARD

NEW PRODUCTS

Inductance Substitution Box 582

Three decades of inductance, from 0.1 to 111 mH by toggle switch selection are featured in model SB-100. Low level contact and low stray capacity are claimed due to gold contact switches. Use of unit in an environmental chamber yields approximately +100 ppm per degree C.

Electronics Div., Bulova Watch Co., Inc., Dept. ED, 40-10 61st St., Woodside 77, N. Y.
P&A: $210.00; 3 weeks.

Servo Phase Shifter 559

A completely solid-state instrument, model SRA is modular in construction and meets MIL-E-400B. It is a companion unit to the model VLA receiver phase comparator, which supplies 19 v dc operating power. Signal out is 3 v max into 100 ohms for recorder, with a digital readout in msec.

Specific Products, Dept. ED, 21051 Costanso, Woodland Hills, Calif.
Price: $1,485.00.

Analog Converter 557

Transistorized unit has self contained power supply. Capcoder, model OC-2000, is an 8-bit, serial or parallel output, capacitive charge transfer analog to digital converter. Unit offers 0 to 210,000 encodings per sec, with a min of 4 msec between encodings.

Towson Laboratories, Inc., Dept. ED, 200 E. Joppa Road, Baltimore 4, Md.
P&A: $8,000.00; 60 days.

ELECTRONIC DESIGN • November 8, 1961
**Binary**

Direct binary to BCD conversion of 24 bits to a 7 decade decimal output in 50 cycles, with 1-2-4-8 BCD code. Other units can be furnished for any number of bits, with any standard code output. Size varies from 3-1/2 to 7 in. in a 19-in. rack, depending on the number of bits.

Wang Laboratories, Inc., Dept. ED, 12 Huron Drive, Natick, Mass.

P&A: $600 to $6,000; 6 weeks.

---

**Epoxy Heads and Cases**

Epoxy module packages plug into standard crystal can relay sockets. Friction fit between header and case prevents leakage during encapsulation. Unit will withstand continuous operating temperature of 400°F. Models are either 8 or 10 pin.

Epoxy Products Div., J. Waldman & Sons, Dept. ED, 137 Coit St., Irvington 1, N. J.

P&A: $0.50 to $2.00 each; stock.

---

**Solid-State Delay**

Time delay module is housed in a crystal case. This spst is normally open and can handle dc voltages up to 300 v. Operation is delay on make with a 1 amp rating and 26 v input. Units meet MIL-E-5400C and MIL-E-5272C. Two ranges are available: −55 to +85 C and −55 to +125 C.

Accutronics, Inc., Dept. ED, 403 N. Foothill Road, Beverly Hills, Calif.

P&A: $60.00 ea per 100; 2 weeks.

---

**NEW INDOX® VI-A . . . . . . another ceramic magnet advance for microwave use**

Developed by Indiana General's Indiana Steel Products Division, new INDOX VI-A has the highest coercive force of any commercially available magnetic material now in quantity production - plus better resistance to low temperatures, higher residual induction, higher peak energy product.

Indiana General's new INDOX VI-A is a highly oriented barium ferrite material that will effect substantial savings in both material and space in critical equipment such as periodic-focus traveling wave tubes.

One big advantage is that in many applications INDOX VI-A may be magnetized before assembly. Like INDOX V, INDOX VI-A is best suited for simple shapes: rings, discs, rectangles and squares. Magnet length (pressing direction) is limited to one inch or less; longer units can be built up from separate magnets.

Indiana design engineers worked closely with leading microwave manufacturers in the development of INDOX VI-A. The same characteristics that make this material outstanding for microwave application will open the door to other new applications and improve existing products.

INDIANA STEEL PRODUCTS
Phone HOward 2-3131 - Direct Distance Dialing Code 219
VALPARAISO, INDIANA

INDIANA PERMANENT MAGNETS
CIRCLE 55 ON READER-SERVICE CARD

---

**From the Indiana Steel Products Division of INDIANA GENERAL CORPORATION**

**Room Temperature**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Residual Induction (B) gauss</th>
<th>Coercive Force (Hc) oersteds</th>
<th>Intrinsic Coercive Force (Hk) oersteds</th>
<th>Peak Energy Product (BH) max.</th>
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</thead>
<tbody>
<tr>
<td>20°C</td>
<td>3900</td>
<td>2740</td>
<td>3000</td>
<td>2.55 x 10^6</td>
</tr>
<tr>
<td>-65°C</td>
<td>3800</td>
<td>2140</td>
<td>2300</td>
<td>3.4 x 10^6</td>
</tr>
</tbody>
</table>

**Typical Characteristics and Demagnetization Curve for INDOX VI-A**

**INDIANA STEEL PRODUCTS**

**Electronics Design** - November 8, 1961
Polaroid has a new film that is so fast, it will reproduce scope traces that are almost invisible to the naked eye. The one above, a scintillation pulse, has never been photographed until now. Pulse duration was ten nanoseconds. Scope sweep speed was 2 nanoseconds/cm. The new 10,000-speed Polaroid PolaScope Land film produced a finished usable print ten seconds after exposure.

The maximum writing speed of the 10,000-speed film is about twice that of the Polaroid Land 3000-speed film, which is currently the standard for high speed photography. The new film not only gets "impossible" pictures, it also produces far better shots of slower pulses and steady-state waveforms. Because of its high speed, less light is required; camera aperture and scope intensity can be reduced considerably, producing sharper pictures.

And besides oscillography, the PolaScope film opens up new possibilities in applications where light is at a premium, such as photomicrography and metallography. It is not suited, however, for pictorial work due to its high contrast and relatively coarse grain.

PolaScope film (designated Type 410) is packed twelve rolls to a carton. The price is actually lower than the 3000-speed film.

The film can be obtained through industrial photographic dealers. For the name of the dealer nearest you, write to Technical Sales Department, Polaroid Corporation, Cambridge 39, Massachusetts.

NEW PRODUCTS

Chopper Amplifier

Transistorized stabilizing amplifier uses a 10,000-hr mechanical chopper. The unit features balanced input, single-ended output and may be used as an inverting or noninverting amplifier. With two output terminals to provide either internally filtered or unfiltered output, Series 200 may be driven from a source impedance up to 50,000 ohms.

C. E. S. Electronic Products, Dept. ED, 5028 Newport Ave., San Diego 7, Calif.

Diode Tester

High voltage constant current power supply production test diodes. Supply features adjustable current levels (with less than 1 mv ripple. Output voltages from 400 to 800 v, with current ranges of 1 and 10 ma are available.

Wiley Electronics Co., Dept. ED, 2045 W. Cheryl Drive, Phoenix, Ariz.

Price: $632.

Temperature Control

Temperature tolerances can be as low as ±1/2 F using this system. Temperature range is limited only by the capabilities of the thermocouple used. Switching of power current is done at 0 v and 0 amp using silicon controlled rectifiers.

Electronic Div., Product Management, Inc., Dept. ED, P. O. Box 6077, San Diego, Calif.

P&A: $135.00 for 650 w unit, fob San Diego; 2 weeks.
Immediate delivery at factory prices... from Mallory industrial distributors

These Mallory industrial distributors stock the lines indicated by numerals:

Key: 1—Tantalum capacitors  
2—Selector switches  
3—Vitreous enamel resistors  
4—Ceramic disc capacitors  
5—Snap-action switches  
6—HC NP capacitors

Wherever you may be, a Mallory Industrial Distributor near you can supply you with Mallory original equipment parts from stock at factory prices. You'll profit by his prompt delivery on all your small-lot orders... for research, maintenance, or short production runs. Each of the organizations listed below specializes in industrial electronic supply. Call them for your rush orders... they're ready to serve you.

Distributor Division
Indianapolis 6, Indiana

MALLORY

CIRCLE 57 ON READER-SERVICE CARD
NEW from DICKSON

...THE INDUSTRY'S BROADEST LINE OF
High Voltage, Temperature Compensated
ZENER REFERENCE DIODES

IN 26 PREFERRED VOLTAGES
AND 3 NEW SPACE-SAVING PACKAGES

26

CASE #1 CASE #2 CASE #3

CASE #1 CASE #2 CASE #3

18.5 21 23 27 30 33 37 43 47
75 82 87 91 100 105 110 120

CASE #1 CASE #2 CASE #3

51 56 62 68 73 79 85 91
140 150 155 160 165 170

CASE #1 CASE #2 CASE #3

75 82 87 91 100 105 110 120

New techniques developed by Dickson Electronics engineers for producing high voltage zener reference diodes result in a sophisticated combination of performance, small size, stability, ruggedness, reliability and value rarely, if ever, approached by any other semiconductor product. And Dickson’s standardization of these hitherto special order devices results in ready availability.

Other series with voltages of 9.3 volts (1N2620-1N2624B) and 11.7 volts (Series 3/4T100A11.7-3/4T5C11.7) also available as standard items.

For prototype orders, complete technical information and prices, call your Dickson distributor or representative...or write

DICKSON ELECTRONICS CORPORATION
248 WELLS FARGO AVENUE SCOTTSDALE, ARIZONA

NEW PRODUCTS
Transistor Test Set 584

Small signal parameters for npn and pnp transistors can be measured with model 1803A transistor parameter test set. Grounded emitter or base connections are measured with 3% accuracy and collector leakage current can be read from less than 1 na to 1 ma.

Dynatran Electronics Corp., Dept. ED, 178 Herricks Road, Mineola, N. Y.
P&A: $795.00; stock.

Conical Helix Cable 574

Spectra-Flex extensible cable is suited for extension and retraction in vertical plane. Cables are custom built from No. 10 to No. 30 AWG and retract to a flat disk. Large numbers of conductors can be used.

Spectra-Strip Wire & Cable Corp., Dept. ED, P. O. Box 415, Garden Grove, Calif.
P&A: depending on specifications; 2 weeks.

Precision Resistors 459

Micromodule, rectangular and dot resistor microelement, and microminiature ceramic printed circuits with printed resistors are available. Micromodule resistors range from 10 to 100,000 ohms for 4 resistors per wafer. Rectangular resistors rated at 1/10 w at 100 °C range from 10 ohms to 1 mekohm. Dot resistors have some rating and range from 10 ohms to 50 K.

Microelectron, Inc., Dept. ED, Santa Monica, Calif.
Static Relay

Maximum contact voltage is 28 v dc with resistive load, 25 v dc with inductive load; maximum contact current is 50 ma dc. Model DD-5 has nominal actuation voltage of 10 v at 4 ma, pull-in voltage of 10 v ±1 v and frequency response of 1,000 cps. The dpst unit is epoxy encapsulated.

Kidde Electronics Laboratories, Walter Kidde & Co., Inc., Dept. ED, 675 Main St., Belleville 9, N. J.
Availability: 60 to 90 days.

Ammeter Shunt

Accuracy is ±0.3%. Series 8500 miniature, external ammeter shunt meets the operational requirements of MII-S-61B. All units are individually calibrated by means of the Kelvin Comparison Bridge method. This shunt measures 5/8 x 1 x 13/16 in.

Janco Corp., Dept. ED, 3111 Winona Ave., Burbank, Calif.
P&A: $7.00; stock.

Voltage Reference

Isolation is 100 db. A solid-state device, designated type PRI, the voltage reference source is available in models to accept both 115 and 6.3 v inputs, from 50 to 400 cps. Outputs may be specified at 5.9, 8.6, 11.0, 14.5, 17.2 and 22.0 v, nominally. Temperature coefficient is 0.0005% per deg C.

CircuitDyne Corp., Dept. ED, 480 Mermaid St., Laguna Beach, Calif.
P&A: $80.00 to $120.00; 30 to 60 days.

The all new 60 amplifier .01% Donner 3200 is the first computer designed from the ground up to use the new iterative technique.

Every important assembly in the completely new Donner 3200 series iterative computer combines better performance and more features in less space than ever available before from any maker at any price.

The user can start with as few as 10 amplifiers and expand to 60 as necessary. Two or more 60 amplifier computers can be slaved to solve more complex problems. This flexibility is the product of a new packaging concept which emphasizes modularity and etched wiring. The plethora of cables usually associated with computers is gone but hardly grieved. Note these other unique features and specifications.

- **NEW AMPLIFIER** Bandwidth, 1 mc; drift, 20 microvolts per day; gain, 10^8; noise, 500 microvolts; output, ±100 volts @ 20 milliamps. Three types of dual amplifiers are available — integrators, summers and inverters.

- **NEW DUAL MULTIPLIER** Solid state .05% quarter-square multiplier which can be programmed to function as multiplier, divider, or 2 squaring networks.

- **NEW FUNCTION GENERATOR WITH STORABLE PROGRAMS** Each module contains 2 independent 12-segment silicon diode function generators. Channels can be paralleled to provide 24 line segments. Programs can be stored by simply unplugging and removing the inexpensive potentiometer element from the function generator.

- **NEW POTENTIOMETER MODULE** Each compact module contains 20 fused precision potentiometers mounted on the smoothest drawer slides we’ve ever found. Eighty potentiometers take only 7" of panel height.

- **NEW CONTROL CENTER** Pushbuttons select these modes of operation: compute, hold, reset, automatic recyle, slave, audible overload indication, and automatic hold. A new reference potentiometer allows null voltage measurements accurate to 0.02%. Meter sensitivities which can be pushbutton chosen are 300, 100, 30, 10, 3 volts, zero centered.

Forward and reverse relay logic is incorporated for either iterative or continuous operation.

OTHER FEATURES The novel amplifier construction incorporates a built-in jack field on every module which helps the user get a quality computer for minimum cost and later, when he adds the standard removable patch board, he can use the amplifier patching bay as a built-in simulation board. Several sizes of removable patch boards are available both shielded and unshielded. All critical computing components are mounted in a temperature controlled environment.

DONNER SCIENTIFIC DIVISION

CONCORD, CALIFORNIA
POWER RELAY
DEPENDABILITY
IN A CRYSTAL CAN TYPE

Packed into this Struthers-Dunn FC-215 DP-DT relay is reliability heretofore unattained in a tiny sealed can unit for heavy duty power service under critical ground and air uses up to 125°C.

Designed to meet or exceed MIL-R-5757D, MIL-R-6106C and the superseded MIL-R-25018 requirements. Assembled under rigid environmental conditions. Laboratory checked and quality controlled throughout.

Contacts rated for 10 ampere DC operation. Standard coils rated 26.5 volts DC nominal with 400 ohms coil resistance. Others available. Hook or wire lead terminals available on 0.2 grid-spaced headers.

Write for Dunco Data Bulletin FC-215 to Struthers-Dunn, Inc., Pitman, N.J.

All-welded Internal
Construction

... assures reliable operation under 30G vibration to 2000 cycles and 50G shock.

STRUTHERS-DUNN
PIONEERS OF SPACE AGE RELAY DEPENDABILITY

NEW PRODUCTS

Silicon Rectifiers 554

Micro-second switching speeds are featured in two series of silicon controlled rectifiers. Types 2N1842 through 2N1849 are rated at 10 amp with piv of 25 to 1000 v between -40°C to +100°C. Rated at 16 amp, with the same piv over a range of -65°C to +125°C are types 16RC2 to 16RC40.

International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.
P&A: $11.25 to $75.00 each, 1 to 99; stock.

Gold-Plated Connectors 519

Plated aluminum connectors are designed to retain the mechanical and electrical characteristics of gold-plated brass, while weighing approximately one-third that of the brass type.

Micon Electronics, Inc., Dept. ED, Roosevelt Field, Garden City, N. Y.

Vertical TV Monitor 490

Three screen sizes are available: 14, 17 and 21 in. Unit operates with standard vidicon and image orthicon cameras in which the pick-up tube and deflection yoke have been rotated to provide a vertical signal. Size, focus and linearity controls are operated individually, and adjustment of one has no effect on the others.

General Electric Co., Dept. ED, P. O. Box 4197, Lynchburg, Va.
Ranges of dc milliamperes, amperes, millivolts and volts are available. Type MDE-4 contains four self-shielded, coaxial meter movements that can be supplied with sensitivities as low as 100 μA. Units can be supplied with or without lighting.

Minneapolis-Honeywell Regulator Co., Precision Meter Div., Dept. ED, Grenier Field, Manchester, N. H.

Transistorized Instruments

The Designer series features a line of single instruments which are 4 x 8-1/2 x 10 in. All circuits contain transistors and are etched circuit boards. The series will include 25 different instruments. The linear amplifier and discriminator have a gain of 400 and rise time of 0.25 μsec. Discriminator range is 0.1 to 10 V. Five other instruments are immediately available.


Wound Motors

Type GJ wound field dc motors are 1-3/8 in. in diam and are available in two basic ratings: type GJA is 3 in. long and is rated 1/50 hp at 10,000 rpm; type GJY is 2-1/2 in. long and is rated 1/100 hp at 10,000 rpm. Both versions are normally available split series for three-wire reversibility with spdt switch.


These two Spectrol 10-turn precision pots are not specials in any way. They’re standard production items in two popular sizes, tailored-made to fit almost all 10-turn requirements. Here’s where Spectrol excels to give you the best pot for your 10-spot:

END RESISTANCE Spectrol’s low end resistance is achieved by tap welding terminations to the turn of resistance wire nearest the mechanical stop. In addition, Spectrol provides an extra turn of helical resistance element beyond the stop insuring electrical continuity under all conditions.

ROTOR MASS Spectrol’s lightweight rotor reduces inertia and starting torque, as well as minimizing the effects of shock and vibration.

WIPER MASS A wiper that’s the lightest we’ve seen in any 10-turn pot allows lower contact force with resultant long life and superior performance under shock and vibration.

SHAFT SUPPORT Spectrol pot shafts are supported by bearings at both ends and have provision for rear shaft extension.

STOPS Spectrol uses 750 oz. in. stops on Model 860; 50 oz. in. on Model 510, the strongest you’ll find.

LIDS SECURED BY INTERNAL SNAP RING Use of snap rings gives 360° lid support as opposed to other methods of attachment. Another exclusive feature: Remove or replace lids without damaging unit.

POWER RATING Model 860, 8 watts, and Model 510, 3 watts; at 40°C ambient.

SPECIAL FEATURES AVAILABLE Additional taps up to 111 on Model 860; up to 49 on Model 510. Special front shaft configurations and rear extensions. Special linearity and resistance tolerances.

More Data Available For complete electrical and mechanical specifications, and quantity discounts, contact your Spectrol representative or call or write the factory.

SPECTROL

ELECTRONICS CORPORATION

1704 South Del Mar Ave. • San Gabriel, Calif. • Phone: Atlantic 7-9761
Adams Court • Plainview, Long Island, N. Y. • Phone: Wells 8-4000
P. O. Box 130 • Brampton, Ontario, Canada

The World's Broadest Line of Precision Potentiometers
**NEW PRODUCTS**

**Winding Compensated Resolver**  491

*Excitation voltage is 26 v and frequency is 400 cps. Model T980-003 size 15 operates from -54 to +85 C. Impedance of the primary is 480 + j2500 ohms; of the secondary, 440 + j2650 ohms. This unit features 0.1% function error and maximum perpendicularity of 5 min.*

Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

**Magnetic Material**  551

*High energy permanent magnet material for timing motors is called Lodex. Material has high torque output, good flux distribution from magnet to magnet; is resistant to stray fields, vibration and temperature. Small complex shapes can be produced.*

General Electric Co., Dept. ED, 7852 Neff Road, Edmore, Mich.

**Multi-Station Indicators**  469

*Model LP-18 reads out up to 18 contour points and the variation from nominal “thickness” between any of the nine probes in the left-hand bank and any of the nine in the right-hand bank. Standard range is ±0.010 in. and accuracy is within 0.0002 in. Unit requires 115 v, 60 cps current. Model LP-9 reads up to 9 contour points.*

Winslow Manufacturing Co., Dept. ED, 1751 E. 23 St., Cleveland 14, Ohio.

---

**FROM MOTOROLA...**

**POWER**

**NEW PNP GERMANIUM SERIES RATED AT**

170 W.  Pd

OPERATES UP TO

110° C. Tj

AVAILABLE WITH CERTIFIED RELIABILITY

“MEG-A-LIFE”

**NEW 2N2075-82 SERIES OFFERS:**

- **170 WATTS**—93% greater power dissipation capability than conventional TO-36 power transistors.
- **110° C. Tj** — Maximum junction temperature rating (15° higher than conventional TO-36 units) provides added operating temperature safeguard and also increases allowable power dissipation at any given case temperature. In over 3,000,000 device hours of storage life testing at temperatures up to 150°C, the failure rate was only 0.030%/1000 hrs.
- “MEG-A-LIFE” — a program offering industrial users certified reliability based upon complete electrical, mechanical, and environmental tests to military type specs. Lot acceptance data and test results available to purchasers of “MEG-A-LIFE” versions of these devices.

---

**2N2075 SERIES, 15 AMP**

<table>
<thead>
<tr>
<th>h_{FE} @ 15A</th>
<th>BV_{CES}</th>
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<tbody>
<tr>
<td>40V</td>
<td>2N2076</td>
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<tr>
<td>50V</td>
<td>2N2077</td>
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<td></td>
<td>2N2080</td>
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<tr>
<td></td>
<td>2N2079</td>
</tr>
</tbody>
</table>
THE LEADER IN TRANSISTORS

Plus this most complete line of other TO-36 and TO-3 devices

POWER TRANSISTOR HANDBOOK
If you have not yet purchased this valuable reference book covering power transistor design considerations and applications, you may still obtain a copy from your Motorola distributor. Price is $2.

IMMEDIATE LOCAL AVAILABILITY—You may obtain sample or volume quantities of any of these devices by contacting your nearest Motorola distributor. Also be sure to ask for the complete Motorola Power Transistor Selection Chart, listing Motorola's new low prices.

DISTRIBUTORS:

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CIRCUIT BOARD

Fla. / Phoenix / Silver Spring, Md. / Syracuse / Toronto, Canada.

CIRCLE 64 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

Piston Capacitors

Solid dielectrics enable miniaturizing of piston trimmer capacitors. These capacitors range from less than 1 to 30 pf, with Q (MIL) specification of 500 and temperature range of -55 to +125 C. The temperature coefficient is 50 ppm per C, or less.

Voltronics, Inc., Dept. ED, 34-51 56th St.,

Woodsie 77, N. Y.

P&A: $2.35 to $3.50; stock.

Half-Wave Rectifier

Welded hat construction provides compact, 1-3/16 in. over all, rectifier series. Designated Trans-Sil type MA, twenty types are available with piv of 50 v to 800 v, in 50 v multiples. This double-diffused silicon junction unit has a max surge rating of 30 amp.

Trans-Sil Corp., Dept. ED, 55 Honeck St.,

Englewood, N. J.

Availability: 5 days.

Lissajous Scale

Phase relationship can be read directly with the Pha-o-Scale. The scale, calibrated in degrees on the vertical axis, allows direct read-out of signal on X and Y axis.

Walker Pacific, Dept. ED, P. O. Box 2242,

La Puente, Calif.
**NEW PRODUCTS**

**Telephone Click Reducer**

Solid-state telephone click reducer lasts over 200,000 hrs and operates from -65 to +175 C. Device, made to replace copper-oxide units, contains silicon rectifiers in a miniature hermetically-sealed package. Two eyelet leads are provided for mounting.

Solatron Devices, Inc., Dept. ED, 500 Livingston St., Norwood, N. J.

P&A: $0.40; immediate.

**Set-Reset Indicator**

Plug-in module, model (D9)G-104/N-IA is expressly designed for parallel transfer of 1-2-4-8 code to a remote NIXIE digital display. The unit has a diode matrix, measures 4-1/2 x 9 in. and operates up to 100 kc. Electronic Control Products, Dept. ED, U.S. Rt. 22, Box 286, Dunellen, N. J.

P&A $82.00 to $103.00; 1 week.

**Test Clip**

Scissors action of “Monte-clip” test device gives high contact pressure on leads. Tapered throat guides leads to contact blades, which are individually adjustable. Blades are connected to banana plugs and show negligible fatigue at 10-million insertion cycles.

Monterey Engineering, Dept. ED, P.O. Box 3083, Granada Hills, Calif.

Price: $11 a pair.
A fail-safe alarm is provided by model VC670, transistorized voltage monitor. When the signal value exceeds the external reference limit the contacts open. Two sets of contacts indicate a go or no-go condition in this compact 10-oz unit. Input impedance is 2 meg, and sensitivity is 5 mv.


Dip Soldering Device

For printed-circuit boards, the DIP-RAC soldering fixture is adjustable in widths from 1/4 to 10 in. and accommodates cards to 1 ft long. All parts are made of high-temperature-resistant materials. Card assemblies are held firmly in flat position through thermal cycling.

Defiance Printed Circuit Corp., Dept. ED, 144 Commercial St., Malden, Mass.
P&A: $29.95; stock.

Isolation Transformer

Portable voltage correcting transformer, for tools and lights comes in ratings of 1 through 5 kva and voltages through 600 v. Encapsulated core and coil are water and shock proof. Included are an output socket and a 15-ft cord and plug for input.

Westinghouse Electric Corp., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

Coors

ALUMINA CERAMICS
Coors Porcelain Co., Golden, Colo.
**NEW PRODUCTS**

**Chopper Amplifier**

Input dc is converted to ac at 94 cps with a mechanical spdt chopper. Ac is amplified in three stages, demodulated by the same chopper, and then filtered. The 94 cps is internally generated. Model C-2 features dc gain of over 10,000 and drift of less than 0.5 μv per C over the range of 25 to 50°C. Filter time constant is 6 sec.

Ridgefield Instrument Group, Schlumberger Corp., Dept. ED, Ridgefield Conn.,
P&A: $195.00 fob Ridgefield; 30 days.

**Laboratory Power Supply**

Providing 24 to 28 v power, dc and 60 and 400 cps ac, regulated to 1%, the model LPC-220 laboratory power center operates from 220 to 440 v, 60 cps, 3-phase power. Power is converted by a 3,500 rpm induction motor. Voltage regulators are solid-state. Self-contained unit is in a cabinet measuring 54 x 22 x 36 in.

Electric Specialty Co., Dept. ED, 211 South St., Stamford, Conn.

**Delay Lines**

**Nanolines** are available in 10-nsec delay increments ranging from 20 to 100 nsec and are epoxy encapsulated. Delay to rise time ratio ranges from 5 to 1 for the 20-nsec units to greater than 10 to 1 for the 50- to 100-nsec lines. Impedance is 500 ohms ±10%. The lines meet or exceed environmental requirements of MIL-STD-202B.

Richard D. Brew and Co., Inc., Dept. ED, Concord, N. H.

Availability: samples from stock.

---

**AT 500 VOLTS... > 300°F... 20,000 PSI,**

**DO W EPOXY RESIN HOLDS 1000-MEGOHM RESISTIVITY!**

Made of Dow epoxy resin, this electrical lead holder costs $35.00 less to produce than a similar unit constructed of other materials. Yet it maintains a constant high resistivity of 1000 megohms at 500 volts under tremendous bottom hole pressures and temperatures which can reach 20,000 psi and more than 300°F.

Dow epoxy resin was selected for laminating this part because of its durability, chemical resistance, low water absorption, and excellent electrical characteristics. This same resin is also used in making other accurate PGAC down-hole instruments.

The Dow family of epoxy resins for electronics applications includes unusual brominated epoxies... casting and laminating resins which offer self-extinguishing properties, and excellent electrical and other physical properties.

Dow offers designers the important advantage of uniform high purity and quality. Because Dow produces the raw materials required... and controls every step... in the production of epoxy resins, Dow can maintain absolute control over the purity and properties of its epoxies. This basic epoxy position assures a product you can depend on.

For information and data on the family of Dow epoxy resins, write us today in Midland, C/O Coatings Sales Department 1957BC11-8.

---

**THE DOW CHEMICAL COMPANY**

Midland, Michigan

CIRCLE 68 ON READER-SERVICE CARD

---

**ELECTRONIC DESIGN • November 8, 1961**
Potentiometers

A stable composition resistance element in this line of potentiometers is temperature and humidity resistant. Resistance change from 20 to 105°C is ±3% avg. Voltage coefficient is less than 0.01% resistance change per °C. Life of 25,000 cycles has less than ±4% resistance change. Tandem controls are matched in production. All standard tapers are available.

Stackpole Carbon Co., Dept. ED, St. Marys, Pa.

Availability: three weeks.

Liquid Level Detector

Bellows or bourdon tube respond to pressure changes in the Chronoflo transmitter, model 231-10. Unit can measure liquid levels despite turbulences and ice formations. Information is telemetered with a pulsed code.

B-I-F Industries, Dept. ED, Providence, R.I.

Sprayed-On Heaters

Custom “sprayed-on” elements are designed for use where stable temperature environment is mandatory. Conductive and insulating coatings combined are 0.015 in. thick. These elements may be applied to flat, cubic or contoured surfaces of any kind or size.


Slip Clutches

Locking-type set screw adjusts torque transmission through a range of from 0 to 4 lb-in. Clutch parts are constructed of oil-impregnated sintered alloy and require no lubrication. Model K is designed to couple two shafts. Model M is supplied with a 1/4-in. bore on one end and 1/4-in. shaft on the other.

Precision Specialties, Inc., Dept. ED, Pitman, N.J.

TWO NEW APPLICATION REPORTS AVAILABLE!

Two new papers on low noise transistor design, "Low Noise Transistors: A General Discussion," and "Calculating Noise Figure When Equivalent Input Noise Voltage and Noise Current are Known," are available from NSC.

For complete technical information on NS430 series transistors and new engineering papers, check key number below, or write:

National Semiconductor Corporation

Danbury, Conn. • Pioneer 3-7624 • TWX DANB 452-U

CIRCLE 69 ON READER-SERVICE CARD
NEW PRODUCTS

Impulse Counter 569

Automatic-reset impulse counter model 310-B requires a pulse of 50 msec duration. Standard ranges are: 1 to 40, 2 to 120, 5 to 480 and 10 to 960 counts at 500 counts per min. A 14-point terminal block permits wiring for all connections. Load ratings are 10 amp at 115 v ac, 5 amp at 230 v ac, 1/4 amp at 115 v dc.


Digital Voltmeter 656

Range is 1 mv to 1 kv. Model Vit-2100 digital voltmeter reads dc voltages with an absolute accuracy of 0.01%, +1 digit. The input impedance is so high that the instrument can be standardized directly from standard cells. It withstands abnormal humidity, extreme shock and vibration, explosive atmospheres.

Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.
Price: $3,580.

Power Source 564

Output is 115 v dc at up to 3 amp. Model 10-C power source operates from an input of 115 ±10 v and 230 ±20 v, single phase, at 25 to 60 cps. It uses silicon rectifiers in full-wave configuration. It can be used as a power source for fractional horsepower dc motors, local relays and selector magnets.

H. O. Boehme, Inc., Dept. ED, 915 Broadway, New York 10, N.Y.
Look to Westinghouse for Silicon Power Transistors with lowest saturation resistance

**LSR** = 0.037

Lowest saturation resistance ratings in the industry enable design engineers to obtain three-fold increases in power-handling capability. Now—with these higher performance specifications you can replace germanium units and gain the silicon power transistor advantages of reduced heat sink size . . . higher allowable ambient . . . improved control range . . . and upgraded reliability in almost all circuits.

<table>
<thead>
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<th>Vce</th>
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<td>30 A</td>
<td>50-200V</td>
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<td>7.5 A</td>
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<tr>
<td>WX118</td>
<td>10 A</td>
<td>50-150V</td>
<td>0.022</td>
</tr>
</tbody>
</table>

2N1809-2N109 series. New 30-amp "Rock-Top" transistors . . . world's most powerful! With 30-amps, 200-volt, 250-watt ratings these newest Westinghouse series 2N1809 and 2N109 transistors are designed to meet the most exciting high power applications. Germanium-level saturation resistance (.037 ohms), and freedom from secondary breakdown mean highest efficiency and operating reliability.

WX118 series. World's highest gain power transistors provide current gain of 400 at 10 amps! New Westinghouse Type WX118 high-gain silicon transistors simplify circuitry, increase reliability, reduce cost of assembly. They're ideal for application in high power, high efficiency regulators, inverters and switching circuits. Saturation resistance is only 0.22 ohms.

2N1015-2N1016 series. Highest reliability from production-proved 150 watt designs. Get maximum circuit reliability at no extra cost by specifying the Westinghouse 2N1015-2N1016 series. These popular transistors have been field-proven in thousands of operating equipments. They can replace lower rated transistors (2N1490, 2N1809, 2N109, and others), and give you up to twice-the-power derating margin. In addition to the exclusive rating characteristics of these transistors, you get greater assurance of performance reliability from:

- True voltage ratings. Westinghouse transistors can be operated continuously at their full published ratings into highly inductive loads. True Voltage Ratings are verified by 100% Power Testing.
- 100% Power Testing. Each Westinghouse transistor is 100% Power Tested before leaving the plant. Tests are conducted over the full operating range—under all conditions of base bias and collector current at maximum rated dissipation. For more information or technical assistance, see your nearest Westinghouse representative or write: Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Penna. You can be sure . . . if it's Westinghouse SC-1054

---

**Telemetry Commutator 460**

Life is 1,000 hr min at the highest sampling rate for the Datametrics type 100 telemetry commutator. Sampling rates as high as 1,350 per sec are offered with a standard 90-channel unit. Contact noise is less than 5 v.

Datametrics, Inc., Dept. ED, 87 Beaver St., Waltham, Mass.

**DC Signal Amplifier 628**

Low-level, dc signal amplifier model MA-100 is for measurements such as temperature or strain in industrial and military applications. Output is 0 to 5 v dc from 0 to 10 mv dc input. Input resistance is 10 ohms ±10%; output load is 1 to 100 K; frequency response is 0 to 2 cps; response time is 100 msec. DC voltage gain is 500 v ±10%.

Dynex Industries, Inc., Dept. ED, 170 Eileen Way, Syosset, N. Y.

**Pulse-Height Discriminator 567**

For electronic scalers with high speeds, model 2301 pulse-height discriminator provides an output pulse when the input signal is within a certain range. It resolves paired pulses spaced at 0.5 sec. Overload capacity is 120 v. It can be used in nuclear radiation or X-ray spectrum analyses.

Beckman Instruments, Inc., Berkeley Div., Dept. ED, 2200 Wright Ave., Richmond, Calif. P&A: 898; 90 days.

**Transmitting Equipment 393**

Am, 1,000, 500, 250-w transmitter type 20V-3 has pushbutton control of filament and plate power which may be extended to a remote position. Automatic sequencing of power-control circuits is used. Also offered is the matching 81M phasor with T-designed phase shifting networks.

Collins Radio Co., Dept. ED, P. O. Box 1891, Dallas 21, Tex.
NEW PRODUCTS

Telemetry Preamplifier 501

Noise figure is 4.25 db max. Model TPA-1 has a range from 215 to 260 mc. Ceramic tubes, hermetically sealed transformers and the elimination of blower motor and relay contribute to optimum performance under field conditions. Gain is 20 db min. The unit, which features type N connectors, operates from 117 v ac, 60 cps.

Defense Electronics, Inc., Dept. ED, 5455 Randolph Road, Rockville, Md.
Price: $975.00

Miniature Pressure Switches 495

Proof pressure is 750 psig. Switches can be factory adjusted to pressure settings from 10 to 500 psig. Type 1100 has an ambient temperature range from -65 to 250 F. This unit is available with or without pressure port and with options of solder terminals, potted leads or electrical connector for termination. Size without external port is 1-5/8 x 15/16 in. diam; weight is 0.75 to 2 oz.

Haydon Switch, Inc., Dept. ED, Waterbury, Conn.

Silicon Rectifiers 500

Piv ranges from 200 to 1,000 v. Full cycle average leakage ratings for the three types are: type 10AL, 10 µa max at 150 C; type 10AT, 150 µa max at 150 C; and 10AG, 500 µa max at 100 C. Double-diffused silicon junction is hermetically sealed in flangeless cylindrical case measuring 1/4 x 1/4 in.

Electronic Devices, Inc., Dept. ED, New Rochelle, N. Y.
P&A: $0.50 to $5.50; stock to 2 weeks.

Accuracy Is Our Policy

The new product item appearing on p 118 of the Sept. 27 issue of ELECTRONIC DESIGN was in error. It should have read: the discharge of the “Hi-Jul” storage capacitors manufactured by Dearborn Electronic Laboratories, Inc., is as low as 0.1 µsec.
Digital Voltmeter

Reed-relay digital voltmeter model V-70 has a range of ±0.000 to ±999.9 vdc with a sensitivity of 1 mv. Absolute accuracy is ±0.1%. ±1 digit; balance time is 500 msec max. Common mode rejection is 80 db at 60 cps and input impedance is 10 meg.

Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.

Price: $1150.

FM Transmitter

Rated at 5,000 w, the 830E-1 fm transmitter uses the 830B-1 250-w driver and an amplifier. It is completely self contained with high-voltage transformer, directional couplers and filters mounted inside the cabinet. The amplifier power supply may use silicon rectifiers.

Collins Radio Co., Dept. ED, P. O. Box 1891, Dallas 21, Tex.

Infrared Spectrometers

Two models offered. Model I-4S and I-4T infrared spectrometers have the following specs: range, 0.35 to 3.0 and 1 to 16 microns; resolution, 40 cm⁻¹ max; entrance aperture, 2.25 cm²; angular acceptance, 15 deg; output impedance, 1,000 ohms resistive.


Price: $4,515 up.

Power Supplies

Noise-free power supplies have precise voltage regulation for both line and load. Six Sorensen QIS 60-cps and six DQIS 400-cps models are transistorized, 115-v ac or dc, sine-wave inverters. Outputs are 20, 40 or 60 w, from 12 or 28 v dc. They are suitable for replacing vibrators.

Raytheon Co., Sorensen Products, Dept. ED, South Norwalk, Conn.

P&A: $190 to $200; stock.

NOW AVAILABLE FOR IMMEDIATE DELIVERY!

Bifurcated Contact Connectors with two flexing surfaces instead of one to provide positive contact! ... accommodate irregularities in Printed Circuit Boards.

TWO TYPES—conventional wiring tail (type 251) or dip solder (for .051 dia. hole) (type 252) ... with 6 to 25 contact positions (12-50 contacts).

INSULATION—glass filled dialyl phthalate type GDI 30 per MIL-M-1983.

POLARIZING KEYS—can be supplied loose, or inserted in any position designated.

FINISHES—phosphor bronze or beryllium copper ... .0003 Min. Sel.-res. gold plated.

PART NUMBERS—customer part numbers imprinted when required.

MEETS MIL-C-2109A (ships) specs for printed wiring board connectors

WRITE FOR FULL INFORMATION TODAY! Complete details and performance specifications on new Bifurcated Cinch Printed Circuit Board Edge Connectors are available for the asking. Write for full information now.
NEW PRODUCTS

PDM to PCM Converter 426

Pdm data in 30 x 30 to 90 x 10 format is converted to pcm signal by this converter. Designated model 29309, the unit synchronizes conversion operation with the pdm frame rate, even when input momentarily drops out. Unit, self checking, allows either even or odd parity in output code. A portable input unit may be located up to 3 miles from other units.

Price: $17,500.

Rack Cabinets 486

Custom built UNICABINET units include heavy 11-gage vertical posts in "arrowhead" configuration integrally welded both to its one-piece top and base. Panels and doors are available in both flush mounted and surface mounted stylings. The cabinet will meet most military specifications, and provisions have been made for rf shielding and metalizing as may be necessary.

Dahlstrom Manufacturing Corp., Dept. ED, Jamestown, N.Y.

Eyeleting Machines 439

Feeds and sets as many as 12 eyelets automatically. Model F features easy change of raceways and setting tools to accommodate different sizes of eyelets. Model A permits conversion from hand-fed and foot-power operation to automatic feed and motor drive.

Fastener Div., United Shoe Machinery Corp., Dept. ED, Shelton, Conn.

Delay Lines 506

Signal-to-noise ratio is 7:1, and can be improved to 30:1. Input and output impedances of types ML and MT are supplied to accommodate driving and output circuitry. Type ML delays up to 100 μsec; type MT delays up to 5,000 μsec.

Computer Devices Corp., Dept. ED, 6 W. 18 St., Huntington Station, N.Y.

You mix 'em!

To your systems specifications on Flexi-Card

Harman-Kardon's new economical
Digital Card Assembly

Now, Harman-Kardon's new flexi-card circuit assemblies bring logical versatility to logical circuits. Each Flexi-card is factory-assembled to your specific requirement quickly, and at competitive prices, for any of the thousands of combinations of digital logic you require.

...And two new series of Encapsulated Logic Modules

Completely compatible modules now available at 125°C. • 5 MC. • 250 KC.

Send for complete details and...

FREE guide to Boolean Algebra!
Bias Oscillator
Output frequency is 100 kc. Output level of type RA-1668 is sufficient to provide bias current to drive six direct record channels. Normally encapsulated in polyurethane or modified epoxy resin, the unit requires 24 ± 1 v d.c. at 50 ma. Temperature range is -30 to +80 C.
Westrex Co., Dept. ED, 335 N. Maple Drive, Beverly Hills, Calif.

Planar Transistor
Triple-diffused planar transistor type 2N2102 offers the following ratings: \( V_{\text{on}} \) of 120 v with \( I_c \) at 0.1 ma, \( V_{\text{ce}} \) of 0.5 v max at \( I_c \) of 150 ma, \( V_{\text{be}} \) of 1.1 v max at \( I_c \) of 150 ma. Output capacitance is 15 pf, noise is 6 db max, switching speed is 30 m/sec max.
Radio Corp. of America, Semiconductor & Materials Div. Dept. ED, Somerville, N. J.

Twin Tetrode
Warmup is 0.7 sec to full 3-db power output. Type 7983 twin tetrode can be used as a power-output amplifier, driver or frequency multiplier. It provides 16 w at 200 mc. Cathode voltage is 3.15 v. Rf performance is comparable to that of indirectly heated cathodes.

Screen Press
For printed circuits. The unit features horizontal working action on rollers, registration and off-contact height adjustments, 3-way line adjustment, and positive taper pin automatic positioning of work frame. Plane registration plate is for drilled hole and pin holding.
Etchomatic, Inc., Dept. ED, P. O. Box 444, Waltham 54, Mass.
Price: $855.00.

General Instrument Silicon Planar Epitaxial Transistors

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Source for Silicon Planar Epitaxial Transistors. Get the benefits of both planar and epitaxial constructions in the transistors you specify for computer logic circuits. New General Instrument silicon transistors supply both. To the superior stability and freedom from contaminants our unique Molecular Shield™ planar-passivation process offers, we've added the high speed, low saturation resistance and high breakdown voltage of epitaxial devices.

General Instrument Semiconductor Division
65 Governor Street, Newark 4, New Jersey.
THIS WELDMATIC WELDING HEAD IS USED TO PRODUCE MORE MODULES THAN ALL OTHER MAKES COMBINED

NEW PRODUCTS

DC Power Supply

For thermoelectric coolers. All components are mounted on a base plate which acts as a heat sink or cooling surface for the rectifier. At maximum output, ripple content in the output voltage waveform is limited to 10% of the dc level, according to the manufacturer. The unit is rated at 60 cps, 117 v input, 4 v at 50 amp output.

General Electric Co., Dept. ED, Schenectady 5, N. Y.

Digital Voltmeter

Exhibits 5-digit resolution on all readings by means of a front panel meter which verifies the null balance condition. Features of the model 2000 include ±1 digit accuracy, floating operation, 0.001% resolution, transistorized circuitry and optional printout.

Auto-Data, Dept. ED, 943 Turquoise, San Diego, Calif.

Crossbar Scanner

Accommodates up to 100 one-wire channels, 60 two-wire channels, or 40 three-wire channels. Bounce is less than 400 μsec, none on break. Model ST-1L handles 100 ma at 50 v dc and the breakdown voltage is not less than 1,000 v ac rms. Signal frequency range is dc to 10 mc.

James Cunningham, Son & Co., Inc., Dept. ED, 33 Litchfield St., Rochester, N. Y.
P&A: $1,600 to $1,800; 6-8 weeks.

Now! Kide “know-how” delivers pre-engineered static frequency changers with...

- CUSTOM DESIGN
- LOW COST
- FAST DELIVERY

Kidde Electronics Laboratories now offer static frequency changers on a “custom” basis at lowest cost. Utilizing the extensive experience gained in the design and production of working units, Kidde static frequency changers employ any of the three principal design techniques—intermediate DC link; phase modulation, straight-through method; and switch modulation, straight-through method.

This background of experience with these techniques has resulted in circuits which are now available almost on an “off the shelf” basis, and can be used to produce custom static frequency changers in minimum time and at lowest cost. They are available from 10VA to 10 KVA and within the range of 50 cps to 2200 cps upward and downward. For more information write or call Kide today.

Phone: Gregory 2-5000 (Area Code 201)

K i d d e

Electronics Laboratories

Kidde Electronics Laboratories, Inc.
1174 Brighton Road, Clifton, N. J.
Static Frequency Changers, Static Inverters, Static Converters (DC to DC), Static Power Supplies.

CIRCLE 77 ON READER-SERVICE CARD
Recording Amplifier

For airborne and missile environments. Temperature range of type RA-1667 is -30 to -80 C. Output signal is 2.5 mA rms. Input is adjustable from 35 mV rms to 4 V rms for output recording current of 1 mA rms. The unit requires 24 ±1 V dc at 15 ma. Bias frequency is 100 kc at 15 ma rms.

Westrex Co., Dept. ED, 335 N. Maple Drive, Beverly Hills, Calif.

Dual Pressure Switch

Range is 1 to 10 in. Hg with a calibration accuracy of ±0.05 in. The dual pressure switch, for spdt, normally closed operation, has contacts rated at 3-amp inductive load at 28 V dc. Maximum inrush is 15 amp. Switches meet MIL-S-8805, Class A-8, and environmental requirements of MIL-E-5272.

Assembly Engineers, Inc., Dept. ED, 3640 Holdrege Ave., Los Angeles, Calif.

Silicon Rectifiers

Rated at 20 amp at 150 C case temperature, types USA-1N249B, 1N250B and 1N2135A silicon rectifiers have 100, 200 and 400 piV, respectively. They are designed in accordance with MIL-S-19500/134.

Radio Corp. of America, Semiconductors & Material Div., Dept. ED, Somerville, N. J.

Tunnel Diodes

High current silicon tunnel diodes, HT-25, HT-26, and HT-27, have output voltages up to 0.8 V and typical switching time of 5 nsec. Peak current tolerances are ±10% with a temperature coefficient of ±0.04% per C. Operating and storage temperature range is -85 to +200 C.

Hoffman Semiconductor Div., Dept. ED, 1001 N. Arden Drive, El Monte, Calif.

P&A: $25 to $45; immediate.

THE OFFNER DYNOGRAPH

The most versatile and sensitive direct-writing unit available!

Ink, heat, electric recording media
Handles all your recording requirements.

This one high-speed direct writing assembly handles all your recording requirements. You change only the input coupler for thermocouples, strain gages, servo monitors; for industrial, scientific, and medical applications.

☆ From one microvolt, d-c to over 200 cps.
☆ Ink, heat, electric recording media—easily convertible.

Write for complete details.

OFFNER DIVISION
of Beckman Instruments, Inc.
3900 River Road, Schiller Park, Ill. (suburb of Chicago)
NEW PRODUCTS

Cathode-Ray Tube 390

For general purpose oscilloscopes in which two independent signals are displayed on a common time base. This double-gun helical tube, type 1000F, has 10 cm diam. and a window of 6.3 x 6.3 cm. Deflection sensitivity in the X direction is 24 v per cm and in the Y direction, 14 v per cm, with a gun voltage of 1.2 kv and a final anode potential of 4 kv.


Pneumatic Timer 566

Is 1.5 in. sq, weighs less than 1 oz. Model 90 pneumatic timer has an adjustable range of 0.2 to 15 sec and is built for 5 million cycles. Repeat accuracy is within ±10% from 32 to 120 F. The switch is rated at 10 amp and is easily replaced.

Hagen Manufacturing Co. Div., E. W. Bliss Co., Dept. ED, 104 Walnut St., Baraboo, Wis.

Precision Resolvers 388

Transformation ratios are ±0.5% for size 8, ±0.2% for size 11 and ±0.15% for size 15 from room ambient value over -65 to +125 C temperature range. Size 8 has input of 26 v, output of 11.146 v, phase shift of 22 deg, accuracy of ±7 min max, and total null voltage of 0.030.

John Oster Manufacturing Co., Avionic Div., Dept. ED, Racine, Wis.

Availability: 60-90 days.

Fast “Off-The-Shelf” delivery

Overnight delivery on many items at factory prices

When standard CLARE relays or switches meet your needs, distributor service saves you time, costs you no more.

Top quality — the same fine design and long life you get in CLARE custom-built relays and switches.

Easy purchasing — you can order CLARE relays at the same time you purchase other components... have them delivered together.

Engineering assistance — always available from CLARE field engineers who work in close cooperation with CLARE distributors.

NOW AVAILABLE

... mercury-wetted contact relay modules for mounting on your own printed circuit board

Type HGM relay module (left) with cut-away (right) showing mercury-wetted switch capsule and coil potted in steel enclosure.

Your nearby CLARE distributor can now supply you with the new CLARE mercury-wetted relays, steel enclosed and ready for mounting. They combine the famous CLARE billion-operation reliability with unusual ease of handling and application. You can choose either the standard CLARE HG relay module or the HGS, super-fast and super-sensitive. Each module contains the CLARE mercury-wetted contact switch capsule with contacts continually wetted by capillary action. They never bounce, never get dirty, never weld and never wear out.
of top-quality Clare relays

From these distributors

PACIFIC COAST
1. Puget Electric Products
   318 Fourth Ave., South
   Seattle 8, Washington
   Tel: Parkway 5-7070
2. Bell Electronic Corporation
   1600 O'Brien Drive
   Menlo Park, California
   Tel: Davenport 3-5431
3. Bell Electronic Corporation
   305 F. Alondra
   Gardena, California
   Tel: Faculty 1-5023
4. Bell Electronic Corporation
   8032 Electronic Ave.
   San Diego 7, California
   Tel: Brownie 6-4350

SOUTHWEST
5. Radio Specialists Co., Inc.
   9203 Acorn Road, S.E.
   Albuquerque, New Mexico
   Tel: Alhidel 3-4901
6. Radio Specialists Co., Inc.
   505 Main Avenue
   Alamogordo, New Mexico
   Tel: Hemlock 1-0570
7. Engineering Supply Co.
   200 Denton Drive
   Dallas 35, Texas
   Tel: Fleerwood 7-8121

CENTRAL
8. Harrison Equipment Co., Inc.
   1422 San Jacinto St.
   P. O. Box 1506
   Houston 1, Texas
   Tel: Capitol 4-2731
   1234 East Fourth Street
   Tulsa 30, Oklahoma
   Tel: Luther 3-8121
10. Relay Sales, Inc.
    P. O. Box 188
    West Chicago, Illinois
    Tel: 221-1100
11. Steele, Inc.
    314 Lee Street
    Dayton 4, Ohio
    Tel: Baldwin 8-2540
    1503 Prospect Avenue
    Cleveland 3, Ohio
    Tel: 432-0010
    213 South 11th Street
    Birmingham 3, Alabama
    Tel: 2-0448

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7. R & D Supply, Inc.
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   Needham 92, Mass.
   Tel: Hilcrest 4-4500
8. Avnet Electronics Corp.
   70 State Street
   Westbury, L.I., New York
   Tel: Edgewood 3-5800
9. Electronic Wholesalers, Inc.
   1301 Hibernian Boulevard
   P. O. Drawer 155
   Melbourne, Florida
   Tel: PA 3-1541
10. Electronic Wholesalers, Inc.
    8390 N. W. 77th Ave.
    Miami 47, Florida
    Tel: Oxford 8-1620

Gear Transmission
Multispeed, direct coupled gear transmission changes speeds while rotating. Offered in several sizes for different torque requirements, it is for use in power transmissions for industrial-process controls and instrumentation of computers, data-reduction equipment, and film and tape-drive mechanisms.

Silicone Compound
Compound oil resistance with low temperature flexibility. Rubber-base compound has a useful temperature range of -120 to +450 F. Volume swell in fluids is equivalent to that of dimethyl silicone rubber compounds which have brittle point of -80 F. Type KW-1920 is designed for vital parts for military aircraft and missiles.

Silicones Div., Union Carbide Corp., Dept. ED, 270 Park Ave., New York 17, N. Y.

Differential Transformers
Electromechanical transducers, the Atcotran differential transformers convert linear displacement into a proportional ac mv signal. They can be used with motion from bellows, diaphragms, Bourdon tubes, flow meters and levers. The electrical signal can be transmitted several miles over wire.


< CIRCLE 80 ON READER-SERVICE CARD
NEW PRODUCTS

Saturable Reactor

Power-O-Matic 60 includes control, saturable power reactor, voltmeter and circuit breaker plus heavy gage polished aluminum ventilated housing. Three ranges are -20 to +650 F and sizes are 2 to 10 kva.

Blue M Electric Co., Dept. ED, 138th & Chatham St., Blue Island, Ill.

Brushless Fan

Cabinet fan meets the temperature requirements of MIL-E-5272-C (-65 to 160 F). Elimination of the brushes increases the life expectancy of the unit. The device uses a shaded pole motor.

Rotronics of California, Dept. ED, 11168 Santa Monica Blvd., Los Angeles 25, Calif.

Digital Switch

Thumbwheel switches can be stacked up to 15 sections in a panel slot 8 x 1-9/16 in. Deca-switch sections are available in single-pole 10-position, single-pole 11-position, plus/minus, binary and 2-pole, 5-position models. Switch contacts are gold plated and are said to feature low resistance.

Hallamore Electronics Div., The Siegler Corp., Dept. ED, 714 N. Brookhurst St., Anaheim, Calif.
Precision Potentiometer 570

Low-noise, 10-turn precision potentiometer has the following specs: resistances, 25 ohms to 200-K, 0.03% linearity; 0.007% resolution; power rating, 3 w at 40 C; temperature range, -55 to +110 C; life of 2 million revolutions. Dimensions are 1-in. in diam by 1-53/64 in. long.

Arcon Electronics, Dept. ED, Box 31, Los Alamitos, Calif.
Availability: 1 to 2 weeks.

Pneumatic Instrumentation 389

Instruments feature automatic switching with no matching of any pressures, accessible zero and damping adjustments, 4-in. charts with rectilinear recording, calibrated control adjustments and optional front-set control adjustments. Available are S1004-1 indicators and recorders, S1004-2 recording and indicating control stations, and S1004-3 recording and indicating control stations for cascade control.


Sequence Timer 493

Battery-powered timer is accurate to ±10 sec per day over a temperature range of 30 to 140 F. A 4.5-v “A” battery will power the unit for 8-12 months. Cams are available with 1, 2, 3, 4 or 6 lobes, enabling the spdt switch to be cycled as many times in a 1- or 12-hr period.

Geodyne Corp., Dept. ED, 180 Bear Hill Road, Waltham 54, Mass.

Send Today for CATALOG A101 ED

NATIONAL TRANSISTOR MFG., INC.
500 Broadway, Lawrence, Massachusetts

RELIABILITY BY DESIGN — NOT BY CHANCE
VERSATILITY
FRONT END PLUG IN
VERSATILITY

THE ONLY SOLID STATE
10 MC COUNTER-TIMERS
THAT PROVIDE COMPLETE
FRONT END FLEXIBILITY.
ALL MODELS ARE READILY
CONVERTIBLE TO UNIVERSAL COUNTER-
TIMERS BY USE OF PLUG-IN UNITS.

The 1039 Series equipment represents a significant engineering design contribution to user convenience; ease of operation, performance, flexibility and modular solid state reliability are achieved.

PICK A PLUG-IN FOR YOUR SIGNAL

Universal Amplifier AC-DC Coupled
Sensitivity: 0.1vrms 0 to 11 mc
Impedance: 1mΩ 50 pf
Attenuator: 1, 3, 10, 30, 100
with Trigger Level Control

Low Impedance Unit — DC Coupled
Sensitivity: 0.25vrms at 10 mc
Impedance: 93Ω or 50Ω
Trigger Level: ± 1 volt

These instruments, depending upon the model desired, are priced between $2,325.00 and $2,750.00

Let us send you complete specifications of the Model 1039 Series.

NEW PRODUCTS

Tantalum Capacitors

For filter, by-pass, coupling, blocking, RC differentiating and integrating circuits, phase shifting and vacuum tube grid circuits. Available in MIL case sizes A, B, C, and D, to MIL CS 12 or CS 13, these capacitors range from 1.0 to 330 μf with tolerances of ±5%, ±10% or ±20% and working voltages of 6, 10, 15, 20 and 35 v. The units operate from -80 to +85 C at full rated voltage or to +125 C at de-rated voltage.

Erie Resistor Corp., Dept. ED, 644 W. 12th St., Erie, Pa.
P&A: $0.67 to $4.53; 3 to 4 weeks.

Dielectric Material

High-K 707 is available in dielectrics of 6, 9 and 12 as rods, bars and sheets. The range of dielectric constants is from 3 to 18 and the material can be manufactured for the customer to a tolerance of ±0.1 at microwave frequencies. The high-temperature (500 F continuous operation) material is also available as a casting compound in a 1-lb containers.

Custom Materials, Inc., Dept. ED, 279 Billerica Road, Chelmsford, Mass.
Price: on request.

Gaging Console

Reads- and prints-out up to 24 gage points in 1 min. Digital read-out windows give the gaging position and variation in lighted numerals 1 in. high. Readings are accurate to 0.0002 in. Range is ± 0.010 in. Model CS-24 uses 110-120 volts, 60 cps ac and consumes 350 watts.

Winslow Manufacturing Co., Dept. ED, 1751 E. 23 St., Cleveland 14, Ohio.
Pulse Generator

Transistorized 10-mc pulse generator has rise time of 10 nsec. Extended performance capabilities of model 4550A include: pulse train generation to 10 mc, coherent double pulse rate generation, multiple-channel pulse generation and dc biased pulse generation.

Servo Corp. of America, Dept. ED, 111 New South Road, Hicksville, N. Y.

Pulse

Electronic Timer

Two adjustments for predetermined time intervals are featured in the "Protectal" timer: on—from 1/16 to 5 sec; off—from 1/16 to 30 sec. Step switch consecutively energizes up to 24 external circuits. Incorporating a single electronic tube, the device operates from 115 v, 60 cps.

Protection Controls, Inc., Dept. ED, 7317 N. Lawndale Ave., Skokie, Ill.

Temperature Chamber

Tests 150 component parts simultaneously. Range is from —100 to +350 F. Model SU-100-10-HC, 10-cu ft chamber, has a thermal capacity of 400 BTU per hr at —80 F. The unit is 30 x 24 x 24 in. and is equipped with fin coil evaporator on the rear wall, 1,000-w heaters and air baffle.

Cincinnati Sub Zero Products, Dept. ED, 3952 Reading Road, Cincinnati 29, Ohio.

If What You’re Doing Involves Precious Metals*

HANDY & HARMAN CAN HELP YOU DO IT

Gold and silver…and their alloys…possess a combination of characteristics that offers unique advantages to the electronics and electrical industries. Their excellent electrical and thermal conductivity makes them ideal for a vast range of applications, particularly in subminiature components. Their ability to resist corrosion imparts long service life and dependability to critical control items. The fact, too, that they can be obtained in so many convenient forms…wire, strip, sheet, powder, bimetals, flakes and plating anodes…lends them unusual versatility.

These are only a few examples of the ways in which Handy & Harman precious metals are used in the electronics and electrical fields. Perhaps they will suggest some ideas to help you apply them advantageously in your own products or operations. Our technical staff invites your inquiries. No obligation.

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BIMETALS • SILVER PAINTS • POWDERS AND FLAKE

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Rotary Switches?

Low contact resistance and ability to withstand corrosion make silver ideal for switch parts. The stationary contacts of this rotary switch are made of fine silver…the multiple lead brushes are of durable silver alloy. Life tests of one million operations, representing several years of normal use, show that “Zero” resistance of 0.001 ohm through the switch body changes by less than 0.0005 ohm.

The First Major Variable Resistor

In load life, freedom from resistance change under mechanical wear and aging, Stackpole Controls with new STABILITE* Elements surpass any general purpose variable resistors produced since the early days of radio!

By achieving far greater variable resistor stability—at no increase in cost—the new Stackpole STABILITE elements provide greater circuit design freedom while assuring maximum dependability for the equipment in which they are used.

Available in all Stackpole Control

*Trademark, Stackpole Carbon Co.
types, STABILITE elements handle higher loads with an absolute minimum of derating. And they maintain their tolerance through years of hard use!

STABILITE elements result from entirely new techniques in applying carbon dispersions to a specially-developed base material. The accompanying data tells its own story of truly remarkable performance under pertinent conditions of normal use.

For complete details and engineering samples, call your local Stackpole sales engineer or write on company letterhead to: Electronic Components Division, Stackpole Carbon Company, St. Marys, Pennsylvania.

**STACKPOLE**

**VARIABLE composition RESISTORS**

- Fixed Composition Resistors
- Slide & Snap Switches
- Ceramic Cores
- Fixed Composition Capacitors
- Ferrite Cores
- Ceramic Magnets
- Electrical Contacts
- Brushes for all Rotating Electrical Equipment
- Graphite Bearings, Seal Rings, Anodes
- Hundreds of Related Carbon & Graphite Products

---

**Silicon-Controlled Rectifiers**

Types 3RC5A—3RC40A, the 3-amp rated series, and types 5RC2A—5RC40A, the 5-amp rated series, have a prv range from 25 to 400 v. All types enable rapid firing with 2.5 ma at 125 C. Units measure approximately 1.18 in. over-all length.

International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.
P&A: $7.46 to $53.25 each, (1-99); stock.

**Paper Phenolic Laminate**

Redi-Kote 160 is a warm punch laminate meeting NEMA X and XP requirements. Perpendicular short time dielectric strength is 500 v per mil. At 1 mc, dissipation factor is 0.666 and dielectric constant is 5.7. In 1/32-in. thickness, it is punched at 170 F.

Continental-Diamond Fibre Corp., Dept. ED, Newark, Del.

**Ionic Crystals**

Twenty-two crystal types, including masers and lasers, are available in disk, plate and boule shapes. These crystals span a wide range of metallic halogens, including sodium, calcium, lithium, cadmium, lead, potassium and magnesium.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.

**Resistor Kit**

Experimental kit contains seven microminiature solid cermet fixed resistors, each with a different resistance value within the range of 250 ohms to 12-K. CERADOTS are designed for insertion into printed circuit boards. Each is 0.650 in. diam x 0.030 in. thick and is without leads.

CTS Corp., Dept. ED, Elkhart, Ind.
P&A: $7.00; stock.
New Du Pont Resistor Compositions are easy to apply... permit you to vary resistance values by blending the compositions

One major advantage of Du Pont Resistor Composition is its ease of application on ceramic or glass substrates. Just a simple screen-print, dip, brush or spray application, and the resistor is ready for firing under normal atmospheric conditions in the range of 1100-1400°F.

Du Pont resistor compositions allow you to vary resistance values by changing the composition of the resistor without altering its geometric form. You are no longer limited by the physical shape of conventional resistor materials. These compositions give you greater design flexibility, essential for miniaturized circuits. They are available at three approximate resistance values: 500, 3,500 and 10,000 ohms/sq. per mil thickness, and they can be blended to give a range of intermediate values.

Electrical properties are reproducible. Laboratory tests show that fired printed patterns and coated rods have abrasion and impact resistance similar to fired silver coatings.

Fired samples are available for your own evaluation. Request them on your letterhead. For more technical information, write: Du Pont, Electrochemicals Department, Ceramic Products Div., Wilmington 98, Del. Please indicate the application you are considering. Du Pont does not manufacture resistors... only resistor compositions.

Perhaps you can also profit from these Du Pont Products for the Electronics Industry

Conductive Coatings—Specially compounded silver, gold, palladium and platinum compositions that are used to produce capacitor electrodes, ceramic-to-metal hermetic seals, electrical shields and surfaces of high conductivity on non-conductive materials.

Conductive Cements—Silver and gold compositions consisting of finely divided metalic particles dispersed in a resin system; Du Pont conductive cements may be used to replace solder as lead attachments for transistors, diodes, resistors and as a base for electroplating.

NEW PRODUCTS

Digital Multimeter

Measures dc volts, dc ratios, ac volts and resistance. Dc voltage and ratio range and ac voltage range are 0.0001 to 999.9; resistance range is 0.0001 K to 999.9 K. Input impedance (dc) is 1,000 to 10 megohms. Model 851 has provision for directly driving a digital printer.

Electro Instruments, Inc., Dept. ED, 8611 Balboa Ave., San Diego 11, Calif.

Power Transformer

Triaxial 30 kc output power transformer has a 2,000 v dielectric breakdown rating. Potted in flameproof epoxy resin, it meets all applicable military specifications for flammability and thermal shock.

PCA Electronics, Inc., Dept. ED, 16799 Schoenborn St., Sepulveda, Calif.
Price: $25.00 to $35.00.

One-Station Indicator

Standard range is ±0.010 in. with accuracy of 0.0002 in. for model IN-27 Electro-chek. Optional ranges are ±0.020, ±0.005, ±0.003, ±0.001 in. Scale length is 4 in. The unit requires 20 w of 115 v, 60 cps regulated power. A knife-edge pointer minimizes reading errors due to parallax.

Winslow Manufacturing Co., Dept. ED, 1751 E. 23 St., Cleveland 14, Ohio.
Telemetry Receiver-Recorder

Signals from fluid-flow transmitters made by the firm are received, totalized, indicated, and recorded by this receiver. Unit includes a modular circuit pre-wired to handle 16 control switches. Three recording pens on a circular graph are provided.

B-I-F Industries, Dept. ED, Providence, R. I.

Insulating Coating

Designed for high temperature applications, type 1C40 is recommended for continuous operation up to 300 C. The manufacturer claims that the single-component coating has good weathering resistance and excellent adhesion. The compound is made to meet MIL-E-005272B.

Columbia Technical Corp., Dept. ED, Woodside 77, N. Y.

Relay Module

Uses dry-reed switch contactor. The unit consists of a spdt normally open reed switch rated at 12 v a up to 250 v ac resistive load. Up to 12 switches can be operated by the same coil. Operating time is from 1.5 to 3 msec at coil power of 0.1 to 0.4 w. Coils are available for operations at 6, 12, 24, 32, or 48 v de.

D. Randall Co., Dept. ED, 6 Pawcatuck Ave., Westerly, R. I.

Molding Compound

Designed for use in apparatus operating at 130 C continuous. Components produced with grade 1703-A have a dielectric strength of more than 400 v per mil, good thermal stability and high corona starting voltages, according to the manufacturer.

The Glastic Corp., Molding Materials Div., Dept. ED, 4321 Glenridge Road, Cleveland 21, Ohio.

Accuracy Is Our Policy

Model 5000 analog to digital converter, manufactured by Non-Linear Systems, Inc., Del Mar, Calif., has an overall accuracy of ±0.01% plus 1 digit. In the Sept. 27 issue on p 78, ELECTRONIC DESIGN incorrectly reported the accuracy as being ±1% plus 1 digit.

You can
FEEL
the Difference
in an Ohmite Rheostat

Sm-o-o-oth Operation Prolongs Life...Aids in Close Control

TRY IT YOURSELF! Note the smooth, silent glide of the contact over the windings . . . and of the contact moving off and on the terminal bands. There's absolutely no raspy grinding to cause premature wear . . . no aggravating "jerk" points that make you hunt for a setting.

The smooth, close control of Ohmite rheostats doesn't just happen. It's the result of special production operations that eliminate roughness. All 11 sizes of Ohmite rheostats from 12½ to 1000 watts bring you this plus value . . . a refinement that pays dividends in your equipment, whether the rheostat is to be hand operated or motor driven.

Write on Company Letterhead for Catalog 58.
NEW PRODUCTS

Amateur-Band Coils 482

Operating in the 3.5- to 28-mc bands, coil series 2419 consists of five coils used as a set. Coil no. 2546 enables obtaining a wide variety of inductances by shorting different sections of the coil. The amateur bands of 80 through 10 meters may be covered by presetting the entire coil to tune at 4 mc with 37 pf of shunt capacity.

P&A: $1.50 to $2.00; stock.

Regulated Power Supplies 432

Rated up to 3,500 v dc, continuously variable, this line of power supplies offers 0.4 amp at high voltage and up to 50 amp on low-voltage models. The line includes narrow-band models variable over ±10% of nominal output, rated from 6 to 60 v dc. Line and load regulation is from 0.1% to 0.005%, with long-term chopper stability of 0.01%


Heat-Sink Kits 596

For evaluation purposes, four heat-sink kits are available. Kit A contains three TO-3, two TO-5, one TO-8 and two TO-18 heat sinks; kit B contains one TO-3, two TO-5, four TO-8 and two TO-18 types; kit C contains one TO-3, six TO-5, one TO-8 and two TO-18; kit D contains one TO-3, two TO-5, one TO-8 and seven TO-18 types.

National Beryllia Corp., Dept. ED, First & Haskell Ave., Haskell, N. J.
Price: $18.

The Porter Alloyist delivers the right alloy
IN THE SPOTS THAT COUNT
There can be no compromise for instant, reliable communication when disaster strikes. That's why the Porter Alloyist recommends phosphor bronze and other special alloys for telephone and switchboard components. Contact springs and other vital parts made from these alloys deliver high electrical conductivity and resist deformation after repeated use.

**The Porter Alloyist Is A Specialist In A Wide Range Of Special Metals**

Porter's Riverside-Alloy Metal Division is your single reliable source for specialty alloys in 8 basic groups of wire, rod and strip... phosphor bronze, nickel silver, cupro nickel, brass, stainless steel, nickel, Monel and Inconel.

Ask for a free copy of "Alloys for Industry" describing our wide range of specialty alloys. Write H. K. Porter Company, Inc., Riverside-Alloy Metal Division, Riverside, N. J. or contact our sales offices in Hartford, Chicago, East Orange, Atlanta, Cleveland, Detroit, Cincinnati, Los Angeles, and Rochester.

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**Couch Rugged Rotary Relays**

**Specifications**

- **Contacts** — 4 PDT (4 form C) 5 A @ 30 VDC
- **Size** — 1⅞" D. x 1½" H.
- **Weight** — 3.2 oz.
- **Pull-in-power** — ½ watt
- **Vibration** — 50 G, 10 to 3,000 CPS
- **Shock**, Electrical — 100 G minimum
- **Type** — CVE with patented rotary armature

**Write for Data Sheet 7**

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**Gaging Probe**

A transducer of the inductive type. Gaging range is 0.040 in. and total plunger travel is 0.080 in. Linearity is 0.1% over 0.020 in.; 0.25% over the full 0.040-in. range. Output is 5 mv per 0.00 in. with 6 V excitation. Units are designed for 60 cps operation. Sensitivity of model S reaches 0.00001 in.

Winslow Manufacturing Co., Dept. ED, 1751 E. 23 St., Cleveland 14, Ohio.

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**Simulators and Converters**

Repeated serial data words up to 120 bits in length are provided by the 600-series digital data simulators. Bit rates from 1,000 to 500,000 per sec are available. Up to 8 parallel channels are provided. C-series binary to decimal converters accept 10-bit binary data, either serial or parallel, and convert data to 12-bit binary-coded decimal.

Howard Instrument Co., Dept. ED, Red Bank, N. J.

---

**Ceramic Capacitors**

In values up to 0.2 µf, miniature 20-v Ultra-Kap ceramic capacitors can be substituted for paper capacitors in semiconductor circuits. They are stable at temperatures from -55 to +85 C. The basic construction principles of previous lower voltage Ultra-Kaps is employed.


**P&A:** $50 to $100; 3 to 4 weeks.
NEW PRODUCTS

Harmonic Generator

Wide-range harmonic generator model CDH-01 uses three tubes and two crystal diodes. Accuracy of the crystal is ±0.005%. Several of the units can be used at one time with a sweep generator. It can be furnished with crystals ranging from 0.1 to 100 mc.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

Price: $55 to $75.

Mobile Data Acquisition System

With 48 channels of instrumentation, this data acquisition system is designed as a mobile device. Called Mobidac, it measures 36 x 24 x 20 in. and weighs 175 lb. Magnetic tapes produced by the device are suitable for direct input into computers. Digital logic is contained on five different standard circuit cards. Nixie output is provided.

Systems Engineering Laboratories, Inc., Dept. ED, P. O. Box 9148, Fort Lauderdale, Fla.

Secondary Frequency Standard

Checks and sets operating frequencies of mobile communications systems. ZEROBEAT will produce signals from 5 kc to 500 mc with an accuracy of ±0.0002% as a primary standard in the field or ±0.00003% as a secondary standard in the laboratory. The unit can also be operated in the field from a 6- or 12-v inverter, weighs 21 lb, and is 19-7/8 x 11-1/8 x 6-1/4 in.

Eltec Laboratories, Inc., Dept. ED, Middletown, Conn.

Price: $550.00
Light Source

Gives 50-ft scanning range with omni-directional mounting. Type LS-3 light source includes a low-voltage lamp and a step-down transformer for connection to any 115-v ac circuit. Housed in aluminum, it is sealed against moisture and dirt. Dimensions are 6-1/16 x 5-7/8 x 3-15/16 in.

Pulse Switch

One-shot pushbutton switches, series 1PB3000, produce one square-wave, msec-length pulse with each operation. Eight circuits are available to produce lengths from 0.005 to 0.5 sec at amplitudes of 6 to 20 v and 20 to 55 v. Characteristics are: operating force, 30 oz.; total travel, 0.105 in.; pretravel, 0.040 in. min.; differential travel, 0.050 in. max.

P&A: from $28 to $28: immediate.

Servo Assembly

Integrated servo assembly is designed to provide remote transmission of angular positions. It contains a size 5 motor, a size 5 synchro and precision gearing with gear ratios of up to 875 to 1. The output shaft is geared 1 to 1 with a size 5 control transformer. The complete assembly is integrally housed in a size 11 configuration.


Here's Long-term Proof of TI Grown-Junction Transistor Reliability

- Only Texas Instruments offers life-test data from lots that have been continuously on operating life-test for over five years — showing an extremely low average failure rate of less than 5 x 10^-6. More than six-million life-test hours give you the industry's greatest source of reliability data for predicting TI transistor performance.

- Successful applications in thousands of circuits over the years testify to the consistent reliability of these TI units.

- Independent Quality and Reliability Assurance department augments TI's own production and testing know-how... independently measuring device reliability at every manufacturing stage. Approximately one-million life-test hours monthly offer continuous verification of TI grown-junction reliability.

- Low cost of TI grown-junction transistors is made possible through industry's wide acceptance and usage of these units in many applications, enabling TI to provide fast, cost-saving production in large quantities. Added savings in time and money too, through one-source purchasing from TI's complete line of military and industrial grown-junction types.

Take advantage of the predictable reliability of these devices in your low frequency and switching designs. Call your local TI sales office or TI distributor now for immediate delivery in sample or production quantities.

Write on your company letterhead for TI grown-junction reliability data, application notes, data sheets or engineering assistance.

Texas Instruments Incorporated
13500 N CENTRAL EXPRESSWAY
P. O. BOX 5012 • DALLAS 22, TEXAS

CIRCLE 95 ON READER-SERVICE CARD

18594
NEW PRODUCTS

Signal Integrator

Integrates amplified signals from various transducing elements. Model J101B can be used with current and voltage indicators, recorders or any instrument that supplies a full-scale output of 1 ma from 10 to 100 v. Accuracy is 1%. Drift is less than 0.01% per hr. Information is indicated by a 6 decimal digit counter and a 2-1/2 in. meter.

Eleor, Inc., Dept. ED, 1225 W. Broad St., Falls Church, Va.
P&A: $795.00; 4 weeks.

Stack Switch

Telephone relay type. Switch features tempered nickel-silver springs, ranging in thickness from 0.0063 to 0.016 in.; type XXXP paper-base phenolic spacers in thicknesses of 1/32, 3/64, and 1/16 in. Silver or welded crossbar palladium contacts are used and tubing is polystyrene or bakelite.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Pulse Transformer

The PIP series of nine pulse transformers are completely metal cased. Measurements are 5/16 in. diam x 3/16 in. high, weight is 1/20 oz. Units meet MIL-T-21038 and MIL-T6RX-4410CZ. Parameter ranges are: 0.05 to 10.0 μsec pulse width; 0.018 to 0.4 μsec rise time; 50 to 200 ohms impedance (in, out).

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.

New SYNTRON Power Point

Delivers up to 22 KW

Plagued by the lack of space for your power rectifier circuits?
Looking for more delivered d-c power?
Like to reduce the costs of the rectifier assemblies you're using by 30% or more? Want certified and guaranteed performance? You'll want the new Syntron Power Point**, the new component you mount right at the point of use, right where you need the d-c. It's a single unit replacing the usual complicated assembly of silicon rectifiers, heat sinks, cooling fins, terminal posts and mounting lugs, spacers, etc.
It's a compact unit that supplies a lot of power. Example: a force cooled heavy duty model, measuring only 4½ by 3½ by 4 inches, can deliver 22 kw at the d-c terminals. If you prefer to use the smaller of the two available models, you can get as much as 17 kw d-c. This little fellow is only 4 by 2½ by 2½ inches.
You can get either of these two sizes for single phase or three phase operation... current range from 3-25 amperes (75 amperes on force cooled units).

What about cost... Depending on the number you need, you'll find that the Power Point costs from 30% to 50% less than any comparable silicon rectifier assembly. If you want a firm dollar quote, let us know your requirements and the quantity desired. We'll tell you exact prices along with delivery dates. Usually, delivery is 15 days or less after you order. (We can make it fast because the Power Point is in stock NOW and it's available direct from Syntron or from selected distributors throughout the country.)

Want a quote or more information? A complete data sheet showing performance curves, dimensions, operational characteristics is yours by completing the coupon or by writing Syntron Company, Semiconductor Division, Homer City, Pa. In Canada: Syntron Company Ltd., Stony Creek, Ontario.

**Syntron Trade Mark
Replaces Bridge Assemblies in 50% less space, 30% less cost

WHERE TO USE THE POWER POINT

- on clutches, computers, for cathodic protection
- on business machines, and burglar alarms, and battery chargers
- on magnetic chucks and amplifiers and magnetic reactors
- on motors and brakes and to close circuit breakers
- on circuits with telephones, telegraph and other equipment, such as
  - vibrators and relays and traffic control
- power supplies for autos and airplanes and electro-plating
- In short: almost anywhere you need d-c power close to the Point of use

SYNTRON certified SEMICONDUCTORS

CIRCLE 96 ON READER-SERVICE CARD

SYNTRON Co., Semiconductor Div., Homer City, Pa. ED-11

Please send me more information on Syntron Power Point.
Please have a Syntron representative call.

Name
Title
Company
Address
City State

Thermoelectric Coolers

Using 3.0 amp max, these 2 and 3 stage cascade coolers will reach -95°C from a sink temperature of +20°C. The 2 stage model 615-5 has a maximum delta T in open air of 65°C; in vacuum, 86°C. The 3 stage model 615-5-1 specifications are 75 and 115°C, respectively. Both units have a maximum active heat pumping capacity of 20 mw.

Jepson Thermoelectrics, Inc., Dept. ED, 139 Nevada St., El Segundo, Calif.
P&A: model 615-5, $309, model 615-5-1, $349; 30 days.

Digital Control Equipment

Digital transducers and a sampling multiplexer are available to operate over range -40 to +158°F ambient. Higher ranges are available. Components are capable of operating individually or collectively with any digital controller or data recorder.

Diginamics Corp., Dept. ED, 2525 E. Franklin Ave., Minneapolis 6, Minn.

Vibration Isolator

Based on the principle of seismic motion, this shock and vibration isolation system is designed to protect supported mass in all altitudes, even in combination with high steady-state G-loads. Featuring all-metal construction, the isolator is unaffected by temperatures from -100 to +500°F; meets MIL-E-5272C and exceeds performance requirements of MIL-C-172.

Aeroflex Laboratories, Inc., Dept. ED, 48-25 36th St., Long Island City 1, N. Y.
P&A: $4 to $50; stock to 60 days.
NEW PRODUCTS

Silicon Transistors

Power dissipation is 85 w. Types 2N1212 and 2N1208 are diffused junction npn high power transistors designed to operate from -65 to +200 C. V_ao is 60 v, V_diode is 60 v, V_b is 10 v, and I_ is 5 amp. These transistors meet the environmental requirements of MIL-S-19500B.

Silicon Transistor Corp., Dept. ED, 150 Glen Cove Road, Carle Place, L. I., N. Y.

Ultrasonic Cleaner

Features 5 gal capacity. The system 320 has a generator rated at 320 w average power, 1,280 w at peak power output. Fused for 7 amp, the generator operates from 117 v, 50 to 60 cycle line current. A 220 v, 50 to 60 cycle export model is also available. Broad-band frequency modulation is used to prevent overloading of transducers.

Ultrasonic Industries, Inc., Dept. ED, Engineers Hill, Plainview, L.I., N. Y.

P&A: $499.95; immediate.

Pressure Switch

Trips at 50 psi; resets at 30 psi. Model 65M291 is designed for a wide range of environmental conditions and operates from -65 to +300 F at altitudes from sea level to 800,000 ft. Featuring explosion proof construction, the unit measures 1-in. sq by 1-1/2 in. overall length.

Captive Seal Corp., Dept. ED, Caldwell, N. J.
Three-terminal, high-frequency, low-pass filters are designed to eliminate parallel resonance peaks in the uhf range of 100 to 2,000 mc. At 500 mc the transfer impedance of the filter is below 0.01 ohms; effective filtering continues to above 1 Gc. Temperature ranges are up to 125 C.

Erie Resistor Corp., Dept. ED, 644 W. 12th St., Erie, Pa.

P&A: from $0.60 to $12.50 each in lots of 1M to 10M; immediate.

For push button and selector switches, Type H and HO melamine contact blocks can be supplied for panel mounting with 1 NO or 1 NC contact and 2 NO or 2 NC contacts for base or panel mounting. They are rated at 6 amp, 110 to 125 v; 3 amp, 220 to 250 v; 1.5 amp at 440 to 480 v; 1.2 amp at 550 to 600 v.

Clark Controller Co., Dept. ED, 1146 E. 152nd St., Cleveland 10, Ohio.

A pressure sensing, pencil-probe type welding handpiece, the VTA-43, has been designed to facilitate small, pin-point welds entirely from one side of a work surface. The probe is adjustable to fire and weld energy at preset pressures ranging from 1/2 to 5 lb. The unit weighs 6 oz with cables.

Hughes Aircraft Co., Dept. ED, 2020 Short St., Oceanside, Calif.

P&A: $75 each; from stock.

Write for full details on Types DA 2 and DA 4.

Daven metal film resistors
- True glass-to-metal seal plus epoxy encapsulation
- 25 PPM/°C. temperature coefficient over normal operating temperatures at no surcharge
- Weldable leads, which are readily solderable, are standard on all units at no surcharge
- Exceeds MIL-R-10509D, Characteristic C specs
- Off-the-shelf delivery from your Daven distributor

Write for full details on Types DA 2 and DA 4.

THE DAVEN COMPANY, Livingston, New Jersey

RESISTORS

TODAY, MORE THAN EVER, THE DAVEN STANDS FOR DEPENDABILITY
NEW PRODUCTS

Data System

Density and pressure can be digitized and recorded on Mobidac for later computer analysis of standard deviation, variance, quantities, mean values, etc. This unit accepts 48 input data channels directly from transducers at full scale levels at low mv. Inputs are multiplexed and digitized into binary or binary-coded decimal codes and recorded on magnetic tape.

Systems Engineering Laboratories, Inc., Dept. ED, 4066 N. E. Fifth Ave., Fort Lauderdale, Fla.
P&A: $50,000 to $60,000; 90 days.

Power Transistor

Silicon power transistor has a current gain of 1,000 at 2 amp and a 0.35 ohm saturation resistance. This 10 amp device, designated WX-118, has voltage ratings up to 150 v and a power rating of 150 w. The low saturation resistance of this device improves efficiency and reduces cooling problems in power switching circuits.

Westinghouse Electric Corp., Dept. ED, 2519 Wilkins Ave., Baltimore 3, Md.

Optical Oscillograph

Featuring direct readout, the 8-channel unit has 0 to 500 cpm response with standard galvanometers. The model 658 T system uses an 8-in. wide chart, has 9 chart speeds from 1,000 to 2.5 mm per sec, timing lines at 0.1 and 1.0 sec intervals, and a beam interrupter for trace identification. Amplitude lines are "written," and may be eliminated from 1/4, 1/2, 3/4 or the entire width of the band.

Sanborn Co., Medical Div., Dept. ED, 175 Wyman St., Waltham 64, Mass.

HOW TO SAVE TIME
WHEN YOU NEED
CORNING COMPONENTS
IN A HURRY

Check this list for the Corning Electronic Components distributor located nearest to you...Clip and save.

You can get immediate delivery from him at factory prices on virtually the full line of top-reliability Corning components...tin oxide resistors, from the 6¢ C line through the environment-proof NF type; capacitors, axial lead and wafer types; shock- and vibration-resistant precision trimmers; rugged, high stability inductors and inductor kits, and printed circuit grid boards and grid board kits.

All you need: your distributor’s name, a telephone and a purchase order. Your distributor will do the rest...quickly.

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CORNING CYFM CAPACITOR has reliability you can see

You get total protection against environment for less money than ever before

The new Corning CYFM capacitor gives you reliability at a markedly lower cost than that of any like capacitor.

The CYFM goes far beyond MIL-C-11272B specs. It has proved its performance through more than 3,000,000 hours of testing. It took a 50-day MIL moisture test and a 90-hour salt spray test with no measurable effects. We stopped testing only when it became evident that no more significant data could be developed. The CYFM went through other tests, with solvents, fluxes, boiling salt, and steam, to make sure it is the most completely sealed capacitor you can buy.

You'll see why the CYFM can take such torture when you check its design. We stack alternate layers of stable ribbon glass and aluminum foil. Then we weld the foils to the bead-terminal assembly, which has a glass bead sealed to the Dumet wire lead. With heat and pressure, the entire capacitive element is frozen in glass for complete protection against environment and for structured protection against physical shock.

True glass-to-metal seals at the weld area and along the leads bar moisture. The seal of the leads to the glass shifts stresses from the leads to the entire monolithic unit, guarding the capacitance area. Of course, you get electrical performance to match this environmental stability, since the CYFM has our glass-foil capacitor construction.

The CYFM is machine made... each capacitor is the same as every other, to give you uniformity which hand production cannot match.

You can get immediate delivery on the CYFM in four types. The CYFM-10 gives capacitance values from 0.5 to 300 pf; the CYFM-15, from 220 to 1200 pf; the CYFM-20, from 560 to 5100 pf, and the CYFM-30, from 3600 to 10000 pf.

For the rest of the story on this capacitor, send for our data sheet. Write to Corning Glass Works, 104 High St., Bradford, Pa.

This is the CYFM capacitor. 5 times actual size. The dark areas between the ends of the glass and the capacitance element are your visual proof of the complete glass-to-metal seal.

CORNING ELECTRONIC COMPONENTS
CORNING GLASS WORKS, BRADFORD, PA.
CIRCLE 102 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

NEW

Fixed Span Recorder

With 24 plug-in modules, this unit operates as a strain gage or a potentiometer-following recorder. No rewiring is needed to change from one module to another. Tape sizes are either 5 or 11 in., with single or dual pen and multipoint models.

Westronics, Inc., Dept. ED, 3605 McCary, Fort Worth 10, Tex.

Frequency Changer

Maintains ±0.25% frequency stability. This 400 cycle sine wave frequency changer has input of 105 to 130 v, 47 to 1,000 cps, 2.5 amp max. Regulation of the adjustable 105 to 130 v single phase output is said to be ±1% from full load or over 105 to 130 v line change. The solid-state 100 va converter is packaged for bench or rack-mounted applications.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

Logic Module

Available in two package styles, this module contains three gate circuits and a flip-flop which is capable of being set, cleared and complemented at a 10 mc. Model 1012 is designed for basic test equipment and prototype system design applications. Model 2012 is intended for use in final systems.

Harvey-Wells Electronics, Inc., Dept. ED, 14 Huron Drive, Natick, Mass.

P&A: $140; from stock.
NEW Time Delay Relays

INSTANTANEOUS RESET... VOLTAGE-TEMPERATURE COMPENSATED

Designed with an instantaneous reset feature, these relays provide the same time delay for a series of cycles when temperature and voltage vary.

They are pre-set from 3 to 180 seconds, are chatter-free and will withstand severe shock and vibration. Because of this unique combination of features, these relays are now being used in such new circuit applications as:

Sequential timing for missiles • Automatic reset on digital readout equipment • Oscillator stabilization • Overload protection

“DM” SERIES STEPPING MOTORS

Curtiss-Wright Stepping Motors convert digital pulses into mechanical work or motion. Units are bi-directional with high starting torque.

Write for complete Components Catalog 260 to help you select Curtiss-Wright electronic components for use where dependability is of prime importance.

COMPONENTS DEPARTMENT - ELECTRONICS DIVISION

CURTISS W. Wright
CORPORATION • EAST PATerson, N. J.
CIRCLE 103 ON READER-SERVICE CARD

NEW PRODUCTS

Radiation Meter 375

Little larger than a pack of cigarettes, this device weighs less than 8-1/2 oz and operates on power from ordinary penlight batteries or mercury cells. In normal use, the mercury cells are said to power the unit for more than a year. The meter is accurate at any temperature from -20 to +140°F, according to the manufacturer.


Production Machine Programmer 421

Card programmer, model 1600, allows machine tool systems, automatic check-out equipment, and circuit testers to be programmed from standard computer cards. Unit includes a series of memory bands, each containing 960 normally open latching relays. Relays remain closed according to instructions until program is erased.

Embree Electronics Corp., Dept. ED, 993 Farmington Ave., West Hartford, Conn.
Price: less than $8 per connection.

Power Source 417

For emergency operation of critical equipment. The unit supplies up to 750va at 115 v ac, 60 cps from reserve battery sources of 120, 130 or 140 v dc. Capable of picking up full load from standstill within 50 msec, the equipment maintains an output power frequency of 60 ±1/2 cycle regardless of battery condition or load.

Cornell-Dubilier Electronics Div., Dept. ED, 118 E. Jones St., Fuquay Springs, N. C.
Environmental Tester 638

Combination vibration and shock-testing instrument ST300 has a 250-force-pound air-bearing exciter. The instrument allows shock testing to over 5,000 g and vibration testing over a useful frequency range from 5 to 30,000 cps. The first major resonance is above 6,000 cps.

International Telephone and Telegraph Corp., Industrial Products Div., Dept. ED, 320 Park Ave., New York 22, N.Y.

Electron Gun 608

Produces 10,000-deg Kelvin at the smallest spot size. The electron gun and transport mechanism is designed for mass production of thin-film microcircuit elements. A pulsed triode, it operates at 55 kv peak with a beam current of 1 to 10 ma. Spot size is 0.010 to 0.125 in. Hole-punching rate is 60 or 120 per sec.

Rescon Electronics Corp., Dept. ED, 151 Bear Hill Road, Waltham, Mass.

Magnetic Core Memories 647

For use in the design of data conversion and data processing systems, the EECA 8-level series has a capacity of 128 to 2,048 characters. The series has three models: random access; sequential access; sequential interlace. Self-checking features provide automatic test of the entire memory at the 200 kc rate or a manual step-by-step test can be made.

Electronic Engineering Co. of California, Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

P&A: $10,000 to $15,000; 60 to 90 days.

NOW CURES FAST AT ROOM TEMPERATURE TOO!

(OR 2 HOURS WITH HEAT)

A clear, solventless liquid, General Electric clear LTV-602 cures at 75-80°C to form a resilient compound with excellent electrical properties. Even thick sections are perfectly transparent. Useful from -65 to 175°C. Tests indicate that LTV retains protective properties even after 1000 hours aging at 175°C. Other tests confirm LTV's resistance to moisture and water immersion.

<Low Temperature Vulcanizing>

General Electric clear LTV silicone compound for potting and embedding

Transparent, resilient, self-supporting and easy to repair

LTV-602 is easily applied, flows freely in-and-around complicated parts. Having a low viscosity in the uncured state, 800-1500 centipoise, LTV is ideal for potting and embedding of electronic components. Unlike gel-like potting materials, LTV-602 cures to a true solid. Oven cure is overnight, or from 6 to 8 hours at 75 to 80°C.

LTV-602 is easy to work with and easy to repair. To repair parts embedded in LTV, merely cut out and remove section of material, repair or replace defective part, pour fresh LTV into opening and cure. Pot life, with catalyst added, is approximately 8 hours and may be extended with refrigeration. When desirable, LTV may also be cured at room temperature.

LTV-602 is the newest addition to the broad line of GE silicone potting and encapsulating materials which also include the RTV silicone rubbers. For more information, write to General Electric Company, Silicone Products Department, Section 1156, Waterford, New York.

3 TIMES FASTER THAN BEFORE

SEND FOR DATA ON NEW FAST CURE
NEW PRODUCTS

Semiconductor Component Kits 369

Contains spheres, washers, rings, pellets, base tabs and foils of various alloys, cladings and combinations. Nine different kits of spheres, four different kits of specialized stampings and three kits of foils and clad metals are available, along with special kits for micro-wave devices and tunnel diodes.

Semi-Alloys, Inc., Dept. ED, 20 N. MacQuesten Parkway, Mount Vernon, N.Y.
Price: $18.50 to $47.50.

Brushless DC Motor-Fan 359

Capacity is 270 cfm free air delivery. Operates at 28 v dc, and requires 50 w of power. Designed model 3301, the fan has sealed ball bearings for adverse environmental conditions and is housed in a black anodized aluminum frame per MIL-A-8625, type II. Featuring stainless steel shaft and hardware, the unit is designed for operation in ambient from -55 to +55 C.

P&A: $75 to $150; 2 weeks.

Accuracy Is Our Policy

Volt-ohmmeter model 21A, manufactured by J-Omega Co., Los Altos, Calif., was erroneously described, on p 76 of the Sept. 13 issue of ELECTRONIC DESIGN, as having an accuracy of ±15% of full scale. The accuracy is actually ±0.15% of full scale.
Relays and Contactors

For noninductive loads. The four units available are contact rated at 30 amp, 250 v ac and may be applied continuously up to their full rating, open or enclosed, with conservative temperature rises.

Automatic Switch Co., Dept. ED, Florham Park, N. J.
Price: $27.00 to $35.00.

Six-Channel Oscilloscope

Features upper 5-in. memory tube and lower 5-in. square five gun tube. Range of sensitivities is 100 v per cm to 0.1 v per cm. Rise time is 40 nsec. Sweep speeds are available between 5 sec per cm and 0.1 μsec per cm in 23 calibrated steps. A 1-kc oscillator acts as the driving source of a square wave generator to provide calibrating voltages and time intervals.

Clifton Technical Physics, Dept. ED, 3329 Doris Ave., Wanamassa, N. J.
Price: $8,500.

Instrument Rectifier

Redesigned model 500 has 0.5-in. cell size and 0.125-in. active cell area. The device has a 6-32 stud mounting and is available in five standard types. Terminal ends clamp on to lead wires in a vise-like hold.

Conant Laboratories, Dept. ED, Box 3997, Bethany Station, Lincoln, Neb.
NEW PRODUCTS

Adjustable Stop Switches

Permit an increase or decrease of positions as circuit requirements dictate. Built in square configuration in 1-3/4 and 2-1/4-in. sizes, these units are said to be constructed of corrosion resistant metals and heat resistant plastics. They meet MIL-S-3736 and MIL-E-5272.

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

Availability: immediate, from distributors.

Compression Amplifier

Bridging type, 12,000-ohm, balanced 3-terminal input is featured on model WSC525. Power output is 3.8 v on 600 ohm or ±13.8 dbm average at full compression. Attack time is 35 msec; recovery time, 1 sec. Frequency response is within audio range. The three-tube unit has 110-120-v, 60-cps, 0.16-amp power supply.

Webster Electric Co., Dept. ED, Racine, Wis.

Component Heater

For bench-top temperature testing. Probe tips fit the component to be heated and are controlled at the temperature set within ±3 C. Temperature stability is ±0.5 C. A 35-w heater probe is interchangeable with one of 9 w. Tips supplied fit TO-3 and TO-5 transistor cases.

Kennedy Co., Dept. ED, 2029 N. Lake Ave., Altadena, Calif.

P&A: $150.00; 2 weeks.
Shaft Angle Translator 648

Visual display and BCD data outputs derived from the translation of shaft encoded input signals are produced by the EECC 780 shaft angle translator. It is possible for angles to be read instantly and with resolution of 0.01 deg. Translation speed is approximately 75 msec after interrogation command.

Electronic Engineering Co. of California, Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif. 
P&A: $4,150 fob Santa Ana; 60 to 90 days.

Regulated Power Supply 467

A static magnetic power supply, the Sola CVDR is modified by the addition of a saturable reactor to regulate the output voltage for load variations. Regulation is ±2% overall for both line and load changes. Ripple is 1% peak-to-peak. Units are available in 4 types from 6 v, 10 amp to 24 v, 5 amp ranges.

Sola Electric Co., Dept. ED, Elk Grove Village, III.

Precision Thermostat 386

Pre-sets temperature control within narrow limits is accomplished by the M2 thermostat. Suggested uses are for warning devices in missiles, heating blankets and similar devices. The unit is designed to fit small spaces and can be supplied to open or close on temperature rise. All-welded construction eliminates use of organic substances.

Metals & Controls Inc., Dept. ED, 34 Forest St. Attleboro, Mass. 
P&A: $3 to $10 depending on quantity; 3 weeks.

CIRCLE 113 ON READER-SERVICE CARD >

100 mc
SOLID STATE
Universal Counter-Timer

KEY SPECIFICATIONS

FREQUENCY
0 cps to 100 mc

TIME INTERVAL
0.02 usec to 10 sec

PERIOD
0 cps to 10 mc

INPUT SENSITIVITY
1.0 v rms

GATE TIMES (FREQUENCY)
1 usec to 10 sec in 8 decade steps or external. Reads in cps, kc, mc.

FREQUENCY OUTPUTS
0.1 cps to 1 mc output in decade steps

ACCURACY
±1 count ± stability
±10 nanosecond ± stability

STABILITY
Short term: ±1 part in 10^4
Long term: within 5 parts in 10^4

PRICE, F.O.B. FACTORY
$3,950; inline readout $200 extra

* SEVEN BASIC FUNCTIONS, including dc to 100 mc frequency measurements without heterodyning techniques* Time interval measurements with 10 nanosecond resolution* Straight or totalizing counting* Frequency ratio measurement* Period measurement* Sensitivity better than 1.0v rms* Power consumption 50 watts* Decade countdown time base (no adjustments necessary)* Two year free service warranty* No vacuum tubes* Connector on rear providing standard 1-2-4-8 BCD output for operating printer, punch, etc.

Model 728B is a production unit, not a showpiece prototype. Demonstrators are now in the hands of CMC engineering reps. Call, wire or write to arrange a demonstration. Complete technical data plus a copy of our new 20 page short form catalog is yours for the asking.

Computer Measurements Company
12970 BRADLEY AVENUE • SAN FERNANDO, CALIFORNIA 
EMPIRE 7-2161
NEW PRODUCTS

Logic Card Systems 374

Made of 1/16-in. glass bonded epoxy, the standard card is 7-1/2 x 6 in. Connector is a 47 pin hermaphrodite design with card contacts staked and soldered to the etched circuit. Power supply voltages required are -12 v, -6 v, and -24 v regulated within ±3%. Temperature range is 0 to 55 C. All outputs are clamped. Output signals are 0 v and -6 v.
Drexel Dynamics Corp., Dept. ED, Horsham, Pa.

Carrier Amplifier 403

Transistorized, single-channel model 8300 is available in 3 or 10 kc, with line regulation of better than 0.1% and a temperature coefficient of less than 0.01% per F. A 10-turn precision potentiometer is provided to form one-half of a bridge circuit when a two-element sensor is employed.
Crescent Engineering & Research Co., Dept. ED, 5440 N. Peck Road, El Monte, Calif.

Ceramic-to-Metal Housings 400

For tunnel diodes. The housings, which are as small as 0.090 in. diam. and 0.030 in. overall height, are constructed to withstand temperature in excess of 1,500 F. Mechanical strength is 15-20,000 psi tension.
Advanced Vacuum Products, Inc., Dept. ED, 430 Fairfield Ave., Stamford, Conn.
P&A: $0.10 to $1.00; 4-5 weeks.

CALIBRATION > STANDARDS

Self Calibrating DC Voltmeters

Now, in the Model DC-200AR Voltmeter, fine accuracy Voltage measurements with a 6 digit readout. Completely transistorized. This instrument and its companion DC-100A use ultra-stable Zener references. The stability, inherent in both these Voltmeters, make them essential to reliable laboratory and production testing. Only 3 watts of power at 117 VAC required. DC-100A available as a DC-100AR in rack mounting. Write for detailed specifications or contact your local CSC representative.
Round Plug

Suitable for relay and miniature plug-in circuits, the K1-14, a 14-pin plug, can mate with TS1405P01 sockets. It has phosphor-bronze-cadmium plated 0.040 in. diam pins, gold flashed pins and higher temperatures are also available. Model R14, a matching 14-pin socket, has saddle mounts.

Vector Electronic Co., Inc., Dept. ED, 1100 Flower St., Glendale 1, Calif.
P&A: 30.55 ea. in lots of 100; stock.

Phase Checker

Determines correct phasing of loudspeakers in stereo, hi-fi, and public address systems. The sound-powered device, designated WG-360A, may be used with any conventional volt-ohm-milliammeter, vtvm, or cathode-ray oscilloscope. The effective frequency range of each of the two receptor units is 40 to 4,000 cps. Resonant frequency is 180 cps, approximately.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N. J.
P&A: $11.95; immediate.

Instrument Motor

Six positive, repeatable speed ratios, which can be changed while the motor is running, are incorporated in this gear motor. Built to NEMA size 25 frame, the gearhead can be adapted to motors from 1 to 600 rpm. Speed ratios are from 1 to 1, to 50 to 1; others can be suited to requirements. Operation is 115 v ac, 60 cps.

Inco Co., Dept. ED, Hollis St., Groton, Mass.

ENGINEERED COMPONENTS
for the Electronics Industry

As close at hand as your nearest authorized Garlock distributor—CHEMELC Insulators, Subminiature Tube and Transistor Sockets, Connectors.

Available as well as reliability are two reasons why it is smart to specify Garlock when buying components.

Through a new organization of authorized distributors, Garlock now offers immediate delivery of CHEMELC Stand-off and Feed-Thru Insulators, Subminiature Tube and Transistor Sockets, Connectors, and other standard components.

As near as the telephone, your authorized Garlock Electronic Products Distributor offers prompt, courteous service. Call him at the nearest of these locations:

CALIF
NEWARK ELECTRONICS CO.
474 W. Century Blvd.
Fremont, Calif.
SCHAD ELECTRONICS
499 S. Market St.
San Jose, Calif.
WESCO ELECTRONICS
115 E. Colorado Blvd.
Pasadena, Calif.
COLORADO
INTER-STATE RADIO &
SUPPLY CORP.
1200 S. Platte Street
Denver, Colorado
ILLINOIS
NEWARK ELECTRONICS CO.
223 West Madison St.
Chicago 6, Illinois
MARYLAND
ELECTRONIC ENTERPRISES.
INC.
4902 Snader Avenue
Baltimore 15, Md.

Take advantage of on-the-spot availability—specify these skillfully engineered Garlock electronic components. Reliable under the most severe conditions, they are ideal for high temperature, high voltage, high frequency service on missile guidance, fire control, tracking, and radar systems. Garlock has the technical personnel and modern facilities to produce components of all materials—Teflon TFE and FEP, Nylon, Delrin, C.T.F.E.; and a range of sizes, designs, and tolerances to fit your exact needs. At your disposal, too, for development of new electronic products, Garlock maintains complete electrical, chemical and physical laboratories staffed by top-flight engineers.

Remember, too, the newest of the Garlock electronic products—Flexible Printed Circuitry of Teflon FEP. For complete details on what Garlock has to offer, write for Catalogs AD-169, 171, and 188. Garlock Electronic Products, Garlock Inc., Camden 1, New Jersey.

Canadian Div.: Garlock of Canada Ltd.
Plastics Div.: United States Gasket Company
Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.
NEW PRODUCTS

Connector Devices

ML-7560
Ceramic Triode

Coaxial terminal, thoriated-tungsten cathode ML-7560 provides:
15 Mw Pulsed Modulator Power Capability at 1% duty...
DC Plate Voltage Max 50 kv
Pulse Cathode Current Max 550 amps
3.0 Mw R-F Pulsed Power capability at 5% duty...
Peak Plate Pulse Supply Voltage Max 40 kv
Pulse Cathode Current, Max 550 amps

Send for 74 page brochure, "Hard Pulsed Modulator Tubes", containing useful information for Radar Design Engineers and others.

MACHLETT
The Machlett Laboratories, Inc.
Division of Raytheon
Springdale, Connecticut

CIRCLE 117 ON READER-SERVICE CARD

Only the required number of contacts are mounted on Edge-Bord and In-Bord pin and cup receptacles. Round 0.040-in. diam pins project 1/4 in. beyond the board edge. Cup receptacles accommodate boards with 10, 15, or 20 pins installed. Connector pins allow the boards to be stacked in a picky-back arrangement.

Vector Electronic Co., Inc., Dept. ED, 1100 Flower St., Glendale 1, Calif.
P&A: pins, $0.015 ea. in lots of 10,000, cup receptacles, $0.06 ea. in lots of 10,000; stock.

Ultrasonic Pulser

Sound from 30 kc to 1 mc is generated in low-frequency pulses by the model 101 ultrasonic pulser. Pulse amplitude is variable to 1,000 v, and a simultaneous 0 to 700 v dc output is provided. Device can be used with all standard crystal and ceramic transducers, including polarizable units.

Elion Instruments, Inc., Dept. ED, 430 Buckley St., Bristol, Pa.
Price: about $900.

Feed-Thru Capacitors

For chassis-wall mounting. Solid tantalum, hermetically sealed type STAF capacitor ranges from 4.7 to 1.0 µf for use on 6 to 35 wvdc max under 8 to 46 surge volts max. They have current ratings ranging from 1.0 amp at 25 C to 0.4 amp at 125 C with working voltages at ambients above 85 C requiring 67% linear derating to 125 C.

**Transistorized Gaussmeter**

Direct reading of flux densities, from 0.3 gauss full scale to 30,000 gauss is accurate to ±2.5%. Gaussmeter model 900, operates from self-contained batteries or ac supply, has eleven switch selected ranges and can be extended to 100,000 gauss.

Dyna-Empire, Inc., Dept. ED, 1075 Stewart Ave., Garden City, N. Y.
*P&A: $475.00; 2 weeks.*

**Copper Coating**

For plated thru-holes in printed circuits. The material is applied by dipping, removing excess, oven-drying, light sanding and copper strike. Laboratory controls are not required.

Etchomatic, Inc., Dept. ED, 182 Newton St., Waltham 54, Mass.
*Price: 6-oz sample kit, $5.95.*

**Ionospheric Sounding System**

Mobile ionospheric sounding system is fully automatic and compatible with existing systems. Sounder transmitter and receiver units weigh 600 lbs each and measure 42 in. wide x 52 in. high. Frequency range is 1 to 25 mc and power output is 10 to 20 kw, with a 25-­µsec Gaussian pulse width. Receiving terminal is designated RM548A; transmitting terminals model RM547A.

Phillips Electronics Industries Ltd., Dept. ED, 116 Vanderhoof Ave., Toronto 17, Ont.

CIRCLE 119 ON READER-SERVICE CARD ▶

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**NEW smaller size foil Tantalytic* capacitors pack foil advantages in near solid dimensions**

No longer can limited space prevent your specifying a foil capacitor with its superior characteristics. General Electric now offers an 85C Tantalytic "A Case" capacitor .131" diam., .47" long—almost as small as the smallest solid! The General Electric foil "A Case" is available at higher voltages, and is inherently more reliable than solids when operated at rated voltages. It is available in non-polar as well as polar ratings. Further, it matches solids for volumetric efficiency.

But there's no compromise on electrical characteristics. The lower leakage currents of the "A Case" actually decrease during operation, while leakage currents in solids normally increase.

The "A Case" comes in single-end, .47"-long, .131"-diam., polar type; or double-end, .54"-long, .131"-diam., polar or non-polar types—rated 6V (12uf) to 50V (1.4 uf) and to higher voltages.

For data, call your G-E Sales Engineer. Or write for Bulletin GEA-7226, General Electric Co., Schenectady, N. Y., Capacitor Department, Irmo, S. C.

Progress Is Our Most Important Product  
Now up to 100-volt ratings

General Electric also offers these reliable Tantalytic capacitors:

- **High-Reliability Oil and Solid Capacitors**
  - Bulletin GEA-7227

- **Porous-­Amode Tantalytic Capacitors**
  - Bulletin GEA-7008

- **125K XSR Tantalytic Capacitors**
  - Bulletin GEA-6766

- **High-Voltage Tantalytic Capacitors**
  - Bulletin GEA-7065

- **125C Cylindrical Tantalytic Capacitors**
  - Bulletin GEA-7085
**NEW PRODUCTS**

**Mica Capacitors**

Flag-type terminal. Available in stand-off and feed-thru styles, models 2922 and 2921, these capacitors range from 15 pf through 2,500 pf, with tolerances of ±2% or ±1 pf, ±5%, ±10% or ±20%. They operate from -55 to +200°C, at which point they exceed life test and temperature cycling requirements of MIL-C-10950.

Erie Resistor Corp., Dept. ED, 644 W. 12 St., Erie, Pa.

P&A: $2.785 to $2.49; 3 to 4 weeks.

**Pressure Valve**

Regulates pressure in the compartment to ±0.25 psi from sea level standard to space at a constant nominal flow of 8 cfm. Flow capacity of model P/N 26100 is 6 to 9 cfm; inlet pressure is 16 to 17 psia and outlet pressure is 0 to 14.7 psia. The unit may be mounted in any position and can operate in the ambient range of -40 to +185°F.

Aerodyne Controls Corp., Dept. ED, 90 Gazza Blvd., Farmingdale, N.Y.

**Materials Tester**

For insulating materials. Model 4712 determines dielectric strength of insulating liquids, solids and sheets at potentials to 60 kv. The dc test potential is continuously variable from 0 to 60 kv, with maximum output rated at 2 kva. Overload breakers and safety interlocks are provided.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.
Protective Packaging

Construct of foamed plastic in two halves, this package may be sealed with pressureresistant tapes and shipped in any shipping container. Weight is approximately 6 oz. Shock loads are distributed equally to all sides of the container. The units have a slow-controlled rate of rebound, are non-hygrosopic, and are said to be unaffected by heat, humidity or altitude. They can be fabricated in a variety of shapes and sizes.

Pac-Tron, Inc., Dept. ED, 225 Crescent St., Waltham, Mass.

Flow Transmitter

Differential pressure caused by fluid flow is measured, and the information is transmitted by model 231-01 Chronoflo telemetering transmitter. Unit sends a pulsed code, the rapidity of pulses indicating the rate of flow. Water differential capacities from 20 to 120 in. are interchangeable. Case is weatherproof.

B-I-F Industries, Dept. ED, Providence, R. I.

Frequency Standard

Incorporates silicon transistors with built-in buffer amplifier. Output frequency is 1 mc or any frequency output from 500 kc to 20 mc. Models RFS 16000 and RFS 17000 have 24 to 28 v dc and 6.3 v ac input. Sine-wave output is 1 v min into 1,000 ohm load. The unit is 1-1/2-in. in diameter and 2-1/2-in. high and meets military specifications.

Greenray Industries, Inc., Dept. ED, 5281 E. Simpson Road, Mechanicsburg, Pa.

P&A: $189.00; 2 to 6 weeks.

AND 67 SIZES IN BETWEEN

to meet your printed circuit specs...exactly

Continental's line of PC connectors include nearly seventy sizes and types. Name your requirement—and the chances are Continental has a standard production type that meets it exactly.

These service-proven connectors are available with up to 210 contacts, for 1/32, 3/64, 3/32, 1/16 and 1/8" PC boards, in both single- and double-row construction. Wiring styles include eyelet lug, wire wrap lug, taper tab and contacts for dip soldering. Continental's patented Bellowform contacts permit use of undersized or oversized boards while maintaining low contact resistance.

New PC connector designs are constantly under development. Our Engineering Department will be pleased to assist you in solving special connector problems. Simply call or write, stating your requirements.

DESIGNER'S DATA FILE

If you're designing around printed circuits you'll want to have Continental's Con-Dex File PC, compiled to help you select and specify the PC connectors best suited to your needs. For your copy, please write to: Electronic Sales Division, DeJur-Amsco Corporation, Northern Boulevard at 45th St., Long Island City, New York (Exclusive Sales Agent) Ravenswood 1-6000.

CONTINENTAL CONNECTORS

CIRCLE 123 ON READER-SERVICE CARD
Itek
Crystal Filters
do Wonderful Things

A toast to Itek for a wonderful thing . . . Itek Crystal Filter 968B, with a near-Gaussian attenuation characteristic makes possible a 10,000 channel receiver! In antenna circuits, this 3 MC Filter optimizes pulse response, minimizes overshoot, and eliminates adjacent channel interference.

Perhaps you don't need a Gaussian crystal filter. But could you use the ingenuity that built one? Could Itek technical leadership help you?

Of course, the world's largest and most complete selection of stock filters is available, too. Choose from more than 3,000 Itek-Hennes designs.

Write for free Brochure "WEESKACFAACP" or, What Every Engineer Should Know About Crystal Filters At A Cocktail Party. You'll enjoy it.

Itek Electro-Products Company
75 CAMBRIDGE PARKWAY, CAMBRIDGE 42, MASS. A DIVISION OF

NEW PRODUCTS

Trimmer Capacitors

Designed for vertical mounting on printed-circuit boards, these piston-type capacitors are available up to 12 pf in three standard ranges: 8.5, 10, and 12 pf. Featuring linear tuning and gold-plated parts, the units are made to meet or exceed the requirements of MIL-C-14409A.

Atlee Corp., Dept. ED, 2 Lowell Ave., Winchester, Mass.

Availability: 2 to 3 weeks.

Delay Line

Eleven standard nsec delay lines, called Nanalines, have time delays of 5 to 100 nsec. The 10 nsec unit has a bandwidth of 100 mc; rise time for a 100 nsec delay line is 9 nsec. Suitable for fast pulse computer applications, some models are tapped for circuit trimming. Units are epoxy potted.

Bel Fuse Inc., Dept. ED, 198 Van Vorst St., Jersey City, N. J.

P&A: small quantities, $4.50 to $10.00 ea.; 2 weeks.

RF Voltmeter

Thermocouple type has 1% accuracy from dc to 100 mc per sec. Ranges available from a low of 0 to 1 v and to a high range of 0 to 100 v. Units may be calibrated against an accurate dc standard and may be certified by the National Bureau of Standards.

Rawson Electrical Instrument Co., Dept. ED, 110 Potter St., Cambridge 42, Mass.
Programmed control of switching elements is controlled by oscillator pulses. No moving parts are incorporated in this module; operation under extreme conditions is dependable. Model R143 meet MS 25096 and uses silicon-controlled rectifiers for positive reliability.

Western Branch, Pesco Products Div., Dept. ED, Burbank, Calif.

High-energy density electron-beam welding techniques, recently developed by the Zeiss Foundation of West Germany and the Hamilton-Standard Division of United Aircraft, markedly improved packaging density and production methods in the field of microelectronics.

In microcircuitry, for example, packaged circuits no bigger than a thumbnail can now be reliably produced. Electron-beam equipment now welds microelectronic components into circuits with pinpoint precision, making intra- and inter-circuit connection, and hermetically encapsulating the completed micromodule.

Only electron-beam welding, performed in a high vacuum, can offer these significant advantages for the field of microelectronics: virtual elimination of contamination; a close control of penetration; low thermal distortion; and close dimensional control. The upper illustration shows weldments of 0.002" thick copper leads to 0.002" thick nickel-plated ceramic substrate. In the field of thin films difficult welds are possible with this revolutionary new equipment such as 0.002" gold tabs to chromium-gold films 3000-Å thick.

Another important use of electron-beam equipment is the welding of ceramics used in vacuum tubes which require extremely high temperature performance. For these procedures, tight ceramic-to-ceramic bonds are necessary — bonds available only through high-energy density electron-beam welding. The lower illustration is a 2 X magnification of two aluminum oxide ceramic wafers ½" x ¼" x .010" thick edge-welded by deflecting the high energy density beam of a Hamilton-Zeiss electron beam welder across the edge surface.

Hamilton-Standard, with over twenty years of metallurgical experience and meeting rigid government specifications, has exhaustively tested the welds produced with Hamilton-Zeiss equipment. The data, which are available for your inspection, demonstrate conclusively that the Hamilton-Zeiss method produces welds in miniature workpieces that are as strong as the original materials themselves. Such results are possible only by the use of high energy density and precision focusing by the Zeiss magnetic lens system which are exclusive features of the Hamilton-Zeiss equipment. Find out what this revolutionary equipment can mean in your business. For full information call Hamilton-Electrona, Inc., exclusive marketing agent for Hamilton-Zeiss equipment in the United States and Canada.

Electronic Giants no bigger than your thumbnail... now through electron-beam welding
NEW PRODUCTS

VHF-UHF Noise Generator

Measures receiver and amplifier noise factors in the vhf-uhf range from 30 to 1,000 mc. Power requirements are 60 w at 115 v, 60 cps. The noise figures between 0 and 20 db can be read directly on the front panel meter. Additional calculations permit the user to obtain measurements beyond 20 db. Model 904-A features a continuously variable output signal level control knob and a type N output connector.

PRD Electronics, Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N. Y.

Punched Tape Reader

For tape duplicating systems, the model TP-522 punched tape reader operates with 8-level, 1-in. punched paper or mylar tape. Unit reads 10 lines per sec. Read heads, designed to resist vibration, have two contacts. Contact life is rated over 10 million operations. Tape can be quickly loaded and unloaded.


Price: $465.

Tachometer Tester

Accommodates four at a time. Evaluates operating characteristics of both integrating and damping tachometers at a temperature range of −60 to +220 F. The equipment is available with two system requirements to accommodate both the component user and the component manufacturer.


G-E LEXAN® POLYCARB

STABLE ELECTRICALS. Binding posts made of LEXAN resin retain electricals even under moist, hot conditions. They do not loosen, are molded in six attractive LEXAN colors for coding. Other features are: low loss and power factor, low dielectric constant, high voltage insulation; non-sink surfaces.

(Superior Electric)

HEAT RESISTANCE. Beautiful handles of LEXAN polycarbonate resin are used in rugged service on U.L. approved soldering irons. They resist the impact, heat and abrasion of daily bench work. The hard, glossy handles are light in weight. Molded in three pastel colors, they provide toughness and sales appeal.

(Ungar Electric Tools)

DIMENSIONAL STABILITY. Maximum allowable change in this 5-inch aircraft instrument part is only 5 mils over a temperature range of −65° to 300°F. And it must maintain this tolerance under high humidity. Part is injection molded of LEXAN resin as half spheres which are solvent cemented, lathe turned and painted. (Lear, Inc.)
ONATE RESIN  GOOD DIELECTRIC—AND MUCH MORE!

TRANSPARENCY of LEXAN resin is important in chart guide for recorder. LEXAN resin is the only transparent plastic able to withstand heat generated by internal lights. It is distortion-free at temperatures up to 270°F and self-extinguishing. Its extremely high impact strength eliminates cracking of guides.

(The Foxboro Co.)

TOUGHNESS. Press-fitted into metal gear used in an electric drill, bushing of LEXAN polycarbonate resin provides safety from electric shock...helps eliminate need for additional grounding. Strength and creep resistance of LEXAN resin enables bushing to withstand torque and load requirements of drill.

(Millers Falls Co.)

CIRCLE 128 ON READER-SERVICE CARD

ARE YOU LOOKING FOR A PLASTIC THAT CAN REALLY TAKE IT?

To demonstrate the toughness of LEXAN resin, salesmen will sometimes slam and hammer a product made of the material. LEXAN has the highest impact strength of any plastic—amounting to 12-16 foot-pounds per inch of notch—and it usually emerges unscathed from encounters with such “merchandising stresses.” It is a high-performance material, likewise, with regard to high-temperature behavior and dimensional stability.

Its many other advantages make it a priority material for thorough investigation by all designers, engineers and molders. We will be pleased to supply you with information on the properties, processing and end-uses of LEXAN resin. Don’t hesitate to write to us. General Electric, Chemical Materials Department, Section ED-61, Pittsfield, Mass.

LEXAN® Polycarbonate Resin

GENERAL & ELECTRIC

Tape Transport

Recording on 600 ft of 1/4-in. magnetic tape, contained in standard cartridge, model M101 starts and stops for each character up to 60 characters per sec. Density of 300 bits per in. allows 350,000 binary coded decimal characters to be recorded on one cartridge. Five-to-eight-level codes can be accepted either as contact closures or pulses.

Kennedy Co., Dept. ED, 2029 N. Lake Ave., Altadena, Calif.

Programmable Power Supply

DC output voltage is programmable over the range of 100 v to 3,000 v by connecting an external resistor across a pair of terminals. Output current range is 0 to 10 ma with a current limiting circuit which operates at 12.5 to 15 ma. Output ripple is below 5 mv rms and the response time is 25 v per msec. Model 1516 power supply measures 8-3/4 x 19 x 4-1/2 in.

Carad Corp., Dept. ED, 3381 Junipero Serra Blvd., Palo Alto, Calif.

Price: under $1,000.

Custom Modules

Completely assembled epoxy encapsulated modules of resistance-inductance-capacitance networks to fit within given size and shape factors are available with this service. Manufacturers can procure various packaged networks meeting their exact electrical and physical specification.

Key Resistor Corp., Dept. ED, 321 W. Redondo Beach Blvd., Gardena, Calif.

Availability: 30 to 45 days.

READOUTS THAT DO MORE THAN DISPLAY NUMBERS

I.E.E.'s complete line of rear-projection readouts display words, numbers, symbols, and color. The alpha-numeric Bina-View readout is self-decoding and operates direct from binary output. And all can satisfy human factors requirements! The engineering staff and facilities of Industrial Electronic Engineers, Inc. have approached the problem of readouts as one of visual communications, the case in point being that

...complete! under the roof

numbers are only one form in a host of methods in visual communications. The engineering talent at I.E.E. work under the formula that the more forms of visual communications that are available the less chance there is for communicative breakdown. In a word: complete.

Your inquiry to complete readout visual communications is invited.

INDUSTRIAL ELECTRONIC ENGINEERS, INC.

5528 Vineland Avenue, North Hollywood, California

CIRCLE 129 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961
Taylor glass-base laminates pop right out as design materials in many applications

There are good reasons for investigating Taylor glass-base laminated plastics as high-strength-to-weight materials in your design. They offer light weight, corrosion resistance, electrical and thermal insulation, and ease of fabrication.

For example, glass-fabric-base laminates have the highest mechanical strength of all laminated plastic materials. They have been successfully used in the fabrication of critical parts, including aircraft parts and bases for printed circuits. They are most valuable where extremely low moisture absorption, increased heat resistance and superior electrical properties are required.

Taylor Fibre produces a number of different glass-base grades in sheet, rod and tubular form, and copper-clad. Those with phenolic resin are recommended for mechanical and electrical applications requiring heat resistance. Those with melamine are characterized by their excellent resistance to arcing and tracking in electrical applications. They also have good resistance to flame, heat and moderate concentrations of alkalis and most solvents. Those with silicone exhibit very high heat resistance, combined with good mechanical and electrical properties. They also have highest arc resistance. Those with epoxy offer extremely high mechanical strength, excellent chemical resistance, low moisture absorption, and high strength retention at elevated temperatures.


NEW PRODUCTS

Sunlight Integrator

Portable, battery-powered sunlight integrator measures 6-1/2 x 8 x 8 in. and weighs less than 8 lb. Instrument employs a solion tetrode as the integrating element and records directly in calories per sq cm. Accuracy is within 2% over periods of a few minutes to several days. Unit is complete with sensor and hook-up cable.

Texas Research and Electronic Corp., Dept. ED, Meadows Bldg., Dallas, Tex.
P&A: $575; from stock.

Dynamic Load

For testing power supplies. The model 705 dynamic load measures internal ac impedance of dc power supplies operating up to 32 v. Unit operates at frequencies from 20 cps to 1 mc, and at dc supply currents from 50 ma to 2.5 amp. Meters indicate power supply ac output current, dc output current, and dc output voltage. Connections for external signal generator, ac voltmeter, and oscilloscope are provided.

Price: $950.

Double Pulse Generator

With modular construction, series 2100 double pulse generator provides many separate or mixed output signals. Rise time is 0.02 μsec; repetition rate is provided to 100 kc, and accuracy is 0.5%. Standard cables adapt the equipment to advanced pulse and pulse pair operation.

Servo Corp. of America, Dept. ED, 111 New South Road, Hicksville, L. I., N. Y.
Force Transducer

Designed for compression and tension service model 344 force transducer guarantees an accuracy of ±0.10% and is available in ranges from 50 to 1,000,000 lb. Materials used are chosen for temperature compensation, low hysteresis and minimum linearity error.

Allegany Instrument Co., Dept. ED, 1061 Wills Mountain, Cumberland, Md.

Power Supply

Strain-gage power supply model 1120 has an output of 3 to 30 v at 0 to 100 ma. Ripple is less than 1 mv, peak to peak, regulation is 0.01% for load and line; drift is 0.01% for 10 days at constant ambient temperature; temperature coefficient is less than 20 ppm per deg C from 0 to 50 C.

Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.

Price: $320.

Solid State Amplifier

Ultra-high impedance solid-state amplifier, model 514, operates without dc power supply, transistors or negative resistance devices. Characteristics are: frequency response, 5 cps to 100 kc within 1 db, 3 cps to 200 kc within 3 db; input impedance, 20,000 meg min shunted by 1 to 10 pf; output impedance, 1 meg shunted by 3 to 10 pf; voltage gain, 0.2 to 0.5; power gain, 30 to 40 db.

Denro Lab, Dept. ED, 2801 15th St., N.W., Washington 9, D.C.

Price: $87 ea.

MATCHED CHOPPERS

SINK YOUR TEETH INTO THESE FACTS...
- High breakdown ratings — 50 to 80 volts
- Two point control of current/voltage offset parameters
- Matched pairs to standard tolerance of 100 
- 10 million -to- 1 minimum “off” to “on” resistance ratio
- Typically 30,000 megohms reverse resistance
- Typically 50 ohms forward resistance
- High temperature stability
- Unlimited quantities available
- Available from local Sperry Authorized Distributors

Don’t gamble — you put your experience on the line when specifying for analog computers, D.C. amplifiers, electronic commutators and multiplex equipment.

Sperry now offers you a complete series of silicon transistors that have the best combination of characteristics — plus an extra margin of safety which provides true design flexibility.

<table>
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<th>Type Number</th>
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<th>BVCE (Volts)</th>
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Write for 16 page Technical Application Bulletin #2107 and new Chopper transistor data sheets on types 2N917 through 2N922 and 2N941 through 2N946.

Sperry semiconductor

DIVISION OF SPERRY RAND CORPORATION NORWALK, CONNECTICUT
with this new low-distortion
ac power source!

New from Krohn-Hite: this variable-frequency, 50 watt ac power
source, with the long-desired specifications of less than 0.01% amplitude stability and 0.1% harmonic distortion! The LDS-1500 offers a continuously variable wide range of voltage and current — up to 1500 volts, and up to 12 amps, at any frequency from 20 cps to 20 kc.

The short-term stability and low distortion now makes it possible for you to calibrate conventional indicating ac voltmeters and ammeters, and digital meters to lab standards, yourself!

As a general-purpose variable frequency source of distortion-free, highly stable power, the LDS-1500 has many applications. Distortion measurements at high power levels of precision voltmeters, inducators, gyro motors and other electro-magnetic components can now be made with greater accuracy and ease.

The 50 watt power output of the LDS-1500 is ample to supply test benches, for quality control testing at unusual frequencies.

Investigate this unusual ac power source. Its unsurpassed stability and distortion characteristics, its convenience of continuously variable frequency, voltage and current — make it a basic instrument of the industry. Send for complete technical specifications.

KROHN-HITE CORPORATION
580 Massachusetts Avenue • Cambridge 39, Mass.
Pioneering in Quality Electronic Instruments

CIRCLE 123 ON READER-SERVICE CARD

NEW PRODUCTS

Video Telemetry System

For real-time television transmission over a mobile link, this video telemetry system consists of a wide-band fm, uhf transmitter and receiver. Carrier frequency is 882 mc, and video response is flat from 30 cps to 4.5 mc. The transmitter, illustrated, has a pressurized enclosure, withstands shock and vibration, can be mounted in aircraft, missile, or satellite vehicles, and provides 20-w power. The receiver provides a satisfactory picture with 10 µv input.

Tapeo Div., Thompson Ramo Wooldridge Inc., Dept. ED, 20555 Euclid Ave., Cleveland 17, Ohio.

Counter Modules

Model M 10 has five identical flip-flops which operate as a counter at rates up to 2 mc. With model M 11 interstage delay module, it forms a parallel-entry adder which will complete a 5 bit addition 4 µsec max.


General Purpose Integrator

Battery-powered and portable, the model GPI-100 general purpose integrator weighs 5-1/2 lb and measures 6-1/2 x 8 x 8 in. The instrument uses a solenoid tetrode as the integrating element. Accurate to 1%, the unit has an input impedance of 10 K, a frequency response from dc to 10 kc. and accepts inputs of 1 v. Input amplifier, time averaging, and digital readout are optional.

Texas Research and Electronic Corp., Dept. ED, Meadows Bldg., Dallas, Tex.

P&A: $475; 30 days.

NOW
A family of Precise Thermistors

YSI produces a family of precise thermistors which match standard Resistance-temperature curves within ±1%.

You can now use stock YSI thermistors interchangeably as components in any temperature transducer or compensator circuit without individual padding or balancing.

DATA

Base resistances at 25° C. of:
100 Ω  1 K  10 K
300 Ω  3 K  30 K
100 K

• Each family follows the same RT curve within ±1% accuracy from -40° to 150° C.
• Cost under $5.00 each, with substantial discounts on quantity orders.
• Quantities under 100 available from stock at YSI now.
• YSI can produce precise thermistors with different base resistances and beta's where design requirements and quantities warrant.

For complete specifications and details write:

CIRCLE 134 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961
Voltage regulation system is contained in this 3-phase, 400-cps unit. The equipment delivers 30 v rms, with an accuracy of ±1% line to line. It operates at 27 ±3 v dc, at 1.5 amp max, delivering 7.5 va per phase max and 3.3 va per phase normal.

M. Ten Bosch, Inc., Dept. ED, 80 Wheeler Ave., Pleasantville, N. Y.

To prepare thermoplastic sheets for bending, The unit consists of two rectangular aluminum heating bars, electrically heated by metal-encased elements. Each bar has two insulated handles. 10 ft of two wire electrical cord and plug. Two models are available for 36-in. and 54-in. wide sheets.

Kamweld Products Co., Dept. ED, 932R Washington St., Norwood, Mass.

Generator voltage regulators and motor generator set controls designed around silicon controls rectifiers are available in sizes from 100 to 3,000 w dc regular output and up to 40 kw on special order. Voltage regulation is 1/2% no load to full load. Power to regulator is 120 or 220 v ac, 60 to 10,000 cps.

Auto Marine Laboratories, Dept. ED, 6 E. Main St., Ramsey, N. J.

Here's a positive approach to miniaturization—a way to handle more circuits per cubic inch! Conservatively estimated, over 650 circuits may be switched in only 38 cubic inches by a Shallcross Miniature Series switch and with the quality and reliability only a button-contact, multi-leaf wiper arm switch can provide. In one recent application, the single 24-deck Shallcross Miniature switch shown above replaced four 'subminiature' units.

Equally impressive space advantages are possible with dual concentric shaft versions of the Shallcross Miniature Series. Either shaft may operate up to five of a total of ten decks. The inner shaft may also control a rheostat, variable capacitor, or other device.

If, in addition to size, switch quality is also your concern, the following highlights substantiate why Shallcross Miniature Switch users repeatedly specify these switches, and no others, for critical airborne, missile control, and computer applications.

Low initial contact resistance—less than 0.002 ohm.
Stable contact resistance—0.5 milliohm for 10,000 operations.
Highly immune to vibration damage—exceeds MIL-S-3786 requirements.
Uncompromised material quality—silver button contacts; silver alloy, multi-leaf, self-cleaning wipers; dialylic phthalate rotors; epoxy-laminate decks (filament woven with glass fiber).

Designed to applicable MIL-S-3786 Specifications.
Minimum thermocouple affects—similar materials for all current-carrying parts.
Excellent RF characteristics.
Minimum depth—1" first deck, 5/8" each additional deck.
Maximum Versatility—up to 32 positions, 1 to 4 poles, shorting or non-shorting in the same switch. 1 to 24 decks, ball detents, many special modifications.

For complete details, write for Shallcross Switch Bulletin

Shallcross Manufacturing Co. Selma, North Carolina

Precision wirewound resistors, Switches, Instruments, D. i. y lines, Resistance networks, Audio attenuators.
NEW PRODUCTS

Variable Transformer

Rated at 50-amp, 0 to 140 v with 120-v input, the model T501U variable transformer is said to have very fine resolution. Designed for either panel or bench mounting, the unit has a square aluminum base providing heat transfer from the coil. Balanced rotor snaps on and off. Transformer measures 13-5/8 x 12-1/2 x 5-1/2 in.

Standard Electrical Products Co., Dept. ED, 2240 E. Third St., Dayton, Ohio.

AC Line Voltage Regulator

With 5-kva capacity, the ac line voltage regulator is a buck-boost, servo type which is said to introduce no wave-form distortion into the ac output. Two models are available; output on one is adjustable ±10% from a nominal 115 v and another variable from 0 to 135 v. Regulation is better than 0.2% for line and load changes. Made for 19-in. rack mounting, fixed model is 5-1/4 in. high and variable model is 21-in. high.

Davenport Manufacturing Div., Duncan Electric Co., Dept. ED, 2530 N. Elston Ave., Chicago 47, III.

Signal Generator

Features 6-band extended frequency range. Model N-2 operates from 115-v line and produces an output of 0 to 10 v rms. Distortion is 0.1% from 100 cps to 350 kc, 0.25% from 10 to 100 cps, 1% from 1 to 10 cps. Line voltage changes from 105 to 125 v ac do not affect the accuracy of its output.

Hathaway Denver, Dept. ED, 5800 E. Jewell Ave., Denver 22, Colo.
Vacuum Gages

Self-contained, miniaturized circuitry is attached directly to the rear of the indicating meter on this line of compact vacuum gages. The complete gage mounts in any panel, requiring only a standard meter panel cutout. Three ranges are offered from 0.2 micron Hg through 20 mm Hg. Up to 5 positions can be monitored with one instrument.

P&A: $110 each; immediate.

Insulating Varnishes

Diallyl phthalate and diallyl isophthalate insulating resins, RAM-23-X4 and RAM-23-X5 are for coating sealing and encapsulating uses. The X4 formulation functions at 150 C, continuous; the X5, at 180 C. They have unusual resistance to moisture, chemicals, corrosion and weathering.

RAM Chemicals, Inc., Dept. ED, P.O. Box 192, 21st E. Alondra Blvd., Gardena, Calif.

Tantalum Capacitors

Polar and nonpolar, solid tantalum capacitors have insulated, hermetically sealed cases. The STA polar series has ten ratings of 300 to 4,000 µf and the STAN series of ten nonpolar capacitors range from 150 to 2,000 µf. All ratings are for 6 to 35 max vdc, at ambients of -55 C to +125 C, with linear deratings above 85 C, to 67% at +125 C.


New Unimite relays are only \( \frac{1}{3} \)rd the height of crystal cans, make boards “wafer” thin

With new General Electric Unimite relays, you can lay out a switching circuit .374" thin, including mounting! Mount Unimites on their .900" side, and they stand only .320" off the board—\( \frac{1}{3} \)rd the height of “stand-up” crystal-can types.

And there’s no performance compromise! Rated one amp, 28vdc, spdt, Unimites switch in a fast 1.5 milliseconds. They weigh only .105 ounce.

In addition, Unimites offer characteristic G-E high reliability. General Electric’s exclusive all-welded construction eliminates solder- and flux-caused malfunctions. Internal contamination is eliminated by isolating the contact chamber, and by using chemically inert materials.


Progress Is Our Most Important Product
NEW PRODUCTS

Nylon-Insulated Slide Switch 444

Clearance of only 1/2 in. is required by the series SS-37 slide switch. Switch is nylon-insulated and rated at 6 amp. Unit, excluding trigger, measures 1-5/8 x 1/2 x 1/2 in. Terminals, silver-plated, accept soldered or solderless connections.

P&A: 0.10 ea for 10,000; 4 weeks.

High-Speed Counter 453

Model T276 is available in five models from a seven digit 500 per sec 166 hour test time model to a ten digit 100,000 per sec 277 hour test time model. The unit may be used with a contact switch, photoelectric cell or motion sensing device. No preamplifier is required.

Avtron Manufacturing, Inc., Dept. ED, 10409 Meech Ave., Cleveland 5, Ohio.
Price: from $25.00.

Hysteresis Clutch 442

Fractional horsepower hysteresis clutch delivers controllable torque through a range of speeds and loads. Unit illustrated is rated at 1/20 hp, 1,800 rpm and measures 2-1/2 in. OD. Devices are capable of synchronous driving or continuous slip with negligible torque variation at any slip differential.

Scanner Corp. of America, Dept. ED, 30595 W. Eight Mile Road, Livonia, Mich.
New ERECTRONIC Kit provides all components mounted on plastic bases with patented jiffy connectors for pegboard breadboarding of thirty-nine experiments.

Used with "Industrial Electronics" manual developed by EIA (Electronic Industries Association), the student quickly gains an understanding of basic circuits and their application.

**The "Industrial Electronics" course covers:**
- Computers
- Thyatrons and Thyatron Control
- Time Constants
- Vacuum Tube and Transistor Time-Delay Relays
- Photo-Electric Control
- Phototransistor Relays
- Saturable Reactor
- Peaking Transformer
- Motor Control
- Regulated Power Supplies
- Radio and Tone Control Systems
- Gaseous Rectifiers
- Synchrons
- Servo-mechanisms

**Indicator Lights**

STI-series subminiature transistorized neon-lights measure 1-15/16-in. in over-all length and mount in a 3/8-in. clearance hole from back of the panel. Socket, lamp, and all connections are well-insulated from the mounting bushing. The units accommodate NE-2E or NE-2V neon lamps and meet applicable military specifications. Dialight Corp., Dept. ED, 60 Stewart Ave., Brooklyn 37, N. Y. Price: 84 to 81.

**Variable Potentiometer**

Infinite-resolution potentiometer pick-off converts linear wiper motion into linear or non-linear voltage. Designated model 10111, the unit is linear to 0.05% per in., and is compensated for electrical loading. Resistances from 500 ohms to 100-K per in. are available. Nonmetal thin-film resistance element is noninductive and has a guaranteed life of more than 10 million cycles. Ganged units are available. Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L. I., N. Y.

**Electronic Control Stations**

Made for 24-v and 1-v systems, these electronic control stations have a manual power supply and are designed for compact panel mounting. Series 701K station provides process indication meters; series 701N is nonindicating. Chassis may be partially removed from panel while in operation. Mode can be switched from automatic to manual. Taylor Instrument Co., Dept. ED, 95 Ames St., Rochester 1, N. Y.
How to find laminations when you need them fast!
High permeability lamination stock list goes out to purchasing agents and engineers semimonthly

A stock list, mailed every other week, pinpoints the quantities and sizes of our high permeability laminations that are immediately available from stock. It's sent to purchasing agents and interested engineers throughout the country. To get your regular copy, just address a request to Magnetics Inc., Department ED-94, Butler, Pa.

What makes the stock list important? Depleted inventories or stepped-up production means that when laminations are needed, they're needed fast—and in perfect condition. Magnetics Inc. stock list shows what types are available for immediate shipment. In addition, the stock list contains information on the new higher permeability "E" grade laminations. What's more, stocks listed reinforce those maintained at regional outlets on the east and west coast (all connected by teletype to assure fast delivery). What makes Magnetics Inc. high permeability laminations special is the fact that they are the heart of high performance audio transformers, chokes and countless other fast response magnetic devices. They're burr-free, precision-sized and flat (thanks in part to a standardized 9" long carton that keeps the laminations undistorted during shipment and stocking). For more information, write to Magnetics Inc., Dept. ED-94, Butler, Pa.

Magnetics Inc. also publishes a bi-weekly stock list on tape wound cores and permalloy powder cores. It's available to you along with the laminations stock list. Ask for it.

PRODUCTION PRODUCTS

Toroidal Coil-Winding Head

For heavy wire build-up, Type 601 toroidal coil winding-head assembly has a two-piece magazine which opens in half for easy insertion of cores. Six magazines can be furnished for winding coils with inside diameters of 5/8 to 1-1/4 in. Wire sizes 20 to 28 AWG can be accommodated.

Waltham Precision Instrument Co., Inc., Boesch Manufacturing Div., Dept. ED, 45 River St., Danbury, Conn.

Production Trays

Form-fitting production trays are custom-molded of foamed plastic to protect delicate parts in assembly. Units are reusable. Plastic is not affected by water, oil, gasoline, or alcohol, and does not scratch.

Pac-Tron, Inc., Dept. ED, 225 Crescent St., Waltham, Mass.

Vibratory Parts Feeder

Electromagnetic drive operates at the rate of 3,600 vibrations per min. Model 251 vibratory parts feeder is designed to feed parts up to 4 in. long into a 24-in., cast-aluminum bowl. A spirally inclined 1-1/4 in. track is built around the inside perimeter of the bowl. Rate of feed is adjustable by means of a rheostat control.

Elk Engineering Works, Dept. ED, St. Marys, Pa.
Variable-speed drive permits instantaneous speed adjustment while the machine is in operation. Fly-wheel speed can be adjusted from 150 to 300 rpm. Model 00 miniature-parts header has a wire diameter range of 0.012 to 0.07 in.

REM Sales Inc., Dept. ED, P. O. Box 41, West Hartford, Conn.

For partial automation, these position displays indicate numerically the position of machine tools. Machines are rated at 20,000 counts per sec. Model PD5 has five decades; model PD6 has six decades. Magnitude and direction of motion are indicated, and machine zero is displayed. Typical resolution is 0.0001 in.

Rheem Manufacturing Co., Electronics Div., Dept. ED, 5200 W. 104th St., Los Angeles, Calif.

Price: $1,350 and $1,495.

For printed-circuit soldering. Attachment sucks excess melted solder from printed-circuit boards into a porcelain cup. Device includes a special replacement tip, on which is mounted the porcelain cup to receive excess solder, and an attached plastic hose and squeeze-type rubber suction bulb.


Price: $7.95 each.

Here are the AC counterparts of Honeywell's popular DC panel meters. Iron Vane AC Meters are perfectly matched to the DC range and are available in both the Medalist and "standard" case styles. This means a minimum of trouble and expense in mounting. And you are assured of harmonious styling in every detail.

Iron Vane AC Meters are designed for a wide variety of commercial applications — including portable equipment, testers, power supplies, generator equipment and medical equipment. The improved moving iron mechanism features magnetic damping, impregnated field coils, and selected fixed and moving iron material to provide long, trouble-free operation.

These meters are available in a wide selection of case styles and colors. Dials can be custom designed with your company name, trade-mark or other data. For full information, contact our representative in your area — he's listed in your classified telephone directory. Or us: Precision Meter Division, Minneapolis-Honeywell Regulator Co., Manchester, N. H., U. S. A.

In Canada, Honeywell Controls Limited, Toronto 17, Ontario and around the world: HONEYWELL INTERNATIONAL — Sales and service offices in all principal cities of the world.
The 1N3471 is a diffused silicon microminiature switching diode designed for high-speed operation. The size and construction of this pinhead diode suit it for high-density packaging. Controlled manufacturing conditions assure the circuit designer of uniform lot-to-lot diode characteristics with exceptional performance and reliability. (A leaded version of the 1N3471 diode is also available.)

**DIMENSIONS OF 1N3471 DIODE**

- Diameter: 0.040 max.
- Diameter: 0.016 max.

**MAXIMUM RATINGS**

(Mounting Surface Temp. 100° C)
- BV: 40 Min.
- Power dissipation: 0.5 Watt
- Tstg: -65° C to +250° C
- I_F: 120 mA

**SPECIFIED LIMITS FOR ELECTRICAL CHARACTERIZATION**

- trr (I_F = 10 mA): 2 nsec max.
- V_T (I_F = 10 mA): 1 Volt dc
- I_S (V_R = 20 Vdc): 20 mA
- C (V_R = 0; f_o = 100 kc): 3 pf
- BV (I_R = 5 mA): 40 Vdc

The 1N3471 microminiature switching diode can be purchased in quantity from Western Electric’s Laureldale Plant. For technical information, price, and delivery, please address your request to: Sales Department, Room 103, Western Electric Company, Incorporated, Laureldale Plant, Laureldale, Pa. Telephone—Area Code 215—Walker 9-9411.

**DESIGN DECISIONS**

*Featuring the clever and unusual in packaging, appearance design, and circuitry in electronic equipment.*

**Reversed Weld Nut Makes Low-Cost Detent**

Standard, commercial weld nuts, used backwards, provide an unusual low-cost detent in an inexpensive citizen’s-band transceiver.

The weld nuts, manufactured by Ohio Weld-Nut Co., have three dimples which are used as weld points. Electronic Instrument

**Standard weld nut, with reverse side welded to instrument case, exposes three dimples. Dimples hold detent plate in place.**

**Detent plate is secured by standard thumb screw and lock washer through carrying handle.**

**ELECTRONIC DESIGN • November 8, 1961**
Carrying handle can be rotated in 30-deg increments to form support bracket.

these nuts to the sides of the instrument case of the transceiver.

The dimples position a steel stamping that serves as a detent plate. The very simple and inexpensive arrangement arrows the carrying handle to be positioned around the case in 30-deg increments so it can serve as a handle or support bracket.

Commenting on his design, project engineer Vincent Proc points out that when an inexpensive, standard, commercial part can do a job well, it is always to be preferred over a "special."

Rubber Cores in Eyelets Speed Circuit Breadboarding

Anyone who has used a breadboard knows the problems inherent in the usual spring-type contacts. They work quite well when leads of equal diameter are inserted. But if it is necessary to join two or more leads of different diameters—like the leads of a small diode and a 2-w resistor—the contacts usually are quite unsatisfactory. The larger wire eases the contact's grip on the smaller one and the small component tends to lose contact.

A novel approach to this problem appears in the "Circuit Builder," manufactured by Circuit Structures Laboratory of Laguna Beach, Calif. This breadboard, conceived by Edmund L. Van Deusen, vice president of the company, uses rubber cores in gold-plated

NEW DVM ENDS MONTHLY RECALIBRATIONS

New EAI Series 5001 Transistorized Digital Voltmeter will maintain full accuracy without recalibration for more than six months. Accuracy specifications have significance only when supported by such stability. This unique digital voltmeter automatically seeks out the correct range for readings of 100 microvolts to 1199.9 volts. In addition to automatic range changing and 20% over-range, it provides floating input, accuracy of 0.01% full scale plus one digit, full time high input impedance up to 1000 megohms and an average of 200 readings per second. In all, the EAI Series 5001 is an outstanding instrument for laboratory, production and system use. Write for full information today to Dept. ED 10.

EAI ELECTRONIC ASSOCIATES, INC. Long Branch, New Jersey Career Opportunity for Engineers — Graduate or advanced degrees in EE, Physics, Math — call or write Gordon Strauf, Director Personnel Leader in Analogics Analog/Digital Computers Data Reduction Process Control Instruments Computation Service CIRCLE 145 ON READER-SERVICE CARD
Micrometer Precision CLAMPS, BLOCKS and HARNESS STRAPS made for the most exacting applications of all...aircraft, missile, marine, automotive and original equipment of all kinds.

33,000 TYPES AND SIZES FOR ALL YOUR REQUIREMENTS - COMPLETE CATALOG AVAILABLE UPON REQUEST

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MOLDED CHOKE COILS

Nicknamed the "Micro Mite", these reliable, rugged coils exhibit high Q, very low distributed capacity, all concentrated into an amazingly small package.

Miller's new "Micro Mite" coils are perfect for use where weight, space and high Q considerations are involved. Their volumetric reduction ranges up to 80%, with current ratings approximately 75-300 millamps and standard series values up to 10,000 uH.

The "Micro Mite" coil construction permits miniaturization without the use of ferrite materials, thus maintaining temperature stability to 125°C. These hermetically sealed molded coils conform to MIL-C-15305A.

ASK FOR OUR MICRO-MITE BULLETIN

J. W. MILLER COMPANY • 5917 So. Main St., Los Angeles 3, Calif.

CIRCLE 147 ON READER-SERVICE CARD

DESIGN DECISIONS

Rubber cores in gold-plated eyelets make it easy to connect leads of different diameters in this breadboard.

eyelets to secure component leads at tie points.

A slight tug at one of the rubber cores makes it easy to insert additional component leads into a tie point without dislodging any other leads.

Round Lights Cut Cost, Improve Panel Appearance

A switch from square panel-light lenses to round ones helped engineers at General Electric's Computer Dept. to cut the cost and improve the appearance of panels in the GE 3100 Status Monitor.

The original concept in designing the panel lights was that square lenses would look neater and more attractive than other shapes. But in the Status Monitor, 20 panels are stacked in a vertical array. To avoid a lopsided appearance of the panel lights, it was necessary to maintain a 1-mil tolerance in the positions of the four sides of the square holes that retain the lenses.

Any slight misalignment or lack of parallelism would have been exaggerated by the

Today's big values in instrument bearings are the tiny but extremely precise bearings made by REED. Produced to ABEC-7 tolerances, they are available at no increase in price over ABEC-5. This added value, in bearings up to ½" OD, is possible because REED's centerless grinding operations provide exacting control of tolerances and operating characteristics. So, precision and price give you two important reasons for listing REED among your approved sources for instrument bearings.

Slight lack of parallelism in square panel-light lenses is exaggerated by viewer.

REED INSTRUMENT BEARING COMPANY
Los Angeles, California
Div. of BSRP Industries, Inc.

CIRCLE 148 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961
For fast, accurate temperature sensing from -435° to +500° F.

REC's Model 176

IMMERSION TYPE
0.2" TIME CONSTANT

Unique new design gives this temperature sensor unusually fast response. Because the precision platinum resistance element is mounted without strain directly on the inner wall of the stainless steel well, the time constant is only 0.2 second.

The Model 176 was designed for storable fuel applications in the missile field. However, it is suitable for use in any part of the -435° to +500° F. temperature range and in any fluid compatible with the stainless steel material of the well. Available in a wide range of lengths, fittings and connectors.

A complete precision line

Rosemount designs and manufactures high quality precision equipment in these lines:

Air data sensors
Total temperature
Pitot-static (de-iced)
Immersion temperature sensors
(including cryogenic)
Surface temperature sensors
Pressure transducers
Accessory equipment
Aeronautical research

For more information please write for the REC catalog. Specific questions welcomed.

ROSEMOUNT ENGINEERING COMPANY
4900 West 78th St. • Minneapolis 24, Minn.

CIRCLE 149 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961

Change to round lenses eliminates appearance of eye and would have given an appearance of careless workmanship.

The change to round lenses eased the hole tolerances by a factor of about 10, according to Henry H. Bluhm, industrial designer.

Watch Crowns Crown Efforts To Waterproof Shaft Seals

Commercially available waterproof watch crowns make excellent seals for precision instruments that must be both adjustable and waterproof. They must meet the Federal Trade Commission standard that defines

Fig. 1. Conventional "O" ring seal makes good dust seal, but water pressure can force the ring to periphery of oversized slot, making for leaks.

REPICON® REMOVABLE CONTACT CONNECTOR

New from Gen-Pro: Repicon "C" high density removable contact connector offers unlimited application in writing installations. Available in 34, 42, 50, 75 and 104 contacts. In accordance with requirements of MIL-C-22857; interchangeable with other connectors of MIL-C-8384 configuration and contact pattern.

Repicon Removable Contacts in crimp or solder type give higher contact retention, closely controlled engagement and separation forces and low millivolt drop. Usable in other existing connector body sizes and configurations. Contacts are ordered separately for assembly by user.

SOCKET CONTACT
PIN CONTACT

MORE FROM PRD!

BROADBAND DIRECT-READING ATTENUATORS now available through K bands ... up to 40 kmc. Compact, precision instruments feature 60 DB Attenuation Range, VSWR 1.15 Maximum, Accuracy to ±0.1 DB, Insertion Loss as low as 0.5 DB, Spectrum Coverage from 3.95 to 40.0 kmc/s (nine models). Direct Reading. Send for data.

PRD ELECTRONICS, INC.
202 Tillary St., Brooklyn 1, N. Y., ULater 2-6800; 1608 Centinela Ave., Inglewood, Calif, Oregon 8-9948 • A Subsidiary of Harris-Intertype Corp.
revol?utioni?z?es soldering!

You get 33 % greater flow with ALPHA Cen-Tri-Core Energized Rosin-filled Solder because only ALPHA Cen-Tri-Core is made this way...

ALPHA Cen-Tri-Core is specially processed from virgin tin and lead plus highly mobile energized resin. Result? A 33% increase in flow and wetting. More reliable solder connections. Increased joints per pound.

Made of a rosin-coated center wire which is visually inspected before an extruded outer sleeve is added. Every inch of this "core within a core" solder is filled with fast-acting, non-conductive flux. Meets Fed. Spec. QQ-S-571-C. Write for details!

When dependability counts!

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PERMACEL Electrical Tapes for Class B and Class H insulation. Glass backing, silicone-varnished or plain. Highly adhesive, strong, conformable, time and temperature resistant.

PERMACEL New Brunswick New Jersey

Tapes • Electrical Insulating Materials • Adhesives

CIRCLE 153 ON READER-SERVICE CARD

DESIGN DECISIONS

"waterproof" as the ability to withstand 35 psi without leaking.

The same waterproofing techniques that watchmakers use so successfully have been used in designing sealing knobs for precision electronic equipment, potentiometers, and other adjustable devices. These knobs, designed by Joseph Waldman & Sons of Irvington, N. J., withstand 72 psi. With modifications, they can be built to take more than 100 psi.

The problem with electronic equipment is that a low torque is often required for precise adjustments and this often conflicts with waterproofing requirements. The conventional seal has a circular retaining slot cut into the wall of the case to hold a sealing ring. As shown in Fig. 1, the slot must have a slightly larger OD than the ring to allow the ring to get into it.

This makes for an adequate dust seal, but water pressure can force the sealing ring out of shape and back into the retaining slot. The ring pulls away from the adjustment shaft and leaks result.

The seal in Fig. 2 overcomes this problem. The recess for the "O" ring seal is slightly smaller than the ring so the ring always maintains positive pressure at four separate points. This is possible because the ring is held in place by a retaining washer so it does not need extra space for insertion.

In this case, water pressure increases the pressure at all four contact points and actually improves the seal. The positive pressure also makes for good vibration resistance. Because only a small tangent edge of the sealing ring contacts the case, the shaft requires very low torque, only 0.3 in. oz.

Fig. 2. "O" ring retained, as in watch crown, actually improves seal under pressure.
Simplified Design Procedure

For Tuned Class-B Power Amplifiers

There's nothing particularly complex about designing tuned class-B power amplifiers. But the design usually involves a good deal of drudgery which paves the way for errors. In this article, author Everett Moore gives a design procedure that obviates the drudgery.

H. Everett Moore
Government Electronics Div.
Admiral Corp.
Chicago, Ill.

The cumbersome calculations normally required in designing tuned class-B amplifiers can be avoided. A simplified technique, along with a graphical plot, give a rapid, precise solution for the resonant, plate-load resistance, \( R_c \).

To design for the optimum condition (\( v_{\text{in}} = v_{\text{max}} \)) in tuned class-B power amplifiers, one normally has to solve the rather messy equation

\[
R_c^2 + \left[ \frac{4r_p}{n+1} - \frac{E_{\text{in}}^2}{P_p} \left( \frac{r_s}{r_p} \right) \left( \frac{n}{n+1} \right) \right] R_c = 0
\]

(1)

where

- \( E_{\text{in}} \) = plate-supply voltage
- \( P_p \) = plate dissipation
- \( v_{\text{in, min}} \) = instantaneous plate-voltage minimum swing
- \( v_{\text{in, max}} \) = instantaneous control-grid voltage maximum swing
- \( r_s \) = dynamic plate resistance
- \( \mu \) = tube amplification factor
- \( R_c = L/RC \) = tuned resistance of parallel-tuned plate-load

For a given tube, with a given dc plate supply and a given plate dissipation (not necessarily the maximum rating for the tube), Eq. 1 gives the necessary \( R_c \) for maximum power output. If \( n \) is defined as equal to \( v_{\text{in, max}}/E_{\text{in}} \), then Eq. 1 can be rewritten as

\[
R_c + \frac{4nr_p}{\mu + n} - \frac{E_{\text{in}}^2}{P_p} \left( \frac{2n}{\mu + n} \right) R_c = 0
\]

(2)

But both Eqs. 1 and 2 are cumbersome; neither is especially suitable for quick, easy, and accurate slide-rule calculations, nor for evaluating the significance of any given parameter in a design.

Fortunately, we can reduce the calculation of \( R_c \) to a simpler form involving fewer
Becco Ammonium Persulfate etches cleanly!

For etching printed circuits, Becco's ammonium persulfate process offers important advantages. As one large producer of printed circuits puts it: “Ammonium persulfate is better all around. We have experienced little trouble and far fewer rejects. It is more easily dissolved than ferric chloride, and can be safely handled in large volumes, with resultant cost savings.

“Moreover, the persulfate solution etches cleanly with a minimum of undercut and can be used with all conventional resists, and on all laminates. A ‘natural’ for solder-plated resist.”

Switch to Becco ammonium persulfate and get these advantages:
1. Various types of circuits can be etched in one system.
2. Etchant is relatively non-corrosive.
3. Etchant remains clear and transparent in use.
4. After-treatment is simplified.
5. Sludge formation is avoided during etching.
6. Waste solution can be easily disposed of.
7. Copper can be recovered from spent etching solution.
8. Venting of the etching area is unnecessary.
9. Equipment corrosion is minimized.
10. Cost of etching solution is low.
11. Conversion from other etching processes is simple and inexpensive.

Want more information? We'll be glad to send full details. Just write us at Department ED-61-21.

BECCO Ammonium Persulfate

BECCO
CHEMICAL DIVISION

ENGINEERING DATA

steps. We can define two new parameters (having the units of resistance) and express \( R_e \) as a function of the new parameters \( a \) and \( b \). We can then use a graphical plot of the function \( F_i \) vs \( a/b \) for a very rapid, precise determination of \( R_e \).

We start by defining the parameters \( a \) and \( b \) and a constant \( c \).

\[
a = \frac{nr_p}{\mu + n} \quad b = \frac{E_s^2}{P_s} \quad c = \frac{2}{e - 1}
\]

With insertion of parameters, Eq. 2 becomes

\[
R_e + (4a - bc)R_e + 4(a^2 - ab) = 0
\]

which, after solution of the quadratic and rearrangement, takes the final form

\[
R_e = c b \left[ \left( 1 - 4 \frac{a}{b} \right) + \sqrt{1 + 4 \frac{a}{c} b} \right]
\]

After the constants are inserted, the relationship plotted in the graph becomes

\[
F_i \left( \frac{a}{b} \right)
\]

\[
= 0.06831 \left[ (1 - 29.28 \frac{a}{b}) + \sqrt{1 + 214.3 \frac{a}{b}} \right]
\]

Design Procedure

Given: \( E_b \), \( P_s \), \( E_b, P_s \)

Step 1. (a) Compute \( n = E_{b, \text{max}} / E_{b, \text{min}} \) or (b) Set \( n = 1 \) for optimum case.

Step 2. Compute \( a = nr_p/(\mu + n) \), \( b = E_b^2/P_s \), and \( a/b \).

Step 3. From the graph, read \( F_i \) \( a/b \) for the computed value of \( a/b \).

Step 4. Compute \( R_e = bF_i \) \( a/b \).

Sample Calculations

Given: An 833A triode with \( \mu = 35 \) and \( \tau_p = 2,215 \) ohms. \( E_b = 4,000 \) v and \( P_s = 400 \) w.

Step 1. Set \( n = 1 \) for maximum power output.

Step 2. \( a = \) \( (1) (2,215)/(35 + 1) = 61.53 \)

\( b = 16(10)^4/400 = 40,000 a/b = 0.00154 \)

Step 3. From the graph, for \( a/b = 0.00154, F_i (a/b) = 0.380 \)

Step 4. \( R_e = 40,000 \times 0.380 = 15,600 \) ohms.

Acknowledgment

The author wishes to acknowledge the work of Nicholas T. Neapolitakis of the Department of Electrical Engineering at the Illinois Institute of Technology. Mr. Neapolitakis derived equations leading to Eq. 2 in this article.
NEW LITERATURE

Digital Circuity 266

"Digital Application Notes" is a new 68-page handbook covering applications of digital circuitry. It contains chapters on basic logic design principles, graphic symbols, logic modules and circuit configurations. Boolean algebra and the analysis of logical processes are also covered. Interstate Electronics Corp., 707 E. Vermont Ave., Anaheim, Calif.

Inductive Devices 267

A complete 48-page catalog on molded rf chokes, if transformers, adjustable coils wound on stable ceramic and resinite materials, and exact replacement coils includes specifications, schematics and prices. J. W. Miller Co., 5917 S. Main St., Los Angeles, Calif.

Electronic Components 268

Products covered in this 6-page catalog include the firm’s complete line of tip plugs and jacks, as well as banana plugs and jacks. Meter type banana and tip plugs, test prods, binding posts, alligator clips, nylon tip jacks, two and three conductor phone jacks and plugs are included. A separate section carries 11 types of molded push-button terminal blocks. National Tel-Tronics Corp., 52 St. Casimir Ave., Yonkers, N. Y.

Transistor Noise Analysis 269

"A Practical Approach to Transistor Noise" is a technical report which deals with the origin and nature of the various types of electrical noise generated in transistors. In addition, specific methods for the quantitative analyses of transistor noise are treated in detail. Quan-Tech Laboratories, Inc., Boonton, N.J.

Solid-State Power Packs 270

The firm’s complete line of high current, miniaturized regulated solid-state power packs is contained in bulletin No. 23-561. Full technical information is given on miniaturized units with outputs ranging from 5 to 82 v dc and current ratings up to 8 amp. Specification data, circuit information, operational data and physical characteristics are included. Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J.

1/2 THE SIZE
1/4 THE WEIGHT

Modular Frequency Converters

Here’s why TIC 4000 Series frequency converters are being used widely in guided missile checkout systems, mag-amp testing, servo systems, aircraft instrumentation, or wherever variable frequencies of 50 to 4000 c.p.s. and fixed frequencies and accuracies to 0.0001% are needed.

- Small size and light weight. (As little as one-half the size and one-fourth the weight of units of equivalent power).
- Over 400 models to choose from
- Constructed of interchangeable modules for extreme flexibility, easy conversion to higher power
- Power output 100 VA to 15,000 VA
- No output voltage change with load (Zero output impedance)
- Handles resistive or reactive loads
- Low harmonic distortion
- Zero recovery time
- Ungrounded output

Write for specifications and prices.
NEW LITERATURE

Torch Brazing 271

Use of low-temperature silver brazing alloys in torch brazing is discussed in this data file, "An Outline of Operations for Successful Torch Brazing with Silvaloy". Joint design, preparation for brazing, fluxing and assembling, heating and making the braze, cooling, flux removal, and inspection are discussed. Engelhard Industries, Inc., 75 Austin St., Newark 2, N. J.

Plastic Film 272

Physical and electrical properties of Lexan polycarbonate films are outlined in this 13-page technical report, CDC-396. Curves describe strength and dielectric constant as a function of film thickness and temperature. Tables give other properties, chemical, electrical, and physical, for the film in both cast and extruded forms. General Electric Co., Chemical Materials Dept., 1 Plastics Ave., Pittsfield, Mass.

Defense Products 273

"Facilities and Capabilities" of this firm's Defense Products Div. are described in a 28-page brochure. Major sections cover reconnaissance and mapping systems; data processing, display and interpretation systems; communication and special radar systems; optics; ordnance and numerous other products. Defense Products Div., Fairchild Camera and Instrument Corp., 300 Robbins Lane, Syosset, L. I., N. Y.

Sensitive Test Instruments 274

Electrometers, electrometer amplifiers, linear and logarithmic microvoltmeters, microvoltmeters, megohmmeters and bridges, voltage supplies and similar instruments are listed in this 32-page catalog. Illustrations, descriptions, specifications, and application suggestions are included. Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio.

Clairex Photoconductive Cells, like the human eye, are "windows to the world" of control system design. Our continually expanding line now includes the 5-1 series of hermetically sealed Cadmium Sulphide cells, employing a sensitive material formulation that matches the spectral sensitivity of the human eye! These are the first real "electronic eyes" and thus are particularly useful in applications involving human vision, such as Daylight Switches, Photography, and Automatic Brightness Control in Television Receivers.

C C L A I R E X
CORPORATION

NEWEST AND MOST ADVANCED
MULTIPLE-USE
CONSOLE CABINET

OIL-TIGHT and DUST-TIGHT

WITH WIDE APPLICATIONS IN BOTH ELECTRICAL AND ELECTRONIC FIELDS

This Hoffman Model 14 heavy-duty oil-tight console enclosure is designed as an operator control station with maximum flexibility to meet variable needs. The sloping front panel is ideal for mounting meters, switches and pushbuttons. Flush key-locking gasketed doors, front and rear, provide access to lower sub-panels which can be either stationary or swing-out. Note provision for pull-out electronic chassis and rack panels if desired, or combination stationary panel with pull-out chassis. This is the most versatile, heavy duty, all-welded oil tight and dust tight cabinet available today! Write immediately for Bulletin 139.

Hoffman ENGINEERING CORPORATION
Dept. ED-171 • Anoka, Minnesota
CIRCLE 165 ON READER-SERVICE CARD
ELECTRONIC DESIGN • November 8, 1961
Feedback Control Units 275

Brief descriptions of unique, high-performance feedback control hardware are provided in this six-page brochure. Included are: test equipment, slideryes, pressure transmitters and receivers, actuators, programmers and computers. Boonshaft and Fuchs, Inc., Hatboro Industrial Park, Hatboro, Pa.

Audio Devices 276

Earphones, microphones, switches, plugs, jacks, sockets, and related devices for audio applications are described in 16-page catalog No. 1000. Illustrations, ratings, and dimensional drawings are included. Rye Sound Corp., 115 Elm St., Mamaroneck, N. Y.

Electronic Template 277

Symbols on the No. 316 missile and space electronic template conform to MIL-STD 70327 specifications. Designed for precision drawing of electronic circuits used in guidance and control systems of military hardware in space, the template is made of 0.03-in. matte finish plastic. Over-all size is 7 x 5 in. Send $4.50 to Rapidesign, Inc., Dept. ED, P.O. Box 429, Burbank, Calif.

Power Supplies 277

A wide variety of regulated, transistorized power supplies is described and illustrated in four-page Short Form Catalog 1961. Also included are three two-page bulletins on 10 amp, 25 amp, and 75-160 v supplies. Harrison Laboratories, Inc., 45 Industrial Road, Berkley Heights, N. J.

Optical Products 278

A 16-page brochure covers the facilities and products of the Photo-Optical Div. of this firm. It describes the military camera, photo instrumentation and optical production capabilities as well as other related activities. Consolidated Systems Corp., Photo-Optical Div., 1725 S. Peck Road, Monrovia, Calif.

McLEAN BLOWERS
add to the ULTRA RELIABILITY of this
High-Speed Automatic Monitor System

The HAM System built for G. E. Hanford Atomic Products Operation demonstrates the practicality of monitoring nuclear reactor temperatures on a high-speed ultra-reliable basis. The system operates in an air-conditioned room. But McLEAN blowers are still essential to prevent overheating and hotspots.

McLEAN stands for highest reliability in electronic cooling! That's why Monitor Systems Incorporated of Fort Washington, Pennsylvania, selected McLEAN blowers to insure reliable operation of electronic components in their new High-Speed Automatic Monitor (HAM) System. The System has achieved a previously unattained order of reliability and represents a major advance in computer and monitoring systems. McLEAN is proud of its part in contributing to the reliability of the HAM System.

WRITE TODAY
44 Page Packaged Cooling Catalog

McLEAN ENGINEERING LABORATORIES
World Leader in Packaged Cooling
Princeton, N. J. • WALnut 4-4440
TWX Princeton, New Jersey 636

CIRCLE 167 ON READER-SERVICE CARD

ABOARD A RADAR PICKET PLANE

... a new Eastern cooling system helps to keep the Philco APS-103 search radar on the lookout for bogies and bandits. The liquid cooling unit has a capacity of 1600 watts, but weighs only 15 lbs., and fits into a compact 5-9/32" x 9-7/8" x 7-7/8" volume. Designed for operation to 50,000 feet, it features an ingenious internal manifold which makes for simplicity, reliability, and which eliminates most internal connections. If you need efficient, miniaturized light weight cooling units for airborne electronics cooling, call on Eastern. Eastern is your perfect source for liquid tube cooling units for capacities from 50 to 20,000 watts.

EASTERN INDUSTRIES
100 Skiff Street, Hamden 14, Conn.

CIRCLE 166 ON READER-SERVICE CARD

ELECTRONIC DESIGN • November 8, 1961
NEW LITERATURE

Silicon Varactors 279
Described in this 4-page folder are 220 new epitaxial silicon high power varactors. It provides specific pointers on how to choose the appropriate varactor for best circuit performance. Also included are pointers for calculating the best diode choice for harmonic generator or modulator applications. Microwave Associates, Inc., Dept. HE, South Ave., Burlington, Mass.

Digital Data Acquisition 280
A technical introduction to Micro-SADIC, an integrated, high-speed, general-purpose solid-state system capable of sampling several channels of analog data at up to 15,000 samples per sec is provided in 16-page bulletin 3047. A functional description of all the system's major components and detailed system specifications are included. Consolidated Systems Corp., 1500 S. Shamrock Ave., Monrovia, Calif.

Closed-Circuit TV 281
A 10-page brochure describes how closed-circuit TV can be used for surveillance, transportation and dispatching, cost reduction and quality control, observation of hazardous locations and for other uses. Also described is the Mini-Camera, able to observe the interior of a 3-in. pipe. Electronics Div., Fairbanks, Morse & Co., 100 Electra Lane, Yonkers, N. Y.

Mathematical Handbook 282
This 64-page pocketsize handbook contains powers and roots, logarithms, decimal equivalents, circular arc tables, mensuration formula, weights and measures, conversion factors, etc. Also included are business formulas such as profit and loss, markup, discount, etc. In addition it provides general arithmetical rules and formulas. Curta Co., 14436 Sherman Way, Van Nuys, Calif.

The ease and speed of changes in IF bandwidth, and interchangeability of modules, makes this receiver the most versatile of Nems-Clarke 1400 series telemetry receivers.

This receiver is unique because it offers a variety of plug-in IF demodulator modules which plug into front panel to determine operating IF bandwidth of receiver. Each module is interchangeable with the others without disturbing the level adjustments of receiver, since each module provides output voltages and meter deflections of essentially the same percentage of bandwidth. Thus, one basic receiver chassis serves to cover bandwidth ranges from 30 kc to 1.5 mc in nine separate bandwidths.

Pre-Detection Feature—In addition to the usual standard outputs for connection to auxiliary equipments (such as signal strength, video frequency response, frequency monitor and spectrum display), this receiver has a 5 mc pre-detection recording output and playback input. When the output is connected to a Pre-Detection Converter, Nems-Clarke Type IFC-1400, and a recorder, telemetry data can be recorded prior to demodulation and stored for subsequent playback and demodulation.

Modules for the receiver may be obtainable separately as required in the following IF bandwidths: 30, 50, 100, 200, 300, 500, 750 kc; 1.0 and 1.5 mc.
Digital Delay Lines 283

Three series of ultrasonic lines, for commercial or military systems, use glass or fused silica as delay media. They are described in a six-page designer's booklet, which includes operating data, as well as characteristics, for each series. Corning Electronic Components, Corning Glass Works, Bradford, Pa.

Circuit Modules 284

A full line of encapsulated circuit modules designed to meet any specific application in military and industrial electronics, as well as special products fields, is described and illustrated in six-page bulletin CC-1. General Instrument Corp., Semiconductor Div., 65 Gouverneur St., Newark 4, N. J.

Proximity Limit Switch 285

The CR115D proximity limit switch, for detection of ferrous and non-ferrous materials without physical contact, is covered in four-page bulletin GEA-7318. Typical applications, including sorting, counting, inspection and limiting machine travel, are shown. Characteristic curves and other data are included. General Electric Co., Schenectady 5, N. Y.

Foam Products 286

Two color charts with many illustrative photos show the properties and uses of a variety of standard foam products. In addition, a tabulation of dielectric and physical properties of artificial and adjusted dielectric constant foams is presented. Emerson & Cuming, Inc., Canton, Mass.

Closed-Circuit TV 287

General applications of closed-circuit TV systems are presented in this eight-page catalog (6-205). A number of typical system configurations are shown, with applicable equipment types delineated. Kin Tel Div., Cahu Electronics, Inc., 5725 Kearny Villa Road, San Diego, 12, Calif.
NEW LITERATURE

Trimmer Capacitor 288

The firm's entire line of variable trimmer piston capacitors is covered in catalog C-61, 24-pages. Complete electrical and physical data of standard, split bushing, miniature, MAX-C, Sealcap, split-stator and differential trimmers in panel mount and printed circuit types is contained. A chart describes and illustrates standard modifications that are optional. JFD Electronic Corp., 6101 16th Ave., Brooklyn 4, N.Y.

Dry-Film Lubricants 289

Lubricants for extreme environmental conditions are the subject of two publications. Special print 461, titled "Inorganic Solid-Film Lubricants" describes the results of tests of inorganic, solid-film lubricant performance in liquid oxygen service and at pressures approaching a complete vacuum. Bulletin 242 presents characteristics, performance reports and application instructions for Molykote X-15, an inorganic-bonded dry-film lubricant for extreme environmental service. Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn.

Motor Capacitors 290

The 16-page, easy-to-use catalog MS61-10 features complete listings of motor-start, motor-run capacitors. Capacities and physical dimensions are clearly shown for all types. Engineering data and a section covering the Capacitor Selector and the Emergency Capacitor are included. Hardware and terminal variations are illustrated. Aerovox Corp., New Bedford, Mass.

Synchronous Motors 291

The construction and operation of 385 different types and models of the company's synchronous motors are described in this 20-page catalog. Included are speed-torque curves, dimensional drawings, wiring diagrams, and performance characteristics. Bodine Electric Co., 2500 W. Bradley Place, Chicago 18, Ill.

Time Meters 292

Applications, features, specifications, standard ratings and schematics of the company's type 236 Elapsed Time Meter are given in the four-page bulletin GEZ-3354. General Electric Co., Schenectady 5, N.Y.
Relays and Timers

Catalog 861A provides illustrated technical data for the company's complete line of electromagnetic relays and motor-driven timers. Sequence, manual reset, automatic reset, cycle, delay and interval timers are among the types presented. Telex Aemco, 21 State St., Mankato, Minn.

Television Manual

A technical manual on 3-D TV describes the operation of the system which optically converts closed-circuit television to three dimensional pictures. Installation, operation and service are covered. Stereotronics Corp., 1717 N. Highland Ave., Los Angeles 28, Calif.

PCM Telemetry System

An "off-the-shelf" PCM telemetry system is described in this 8-page illustrated brochure. The model 1323 system description includes information on reliability, bi-level programming, inputs for processing, inputs for control and synchronization and outputs. Radiation Inc., Melbourne, Fla.

Numerical Positioning Controls

A control block diagram and step-by-step explanation of automatic numerical positioning controls for machine tools are included in a 12-page brochure. Control specifications, tape programming and position display are discussed. Rheem Manufacturing Co., Electronics Div., 5200 W. 104th St., Los Angeles, Calif.

Adjustment Potentiometers

A four-page summary brochure on the company's adjustment potentiometers is designed for quick reference. Key information on 20 basic models is summarized. Resistances, terminal types, power ratings, operating temperatures, dimensions and prices are included. Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

DC Power Supplies

A 12-page picture brochure describes the firm's line of dc power supplies. Production techniques employed in the manufacture of the units are presented along with new facilities available. Jordan Electronics, 121 S. Palm Ave., P. O. Box 2017, Alhambra, Calif.
Take the 4-watt Type M control, for instance. Can't be beat for long life and dependability. It's constructed to take severe shock and vibration and still maintain positive contact. "Off" position for rheostat type eliminates need for separate switch.

Whatever you need in wire-wound controls, Mallory has it... 2 watts, 4 watts, 7 watts... in a big assortment of resistance values, taps, shafts, mounting arrangements and tandem constructions. We build specials, too, to your specifications. Mallory Controls Company, Frankfort, Indiana.

NEW LITERATURE

**Batteries**

Complete details on a line of lead-calcium grid communication batteries are provided in a 14-page catalog, T-532. Weights, cell dimensions, electrical characteristics, discharge curves and rack data are provided. C & D Batteries Div., The Electric Autolite Co., Conshohocken, Pa.

**Anechoic Chambers**

An eight-page catalog and four-page price list present illustrated data in detail on physical and electrical characteristics of Eccosorb anechoic chambers, both shielded and unshielded, and of Eccoshield rf shielded chambers. Emerson & Cuming, Inc., Canton, Mass.

**Metallized Ceramics**

A 16-page bulletin describes the high and low temperature metallizing processes, proves a wide variety of information on design and installation of ceramic-metal assemblies, and catalogs numerous hermetic terminals available from stock. American Lava Corp., Chattanooga 5, Tenn.

**Power Supplies**

Nineteen models of plug-in transistorized power supplies are described in detail in a four-page bulletin, No. 6. Specifications, voltage and current ratings, and performance charts are included. Acopian Technical Co., Easton, Pa.

**Ground Support Equipment**

The GEPAC "100" Programmable Automatic Comparator, a portable unit for use in shop, factory or flight line, is described in 24-page bulletin LMEJ 4837. It is used for automatic checkout of electronic and electromechanical systems. General Electric Co., Light Military Electronics Dept., Armament and Control Section, 600 Main St., Johnson City, N.Y.
Data Acquisition System 305

A 10-channel analog-to-pulse duration system (APD) is described in detail in a four-page bulletin. The system permits direct digital conversion of analog input from dc sensing devices. Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif.

Waveguide Adapters 306

Mechanical data on a variety of types of sidewall and topwall waveguide adapters, covering EIA waveguide sizes from WR28 to WR187, are provided in 20-page catalog JS-61A. Dimensions are tabulated with and without flanges. Microwave Development Laboratories, Inc., Natick Industrial Centre, Natick, Mass.

Polymers 307

Basic information on nine major grades of Cycloac brand polymers is provided in eight-page catalog 10240. Shown are end products particularly representative of the major processing techniques: molding, vacuum forming and extruding. A large chart provides data on properties of the various material grades. Marbon Chemical Div., Borg-Warner Corp., Washington, W. Va.

Rectifier Stacks 308

A 6-page catalog (SR-170) covers thousands of possible selenium rectifier stack variations, including standard and high voltage types and new double and triple density cell types. Write on company letterhead to International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.

R-C Networks 308

Relay contact protection by resistance capacitance networks is discussed in this five-page reprint of an article from Bell Laboratories Record. Theory and application information is presented, with curves and circuits. Characteristics of the firm's line of such units are given. Presin Co., Inc., 2014 Broadway, Santa Monica, Calif.

SAVE 1/4 INCH WITH THIS NEW TINIEST GENERAL ELECTRIC GLOW LAMP

Here's an indicator light that's only two-thirds the size of glow lamps previously available. Yet it lasts as long and has equal brightness. It’s available as a high brightness lamp (A1B) and a standard brightness lamp (A1C).

This new General Electric glow lamp packs 5 mm electrodes into an M.O.L. of 1/2”. Its maximum diameter is .244”. It operates on standard line voltage, and because it uses a higher value resistor than a conventional glow lamp, it runs on half the current. This 1/2” long lamp, therefore, has a reduced total light output but because its brightness is not reduced, it is just as effective an indicator as other glow lamps in most applications.

You can get this new glow lamp for less than 5¢ each in lots of 25,000. (Slightly more with a resistor attached.)


Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 182 ON READER-SERVICE CARD
IDEAS FOR DESIGN

Dual Filter, Phase Detector 742 From Frequency Discriminator

Connecting a dual-output filter to a phase detector results in a frequency discriminator with several useful characteristics. The combination of the filter and detector is shown; its advantages are enumerated below.

First, the circuit allows both the reference channel and the signal channel to the phase detector to be virtually as narrow in bandwidth as the system-signal requirements allow. This reduces noise output from the phase detector to a minimum.

Second, the problem of relative drift between the two channels, which leads to noise bias, is eliminated. This occurs since both channels use the same pair of crystals, and drift in frequency by the same amount.

Third, the circuit uses fewer components because only a single dual-output filter is required to do the job that would normally require two single-output, half-lattice filters.

Donald M. Lauderdale, research engineer, Defense Research Laboratory, University of Texas, Austin, Tex.

If this idea is valuable to you, give it a vote by circling Reader-Service number 742.

Photoelectric Circuit Operates 745 With High Light Resolution

In many applications of photoelectric controls, it is desirable to obtain a change in output current for a very small percentage change in light at the detector. These applications might include burglar alarm systems and industrial proximity controls. The circuit shown affords a direct and inexpensive method for obtaining this type of action.

The circuit is designed so that a change of output current I₂ approaches the change in photocell current I₁ times the product of the β's for the two transistors. However, biasing current I₃, allows quiescent current, I₉, to be set at some nominal, below-saturation level even in the presence of a relatively high ambient light level at the photocell.

Vote for Ideas Valuable to You

Vote for the Ideas which are valuable to you. Other engineers will vote for the Ideas which are most valuable to them. The Idea which receives the most “Valuable” votes will be judged “Most Valuable of Issue.” Its author will receive a $50 award.

Choose the Ideas which suggest a solution to a problem of your own or stimulate your thinking or which you think are clever.

And if you have any Ideas of your own, why not send them in? Remember, to be eligible for the 1961 Seventh Anniversary Awards Program your Idea should be received no later than November 15.

High-resolution photo detector circuit does not require more elaborate differential amplifier techniques.

A type of “suppressed-zero” operation is obtained, giving high light resolution without a more elaborate differential amplifier.

For burglar alarm type of operation R₁ is decreased so that I₂ is just sufficient to hold the relay in. A very small decrease in light input then will drop out the relay (fraction of a foot-candle change causes 20-ma change in I₁). By momentarily depressing S, the relay is again pulled-in, resetting the system. The actual relay used in the low voltage dc circuit was a 6-v ac unit. Pull-in current is 80 ma; drop-out current is 15-20 ma.

E. S. Gordon, Research Engineer, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

If this idea is valuable to you, give it a vote by circling Reader-Service number 745.

ELECTRONIC DESIGN • November 8, 1961
SEVENTH ANNIVERSARY AWARDS

IDEAS-FOR-DESIGN

Entry Blank

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards:

Rules For Awards

How You Can Participate

Entries must be accompanied by filled-out Official Entry Blank or facsimile. Ideas submitted must be original with the author, and must not have been previously published (publication in internal company magazines and literature excepted).

Ideas suitable for publication should deal with:
1. new circuits or circuit modifications
2. new design techniques
3. designs for new production methods
4. clever use of new materials or new components in design
5. design or drafting aids
6. new methods of packaging
7. design short cuts
8. cost saving tips

Awards:
1. Each Idea published will receive an honorarium of $20.
2. The Idea selected as the most valuable in the issue in which it appears will receive $50.
3. The Idea selected as the Idea of the Year will receive a Grand Prize of $1,000 in cash.

The Idea of the Year will be selected from those entries chosen Most Valuable of the Issue.

Most Valuable of the Issue and Idea of the Year selections will be made by the readers of ELECTRONIC DESIGN. The readers will select the outstanding Ideas by circling keyed numbers on the Reader-Service cards. Payment will be made eight weeks after Ideas are published.

Exclusive publishing rights for all Ideas will remain with the Hayden Publishing Co.

I submit my Idea for Design for publication in ELECTRONIC DESIGN. I understand it will be eligible for the Seventh Anniversary Awards—$20 if published, $50 if chosen Most Valuable of Issue, $1,000 if chosen Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation.

Hayden Publishing Company, Inc. shall have the exclusive publication rights to these Ideas for Design selected for publication in Electronic Design. This right extends to the subsequent use of the Idea for Design by Hayden in any of its other publications. Honorary, if any, for subsequent publication shall be solely in the discretion of Hayden Publishing Company, Inc.

Name ______________________________________ Title ______________________________________

Company Name __________________________________________

Address ________________________________________________

For Additional Entry Blanks, circle 750 on Reader-Service Card.
LARGEST LINE OF MILLIMETER WAVE LENGTH BWO Bendix BWO tubes for higher frequency transmission. These Backward-Wave Oscillator Tubes—exclusive with Bendix—generate microwave energy over the largest continuous frequency range. Ideal for advanced multichannel telephone and television systems, microwave spectroscopy, high definition short range radar, highly directive communications, and many other applications needing low power, voltage-tuned millimeter wave length radio frequency energy. Write today for complete information. Electron Tube Products, The Bendix Corporation, Eatontown, New Jersey.

IDEAS FOR DESIGN

Small Test Probe Uses Hybrid Isolation Amplifier

A small test probe needed an isolation amplifier with high input impedance and unity gain. The amplifier had to have a gain deviation of no more than ±1 per cent over a 25-mc bandwidth, with the gain remaining stable within ±2 per cent over long periods.

The problem was solved by designing a hybrid amplifier combining the high input impedance of a vacuum tube and the low output impedance on a transistor. A nuvistor triode, having the advantages of both small physical size and high input impedance, was used at the input. Thus, the input impedance of the circuit, shown in the figure, is about 1 meg in parallel with 10 pf.

Hybrid isolation amplifier uses nuvistor and transistor to achieve high input impedance, unity gain.

The output at the plate of the monitor, \( V_p \), is coupled to the base of \( Q_i \). The transistor output, taken from the emitter, is then fed through a length of coaxial cable terminated in its characteristic impedance.

High gain stability is achieved by providing negative feedback from the collector of \( Q_i \) to the cathode of \( V_i \). This results in an overall gain of unity. Measurements have shown that the overall voltage gain remained within 1 per cent of its initial value for a 30 per cent reduction in \( g_m \) of \( V_i \). The frequency response (1 db down) is 10 cps to 55 mc. The collector supply voltage was also used to operate the filament of \( V_i \). The maximum input level is limited to about 0.2 v which was satisfactory for our application.

Owen B. Laug, Electronic Engineer, National Bureau of Standards, Washington, D. C.

If this idea is valuable to you, give it a vote by circling Reader-Service number 749.
Single Potentiometer Adjusts Range of Simple VFO

Here are the design equations for a variable-frequency, phase-shift oscillator that will operate over a frequency range of 5:1 to 20:1. The frequency of the circuit, which uses noncritical components, can be varied by a potentiometer adjustment.

Referring to the circuit, if:

\[ R' = R_2 + \text{input resistance of } T_1 \]

then the circuit's frequency of oscillation is:

\[ f_o = \frac{1}{2 \pi \sqrt{3 RR_L + R_4^2 + 3R^2 + 3R R_L}} \]

For this oscillating frequency the required transistor \( \beta \) is:

\[ \beta_{req} = 11 + \frac{10R + 3R_2 + R_4 R_L + 9R_6 + 14R_L + 2R_2^2 + 6R_6^2}{R + R_2 + R_4^2 + R_6 + R_L + R + R_6} \]

These equations can be simplified somewhat by making the substitutions:

\[ M = \frac{R_6}{R} \text{ and } K = \frac{R'}{R} \]

Thus, the required \( \beta \) is:

\[ \beta_{req} = \frac{2K + 10K + 11 + M(3 + K) + 1}{M(9 + 11K + 6K)} \]

and the frequency of oscillation is:

\[ f_o = \frac{1}{2\pi \sqrt{K(M + 3) + 3(M + 1)}} \]

Frequency is varied by adjusting \( R' \).

![Diagram of the oscillator circuit](image)

Variable frequency oscillator is variable over range of 5:1 to 20:1.


If this idea is valuable to you, give it a vote by circling Reader-Service number 746.

Frankly, we hope you're a fusspot. If you are funny about the way you work, and proud of it, we think you'll enjoy knowing about these K&E items . . .

A Real "Clinging Vine"

Some of our more meticulous K&E people have been known to walk out of a drafting room in a cold sweat at the way the drafting boards were covered. Its those ripples, wrinkles and bends that cause all the anxiety. "How," mutters our loyal agent, "can you expect to draw a straight line on an easy surface?"

And its all so easy if you just take the right K&E product and mount it in the right way. The product in this case is LAMINENE® N70 Board Surface Material. This is a product unique with K&E. We hold a patent on the process that laminates a thin acetate film to a tough paper base - quite a bit different than simply coating a paper with plastic. And the results are different too.

It's rather a dramatic show of force that LAMINENE stages on a board. The secret is in the irresistible urge of a natural product to return to its normal state. In this case, when you wet the back of LAMINENE you expand it ever so slightly. When tacked or taped under the edges of the board, it begins to dry and shrink. The paper backing builds tension on the surface as it dries, finally reaching a smooth taut state . . . with enough tension left over to keep it permanently wrinkle-free. No matter what the temperature or humidity, LAMINENE stays with the board as if cemented there.

Add to this a fine, springy quality, and a variety of other features - grid lines, green color, washability - and you can see why LAMINENE rates at the top in popularity for a semi-permanent board covering.

Would you like a sample? It's yours for the asking. See your K&E dealer or return the coupon at the right.
In 184 words or less, write to Sigma saying why you intend, without hesitation, to use a new Sigma Series 46 instead of almost any other AC or DC DPDT octal plug-in relay. This contest isn’t limited just to your exciting new designs—the products you’ve been making every day are also eligible. (See helpful hints below.) All entries will be judged on the basis of ingenuity, originality and Sales Dept. records of purchases made by the entrant. (Entries by Sigma competitors will be given special consideration.)

First prize will be one (1) magnificently dented left front fender from the Sigma Sales Manager’s Lily-White Sportscar, removed after recent spirited trip by owner. Second prize will be a genuine memento of the Advertising Manager’s European Tour, 3rd through 10th prize will be a Series 46 relay in winner’s choice of type, adjustment and contact material.

All entries must be received by Nov. 30th, 1961 and indicate that entrant knows what a Sigma Series 46 Relay is (for). Judges will include various qualified Sigma personnel, such as the engineer who designed the Series 46, Head Shipper and Chief Dietician. Suitable final arrangements will be made for all entries.

Some hints on preparing winning entries
- rated to switch 5 amps at 28 VDC, 1 amp at 120 VDC; on AC, 1200 volt-amperes per pole with 240-volt and 10-amp maximums
- outlasts other things; works 10 million times on 1-amp loads, half a million times on 10-amp loads
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<table>
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<tr>
<th>MODE 302</th>
<th>MODE 300</th>
<th>MODE 308A</th>
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<tr>
<td><strong>FUNCTION</strong></td>
<td><strong>High or Low Pass Band Pass or Reject</strong></td>
<td><strong>High or Low Pass Band Pass or Reject</strong></td>
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<td>Cut-off Freq. Range</td>
<td>20 cps to 200 kc</td>
<td>20 cps to 200 kc</td>
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<td>36 db/octave</td>
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<td>2 cps to 4 mc</td>
<td>2 cps to 4 mc</td>
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<tr>
<td>DIAL ACCURACY</td>
<td>± 3% to 50 kc</td>
<td>± 5% to 50 kc</td>
</tr>
<tr>
<td>INSERTION LOSS</td>
<td>0 ± 1 db</td>
<td>0 ± 1 db</td>
</tr>
<tr>
<td>NOISE LEVEL</td>
<td>60 microvolts</td>
<td>60 microvolts</td>
</tr>
</tbody>
</table>

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CIRCLE 189 ON READER-SERVICE CARD

German Abstracts

E. Brenner

FREQUENCY OF TUNNEL

The upper frequency limit of tunnel diodes, based on the physics of the tunneling effect, has been estimated as $10^{11}$ cps. Practically, however, frequencies of the order of 10 Gc can hardly be exceeded, or even reached. This conclusion is based on an analysis of the tunnel diode equivalent circuit, Fig. 1, together with geometrical considerations of the size of the semiconductor.

The tunnel diode is represented by the negative incremental resistance $-R$, the capacitance $C$, the internal inductance $L_s$ and the series (positive) resistance $R_s$. A tuning element, represented by $R_t - L_s$, and a load, $R_l$, are also included. The negative incremental resistance, $-R$, corresponds to the largest value of the negative slope of the diode volt-ampere curve. In the microwave region, it is about $-1$ ohm and is virtually independent of the semiconductor material or of the frequency.

Fig. 1. Equivalent circuit of tunnel diode with tuning element represented by $R_t$ and $L_s$.

Electronic Design • November 8, 1961
Limitations

Diodes

The net admittance of the circuit of Fig. 1 at the terminals $a-a'$, is zero if:

$$L_e = R R_e C$$  \hspace{1cm} (1)

and

$$\omega_0 = \frac{1}{RC} \sqrt{\frac{R}{R_e} - 1}$$  \hspace{1cm} (2)

where

$$R_e = R_s + R_L + R_e$$ and $$L_e = L_a + L_e$$

The upper frequency limit is approached when $R_L$ is made to approach zero in Eq. 2, provided, of course, that $R_e < R$ (which is necessary for oscillations). Thus, if $R = -1$ ohm, $f_0 = 320$ mc for $C = 1$ nf and $R_e = 0.2$ ohm; and $f_0 = 10$ Gc for $C = 15$ pf and $R_e = 0.5$ ohm.

The capacitance of the tunnel diode is given, for germanium, by:

$$C = 0.045 \frac{r^2}{(nf)}$$  \hspace{1cm} (3)

where $r$ is the semiconductor disk radius, Fig. 2, in millimeters. For $r = 0.1$ mm, $C = 450$ pf; for $r = 0.015$ mm, $C = 10$ pf.

Most of the series resistance, $R_e$, stems from the semiconductor material. Therefore, its bulk should be minimized. The external circuit inductance, produced by a coaxial cable, together with contact resistance accounts for resistance of the order 0.05 to 0.1 ohm.

Considering current density $J$ and semiconductor geometry ($h$ and $r$, Fig. 2) as

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 Flyback Transformer Voltage controlled by Carborundum Varistors

Under some operating conditions such as high line voltage, the output from the flyback transformer in a TV vertical circuit can reach 2500 volts. This far exceeds the voltage needed for normal operation and can puncture winding insulation, cause flashover at tube pins, and can damage other components.

A simple solution is the installation of a Carborundum Type 331 BNR Varistor. The voltage-sensitive resistance characteristic of the Varistor holds the flyback output to a safe 1500 volts.

Data Sheet on the reduction of induced transients using Carborundum Varistors and Bulletin CR-2 giving characteristics will be sent on request. Write Dept. EVD-111, Globar Plant, Refractories Div., Carborundum Co., Niagara Falls, N. Y.

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TYPE 2001-2 FREQUENCY STANDARD
Size, 3¾” x 4¼” x 6” H., Wt., 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at +20° to +30°C
Output: 5V at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V, at 5 to 10 ma.
Accessory Modular units are available to
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TYPE K-5A FREQUENCY STANDARD
Size, 3½” x 3” x 1½”
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: .03%, −55° to −71°C
Input: 28V DC ±10%
Output: 400 cy, approx. sq. wave
at 115V into 4000 ohm load (approx. 4W)

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GERMAN ABSTRACTS

Fig. 2. Construction of a microwave tunnel diode.

Analog Output Circuit For A
Decimal Decade

Electronic counters occasionally require an-
alog output circuits for single decades. A
suitable resistance matrix is shown in the
figure. It is assumed that the resistance of
the indicator, Rn, is large compared to the
resistances of the matrix (R1 through R7).
Also, the resistances of the conducting tubes
or transistors are negligible compared to the
matrix resistances. The equation for the out-
put voltage E has the same form as that of a
decade consisting of four flip-flops. This equa-
tion is:

E = E1 - [A1 (E1 - E2) + A2 (E2 - E3)
+ A3 (E3 - E4) + A4 (E4 - E5)]
variables, the optimum current density for maximum $f_o$ is given by:

$$J_{opt} = \frac{11}{f_o} \text{ amp/mm}^2$$  \hspace{1cm} (4)

where $f_o$ is in gigacycles. Thus, for $f_o = 10 \text{ Ge}$ the current sensitivity is 110 amp/mm$^2$.

It can also be shown that semiconductor disk height for germanium is related to the limiting frequency, $f_o$, (assuming $h = 2r$) by:

$$h = 0.0316 \left[ \sqrt{(34.5/f_o)} + 1 \right] \text{ mm } \hspace{1cm} (5)$$

Consequently a 10-Gc upper frequency limit corresponds to $h = 0.035 \text{ mm}$, the smallest size which appears to be practical.


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Circuit of the resistance matrix.

where the values $A_1, A_2, A_3,$ and $A_4$ are determined by the matrix resistance values. For a decade counter:

$$A_1 = 0.1 \quad A_2 = 0.2 \quad A_3 = 0.4 \quad A_4 = 0.6$$

By straightforward application of circuit equations, the resistance network has the same $A$-values of the decade, if

$$R_1 = R_2 = R_3 = R_4 = R; \quad R_5 = R_6 = R/2; \quad R_7 = 2R; \quad R_8 = 0$$

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REPORT BRIEFS

Parametric Limiters
Both theoretical and numerical analyses are presented to describe phase-distortionless, passive parametric limiters. Leakage-spike energy, a troublesome problem when a limiter is used as a protecting device, is small in varactor diode versions, and large in ferrite versions. The analytical result which predicts the behavior of the leakage spikes may be used to control the leakage energy by adjusting certain parameters. Passive Phase-Distortionless Parametric Limiters, I. T. Ho, Stanford Electronics Laboratories, Stanford University, Calif., April 1961, 134 pp, $11. Order AD-256775 from OTS, Washington 25, D. C.

Ferromagnetic Materials
Nonlinear effects on the microwave properties of ferrites and ferromagnetic-garnet materials were studied. Two millimeter-wave generation experiments using nickel-zinc ferrite and Ferroplas type hexagonal single crystals are described. An analysis of a longitudinally pumped ferrite amplifier is given. Expressions for gain, bandwidth, gain-bandwidth product and noise temperature are derived. Investigation Of Microwave Nonlinear Effects Utilizing Ferromagnetic Materials, Roy W. Roberts, Melabs, Palo Alto, Calif., April 1961, 20 pp, $2.60. Order AD-256716 from OTS, Washington 25, D. C.

RFI
In predicting interference the calculation of the frequencies where interference will occur and their magnitudes are of interest. A device used to show this pictorially is the mutual interference chart or mutual interference matrix. The processing of a mutual interference matrix for sets of noninterfering frequencies was separated into two cases. The first case was concerned with symmetric mutual interference matrices with no distinction between the transmitter or receiver frequencies. The second case was applicable to a general mutual interference matrix with the distinction between transmitter and receiver frequencies preserved. Directory of Electronic Equipment Characteristics, Non-Radio Types, I. E. Perlin and C. E. Blakely, Georgia Institute of Technology Engineering Experiment Station, Atlanta, Ga., Sept. 1959, 100 pp, $9.10. Order AD-256545 from OTS, Washington, D. C.

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ELECTRONIC DESIGN • November 8, 1961
Tunnel Diode Circuits

Tunnel-diode circuits were theoretically investigated as a source of high-speed current pulses capable of switching thin film memories in the order of tens of millimicroseconds. Break-point models of the characteristic curve are constructed and piecewise linear analysis is used to predict and extrapolate experimental results. Three basic circuits were chosen as drivers for various load forms and levels. These were tried in the laboratory and results are given. Tunnel Diode Circuits For Switching Thin Film Memories, Paul C. Davis, Electronic Systems Laboratory, Massachusetts Institute of Technology, Cambridge, Mass., June 6, 1961, $5.10. Order AD257015 from OTS, Washington 25, D. C.

Ferrite Devices

Troughline isolator design problems are discussed. A stripline isolator is described which provides greater than 25-dB isolation and under 1.2-dB insertion loss for 4-8 kmc. Also described are phase-shift studies carried out on an axially magnetized, ferrite-loaded stripline bandpass filter. Ferrite Devices for Receiving Systems, R. A. Henschke, D. A. Parkes and S. S. Shapiro, Palo Alto, Calif., May 3, 1961, 55 pp., $3.60. Order AD-260382 from OTS, Washington 25, D. C.

Switches and Lines

Results are presented of a program to investigate (1) the application of crystal switches to the scanning of receiving antennas and (2) the properties of a multiwave transmission line. The crystal switch study was concerned with the characteristics of single and multithrow switches to determine their effectiveness as an antenna scanning device. Measurements on insertion loss, switching ratio, switching speed and noise figure were made. The multiwave transmission line study was concerned with a transmission line consisting of two unbalanced TEM lines whose outer form was a rectangular or ridged waveguide. Major points of investigation were the attenuation of TEM modes, the cross coupling of the TEM modes, the effect of center conductors on the cut-off frequency of the dominant waveguide mode, and the construction of an experimental mode launcher. Multiwave Transmission Line and Semiconductor Switching Elements Studies, James D. Kellett, Sylvania Electric Products, Inc., Waltham, Mass., Feb. 1961, 18 pp., $6.60. Order AD-258421 from OTS, Washington 25, D. C.

Linde News

Lindeg Materials & Coatings

Linde Company, Division of Union Carbide Corporation

Polish semiconductors scratch-free with 99.98% pure alumina powders

Photo at left: A typical as-lapped silicon wafer, showing edge chip, prior to finishing. (Magnified 4x). Right: Complete polishing with LINDE alumina abrasives leaves edge of silicon and wafer scratch-free. (Magnified 14x).

The surfaces of the semiconducting wafers used in the new high-speed mesa switching transistor and planar diodes must have a superior surface finish, flatness, and parallelism—prior to final etching and diffusion. This effect is now being achieved in full production with high-purity alumina abrasives produced by LINDE.

Three particle sizes

Three basic particle size ranges of aluminum oxide powders suitable for polishing silicon and germanium wafers are available for this application, as well as other. The difference in size and hardness, as listed below, gives these 99.98% pure powders their individual properties.

<table>
<thead>
<tr>
<th>Type 0.3A</th>
<th>Type 0.05B</th>
<th>Type 1.0C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formula</td>
<td>A10O3</td>
<td>A10O3</td>
</tr>
<tr>
<td>Form</td>
<td>(Alpha)</td>
<td>(Gamma)</td>
</tr>
<tr>
<td>Crystal</td>
<td>Hex.</td>
<td>Cubic</td>
</tr>
<tr>
<td>System</td>
<td></td>
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</tr>
<tr>
<td>Hardness</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>MOHS'</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Size</td>
<td>0.3</td>
<td>0.05</td>
</tr>
<tr>
<td>Microns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Type 1.0C is used to remove stock from surfaces that are rougher than 6 micro-inches rms; Type 0.3A for preliminary polishing and Type 0.05B for final polishing of the wafers.

In the initial stages of junction transistor or diode production, the powders can be used for preparing metallographic cross-sections of the assemblies according to standard methods on a horizontal polishing wheel. For semiconductors, LINDE has developed several adaptations of standard techniques.

Extremely uniform

LINDE Types A, B, and C alumina powders are chemically prepared and have an extremely uniform ultimate particle size which obviates any further levitation before use. By simple reference to a specific lot number, succeeding production lots can be ordered with abrasive properties tailored to individual requirements. For data on semiconductor and other critical polishing, check the coupon.

Flame-Plated tungsten carbide coatings precision-finished

Tungsten carbide coatings, applied with the LINDE Flame-Plating process, are being used successfully on hundreds of precision parts because the coatings are well suited for finishing down to 1 micronichs rms.

Most frequently used precision grinding equipment is diamond wheels, resulting in lowest overall cost on ordinary cylindrical and flat work. On many contour grinding jobs, special grades of silicon carbide wheels will do the job, eliminating the high cost and lack of precision associated with shaped diamond wheels. Diamond-abrasive lapping techniques give high finishes.

Get complete data on Flame-Plating precision parts—send the coupon.

Plasma-Plate process applies thin dielectric coatings

Next time you need a low-cost, thin dielectric coating for cathode cups, consult Linde Company. LINDE'S Plasma-Plate process has economically put alumina insulation coatings on molybdenum cups, and has even built structures on mandrels—for example, the grid cage shown below. This inert gas process can apply refractory metals melting up to 7100° C., also metal carbides, borides, and oxides, to a variety of base metals. Discuss your requirements with us. For further information, check and send the coupon.

Tungsten grid cage—intricate structure built up on mandrel using the Plasma-Plate process.
REPORT BRIEFS

Phase Shifters

Two general phase-shifting techniques employing semiconductor elements were investigated. The first technique uses a step or incremental phase-shifting device that provides for discrete changes in phase. The second phase-shifting device is continuously variable and provides for a greater flexibility in phase control. Phase shifters were built for L-band which, for the incremental type, can handle peak powers in excess of 10 kw, and for the continuous type can handle 1 kw peak power. Phase Shifters Study Program, Kenneth E. Mortenson and Charles Horel, Microwave Associates, Inc., Burlington, Mass., Aug. 1, 1961, 52 pp, $5.60. Order AD 260092 from OTS, Washington 25, D. C.

Radar Clutter

Radar pulse coding (or pulse comprehension) techniques to improve detection of targets in clutter is discussed. Assuming a simple clutter model and an appropriately optimized receiver, an expression is derived for the single-pulse detection capability of a radar operating in the presence of both clutter and additive white receiver noise. From the expression it is seen that detection performance is simply related to the spectrum of the transmitted signal. Generally speaking, it improves as the bandwidth of the transmitted signal is increased. The Use of Pulse Coding to Discriminate Against Clutter, Roger Manasse, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass., June 7, 1961, 16 pp, $1.60. Order AD-260230 from OTS, Washington 25, D. C.

Low-Noise Antennas

Principal sources of antenna noise are discussed, together with their effects on antenna performance. The concept of antenna gain-temperature ratio and a mathematical method for handling it as a single design parameter are introduced. Limitations of very large continuous apertures are considered and a multielement system proposed for increasing the useful size of large antennas. Some experiments to determine the feasibility of such a system and its optimum size are described. Some Principles of Low-Noise Antenna Design, Ross Caldecott, Antenna Laboratory, Ohio State University Research Foundation, Columbus, Ohio, Dec. 1, 1960, 55 pp, $4.60. Order AD-260112 from OTS, Washington 25, D. C.

Casting Engineers

Gave us the right component weight with greater strength... and helped us into a new market... says William C. Croft

President, The Pye-National Company

"Before we offered our miniature connectors to the aircraft/missile industry, we searched for a lightweight alloy, easily castable, which would withstand high ambient temperatures. Casting Engineers furnished a stainless steel casting for our product which allowed us to compete very favorably with aluminum in weight, with tremendous increase in strength and corrosion resistance—a real metallurgical breakthrough.

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Section thickness is critical in airborne connectors where weight is a liability and strength is essential. Plastic patterns pioneered at Casting Engineers, assured uniformity in detailed configurations, met all MIL interchangeability specifications for tolerances on diameters and concentricity. Casting Engineers can make a significant contribution to your component design and production. MINICAST parts slash machining costs, eliminate secondary operations. MINICAST means precision, dependability... and economy.

New eight page brochure tells how to specify investment castings to cut your production costs. Send for your free copy today!
Tunnel Diodes

Research was concerned with the theory and applications of tunnel diodes. Effort was also devoted to developing a better understanding of the behavior of negative resistance devices. Most of the known essential elements of tunnel diode theory are summarized. A tunnel diode theory and applications, Rajendra Nanavati and W. Howard Card, Syracuse University, College of Engineering, Syracuse, N. Y., April 10, 1961, 135 pp., $10.50. Order AD-260776 from OTS, Washington 25, D. C.

Antenna Matching

Techniques for using the Smith Chart when developing matching networks for broadband antennas are presented. The chart is used for the matching of broadband as well as single frequency antennas. Practical Matching Techniques on the Smith Chart, Ove Simonsen, Navy Electronics Laboratory, San Diego, Calif., March 31, 1961, 29 pp., $2.60. Order AD-260292 from OTS, Washington 25, D. C.

Analog Circuitry

The results obtained by the application of redundancy to various types of analog circuitry are summarized. Comparisons are made between passive and active switching redundancy. Formulas are derived enabling the designer to determine the actual reliability improvements that may be expected. An Improvement in the Reliability of Analog Circuitry Through the Application of Redundancy, A. A. Sorensen, Space Technology Laboratories, Inc., Los Angeles, Calif., May 1961, 39 pp., $4.60. Order AD-260159 from OTS, Washington 25, D. C.

Reconnaissance Antennas

Research was continued on broadband, low-noise amplifier and mixer circuits to be integrated into an antenna to form a unified system. A broadband, low-noise, hybrid-coupled parametric amplifier is described. Research was also continued on the use of RF circuitry and nonlinear elements as integral parts of an antenna configuration to perform functions such as mixing, phase-shifting, amplifying, and tuning. Research on Electronic Reconnaissance Antennas, Interim Engineering Report, Antenna Laboratory, Ohio State University Research Foundation, Columbus, Ohio, June 5, 1961, 8 pp, $1.60. Order AD256924 from OTS, Washington 25, D.C.
**Project Surveyor engineering openings**

Hughes Space Systems Division has immediate openings for Electronic Engineers, Mechanical Engineers, Physicists and Aeronautical Engineers to work on Project Surveyor—a spacecraft which will soft land on the moon. Once there, Surveyor instruments will perform a variety of scientific tests: drills will pierce and analyze the moon’s surface; high quality television pictures will be transmitted to earth; other instruments will measure the moon's magnetic and radiation characteristics. To accomplish this step into space, Project Surveyor requires the talents of imaginative junior and senior engineers and scientists to augment its outstanding staff. Experience is preferred but not required. A few of the openings include:

<table>
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<th>control engineers</th>
<th>circuit designers</th>
<th>systems analysts</th>
<th>infrared</th>
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<tr>
<td>Concerns hydraulics, airborne computers, and other controls related areas for missiles and space vehicles, satellites, radar tracking, control circuitry, controls systems, control techniques, transistorized equalization networks and control servomechanisms.</td>
<td>Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and others.</td>
<td>To consider basic problems such as: the requirements of manned space flight, automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.</td>
<td>Includes systems analysis and preliminary design in infrared activities involving: satellite detection and identification; air-to-air missiles; AICBM; infrared range measurement; air-to-air detection cryogenics and others.</td>
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**inquire today**

Your reply will be treated with strict confidence. Please send your resume to:

**Robert A. Martin**

Supervisor of Scientific Employment,
Hughes Aircraft Company,
11940 W. Jefferson Blvd., Culver City 32,
California. WE PROMISE YOU A REPLY WITHIN ONE WEEK.

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**YOUR CAREER**

**IBM Systems Engineers Briefed at Symposium**

Systems engineers of International Business Machines, Inc., recently attended the company’s First Systems-Engineering Symposium. They heard reports on advanced computer techniques and received instruction on the new solid-state 1410 data-processing system.

More than 70 technical papers were presented, describing systems ranging from automatic methods of information retrieval to the programming of nuclear-reactor design problems.

A process-control system for the paper-making industry, simulated on a solid-state IBM 1620 computer, was demonstrated. It consists of an IBM 1710 process-control unit that monitors production on one or two paper-making machines. A 1711 data converter translates instrument readings from the paper-making machine into computer language and the solid-state 1620 data-processing system. The system stores, analyzes, and reports this converted data in visual form to technicians who control the paper-making process.

Instructor Shirley Daniels demonstrates the IBM solid-state 1410 data-processing system to IBM systems engineers.

**Industry Wage Pattern Shows Wide Fluctuation**

The average minimum hourly wage for the electronic-equipment industry is $1.41, according to the Bureau of Labor Statistics and the Electronic Industries Association. However, there are wide variations in minimum wages, dependent upon size of establishment and location.

The lowest rate in median establishments
Advancement Your Goal? Use CONFIDENTIAL Action Form

ELECTRONIC DESIGN’s Confidential Career Inquiry Service helps engineers “sell” themselves to employers—as confidentially and discreetly as they would do in person. The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—the same day the resume is received.

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at ELECTRONIC DESIGN.
- Your form is kept confidential and is processed only by this specialist.
- The “circle number” portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at ELECTRONIC DESIGN, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!
If you were a surgeon instead of an engineer...

... you'd want to work at one of the leading hospitals in the nation—where your associates would represent the finest medical talents available. In such a situation you could grow more in a year than in a lifetime spent in an ordinary clinic.

The same thing is true of every profession. Your own stature as an engineer is determined to a great extent by the calibre of your associates.

At Motorola you will be working for and with some of the most respected engineers and scientists in the electronics field—Motorola is an "engineer's company." And, here at Motorola the horizon is wide and the ceiling unlimited—you can go as far—as fast—as your capabilities permit. You'll be working for a secure, diversified company—not wholly dependent on one single market.

You owe it to yourself and your family to investigate the opportunities at Motorola. Dozens of fields of interest are open—just a few of which are listed below: Write today for the full story.

We'll send you a complete description of "Your Life at Motorola"—in Chicago; Phoenix; Riverside, California; Culver City, California; Minneapolis, Minnesota. Naturally your request will be kept in complete confidence.

- Radar transmitters and receivers
- Radar circuit design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using klystron, traveling wave tube and backward wave oscillator
- Display and storage devices

2 WAY RADIO COMMUNICATIONS
- VHF & UHF receivers
- Transmitter design and development
- Power supply
- Systems engineering
- Antenna design
- Selective signaling
- Transistor applications
- Crystal engineering
- Sales engineering

- Design of VHF & UHF FM communications equipment 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
- Audio radio design
- Mechanical engineering
- Semi-conductor device development
- Semi-conductor application work

Semiconductor Engineers

DELCO RADIO DIVISION of General Motors has immediate openings for qualified men to work in semiconductor process or production engineering.

As manufacturers of power transistors and rectifiers, we need experienced personnel for these areas: MATERIAL PREPARATION... EQUIPMENT DEVELOPMENT... CRYSTAL GROWING... ALLOYING and SURFACE TREATMENT.

We are looking for men with degrees—or equivalent work experience—in PHYSICS... CHEMICAL ENGINEERING... ELECTRICAL ENGINEERING... MECHANICAL ENGINEERING.

Rapid expansion of Delco Radio's line of semiconductor products creates unusual opportunities for technically-trained personnel who are ready to make the move NOW.

Equal opportunity for all qualified applicants

If you're qualified and interested in joining this challenging Delco-GM program, let's talk. Send your resume to the attention of C. D. Longshore, Supervisor Salaried Employment.

CAREERS

MOTOROLA, Inc.

CIRCLE 902 ON CAREER-INQUIRY FORM

DELCO RADIO DIVISION OF
GENERAL MOTORS
KOKOMO, INDIANA

CIRCLE 902 ON CAREER-INQUIRY FORM
ELECTRONIC DESIGN • November 8, 1961
YOUR CAREER

was said to be $1.60, but the regional rates varied as follows: New England region, $1.34; Middle Atlantic, $1.75; South, $1.48; Middle West, $1.56; and Far West, $1.57.

S. Herbert Unterberger, wage consultant to the industry association, said wages in the electronics industry in the six-state New England region have been consistently lower than those in other regions of the country. He also pointed out significant differences in wages between small and large electronics companies, minimum wages being substantially lower in small plants.

The University of Rhode Island and Raytheon Co.'s anti-submarine and undersea warfare center at Portsmouth have joined in a plan to bridge Narragansett Bay with a TV-relay link, thus eliminating lengthy trips by professors and graduate students.

Raytheon will install cameras in the university's new engineering building. When on-campus graduate students receive instruction, another group of students will receive the same courses across the bay at Raytheon through closed-circuit television.

Two water towers, at the university and at Raytheon in Portsmouth, hold TV-relay link antennas, which carry video and audio signals between the university and Raytheon classrooms.

Besides cutting travel time and cost for students and professors, the TV system allows regular biweekly classes, instead of a single three-hour class.

Careers Inc., New York, says it is incorporating teletype links in the "career centers," which it has been holding during the larger technical conventions.

An engineer now can place his qualifications before all the companies in one of the centers within minutes after he has turned in the standard form.

The teletype machine in the center will transmit copies of the man's qualifications to each of the participating company's recruiting suites.

Also, Careers Inc. is going to make available teletype links to the home plants of the participating companies (as well as to companies that are not participating). The advantage of these remote lines, says Careers, is that the home office of a company also can screen the new applicants as they register and can alert the recruiting team if a man looks good to it.

if your future is for growing...

People at Philco's Western Development Laboratories are proud of their achievements, secure in the steady growth of their company, enthusiastic about their future.

In just four years, Philco WDL has expanded from a staff of 18 to more than 2,000. At the end of this year WDL will open a new 250,000-square-foot facility which will accommodate a continually expanding complement of engineers, scientists and supporting staff members.

Philco WDL, the space organization which designed and built the Courier satellite, conducts an ever-growing development program in tracking, satellite instrumentation, communications, data processing and command—moving hand in hand with the federal government in space exploration and space age defense.

Your growth with a growing company, ideal living on the Northern California Peninsula, professional and monetary advancement commensurate with your own ability—these are some of the advantages and satisfactions of working at Philco Western Development Laboratories.

If yours is one of the fields listed at the left, write today to Mr. W. E. Daly, in confidence, of course, Department D-11.

This new 250,000-square-foot addition to Philco Western Development Labs will open by the end of the year.
Enjoy Maximum Responsibility

PROBE
NEW AREAS
in telemetry and data processing

Planned growth and diversification at Electro-Mechanical Research, Inc. (e.m.r) enable men with imagination to exercise the full scope of their professional skills. Opportunity to probe new areas is insured by initiating within the company the major portion of all research. Current projects include development of the test instrumentation subsystem for Dyna-Soar space glider.

ELECTRONIC SYSTEM DESIGN ENGINEERS
Must have experience, state-of-the-art knowledge and a keen interest in the whole systems field, from initial concept through design and prototype development. Includes such areas as magnetics and solid state circuitry, RF transmitters and semiconductor applications, DC through UHF.

Please direct inquiries in confidence to:
ROLAND E. HOOD, JR.,
Personnel Manager,
Systems Division

Electro-Mechanical Research, Inc.
P. O. Box 3041-E, Sarasota, Florida

MATERIALS...  MANUFACTURE...  RELIABILITY

Qualified applicants considered without regard to race, creed, color or national origin.

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BUILDS
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If you've reached a “dead end” in your present position, and are seeking an opportunity with a growth company, where initiative, imagination and ability can be used, then Acme Electric may offer you a great future.

Acme Electric designs and builds a wide range of magnetic and transistorized components including such products as

★ Magnetic Amplifier Controlled Battery Chargers
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★ Control Transformers
★ DC and AC Regulated Power Supplies
★ Military Transformers
★ Phase Changers
★ Power Distribution Centers
★ Rectifier Equipment
★ Saturable Reactors

To save time, please supply detailed resume with first letter which will have our immediate attention.

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Cuba, N.Y.

CIRCLE 906 ON CAREER-INQUIRY FORM

UNIVAC CORDWOOD PACKAGING SHRINKS SIZE 200 TIMES!

A few months ago this unit measured more than 200 times its present size. Univac engineers and scientists reduced it, through cordwood packaging of components, to its present state of "vest pocket" miniaturization without sacrificing Univac's customary high standards of ultra-reliability. Such achievements in high density packaging have led to other Univac accomplishments of startling and yet undisclosed dimensions.

Opportunities are now available at Univac to participate in advanced computer programs which involve various approaches to high density packaging. This state of the art is under constant change by Univac engineers and scientists who enjoy at Univac an exceptional personal freedom for professional expression. These men now extend an invitation to their scientific colleagues who may be seeking new positions of greater promise, challenge and reward.

Immediate openings include:

RESEARCH ENGINEERS
Attractive positions are now available for Research Engineers. These permanent assignments include circuit development work and the logical design of high speed computer elements.

- TRANSISTOR CIRCUIT DESIGNERS
- ELECTRONIC PACKAGING ENGINEERS
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- ELECTROMECHANICAL ENGINEERS
- QUALITY CONTROL ENGINEERS
- PRODUCTION ENGINEERS
- RELIABILITY ENGINEERS
- STANDARDS & SPECIFICATIONS ENGINEERS

Send resume of education and experience to:
R. K. PATTERSON, DEPT. C-11

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DIVISION OF SPERRY RAND CORPORATION
2750 West Seventh St., St. Paul 16, Minn.
There are also immediate openings in all areas of digital computer development at our other laboratories. Inquiries should be addressed to:

F. E. MAGEE, Dept. C-11       D. CLAVELoux, Dept. C-11
REMINSTON RAND UNIVAC      REMINGTON RAND UNIVAC
P. O. Box 510               Wilson Avenue
St. Paul, Minn.             South Norwalk, Conn.
(All qualified applicants will be considered regardless of race, creed, color or national origin.)

CIRCLE 907 ON CAREER-INQUIRY FORM

166
The Role of Electronics Engineers in Weapon System Management at Republic

As one of the top 15 Prime Contractors to the DOD, Republic has demonstrated its capability to create total aircraft, missile, and space vehicle systems. Electronics is an important part of this capability.

Over 250 Electronics Engineers and Scientists at Republic are extending parameters in communications, navigation, guidance & control, detection and data handling. A recent prime contract award has placed special emphasis on reconnaissance. As Weapon System Manager, Republic is responsible for developing this capability for its F-105D "flying electronic platform," the free world's most versatile and sophisticated manned weapon system.

Defining system requirements, conducting analytical studies, evaluating overall design, and monitoring progress of subcontractors are engineering tasks requiring broad technical knowledge and high analytical ability. Difficult problems in subsystem integration, density packaging, and reliability must be solved.


Opportunities are at
2 Republic Locations: Farmingdale and Mineola, Long Island, N.Y.

Write to:
Mr. George R. Nickman
Technical Employment Manager
Dept. 1ZL-1
Republic Aviation Corporation
Farmingdale, Long Island, N.Y.

Mr. Paul Hartman
Technical Employment
Dept. 1ZL-1A
Missile Systems Division
Republic Aviation Corporation
223 Jericho Turnpike
Mineola, Long Island, N.Y.
Pierre de Fermat's last theorem states that the above equation has no solutions in which x, y, and z are positive whole numbers if "n" is a whole number greater than two. Mathematicians have yet to prove him wrong. But their attempts to prove the theorem (or conjecture, since it hasn't been proved) have produced some of the most revolutionary concepts in modern algebra and number theory!

Questions are what answers are made of. Questions about our universe, for example. What is the Moon made of? Is there life on other planets? The answers are coming from Cal Tech's Jet Propulsion Laboratory for the National Aeronautics and Space Administration.

JPL scientists and engineers are supervising the design of spacecraft and their instruments to be sent to the Moon and planets. Ranger, Surveyor, Mariner. Some day, they'll be remembered as our first steps into space.

Today, they're a job to do. And a fascinating job at that. If you'd like to put your experience to work on this kind of a job, maybe JPL is your kind of place. Write to us and find out. It never hurts to ask questions.

**JET PROPULSION LABORATORY**
4824 OAK GROVE DRIVE, PASADENA, CALIFORNIA
Operated by California Institute of Technology for the National Aeronautics & Space Administration

*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG*
DESIGN OF TRANSISTORIZED CIRCUITS FOR DIGITAL COMPUTERS

by Abraham I. Pressman, M.S.
(Digital Circuits Consultant for Radio Corporation of America)

The acknowledged classic in the digital computer design field. The acclaim it has already received from the engineering press throughout the world establishes its value as a "tool" to engineers concerned with transistorized circuitry design in the field of digital computers.

To be of the greatest general utility, the author employs "worst-case" design techniques. "Worst-Case" design is absolutely essential for digital-type circuits, as these are of the nature of all or none circuits, and single errors even over long periods of time cannot be tolerated. His design considerations permit circuits to work when all supply voltages, resistors, passive components, and all transistor parameters as well as diode parameters are simultaneously off their nominal values by the expected maximum tolerances.

Here's another engineering comment about the Pressman book: "... The book is well organized and written. The detailed treatment of particular circuits shows that the author appreciates practical circuit design problems and is able to convey this appreciation to the reader. This is an invaluable book to the beginner and the experienced designer will find much of interest in it." Reviewed for the AMERICAN INSTITUTE OF PHYSICS by Fred Goulding, Atomic Energy of Canada, Ltd.

Design of Transistorized Circuits for Digital Computers—
the book that makes digital computer circuit design easy.
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Though different brands may be made with similar materials and equipment, one brand of wire and cable will outlast, outperform all others. That brand is Hitemp.

Why? Because Hitemp has the greatest store of experience in the industry—two modern production facilities that are second to none—and more than one-fourth of its entire work force devoted solely to inspection and quality control.

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3. Tear out card with items circled. Fill out name and address, and drop in mail box. Fold back remaining card for future use. ED will process your card within 24 hours of receipt.
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### Notes

- For Change of Address:
  - Old Company Name

- New Company Name
  - I Do Design Work
  - I Supervise Design Work
  - I Do No Design Work

- Home Address
For your convenience
ELECTRONIC DESIGN
makes checking
READER-SERVICE CARD
easier with
FOLD-OUT CARDS

To use:

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Fold out card.

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Leave card folded out, and read magazine. No need to turn pages to reach card, or to tear out card until ready to mail. Circle to your heart's content.

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Announcing an advanced miniature tape recorder for airborne applications

Small: 3.97" diameter; 2.98" long.

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Backed by Borg-Warner. This all-new MR-21, a product of the newest division of the Borg-Warner industrial group, was created under a major new development program for advanced data gathering and control equipment design.

Engineering Details Available. A basic specification sheet on this new MR-21 is available—are you interested? Our Recorder Group is also ready to work with you on special applications and associated data handling systems.
The Most Trusted Name in Electronics

RCA-7801 Cermolox Tetrode Power Tube packs higher performance into a small package

Combining high power-sensitivity, high efficiency and very small size, the new RCA-7801 is especially intended for application in small, compact equipment.
A conduction-cooled ceramic-metal beam power tube, small as an acorn, the 7801 performs excellently as an af or rf power amplifier, oscillator, modulator or voltage regulator in missiles, satellites, mobile communications equipment, telemetering systems—wherever space is at a premium.
In continuous commercial service, the 7801 delivers:
- 3.2 watts CW power output at 3,000 Mc
- 15.0 watts CW power output at 1,200 Mc
- 27.0 watts CW power output at 400 Mc
A wide gold-plated copper cylindrical plate terminal assures high thermal and electrical conductivity. Heater operates at 12.6 volts 0.5 amp; a companion tube, RCA-7870, is exactly the same except that its heater operates at 6.3 volts 1.0 amp.

Revolutionary Cermolox Line—and What It Means To You
“Cermolox” designates RCA’s special line of beam power tetrodes with ceramic-metal construction and electrically-broached coaxial grids having perfect alignment. Advantages: High power output • High gain • High power sensitivity • Low driver power • Minimum screen current • Negligible grid emission • Exceptional strength • Small in size • Compact • High-temperature operation
For information on the 7801 or other Cermolox types for your new equipment designs, contact your RCA Field Representative. For technical bulletin on the 7801 write directly to Commercial Engineering, Section K-18-Q-1, RCA Electron Tube Division, Harrison, N.J.