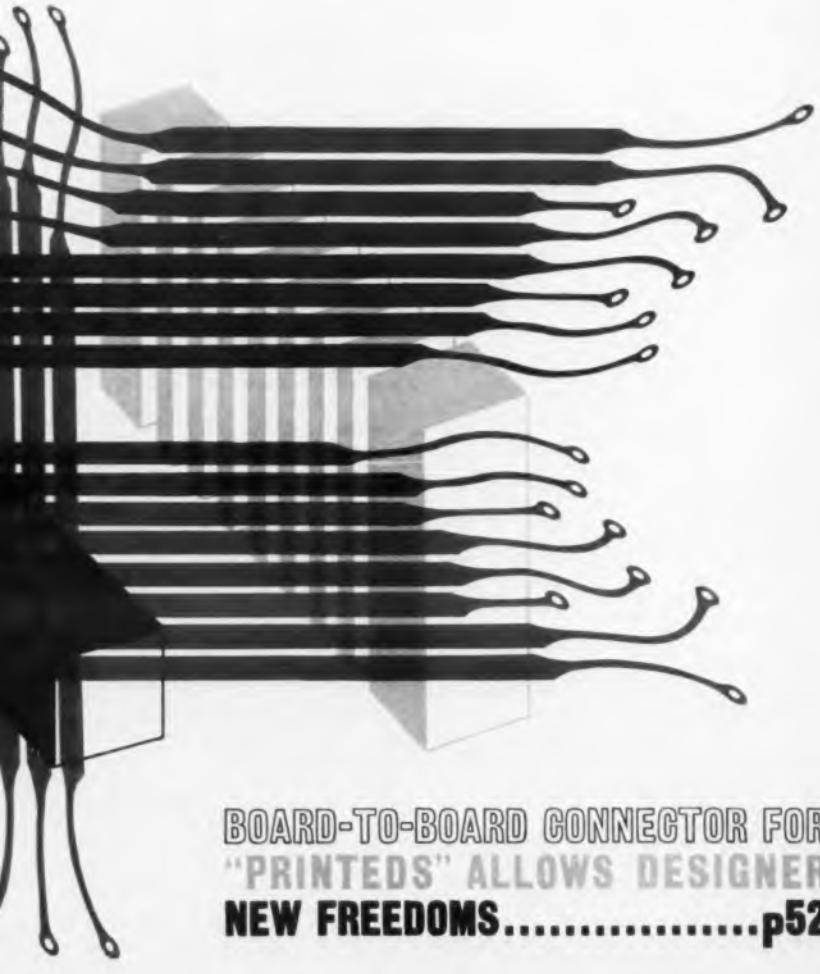
ELECTD

RONIC DESIGN



BOARD-TO-BOARD CONNECTOR FOR "PRINTEDS" ALLOWS DESIGNER NEW FREEDOMS.....p52

COVER: Tightly spaced assemblies of printed circuits can be configured in many complex relationships with a new board-to-board connector. ELECTRONIC DESIGN's art director shows two connectors joining three printed circuits. His spatial view eliminates the actual boards holding the circuits. The cross-sectional rendition of the connector's plastic block shows the beryllium-copper wires that make the electrical interconnections.

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 there 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-within-a-meeting—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.

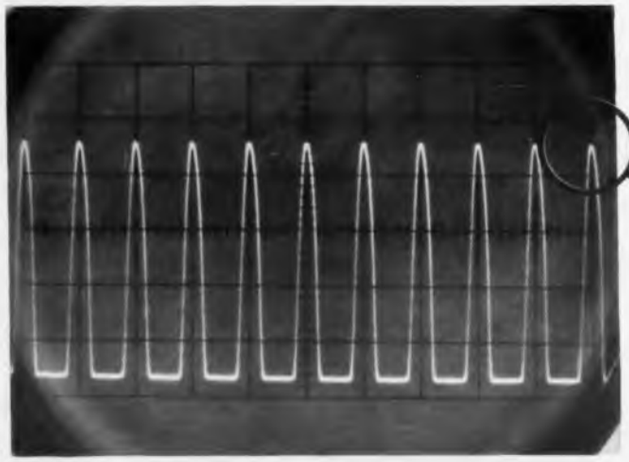
The coming merger talks found favor at the AIEE meeting. Heard at the convention were such remarks as: "If the merger goes through, technical developments will probably be a lot easier to keep up with."

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 AIEEIRE.

New standard of oscilloscope reading accuracy

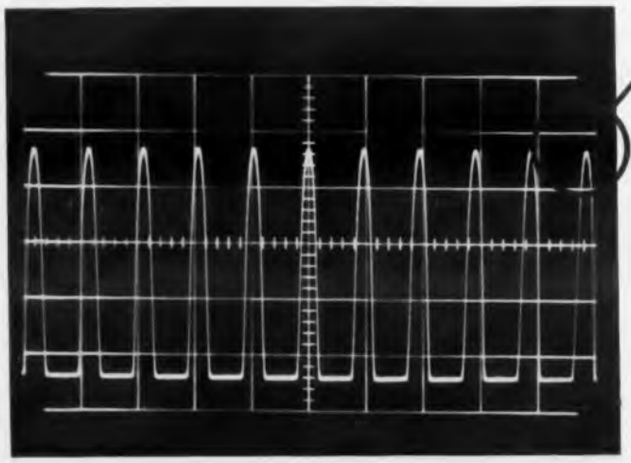
Revolutionary hp CRT'S

ELIMINATE SCOPE PARALLAX ERROR



NEW WAY!

Perfectly linear signal reads perfectly. Each wave peak appears, and is, precisely on proper graticule line.



ERROR-PRONE OLD WAY!

Identical signal on old-type cathode ray tube. Note apparent non-linearity caused by scope face parallax!

Turn the page

to see how hp does it... and read about the versatile new hp 120B 450 KC oscilloscope

Call your hp engineering representative today for data demonstration of these time-saving, precision, advanced instruments

Your hp representative is your headquarters for sales, service and parts on the industry's most complete-coverage instrument array. (*) indicates factory-level field repair stations.

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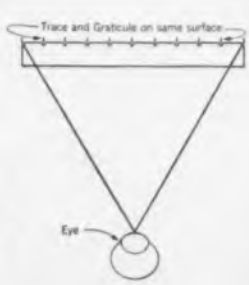
LIFT PAGE

New, no-parallax hp 12 easiest-to-use, surest-reading, 450 KC oscilloscope!

HERE'S HOW hp DOES IT!



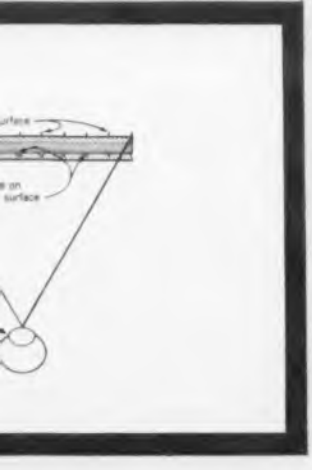
NEW WAY!

Exclusive hp development scribes calibrating graticule in identical inside plane with trace. No layers of glass, filter or plastic optically alter perfect reading. What you see —IS! Parallax is eliminated at last!

OLD WAY!

Conventional oscilloscopes have calibrating graticule a full ¼ inch in front of trace. Between are optically confusing plastic graticule body, filter, and CRT envelope end. Parallax is inescapable; errors up to 5% are possible.

120B...



This new hp 120B Oscilloscope combines probably more actual measuring help and desirable features than any 450 KC scope ever produced.

Not only is reading error from parallax ended and not only are distracting reflections eliminated (the CRT has a new, non-reflecting face developed by hp); but you also have a genuinely unique array of electrical and convenience features for measurements from dc to 450 KC.

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.

Accessories available:

- hp AC-83A Viewing Hood; face-fitting molded rubber, $5.00
- hp 196A Oscilloscope Camera, $440.00
- hp 456A AC Current Probe, $190.00
- hp AC-21J Probe, $9.00

Price:

hp Model 120B Oscilloscope, $475.00
Supplied with rack-mounting hardware.

Data subject to change without notice. Prices f.o.b. factory.

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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.

SPECIFICATIONS

SWEEP

Sweep Range: 1 μsec/cm to at least 0.5 sec/cm. 15 calibrated sweeps, accurate within ±5%, in a 1, 2, 5, 10 sequence, 5 μsec/cm to 200 msec/cm. Vernier for continuous adjustment of sweep time between calibrated steps, extends slowest sweep to at least 0.5 sec/cm.

Sweep Expand: x5 sweep expansion usable on all ranges, expands fastest sweep to 1 μsec/cm, accuracy ±10%.

Synchronization: Automatic, 50 cps to 450 KC.

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 −10 to +10 v.

VERTICAL AMPLIFIER

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.

Internal Calibrator: Calibrating signal automatically connected to vertical amplifier for standardizing of gain, accuracy ±2%.

Input Impedance: 1 megohm, approx. 50 pf shunt.

Balanced Input: On 10 mv/cm range. Input impedance 2 megohms shunted by approx. 25 pf.

Common Mode Rejection: At least 40 db, should not exceed ±3 volts peak.

Phase Shift: Vertical and horizontal amplifiers have same phase characteristics within ±2° to 100 KC when verniers are in CAL.

HORIZONTAL AMPLIFIER

Bandwidth: DC coupled: dc to 450 KC; ac coupled: 2 cps to 450 KC.

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.

Input Impedance: 1 megohm, nominal, shunted by approx. 100 pf.

GENERAL

Internal Graticule: 10 cm x 10 cm marked in cm squares.

CONTENTS

November 8, 1961
Vol. 9 Number 23

Electronic Design

Hayden Publishing Company, Inc.
850 Third Ave., New York 22, N.Y.

Early Birds—Attention!

"Sure, I have an interesting approach to a design problem. But I just don't have the patience or desire to spend several weekends preparing an article."

This is the lament heard frequently by ELECTRONIC DESIGN editors as they discuss potential articles with engineers during plant visits.

To help engineers past the mental block to writing assignments, ELECTRONIC DESIGN will present a writing seminar in conjunction with the NEREM conference in Boston.

Edward E. Grazda, editor of ELECTRONIC DESIGN, will discuss "Let's Write an Article Together." The time and place: Nov. 15, at 8 am, in the Cleveland Plaza suite of Boston's Somerset Hotel—the convention headquarters. All NEREM visitors are invited. It will be a rewarding session.

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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 Haavind
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:

- Producible planar-silicon transistors, capable of operating to over 2 Gc, and of switching with less then 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 as 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.

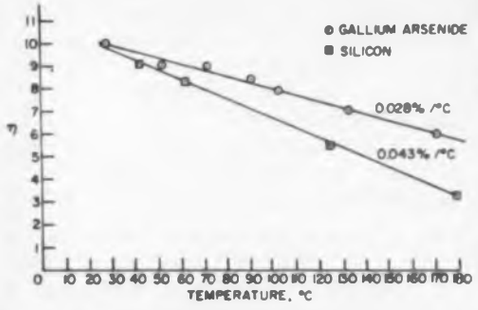
Another important use is in down converters because of the inherent low noise of the devices in this application. Initial work attempted to get optimum values for all parameters at once, but resulted in poor stability. Excellent stability has been achieved, however, by sacrificing gain and operating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

CIRCLE 5 ON READER-SERVICE CARD ▶

NEWS

Electron Devices . . .

(continued from p 5)

An in-flight comparison of these devices with silicon cells will be made next year on the Relay communications satellite, which will be orbited in the Van Allen radiation belts. The chief disadvantages of these devices at present is the expense in obtaining gallium and the difficulty in producing suitable crystals, according to an RCA spokesman.

High-speed driving of memory core arrays has been achieved using an array of silicon-diode junctions by switching with an electron beam, Dr. A. V. Brown of International Business Machines Corp. reported. Higher output currents and shorter switching times than those obtained with present transistor drivers were achieved, he said.

A new type magnetron using an improved anode structure, reported by S-F-D Laboratories Inc., was said to have achieved X-band operation at over 50 per cent efficiency, delivering 1.5-megawatt peak and 750-w average power. The device is called the CEM Coaxial Magnetron.

Information-retrieval systems can make use of the new microspot crt reported by Kurt Schlesinger, consultant to GE's Cathode

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. Godycki, D. P. Foote and I. Weiman of Electro-Optical Systems Inc. becuase 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_{max} 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 imcoming 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.

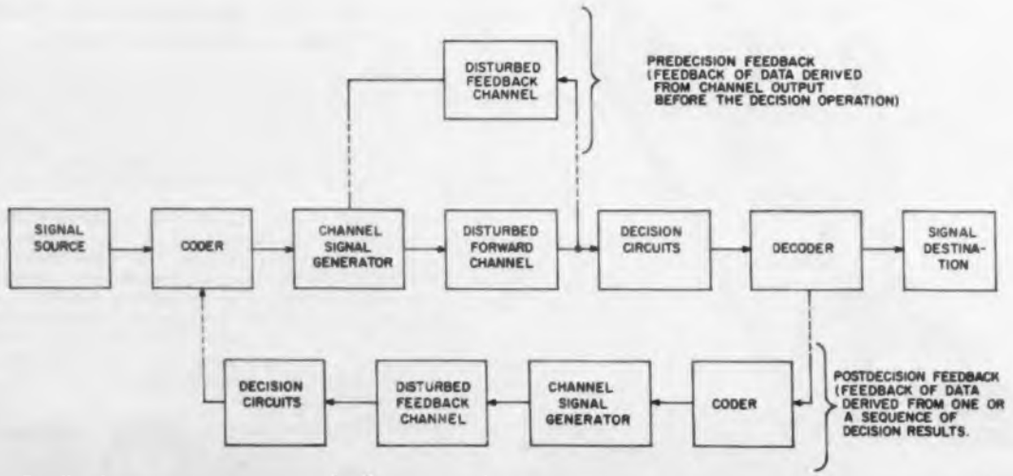
Closed-Loop Adaption Due to Feedback Channel

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.

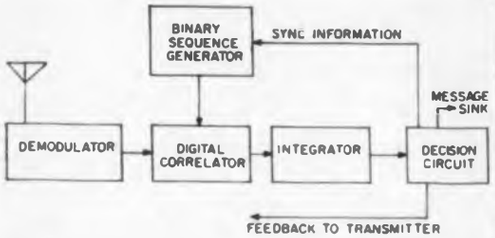
The generator is designed to produce a continuous stream of binary digits that occur with about equal probability and have a repetition period that is long compared with the period of a message symbol. This causes the bandwidth of the phase-modulated signal to approximate the digit rate of the binary-sequence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



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.

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



Receiver of a breadboarded postdecision feedback adaptive communication system, in which the feedback channel carries information that varies the amount of redundance 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 refernce is supplied by the signal itself. This is done by squaring the input signal to remove the phase modulation, using narrow-band 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-

CIRCLE 8 ON READER-SERVICE CARD ➤

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

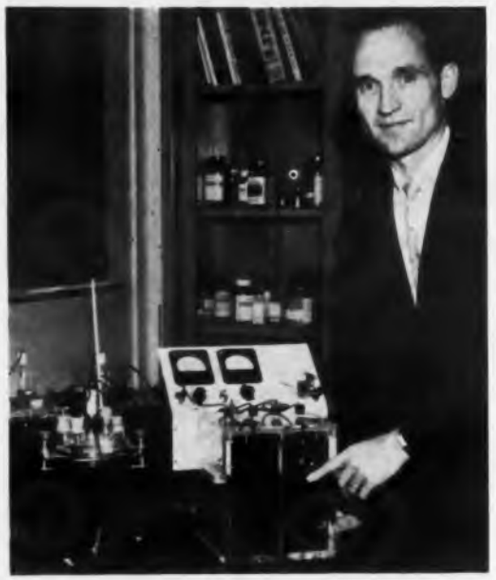
Conversion of "life-energy" into usable electric power has gone far beyond the test-tube stage, according to a company that has had such conversion devices—known as bio-power units—in operation for more than a year.

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



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

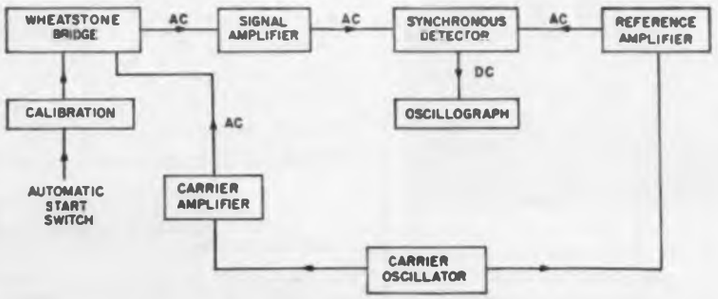
Short leg brace is instrumented with strain gages oriented to permit analysis of the various forces involved in walking with a brace.

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.

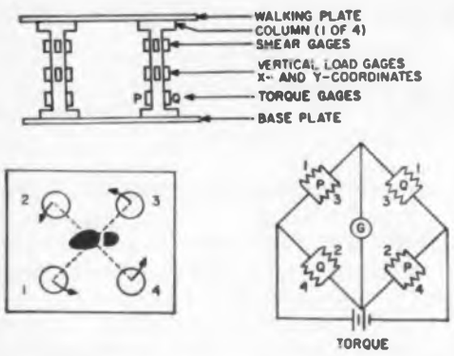
In the past, according to Dr. Edward Peizer, who heads the NYU research program, braces for the legs and lower body have been built by skilled craftsmen on the basis of experience and common sense. Experimental data on such factors as the forces involved in walking, the effects of varying brace construction, 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



Conventional Wheatstone-bridge circuits, fed by a 1,000-cycle oscillator, are used to sense forces in both the force table and the leg braces being used in NYU studies.



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

NEWS

Leg Braces . . .

(continued from p 13)

measuring pressure between brace bands and the body.

- Wireless data transmitters so that test subjects do not have to carry a bundle of wires with them.
- More sensitive strain gages (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.

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 $14 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.

0001

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.

0010

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.

0011

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 Chinese 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.

0100

Design work on a high-powered vlf radio transmitter for fleet communications in the Pacific has been awarded by the Navy to Continental 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.

0101

Ground-based optical techniques for detection 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 observation of the scattering of sunlight by the debris which results from the nuclear blast.

0110

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

0111

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.

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 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-discriminator 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 focussing 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, flash over, 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 circuitry are inside a copper-screen enclosure to reduce interference effects.

WASHINGTON REPORT

Wilbur H. Baldinger
Washington Editor

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.

(Advertisement)

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 keyaway eliminate the possibility of mismating.

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.

CIRCLE 21 ON READER-SERVICE CARD

COAXIAL *feed-thru* HYFEN

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

61-17

NORWALK, CONNECT. BICC-BURNDY Ltd. Prescot, Lancs., England In Europe: Malines, Belgium TORONTO, CANADA

CIRCLE 22 ON READER-SERVICE CARD

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 Dicke-type 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.

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.

NEWS

Designers' Datebook

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November

12-16 Phoenix — 7th Annual Conference on Magnetism and Magnetic Materials; Hotel Westward Ho; IRE, AIEE, AI Phys., ONR, AIME.

13-14 Boston — Electrically Exploded Wires Conference; Kenmore Hotel; Air Force Cambridge Research Laboratories.

14 Kansas City — Electronics Systems Reliability Symposium; Linda Hall Library Auditorium.

14-16 Boston — NEREM Northeast Electronics Research and Engineering Meeting); Somerset Hotel and Commonwealth Armory; IRE.

26-Dec. 1 New York — Mechanical Engineers' Winter Meeting; Statler-Hilton Hotel; ASME.

30-Dec. 1 Minneapolis — 12th National Conference on Vehicular Communications, Radison Hotel; PGVC.

December

12-14 Washington — Eastern Joint Computer Conference; Sheraton Park Hotel; IRE, AIEE, ACM.

26-31 Denver — Annual Meeting and Exposition of Science and Industry; Hilton Hotel; AAAS.

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.

CIRCLE 26 ON READER-SERVICE CARD ▶

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.
Halhen Widex, Inc.
Johnston Hearing Aid & Electronics, Inc.
Maico Electronics, Inc.
The Microtone Company
E. A. Myers & Sons, Inc.
Otarion Listener Corp.
Qualitone Company, Inc.
Sonotone Corp.
Telex, Inc.
Unex Laboratories
Vari Electronics, Inc.

8-61-E

ALLEN-BRADLEY

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY
ELECTRONIC COMPONENTS

Non-Linear Systems, Inc. designs first digital voltmeter to satisfy critical standards for missile work

Digital voltmeters — originated by NLS — permit rapid and accurate voltage measurements. New Series 20 unit — with one plug-in decade board removed — shows the use of Allen-Bradley fixed resistors.

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.

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QUALITY
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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 videotaped 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.

◀ CIRCLE 26 ON READER-SERVICE CARD

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.

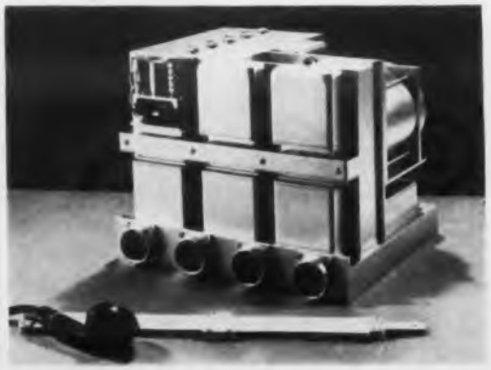
The computer (L-70) was developed by Librascope Div. of General Precision, Inc., Glendale, Calif. It is a follow-on design of Librascope's Centaur guidance computer and, at 19 lb, weighs only half as much as its parent model.

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.

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.

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 10^7 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.

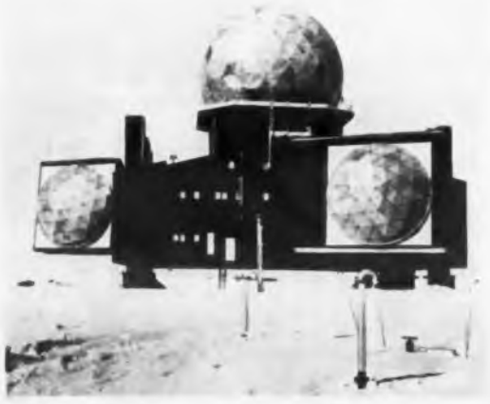
A resistance-temperature curve was determined by calibration at several constant-temperature points. Various temperatures were obtained by resistance heating of the loop. A field was applied to the emitter and a nulling circuit was used to measure the current variation with changes in temperature. The 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.

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.

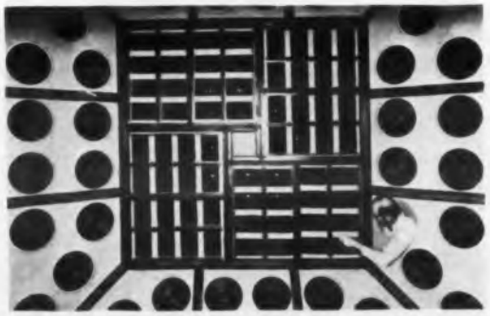
With equipment coded to simulate the many functions of a missile, program tape is run through a typical mission profile. By this direct simulation, using elements of the actual flight-control and guidance equipment of the Minuteman, scientists at Autonetics can locate a defect and thereby prevent costly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

SPERRY ELECTRONIC TUBE DIVISION

microwave memo

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 broadband 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.

VERIFIED RELIABILITY

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.

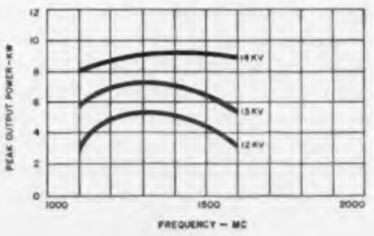
Place your order with your Cain & Company representative. His phone number appears in the adjacent column. Tubes are available within 30 days after receipt of order.

FREE TECHNICAL INFORMATION on the Sperry line of high-power pulsed traveling wave tubes may be obtained by writing to Sec. 504, Sperry Electronic Tube Division, Gainesville, Florida.

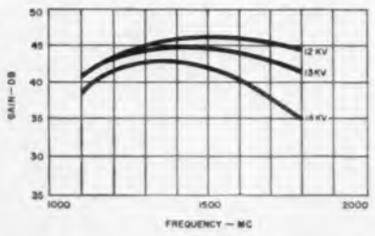
V BAND CAPABILITY

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.

FACTORY ALIGNMENT of a Sperry TWT within its focusing solenoid greatly simplifies field maintenance. Once this operation has been performed by a skilled Sperry technician, the assembly is self-aligning.



Typical saturated power output vs. frequency for a pulsed Sperry TWT.



Typical small signal gain vs. frequency for a pulsed Sperry TWT.

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SPERRY ELECTRONIC TUBE DIVISION
SPERRY RAND CORPORATION

CIRCLE 35 ON READER-SERVICE CARD

EDITORIAL

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. Before 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 spectaculars, 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.

Karl I. Nordling
Burroughs Laboratories*
Burroughs Corp.
Paoli, Pa.

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:

$$A_v = \frac{1}{1 + \frac{r_b}{Z_L}(1 - \alpha)} \quad (1)$$

$$Z_{in} = r_b + \frac{r_e + Z_L}{1 - \alpha} \quad (2)$$

$$Z_{out} = r_b + (r_e + Z_g)(1 - \alpha) \quad (3)$$

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

$$Z_g = R_g + j\omega L_g \quad (4)$$

$$Z_L = \frac{R_L}{1 + j\omega R_L C_L} \quad (5)$$

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

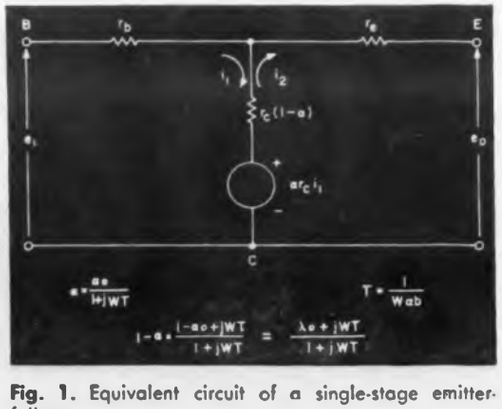

Fig. 1. Equivalent circuit of a single-stage emitter-follower.

$$Z_{in} = R_1 - jX_1 \quad (6)$$

where the real part may be written[1]

$$R_1 = r_b + \frac{R_L\left[\lambda_0 + \omega^2 T^2\left(1 - \frac{\alpha_0 R_L C_L}{T}\right)\right]}{\lambda_0^2 + \omega^2 T^2(1 + \omega^2 R_L^2 C_L^2)} + \frac{(\lambda_0 + \omega^2 T^2) r_e}{\lambda_0^2 + \omega^2 T^2} \quad (7)$$

where $\lambda_0 = 1 - \alpha_0$.

The second term contains a negative term, $\alpha_0 R_L C_L / T$, 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.[1]

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-

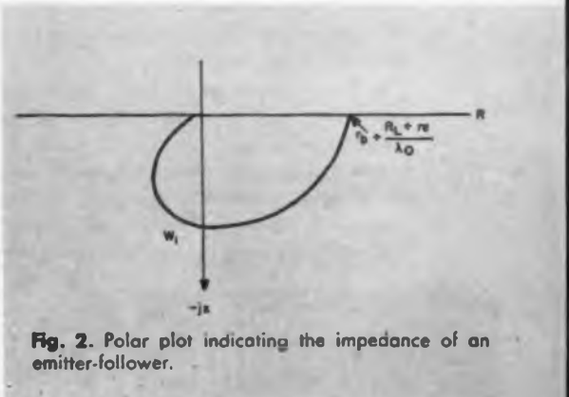

Fig. 2. Polar plot indicating the impedance of an emitter-follower.

*Now with Beckman Instruments, Inc., Beckman Systems Div., Palo Alto, Calif.

ative resistance (above ω_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)

$$A(S) = \frac{R_L(1 + ST)}{K_1S^3 + K_2S^2 + K_3S + K_4} \quad (8)$$

where:

$$K_1 = TR_LC_LL_g$$
$$K_2 = TL_g + R_LC_L[T(R_g + r_b) + \lambda_0 L_g]$$
$$K_3 = T(R_L + R_g + r_b) + \lambda_0 [L_g + (R_g + r_b)R_LC_L] \quad (9)$$
$$K_4 = R_L + \lambda_0(R_g + r_b)$$

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_3
S^2	K_2	K_4
S^1	$\frac{K_2K_3 - K_1K_4}{K_2}$	0
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.

$$K_2K_3 - K_1K_4 = 0 \quad (10)$$

The locus of the solutions to this equation in L_g and C_L is of the form shown in Fig. 3.

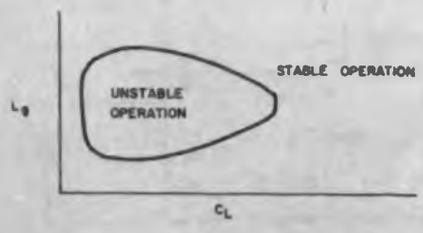

Fig. 3. Locus of solutions to the equation defining the stability of an emitter-follower configuration.

Any point in this figure corresponds to a particular combination of values for L_g 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_g 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

$r_b = 10\Omega$, $T = 1.9 \times 10^{-7}$ sec, $\alpha_0 = 0.988$

$R_L = 10\Omega$, C_L and L_g : variable.

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

$$Z_{out} = r_e + (r_b + R_g)(\lambda_0 + \omega^2T^2) + j\omega T\alpha_0(r_b + R_g) \quad (11)$$

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

$$R_0 = r_e + \alpha_0(r_b + R_g)$$
$$L_0 = \alpha_0 T(r_b + R_g)$$

This approximation is quite good for values of ωT up to 0.1, as can be seen from Fig. 6,

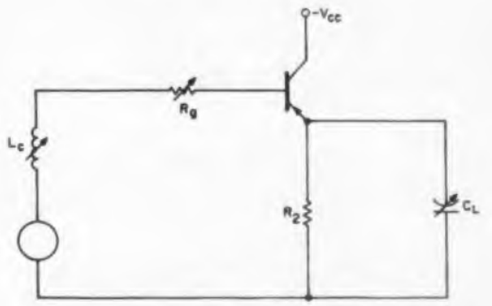

Fig. 4. Schematic of an emitter-follower test circuit using a 2N553.

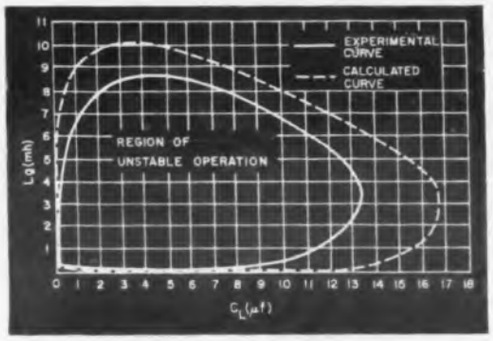

Fig. 5. Experimental and calculated curves for the circuit shown in Fig. 4.

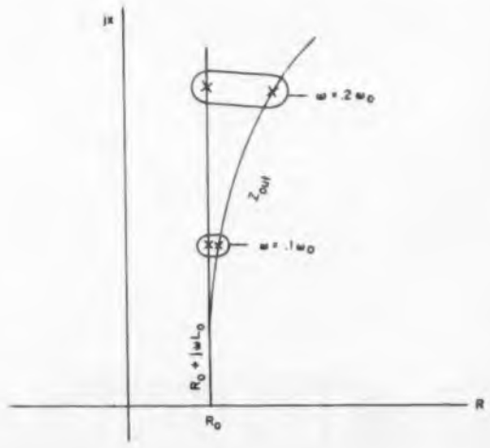

Fig. 6. Plot of actual circuit output impedance compared to $(R_0 + j\omega L_0)$ indicates reasonable similarity up to $\omega = 0.1\ \omega_0$.

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

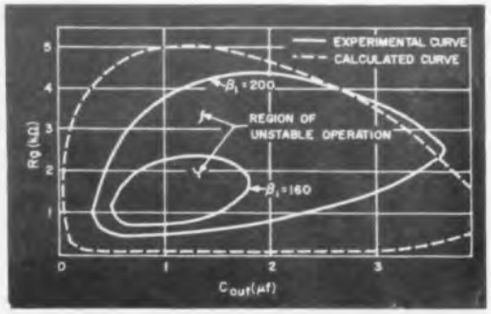

Fig. 7. Locus of instability for a two-stage emitter-follower circuit.

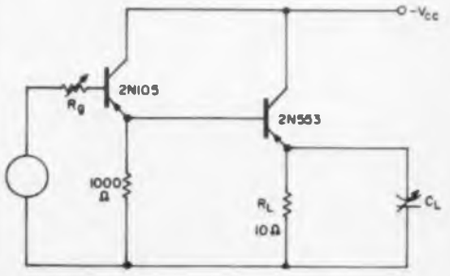

Fig. 8. Test circuit of the two-stage emitter-follower used to obtain the experimental data of Fig. 7.

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

As indicated by Eq. 11, varying R_g in this case has the same effect as varying L_g in the single-stage case, and varying β_1 has the inverse effect of varying r_b 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 α_ω, R_f, C_L, and T in Eq. 7 so that $\alpha_\omega RC \leq T$. This is overdesigning appreciably, since it results in a total series resistance of $r_b + \lambda_1 R_f$ 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_2, becomes

$$e_2 = \frac{e_1 Z_{in}}{Z_{in} - \dfrac{Z_1 Z_{in}}{Z_f}(K - 1) + Z_1} \qquad (12)$$

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

Letting $Z_1 = R_1$ and $Z_f = 1/j\omega C_f$ the resulting output impedance

$$Z_{out} = r_e + \omega^2 T^2 \left(r_b + \frac{\omega^2 T \beta^2 R_1 R_1 C_f}{1 + \omega^2 T^2 \beta^2} \right) + j\omega (r_b T + R_1 R_1 C_f) \qquad (13)$$

which for $\omega = 10^6$, $T = 10^{-7}$, $\beta = 100$ becomes

$$Z_{out} = r_e - 0.01\, r_b + 10^3 R_1 R_1 C_f + j(0.1 r_b + 10^7 R_1 R_1 C_f) \qquad (14)$$

According to this typical example, the amount of damping can easily be controlled by manipulation of R_1, R_1, and C_f.

A way to mechanize the second approach

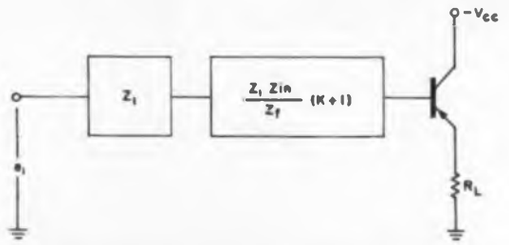

Fig. 10. Equivalent input circuit of an emitter-follower provided with feedback.

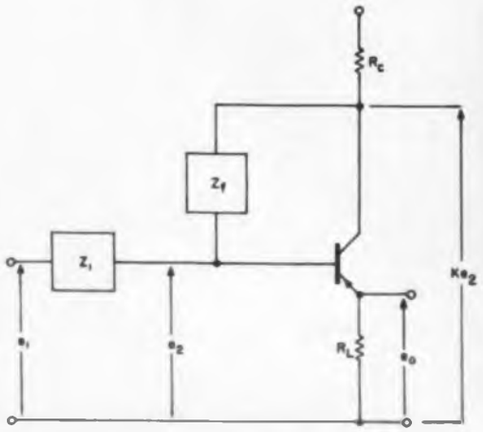

Fig. 9. Feedback around the driver stage may be used to stabilize an emitter-follower circuit.

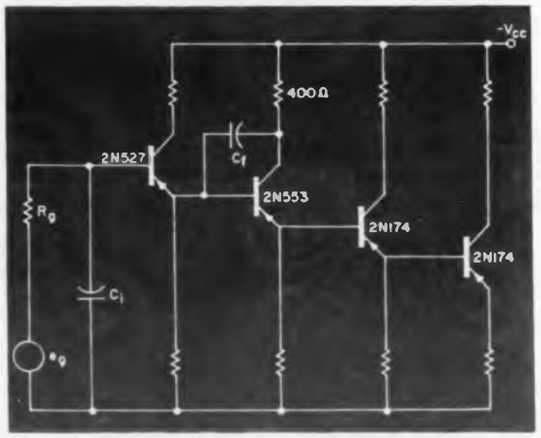

Fig. 11. The design of four emitter-followers, used in a voltage regulator, is outlined to demonstrate the stabilization techniques.

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

$$Z_{out} = r_e + \frac{(\lambda_o + \omega^2T^2)(r_b + R_g) + \omega^2R_g^2C_g(\alpha_o T + \lambda_o r_b C_g)}{1 + \omega^2[R_g^2C_g^2(1 + \omega^2T^2) + T^2]} + j\omega T\alpha_o \frac{r_b(1 + \omega^2R_g^2C_g^2) + R_g\left[1 - \frac{R_gC_g}{\alpha_o T}(\omega^2T^2 + \lambda_o)\right]}{1 + \omega^2[R_g^2C_g^2(1 + \omega^2T^2) + T^2]} \quad (15)$$

Letting the reactive part equal zero and solving for C_g

$$C_{g1,2} = \frac{\lambda_o + \omega^2T^2 \pm \sqrt{\omega^2T^2\left[2\lambda_o + \omega^2T^2 - \frac{4r_b(r_b + R_g)}{R_g^2}\right] + \lambda_o^2}}{2\omega^2T\, r_b} \quad (16)$$

To resolve the ambiguity of this equation, consider the two extreme values of C_g, zero and infinity. It is already known that with zero capacitance, the reactive part is positive; it is in fact $\omega T\alpha_o(r_b + R_g)/1 + \omega^2T^2$ as inspection of Eq. 15 shows. For values of C_g approaching infinity, the reactive part approaches $\omega^2T\alpha_o r_b R_g^2 C_g^2$. Thus, values of C_g between C_{g1} and C_{g2} result in negative values for the reactive part. The value of ω to be used in Eq. 16 is the upper end of the negative resistance range of the input impedance.

Another mechanization of this process is selection of transistor parameters such that the resonant frequency falls in a range where the circuit is stable. It was seen in Fig. 6 that the area of instability is smaller for a lower value of the driving stage beta. For still lower values of β_1, (100 or less), the amplifier was stable. A conclusion to this effect can be drawn from Eq. 11, where the real part, R_o, is seen to increase with increasing λ_o, which corresponds to decreasing β. Also, the reactive part, ωL_o, 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

$$\lambda_0 = 0.008 \text{ (min) } 0.014 \text{ (max)}$$
$$T = 2.5 \times 10^{-8}\ 1 \times 10^{-7}$$
$$r_b = 30\ \Omega$$
$$R_g = 4{,}000\ \Omega$$

we obtain maximum 0.0015 μf $< C_i <$ 0.17 μf using the maximum values of λ_0 and T and 0.013 μf $< C_i <$ 10 μf using the minimum values of λ_0 and T. Thus, the range for C_i is 0.013 μf $< C_i <$ 0.17 μf. A value of 0.1 μf was chosen as being roughly in the center of the range.

To find the value of the feedback capacitor, solve for R_eC_f in the expression

$$\frac{R_1R_eC_f \times \omega^2T^2\beta^2}{1 + \omega^2T^2\beta^2} = R_0 \qquad (17)$$

This expression results from setting the real part of the equation for Z_{out} (Eq. 13) equal to R_0, which is the required value of resistance in the input circuit of the following stage. Resistance r_e is assumed to be so small as to be negligible.

The worst-case values for T and β are

$T = 0.8 \times 10^{-7}$

$\beta = 40$

The maximum value of R_0 was found to be between 10 and 100 ohms at $\omega \doteq 10^6$. These values were obtained by measurements; they could also be found by computing R_1 versus ω in Eq. 7. The output impedance of the previous stage is assumed to be largely resistive (because of the capacitance across the input) and is roughly equal to the r_e of the transistor, which is typically about 3 ohms.

Substituting the following values in Eq. 17:

$T = 0.8 \times 10^{-7}$, $\beta = 40$, $R_1 = 3$, $R_0 = 100$ ohms,

$\omega = 10^6$ and solving for R_eC_f

$$R_eC_f \doteq 4.4 \times 10^{-4}$$

R_e is 400 ohms as dictated by other considerations, which would make $C_f \doteq 1$ μf. By extensive testing, it was found that an optimum value for C_f was about 0.1 μf. This large discrepancy is apparently due to the assumption that Z_{out} of the previous stage consists merely of r_e. Better results would be obtained if Eq. 15 were used to calculate Z_{out} for the appropriate value of ω. ■ ■

Acknowledgements

The author wishes to acknowledge the contributions to this analysis made by William Allen and Richard Fussell.

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.

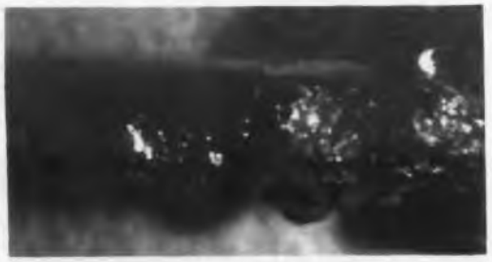

Fig. 1. Gold-plating causes cold-solder joints because it dissolves in the solder and raises the solder's melting point. Here 60/40 solder has been flowed onto a gold-clad nickel wire (from the right) with a 600 F soldering iron. The heavy 0.002-in. thick gold cladding has alloyed with the solder, freezing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

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.

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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

What Lead Material? For Soldering? For Soldering and Welding?

A promising component lead material for soldering is Kovar with a thin 0.000050-in. coating of 24-karat gold applied immediately after drawing to keep the Kovar from oxidizing during storage.

For a universal, soldering-welding, lead, two promising candidates are: electrolytically tin-coated cadmium or phosphor bronze and steel wire with copper cladding. In addition to solderability considerations, universal leads must have sufficient electrical resistance and low enough thermal conductivity to permit the weld temperatures to build up.

them, even by wiping while the solder is melted).

Supplies of this flux, and solder with this flux as a core, are readily available. Residues of this flux *must* be removed after solder coating the nickel lead wire. Therefore, this type of flux and solder should not be used on assemblies of parts to printed-circuit boards, as they cannot safely be rinsed to remove surplus flux after soldering.

A coating of solder properly alloyed to the lead wire is the most reliable preparation for good solderability. Gold-plated leads should be avoided unless a "gilded dress-up" is the chief reason for the gold. The solder coating also is more solderable than a coating of pure tin, if storage for more than a few days is likely.

Wherever possible, it is desirable to use leads made of material which is readily solderable without any sort of coating. There are several copper-nickel and copper-nickel-zinc alloys that remain easily solderable after long storage, are ductile, and have better endurance than pure copper under conditions of twisting or bending. These alloys, however, have higher electrical resistivity than copper. ■ ■

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.

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CLOSE 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-

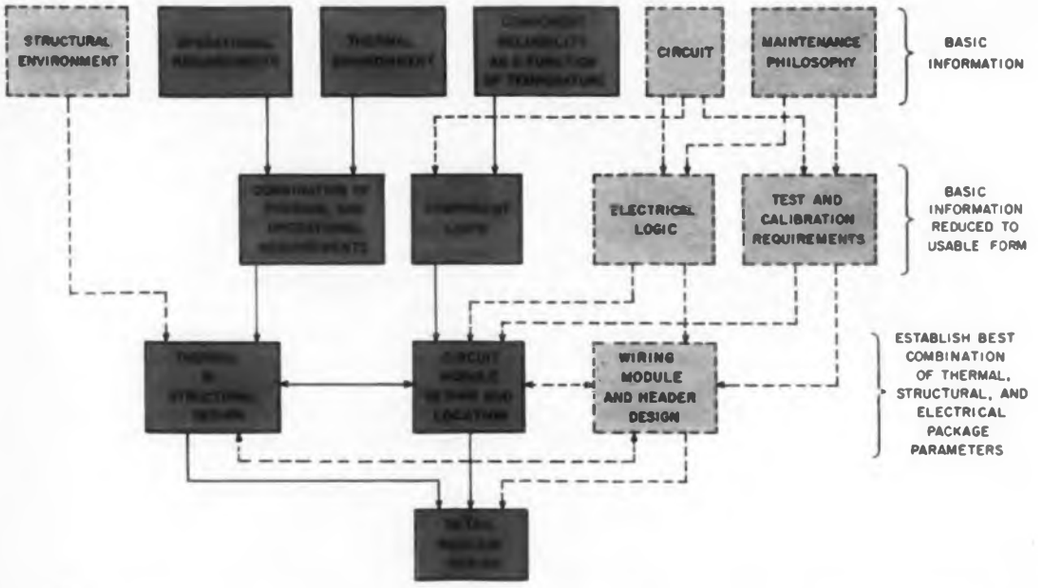

Fig. 1. Information flow chart showing the relationship between package demands and thermal considerations.

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 w' ich deforms under the compressive load ap. . d 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

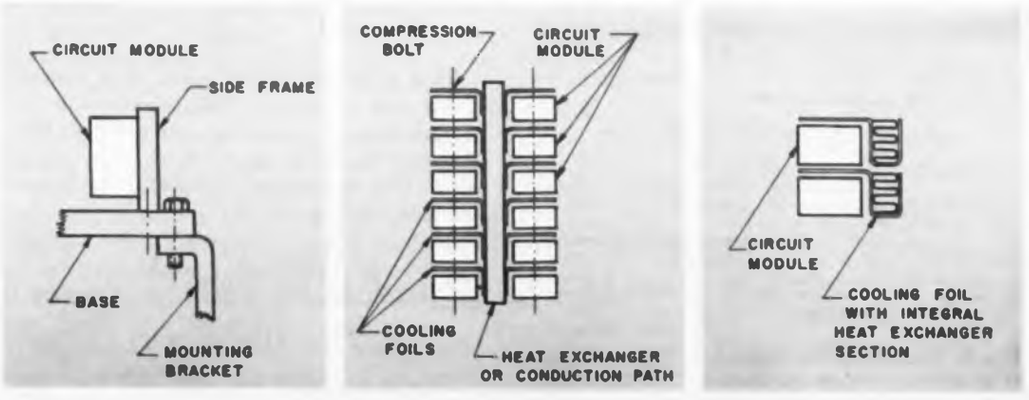

Fig. 2. Various methods of removing heat from a circuit module involve the transfer of heat through a plate or foil to a heat exchanger.

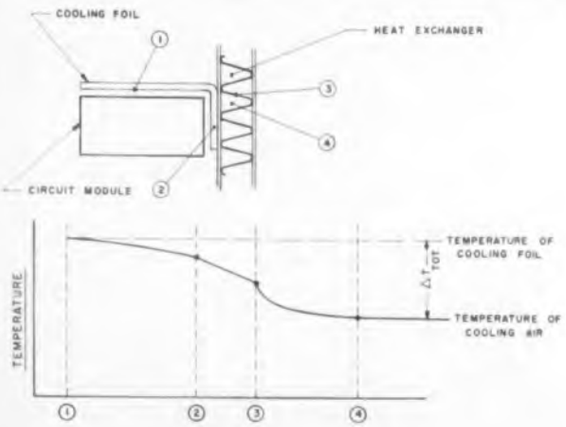

Fig. 3. Typical temperature gradient along a heat path.

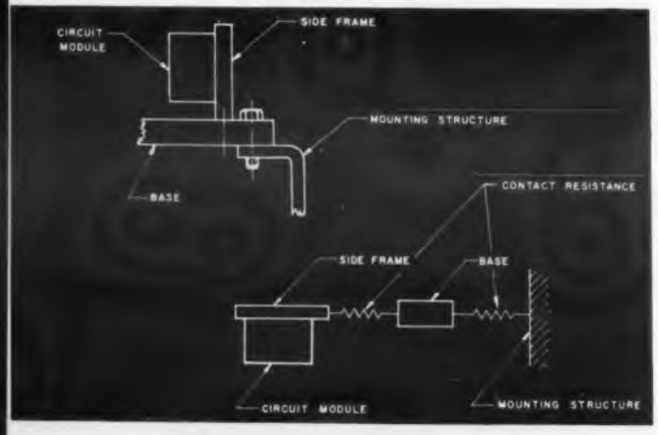

Fig. 4. Theoretical model and conduction path used in transient temperature calculations.

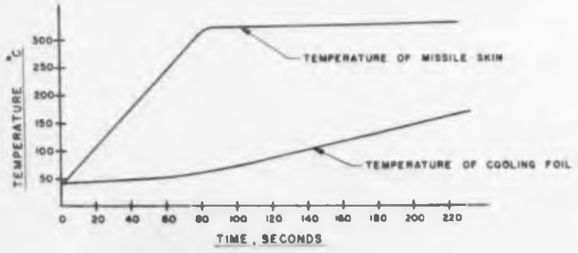

Fig. 5. Temperature-time response at the cooling fin of an assembly mounted to the inside of a missile skin.

basis). This statement is verified by the relationship of thermal conductivity and density for aluminum vs copper:

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

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

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[1] 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:

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

where

Δt = max temperature difference along length of cooling foil
$\dot{q}$ = heat dissipation per unit volume of cooling foil
L = length of cooling foil
K = 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:

$$\Delta t_{max} = \frac{\dfrac{(3.413)\,(0.5)}{(2.5)\,(1.5)\,(0.020)}\,(2.5)^2}{(2)\,\dfrac{(100)}{(12)}} = 8.5 \text{ F}$$

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:

$$\Delta t_{max} = \frac{\dfrac{(3.413)\,(0.75)}{(3.5)\;(1)\;(0.020)}\,(3.5)^2}{(2)\,\dfrac{(100)}{(12)}} = 26.9 \text{ F}$$

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"[2]. 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[3] 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[1*] 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

Materials	Specific Gravity	Thermal Conductivity BTU/hr/ft²/F/in	Volume Resistivity ohm-cm
Eccofoam Hi K 625D (1)	0.37	0.36	1×10^{16}
Stycast 1095 (1)	0.8	0.8	1×10^{15}
Stycast 1231 (1)	1.4	3.1	1×10^{12}
P33 (2)	2.5	12.3	1×10^{14}
Aluminum	2.8	1.100	2.8×10^{-6}

References:
1. Emerson & Cuming Tech. Bulletins Series 6-2 and 7-2.
2. Bacon Industries Tech. Data Sheet P33.

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 pursual 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

Δt = 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

$\frac{K}{X}$ = required thermal path

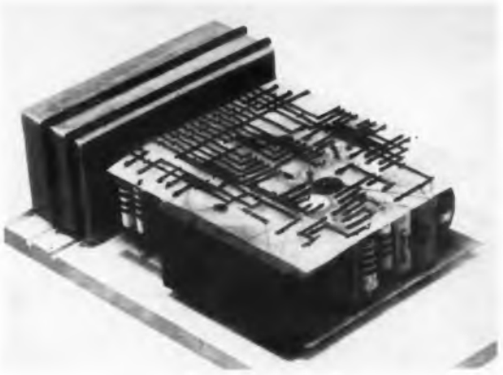

Fig. 6. Assembled circuit module (before potting) showing metallic heat conductor to transfer heat from high-dissipation components.

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. ■ ■

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3. Compact Heat Exchangers, W. M. Kays and A. L. Landon, National Press, 1955.
4. "Cooling Electronic Equipment," ELECTRONIC DESIGN, Oct. 15, 1957.

A Signal Level Monitor For Go-No-Go Testing

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.

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 preselected 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 pnp-npn 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_{cbo}. 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

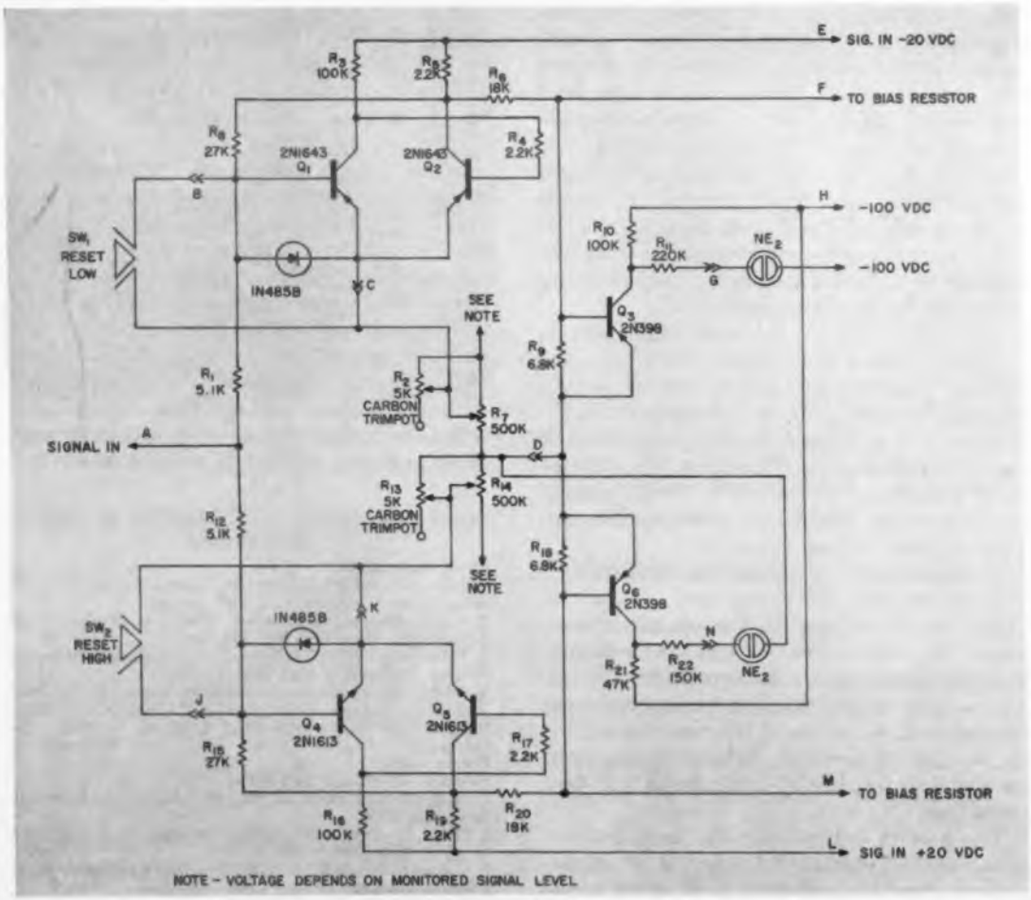


Fig. 1. Reactron monitoring circuit consists of two regenerative, complementary transistor trigger circuits.

Table 1. Specifications for Reactron* Monitoring Circuit.

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

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

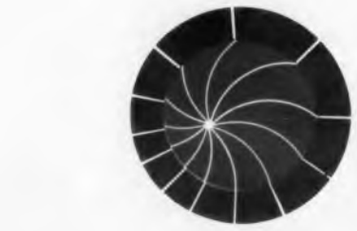
The operation of both the npn and pnp sections of the circuit is identical except for polarity. Thus, a description of the circuit's operation can be concerned mainly with the pnp side.

The input transistor *Q1* is biased to cutoff 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-

*Initial development of the reactron was completed at Autonetics, a division of North American Aviation.



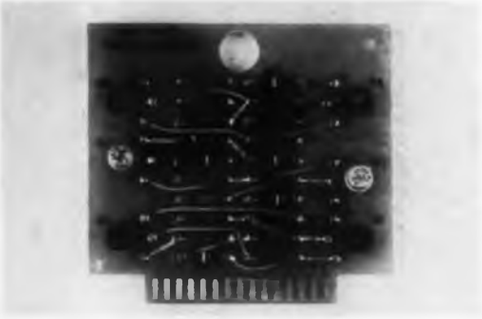


Fig. 2. Complete circuit can be laid out on etched-circuit, plug-in card.

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.

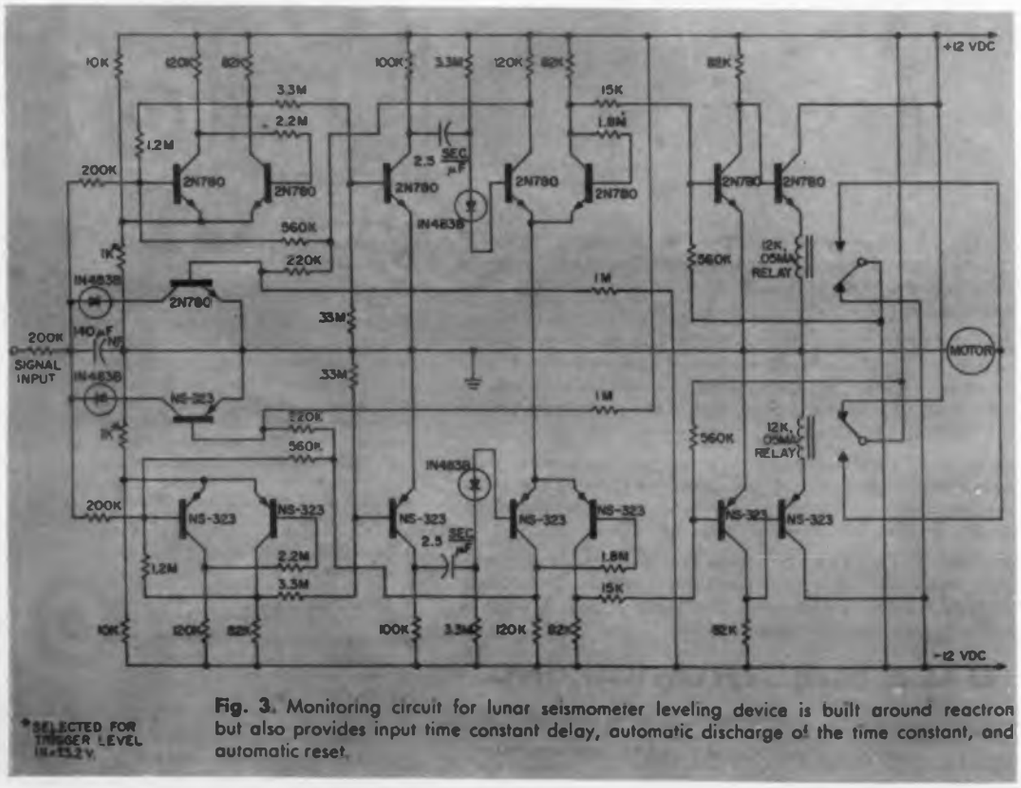


Fig. 3. Monitoring circuit for lunar seismometer leveling device is built around reactron but also provides input time constant delay, automatic discharge of the time constant, and automatic reset.

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 (V_{ce} 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

result is an almost infinite input impedance over limited signal swings.

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 *R3*, *R5*, and *R4*, *R8*), extreme stability results. The normal procedure in design would be to select the collector load of the reaction transistor (*Q2* or *Q5*) to be of optimum value for the current desired. Its value is then multiplied by 50 to find the load for *Q1* or *Q4*. The value of *R4* or *R17*, the base feedback resistors, would then be: $R_4 = R_3\ (\beta - 50)$ where beta is greater than 50. The opposite feedback resistor (*R8* or *R15*) would then be $R_8 = 12\ (R_4)$ and $R_{15} = 12\ (R_{17})$.

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:

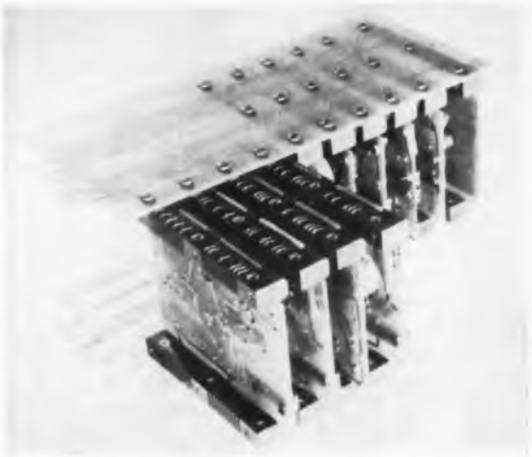
$R_7 = 0.25\ (R_5)$ and $R_2 = 10\ (R_7)$.

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 Minuteman Missile monitored approximately 60 signals derived from a telemetry package during vibration testing. All of the input signals were within the 0 to −5.0 vdc range. Some signal limits were as close as ±10 mv. Under these conditions it was possible to connect all 60 reactrons 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. ■ ■

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

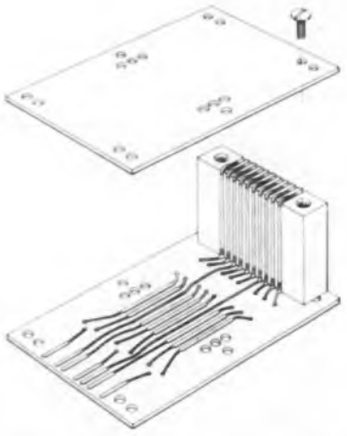
NEW arrangements for assemblies of printed-circuit boards are permitted by a recently developed combined connector-mounting device. The "Becon" connector, which is being offered by the Brown Engineering Co., P. O. Box 917, Huntsville, Ala., was conceived at the National Aeronautics and Space Administration's 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 90-deg version of the Becon connector comes with 20 contacts (shown) or 10 contacts.

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 diallyl 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.

Photoconductive

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 crt 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 neglible.

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.

NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader-Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.

Vaneaxial Blowers Have 2-In. Diameter 256

Up to 50 cfm at 2.1 H_2O 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 cps or 200 v ac, 3-phase 400 cps. 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.

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

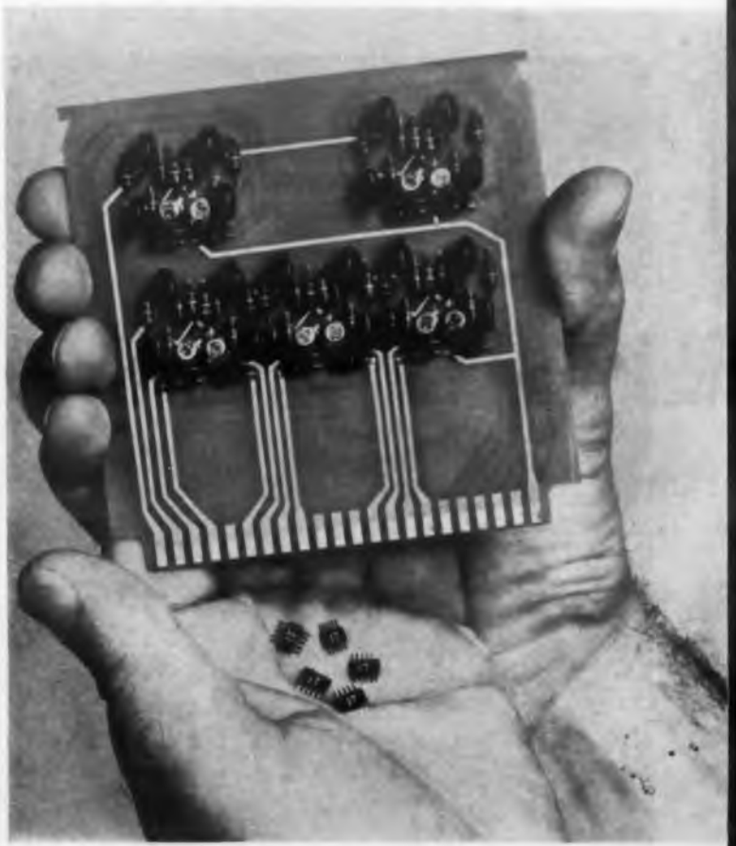
P&A: *factory quote; some from stock.*

SCR Trigger Provides High Stability Firing 255

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.*

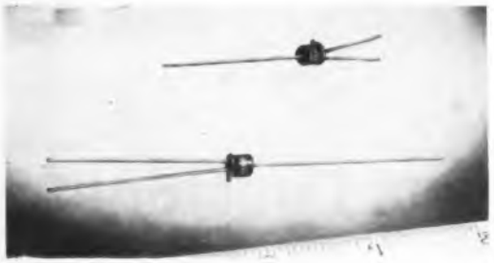


Semiconductor Networks Measure 1/4 x 1/8 x 1/32 In. 257

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 V_{cc} of 3 v.

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

P&A: *$50 to $65 for quantities of 1,000; immediate.*



Silicon Controlled Rectifiers Have In-Line Configuration 258

Newly developed packaging techniques allow miniaturization with no loss of sensitivity, cut-off 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.

Solid State Products, Inc., Dept. ED, 1 Pingree St., Salem, Mass.

P&A: *from $3.50 ea in lots of 100; immediate*

Operational Amplifier Has No Choppers Or Modulators 259

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.

George A. Philbrick Researches, Inc., Dept. ED, 127 Clarendon St., Boston, Mass.

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

New Products Directory

A complete index of all new products contained in this issue of ELECTRONIC DESIGN, *including page and reader-service numbers.*

NEW PRODUCTS

Tube Clamps 478

For subminiature T-3 envelopes. Series 7B is available with or without sockets for in-line and circular basing. The design is the open finger-sleeve which permits easy top insertion and/or withdrawal. The device conforms to irregularities of the envelope to provide greater contact and thus greater thermal conductivity. Lengths are 1-3/4 and 1-15/16 in.; widths 0.60 in.

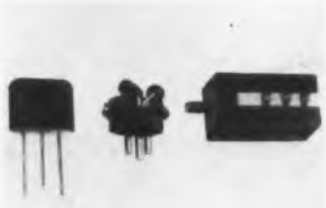
The Birtcher Corp., Industrial Div., Dept. ED, 745 S. Monterey Pass Road, Monterey Park, Calif.
Availability: *stock.*

Compressor Amplifier 523

Model 666 compresses 40 db without increasing distortion, according to the manufacturer. The unit can be used as a line amplifier or preamplifier. Response is ±1 db from 20 to 15 kc and output is +25 dbm with an input of −15 dbm. Inputs and outputs are 150, 300 or 600 ohms. Attack time is 40 msec; release time, 200 msec.

Fairchild Recording Equipment Corp., Professional Products Div., Dept. ED, 10-40 45th Ave., Long Island City 1, N. Y.
Price: *$495.*

Voltage Doublers 463



Ranging from 50 to 1,500 v piv at a current rating of 1.1 amp, three basic configurations of voltage doublers are available. Series DB features miniature size and high surge current rating. Series SC polarized plug-in type has a 3/4-in. diam. Series MB is available in molded blocks with mounting studs and is manufactured to meet all military specifications.

Solitron Devices, Inc., Dept. ED, 500 Livingston St., Norwood, N. J.
P&A: *$0.70 to $4.00; stock.*

AC Power Supply 477

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 492

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.

General Radio Co., Dept. ED, West Concord, Mass.
Price: *$95.00 fob West Concord.*

Push-Button Switch 475

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 PRODUCTS

Slip Clutch 537

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 516

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 531

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.

Electronic Tube and Instrument Div., General Atronics Corp., Dept. ED, 1200 E. Mermaid Lane, Philadelphia 18, Pa.

◀ CIRCLE 52 ON READER-SERVICE CARD

VHF Variable Capacitors 533

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 515

Eutectic. Acculoy 280C, a homogenous Au80-Sn20 alloy has automically interspersed elements. Precision squares, rectangles, disks and washers up to 1.5 in. diam and 0.001 in. to 0.015 in. finished gage, 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 536

Rated at 22 amp at 125, 250 or 480 v ac, 1/4 hp at 125 v ac or 1/2 hp at 250 v ac, type BM-1R-A2 has spdt 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.

Minneapolis-Honeywell Regulator Co., Micro Switch Div., Dept. ED, Freeport, Ill.
Price: *$2 ea., 1 to 9.*

CIRCLE 53 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 μsec.

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 μsec between encodings.

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

Binary Convertor 561

Direct binary to BCD conversion of 23 bits to a 7 decade decimal output in 50 μsec, 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 Headers and Cases 560

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 11, N. J.
P&A: $0.50 to $2.00 each; stock.

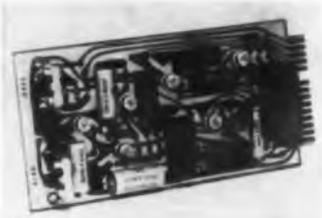
Solid-State Delay 575

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 PRODUCTS

Chopper Amplifier 481



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, 5026 Newport Ave., San Diego 7, Calif.

Diode Tester 563

High voltage constant current power supply production test diodes. Supply features adjustable current levels lwith 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 462

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

TANTALUM CAPACITORS Industry's broadest line. Microminiature to high capacity: 0.33 to 1300 mfd. Sintered wet slug, solid and foil types. Temperature ratings —55 to +200°C.

SELECTOR SWITCHES Push-button, lever action, rotary, wafer, multi-section. Phenolic or ceramic insulation.

VITREOUS ENAMEL RESISTORS Complete line of fixed and adjustable wire-wound resistors including MIL types. 5 to 200 watts, resistances to 100,000 ohms.

CERAMIC DISC CAPACITORS All standard temperature coefficients. Ratings from 50 volts general purpose to 6000 volts. Made by Radio Materials Company, a Mallory division.

SUBMINIATURE SNAP-ACTION SWITCHES Milli-Switch line of precision push-button switches; toggles and auxiliary actuators for slide or cam action. Temperature ratings to 300°F. Also hermetically sealed types.

HIGH-CAPACITY, HEAVY-DUTY ELECTROLYTICS High-capacity HC type and non-polarized NP type. Plastic case. Compact, leak-proof design. High ripple current rating, cool operation. From 3V, 6700 mfd. to 450V, 88 mfd.

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.

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MALLORY

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3—Vitreous enamel resistors
4—Ceramic disc capacitors
5—Snap-action switches
6—HC-NP capacitors

Standard Radio Parts	1						Tucson, Ariz.
Newark Electronics		2				6	Inglewood, Calif.
California Electronics	1	2				6	Los Angeles, Calif.
Federated Purchaser		2				6	Los Angeles, Calif.
Kierulff Electronics	1	2		4	5	6	Los Angeles, Calif.
Radio Product Sales	1	2				6	Los Angeles, Calif.
Lynch Electronics	1	2				6	Monrovia, Calif.
Brill Electronics						6	Oakland, Calif.
Elmar Electronics	1	2		4		6	Oakland, Calif.
Zack Electronics	1	2	3		5	6	Palo Alto, Calif.
Elwyn W. Ley		2				6	Paramount, Calif.
Allied Radio of California	1	2				6	Pasadena, Calif.
Shanks & Wright				4			San Diego, Calif.
Pennisula Eectronics					5		San Jose, Calif.
Denver Electronics	1					6	Denver, Colo.
Westconn Electronics	1	2					Bridgeport, Conn.
Radio Appliance Co.		2					E. Hartford, Conn.
Westchester Electronics		2					Stamford, Conn.
Capitol Radio	1					6	Washington, D.C.
Electronic Indus. Sales	1	2				6	Washington, D.C.
Electronic Equipment						6	Miami, Fla.
East Coast Radio	1			4		6	Orlando, Fla.
Thurow Electronics	1						Tampa, Fla.
Allied Radio	1	2				6	Chicago, Ill.
Chauncey's, Inc.				4			Chicago, Ill.
Newark Electronics	1	2				6	Chicago, Ill.
Melvin Electronics						6	Oak Park, Ill.
Bruce Electronics			3			6	Springfield, Ill.
Graham Electronics	1	2	3	4	5	6	Indianapolis, Ind.
Radio Supply					5		Wichita, Kansas
P. I. Burks & Co.		2				6	Louisville, Ky.
D & H Distributing						6	Baltimore, Md.
Kann-Ellert Electron.		2					Baltimore, Md.
Radio Elec. Serv.	1				5		Baltimore, Md.
Cramer Electronics	1	2				6	Boston, Mass.
DeMambro Rad. Sup.	1	2				6	Boston, Mass.
Lafayette Radio	1	2	3			6	Boston, Mass.
Radio Shack		2					Boston, Mass.
Radio Specialties		2					Detroit, Mich.
Northwest Radio	1	2		4			Minneapolis, Minn.
Burstein-Applebee		2				6	Kansas City, Mo.
Walters Radio		2				6	Kansas City, Mo.
Interstate Indus. Elec.				4			St. Louis, Mo.
Olive Electronics	1				5		St. Louis, Mo.
General Radio		2				6	Camden, N. J.
Eastern Radio		2				6	Clifton, N. J.
Federated Purchaser	1	2				6	Mountainside, N. J.
Aaron Lippman & Co.		2					Newark, N. J.
Lafayette Radio	1					6	Newark, N. J.
Atlas Electronics	1	2				6	Perth Amboy, N. J.
Nidisco, Inc.		2	3				Union City, N.J.
State Electronics		2		4		6	Whippany, N. J.
Ft. Orange Radio		2					Albany, N.Y.
Federal Electronics	1	2				6	Binghamton, N. Y.
GEM Electronics		2				6	Brooklyn, N.Y.
Radio Equipment		2					Buffalo, N. Y.
Standard Electronics, Inc.		2				6	Buffalo, N.Y.
Summit Dists.		2					Buffalo, N.Y.
Wenle Electronics	1					6	Buffalo, N. Y.
Statewide Electronics				4			East Syracuse, N.Y.
Lafayette Radio		2					Jamaica, N. Y.
Greylock Electronic		2					Kingston, N. Y.
Peerless Radio						6	Lynbrook, L.I., N.Y.
Bruno-New York		2				6	New York, N. Y.
Electronic Center		2				6	New York, N. Y.
Harrison Radio	1	2	3	4		6	New York, N. Y.
Harvey Radio	1	2				6	New York, N. Y.
Lafayette Radio	1	2	3			6	New York, N. Y.
Milo Electronics	1	2				6	New York, N. Y.
Terminal Hudson Elec.	1	2				6	New York, N. Y.
Higgins & Sheer Elec.		2					Poughkeepsie, N.Y.
Morris Electronics						6	Syracuse, N. Y.
Valley Indus. Elec.		2					Utica, N. Y.
Westchester Electron.	1	2					White Plains, N.Y.
Dalton-Hege Inc.	1						Winston-Salem, N.C.
Akron Electronic Sup.		2					Akron, Ohio
United Radio	1		3	4			Cincinnati, Ohio
Pioneer Electronics	1					6	Cleveland, Ohio
Thompson Radio		2		4			Columbus, Ohio
Whitehead Radio			3				Columbus, Ohio
Allied Supply	1		3	4			Dayton, Ohio
Srepco, Inc.		2					Dayton, Ohio
Servex Electronics				4			Marion, Ohio
Trice Whisle Electronics		2					Okla. City, Okla.
Engineering Supply	1						Tulsa, Okla.
Eoff Electric				4			Portland, Ore.
Television Parts			3	4			New Brighton, Pa.
Cameradio Co.					5		Pittsburgh, Pa.
Radio Parts	1	2				6	Pittsburgh, Pa.
Almo Radio		2				6	Philadelphia, Pa.
Herbach & Rademan	1						Philadelphia, Pa.
Phila. Electronics	1	2				6	Philadelphia, Pa.
Radio Elec. Serv.		2				6	Philadelphia, Pa.
Geo. D. Barbey Co.						6	Reading, Pa.
West Chester Elec.				4			West Chester, Pa.
Electra Distrib.	1	2				6	Nashville, Tenn.
Engineering Supply	1			4		6	Dallas, Texas
McNicol, Inc.				4			El Paso, Texas
Harrison Equip.	1					6	Houston, Texas
Lenert Co.	1					6	Houston, Texas
Rucker Electronic	1	2	3	4		6	Arlington, Va.
F. B. Connelly Co.	1	2	3	4	5		Seattle, Wash.
Radio Parts			3			6	Milwaukee, Wis.
Canadian Elec. Sup.	1						Montreal, Que.
Wackid Radio	1						Ottawa, Ont.
Alpha Aracon Radio	1						Toronto, Ont.
Electro Sonic Sup.	1						Toronto, Ont.
Wholesale Radio	1						Toronto, Ont.

CIRCLE 57 ON READER-SERVICE CARD

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 megohm. Dot resistors have some rating and range from 10 ohms to 50 K.

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

Static Relay 534

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 526

Accuracy is ±0.3%. Series 8500 miniature, external ammeter shunt meets the operational requirements of MIL-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 538

Isolation is 100 db. A solid-state device, designated type PR1, 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: *$30.00 to $130.00; 30 to 60 days.*

CIRCLE 60 ON READER-SERVICE CARD ▶

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 400 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.

Four-Element Meter 535

Ranges of dc millamperes, 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 509

The Designer series features a line of single instruments which are 4 x 8-1/2 x 10 in. All circuits contain transistors and use etched circuit boards. The series will include 25 different instruments. The linear amplifier and discriminator has 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.

Radiation Instrument Development Laboratory, Inc., Dept. ED, 4501 W. North Ave., Melrose, Ill.

Wound Motors 532

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.

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

CIRCLE 63 ON READER-SERVICE CARD ➤

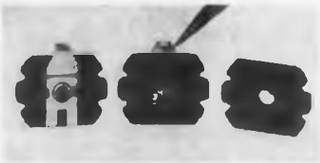
NEW PRODUCTS

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+j-2650 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.

Piston Capacitors 547

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., Woodside 77, N. Y.

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

Half-Wave Rectifier 558

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 572

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 443

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.

Solitron Devices, Inc., Dept. ED, 500 Livingstone St., Norwood, N. J.
P&A: *$0.40; immediate.*

Set-Reset Indicator 550

Plug-in module, model (D9)G-104/N-1A 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 555

Scissor 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.*

Voltage Comparator 383

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.

Verco, Inc., Dept. ED, 1430—130th N. E., Bellevue, Wash.

Dip Soldering Device 654

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 384

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, Pittsburg 30, Pa.

CIRCLE 67 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Chopper Amplifier 472

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 430

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 480

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.*

Potentiometers 445

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 v. 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 423

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 499

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, cubicle or contoured surfaces of any kind or size.

Electrofilm, Inc., Dept. ED, 7116 N. Laurel Canyon Blvd., North Hollywood, Calif.

Slip Clutches 455

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.

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.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

Digital Voltmeter 656

Range is 1 mv to 1 kv. Model VR-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.

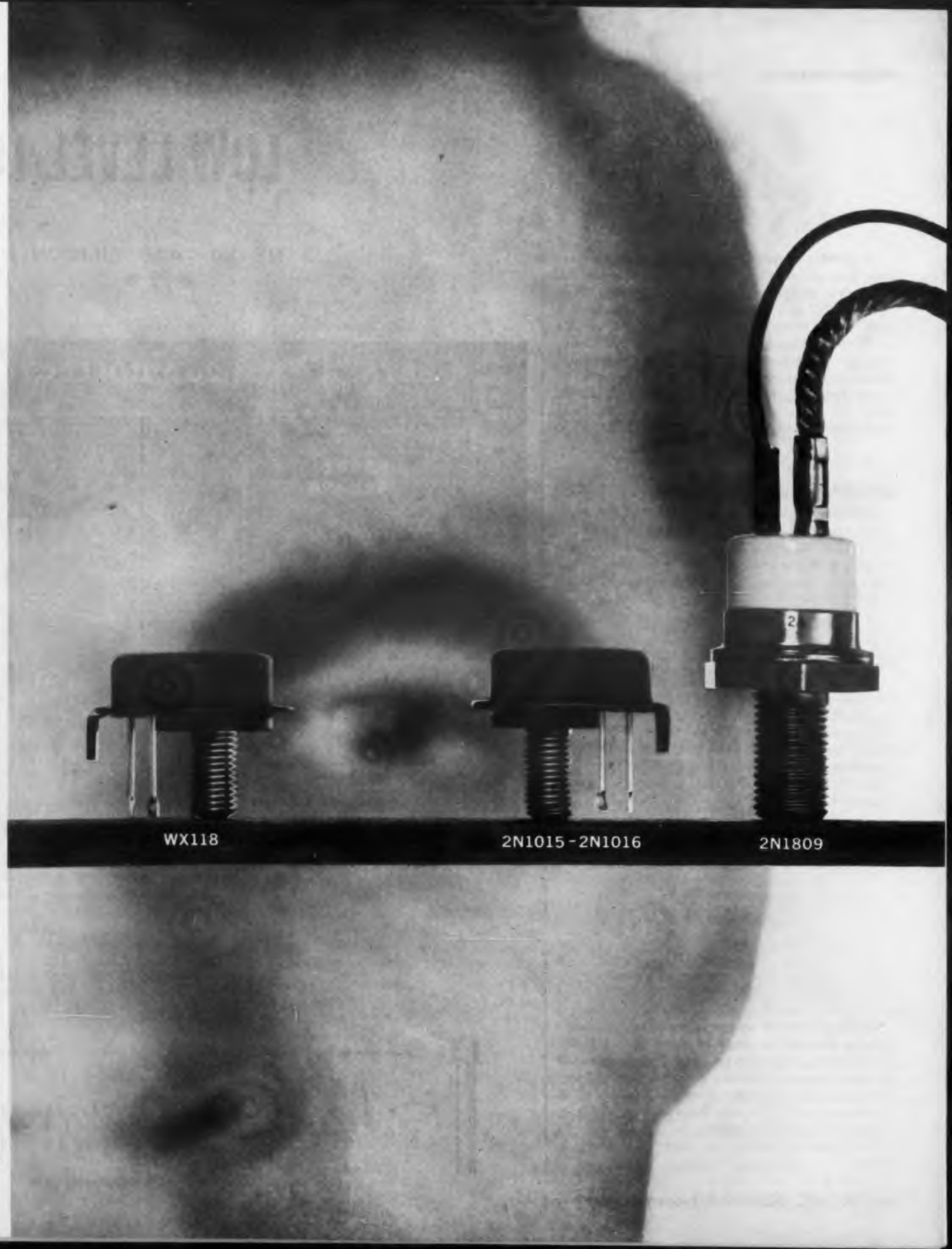
Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.

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.



Telemetry Commutator 460

Life is 1,000 hr min at the highest sampling rate for the Datacel 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.
Availability: *custom units, less than 8 weeks.*

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 μsec. 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: *$895; 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 655

Reed-relay digital voltmeter model V-70 has a range of ±0.000 to ±999.9 v dc with a sensitivity of 1 mv. Absolute accuracy is 0.01%, ±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: $1180

FM Transmitter 395

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 565

Two models offered. Model I-4S and I-4T infrared spectrometers have the following specs: ranges, 0.35 to 3.0 and 1 to 16 microns; resolution, 40 cm^{-1} max; entrance aperture, 2.25 cm^2; angular acceptance, 15 deg; output impedance, 1,000 ohms resistive.

Block Associates, Inc., Dept. ED, 385 Putnam Ave., Cambridge 39, Mass.

Price: $4,515 up

Power Supplies 589

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.

CIRCLE 73 ON READER-SERVICE CARD ➤

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.

Electronic Engineering Co., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.
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.

Bias Oscillator 396

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 dc at 50 ma. Temperature range is −30 to +80 C.

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

Planar Transistor 593

Triple-diffused planar transistor type 2N2102 offers the following ratings: BV_{CBO} of 120 v with I_C at 0.1 ma, V_{CE} of 0.5 v max at I_C of 150 ma, V_{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 mμsec max.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N. J.

Twin Tetrode 577

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.

Amperex Electronics Corp., Power Tube Div., Dept. ED, 230 Duffy Ave., Hicksville, L. I., N. Y.

Screen Press 392

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. Planed registration plate is for drilled hole and pin holding.

Etchomatic, Inc., Dept. ED, P. O. Box 444, Waltham 54, Mass.
Price: $895.00.

CIRCLE 76 ON READER-SERVICE CARD ➤

NEW PRODUCTS

DC Power Supply 456

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 wave shape 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 30 amp output.

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

Digital Voltmeter 476

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 496

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; 4-5 weeks.

Recording Amplifier 397

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 578

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 592

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 391

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.

CIRCLE 79 ON READER-SERVICE CARD ➤

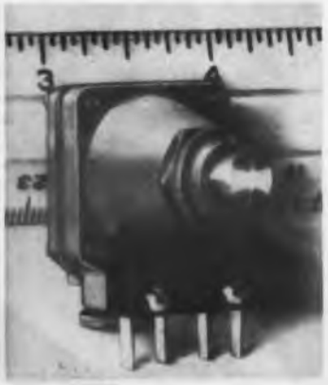
NEW PRODUCTS

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.

The M-O Valve Co. Ltd., Dept. ED, Brook Green, London W. 6, England.

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 −55 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.

Gear Transmission 576

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.

Analog General Corp., Dept. ED, 7-11 Main St., East Rockaway, L. I., N. Y.

P&A: from $200; stock.

Silicone Compound 387

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 568

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.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

◀ CIRCLE 80 ON READER-SERVICE CARD

NEW PRODUCTS

Saturable Reactor 479

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 471

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 shade pole motor.

Rotronics of California, Dept. ED, 11168 Santa Monica Blvd., Los Angeles 25, Calif.

Digital Switch 451

Thumbwheel switches can be stacked up to 15 sections in a panel slot 8 x 1-9/16 in. Decaswitch 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.

Minneapolis-Honeywell Regulator Co., Industrial Div., Dept. ED, Wayne and Windrim Aves., Philadelphia 44, Pa.

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.

CIRCLE 83 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Tantalum Capacitors 489

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 derated 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 505

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.

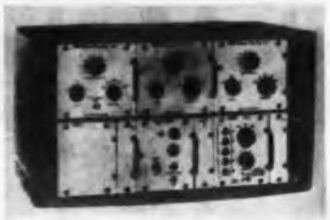
Custom Materials, Inc., Dept. ED, 279 Billerica Road, Chelmsford, Mass.
Price: on request.

Gaging Console 466

Reads- and prints-out up to 24 gage points in 1 min. Digital read-out windows give the gaging position and variation in lighted numeral 1 in. high. Readings are accurate to 0.0002 in. Range is ± 0.010 in. Model CS-24 uses 110-120 v, 60 cps ac and consumes 350 w.

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

Pulse Generator 398



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.
P&A: $18.75; 30 days.

Electronic Timer 473

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 483

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, 3932 Reading Road, Cincinnati 29, Ohio.

Slip Rings?

To provide excellent electrical properties and long equipment life for slip rings, we manufacture and supply fine and coin silver in the form, size, finish and degree of hardness most convenient for the manufacturer and least productive of scrap.

Photo courtesy of Breeze Corporations, Inc., Union, New Jersey

Adjustable Contacts?

The Handy & Harman Bimet shown here is used as an adjustable contact in a Rimset thermostat for control of residential heating, cooling and air conditioning. It is made of fine silver for optimum conductivity and reliability, and clad with bronze to give a more machinable, easily threaded surface. Handy & Harman bimetals give you uniformly clad precious metal just where you need it, with no excess. Available in gold and silver and their alloys in strip, overlays, inlays, edge lays and thrulays.

Photo courtesy of Penn Controls, Inc., Goshen, Indiana

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 leaf 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.

Photo courtesy of Leeds & Northrup Company, Philadelphia, Pa.

CIRCLE 86 ON READER-SERVICE CARD

NEW PRODUCTS

Materials Tester 494

Measures the B-H hysteresis loop of small samples of material. Model 750T is designed to evaluate samples of magnetic films as thin as 10 μin., as well as wire and other bulk material. The unit, which operates from 110 v, 60 cps at 5 amp, is capable of developing magnetic fields up to 1,000 oersteds.

Halex, Inc., Dept. ED, 310 E. Imperial Highway, El Segundo, Calif.
P&A: $5,230; 60 days.

Voltage Regulator Tubes 428

Microminiature voltage regulator tubes are gas-filled cold-cathode diodes. Designated types TD-9A and TD-19, the tubes measure about 1.1 in. long and 0.13 in. in diam. Regulation voltage is 150 and 115 v respectively, at 75 to 400 μa operating current. Typical regulation is within 1.7 v dc. Temperature range is −55 to +125 ambient; shock and vibration characteristics meet MIL-E-1.

Bendix Corp., Red Bank Div., Electron Tube Products, Dept. ED, Eatontown, N. J.

Humidity Indicator 485

Measures true relative humidity. Readings of wet and dry bulb can easily be taken in close proximity to critical manufacturing processes. Accurate measurements may be made with the instrument in any position. Two standard flashlight batteries power a fan of low durrent drain to provide proper air circulation and evaporation. Dimensions are 2-3/4 x 5-1/2 x 7 in. and weight is 1-1/2 lb.

Better Fabrics Testing Bureau, Inc., Dept. ED. 101 W. 31 St., New York 1, N. Y.
P&A: $63.50; stock.

Silicon-Controlled Rectifiers 497

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 504

Dilecto 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 498

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.

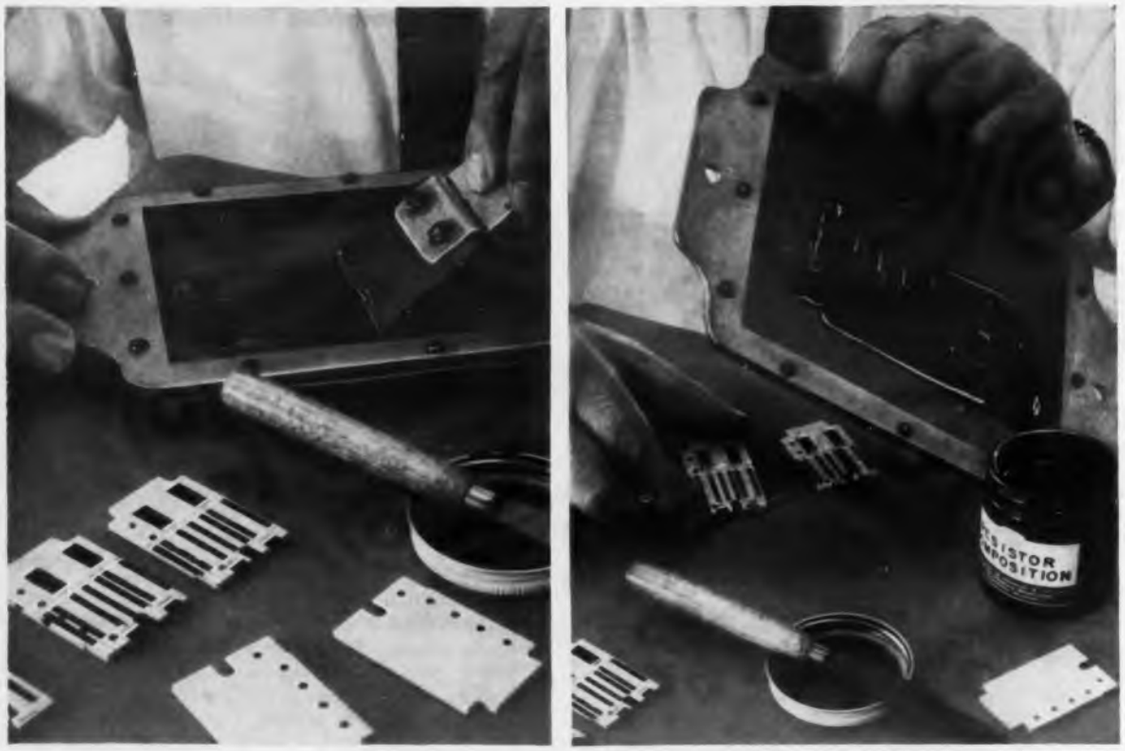
Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.

Resistor Kit 484

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 0.050 in. diam x 0.030 in. thick and is without leads.

CTS Corp., Dept. ED, Elkhart, Ind.

P&A: $7.00; stock.



Laboratory demonstration shows Du Pont Resistor Composition being applied to a ceramic base by stencil screen and squeegee (left). When stencil is removed from ceramic base, resistor is ready for firing (right).

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.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT

REG. U.S. PAT. OFF.

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 metallic 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.

CIRCLE 88 ON READER-SERVICE CARD

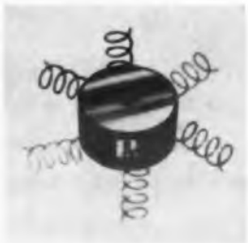
NEW PRODUCTS

Digital Multimeter 487

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 461



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 470

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 429

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.

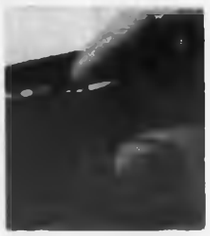
B-I-F Industries, Dept. ED, Providence, R. I.

Insulating Coating 436

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 465



Uses dry-reed switch contactor. The unit consists of a spst normally open reed switch rated at 12 va 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 dc.

D. Randall Co., Dept. ED, 6 Pawcatuck Ave., Westerly, R. I.

Molding Compound 438

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.

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.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.
***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%.

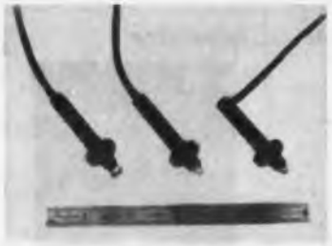
Davenport Manufacturing Div., Duncan Electric Co., Dept. ED, 2530 N. Elston Ave., Chicago 47, Ill.

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.*

Gaging Probe 468



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.

Simulators and Converters 474

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 595

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.

Globe-Union Inc., Centralab Div., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

P&A: $50 to $100; 3 to 4 weeks.

NEW PRODUCTS

Harmonic Generator 599

Wide-range harmonic generator model CDH-0.1 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 431

With 48 channels of instrumentation, this data aquisition 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 488

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 366

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.

Farmer Electric Products Co., Inc., Dept. ED, 2300 Washington St., Newton Lower Falls, Mass.

Pulse Switch 464

One-shot pushbutton switches, series 1PB3000, produce one square-wave, msec-length pulse with each operation. Eight circuits are available to produce lengths from 0.030 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.

Minneapolis-Honeywell Regulator Co., Micro-Switch Div., Dept. ED, Freeport, Ill.

***P&A:** from $26.40 to $28; immediate.*

Servo Assembly 645

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.

Daystrom, Inc., Transicoil Div., Dept. ED, Worcester, Pa.

CIRCLE 95 ON READER-SERVICE CARD

NEW PRODUCTS

Signal Integrator 362

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.

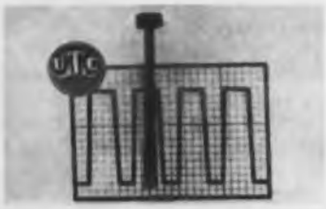
Elcor, Inc., Dept. ED, 1225 W. Broad St., Falls Church, Va.
P&A: $795.00; 4 weeks.

Stack Switch 377

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 356



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-TP6RX-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.

Thermoelectric Coolers 376

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 373

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 358

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 370

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_{ce} is 60 v, V_{cb} is 60 v, V_{eb} is 10 v, and I_c 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 378

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 360

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.

UHF Filters 372

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.*

Contact Blocks 657

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.

Welding Tool 630

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.*

CIRCLE 99 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Data System 371

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 357

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 368

Featuring direct readout, the 8-channel unit has 0 to 500 cps 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 54, Mass.

Fixed Span Recorder 353

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 364

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 363

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 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.

Gelman Instrument Co., Dept. ED, Chelsea, Mich.

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 $6 per connection.

Power Source 417

For emergency operation of critical equipment. The unit supplies up to 750 va 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 EECO 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.*

NEW PRODUCTS

Semiconductor Component Kits 369

Contains spheres, washers, rings, pellets, base tabs and foils of various alloys, claddings 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 microwave 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. Designated 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.

Astro Dynamics, Inc., Dept. ED, Northwest Industrial Park, Burlington, Mass.
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 415

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 414

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 416

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 404

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-3786 and MIL-E-5272.

The Daven Co., Dept. ED, Livingston, N. J.
Availability: *immediate, from distributors.*

Compression Amplifier 412

Bridging type, 12,000-ohm, balanced 3-terminal input is featured on model WSC515. 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 408

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 EECO 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, Ill.

Precision Thermostat 386

Precise 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 ▶

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.

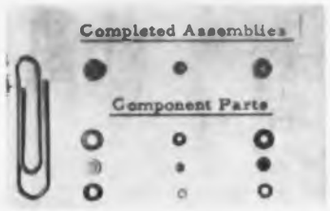
Drexel Dynamics Corp., Dept. ED, Horsham, Pa.

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.

Round Plug 352

Suitable for relay and miniature plug-in circuits, the K1-14, a 14-pin plug, can mate with TS1405P01 sockets. It has phosphor-bronze-cadium 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: *$0.53 ea. in lots of 100; stock.*

Phase Checker 410

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-milliam-meter, 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: *$14.95; immediate.*

Instrument Motor 354

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.

Insco Co., Dept. ED, Hollis St., Groton, Mass.

NEW PRODUCTS

Connector Devices 351

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 piggy-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 424

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 419

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.

Rectifier-Capacitor Div., Fansteel Metallurgical Corp., Dept. ED, North Chicago, Ill.

Transistorized Gaussmeter 381

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 394

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 379

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 ▶

NEW PRODUCTS

Mica Capacitors 405

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: $.785 to $2.49; 3 to 4 weeks.

Pressure Valve 420

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 402

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 365

Constructed of foamed plastic in two halves, this package may be sealed with pressure-sensitive tapes and shipped in any shipping container. Weight is approximately 8 oz. Shock loads are distributed equally to all sides of the container. The units have a slow-controlled rate of rebound, are non-hygroscopic, 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 422

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 320 in. are interchangeable. Case is weatherproof.

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

Frequency Standard 418

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.

NEW PRODUCTS

Trimmer Capacitors 413

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 355

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 411

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.

Static Inverter 385

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.

DC Amplifier 658

Floating, differential dc amplifier model 114C is for thermocouple and strain-gage measurements where transducer, amplifier and output are separately grounded. Ratings include: 180-db dc, 130-db, 60-cps common mode rejection with up to 1,000 ohms unbalance at either input. Drift is within ± 2 μv for 40 hr.

Cohu Electronics, Inc., Kintel Div., Dept. ED, Box 623, San Diego 12, Calif.

Price: *$875.*

Tuning Fork Oscillator 382

Transistorized tuning fork oscillator model DFO-81 is available in any frequency from 50 to 400 cps. Frequency tolerance is $\pm 0.15\%$ from 0 to 60 C and $\pm 0.05\%$ at room temperature. With a supply voltage of +26 v it will provide 3 v rms into a nominal load of 10 K.

Delta-f, Inc., Dept. ED, 113 E. State St., Geneva, Ill.

P&A: *$63.50 to $99.50; stock.*

CIRCLE 126 ON READER-SERVICE CARD ▶

NEW PRODUCTS

VHF-UHF Noise Generator 367

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 425

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.

Electronic Engineering Co., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.
***Price:* $465.**

Tachometer Tester 401

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.

American Electronics, Inc., Instrument Div., Dept. ED, 9503 W. Jefferson Blvd., Culver City, Calif.

Tape Transport 407

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 361

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 409

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.*

NEW PRODUCTS

Sunlight Integrator 440

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 427

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.

Electronic Engineering Co., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.
Price: $950.

Double Pulse Generator 399

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 643

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, 1091 Wills Mountain, Cumberland, Md.

Power Supply 653

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: *$430.*

Solid State Amplifier 646

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 1.5 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.*

CIRCLE 132 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Video Telemetry System 450

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.

Tapco Div., Thompson Ramo Wooldridge Inc., Dept. ED, 23555 Euclid Ave., Cleveland 17, Ohio.

Counter Modules 508

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.

Navigation Computer Corp., Dept. ED, Valley Forge Industrial Park, Norristown, Pa.

General Purpose Integrator 449

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 solion 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 to 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.*

Gyro Power Supply 458

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.

Heating Device 457

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.

Regulators and Controls 452

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.

NEW PRODUCTS

Variable Transformer 446

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 433

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 cago 47, Ill.

Signal Generator 406

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 627

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.

Hastings-Raydist, Inc., Dept. ED, Hampton, Va.
P&A: $110 each; immediate.

Insulating Varnishes 597

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, 210 E. Alondra Blvd., Gardena, Calif.

Tantalum Capacitors 380

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 wvdc, at ambients of −55 C to +125 C, with linear deratings above 85 C, to 67% at +125 C.

Fansteel Metallurgical Corp., Dept. ED, Rectifier-Capacitor Div., North Chicago, Ill.

CIRCLE 138 ON READER-SERVICE CARD ➤

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.

Stackpole Carbon Co., Electronic Components Div., Dept. ED, St. Marys, Pa.
P&A: *$0.10 ea for 10,000; 3 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 $245.00.*

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.

Indicator Lights 454

STI-series subminiature transistorized neonlights 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: $4 to $11.

Variable Potentiometer 441

Infinite-resolution potentiometer pick-off converts linear wiper motion into linear or nonlinear 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 448

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.

CIRCLE 143 ON READER-SERVICE CARD ➤

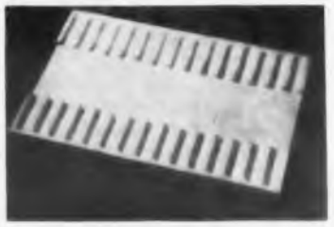
PRODUCTION PRODUCTS

Toroidal Coil-Winding Head 260

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 261



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 262

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.

Miniature-Parts Header 263

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.

Machine Tool Position Display 264

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.

Soldering-Gun Attachment 265

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.

Cyclops Manufacturing Co., Dept. ED, 20839 Fenkell, Detroit 23, Mich.

Price: $7.95 each.

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 Co. of 33-00 Northern Blvd., Long Island City, N. Y., welds the reverse surfaces of 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.

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.

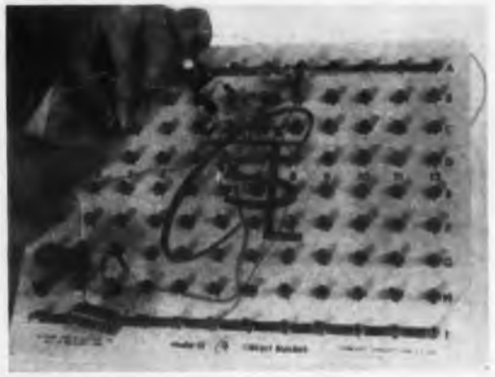
Commenting on his design, project engineer Vincent Proc points out that when an inexpensive, standard, commercial part can do a job well, it is always to be preferred over a "special."

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

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.

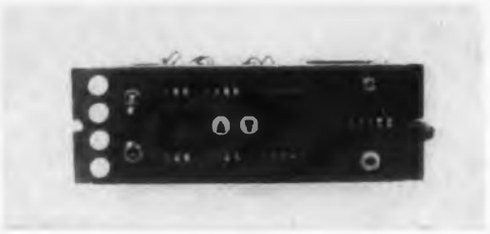
Round Lights Cut Cost, Improve Panel Appearance

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

Slight lack of parallelism in square panel-light lenses is exaggerated by viewer.



Change to round lenses eliminates appearance of misalignment.

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

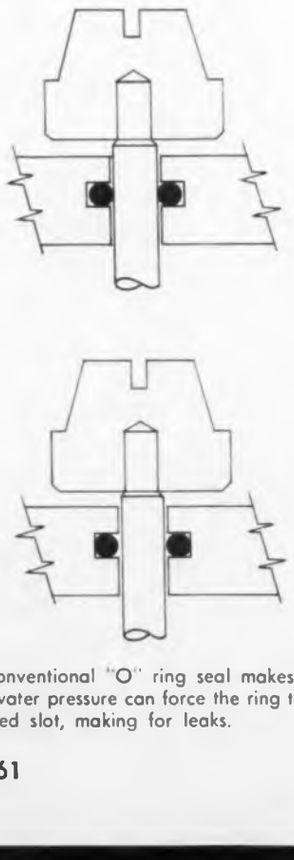


Fig. 1. Conventional "O" ring seal makes good dust seal, but water pressure can force the ring to periphery of oversized slot, making for leaks.

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.

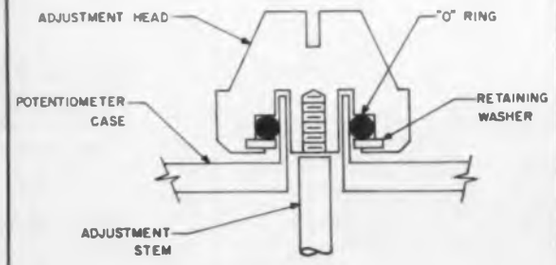


Fig. 2. "O" ring retained, as in watch crown, actually improves seal under pressure.

DESIGN ENGINEERING DATA

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.

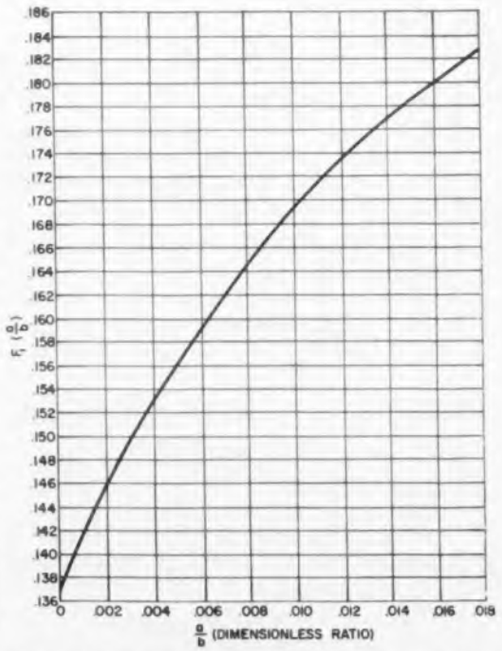
THE cumbersome calculations normally required in designing tuned class-B amplifiers can be avoided. A simplified technique, along with a graphical plot, give a rapid, precise solution for the resonant, plate-load resistance, R_o.

To design for the optimum condition ($e_{b\,min} = e_{c\,max}$) in tuned class-B power amplifiers, one normally has to solve the rather messy equation

$$R_o^2 + \left[\frac{4r_p}{\mu+1} - \frac{E_{bb}^2}{P_p}\left(\frac{2}{\pi} - \frac{1}{2}\right)\right]R_o + \left[\frac{4r_p^2}{(\mu+1)^2} - \frac{E_{bb}^2}{P_p}\,\frac{4}{\pi}\,\frac{r_p}{\mu+1}\right] = 0 \quad (1)$$

where

E_{bb} = plate-supply voltage
P_p = plate dissipation
$e_{b\,min}$ = instantaneous plate-voltage minimum swing
$e_{c\,max}$ = instantaneous control-grid voltage maximum swing
r_p = dynamic plate resistance
μ = tube amplification factor
$R_o = L/RC$ = tuned resistance of parallel-tuned plate-load



Graph for solving for tuned resistance of plate-load tank in class-B power amplifiers.

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_o for maximum power output. If n is defined as equal to $e_{b\,min}/e_{c\,max}$, then Eq. 1 can be rewritten as

$$R_o + \left[\frac{4nr_p}{\mu+n} - \frac{E_{bb}^2}{P_p}\left(\frac{2}{\pi} - \frac{1}{2}\right)\right]R_o + \left[\frac{4n^2r_p^2}{(\mu+n)^2} - \frac{E_{bb}^2}{P_p}\,\frac{4}{\pi}\,\frac{nr_p}{\mu+n}\right] = 0 \quad (2)$$

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_o to a simpler form involving fewer

ENGINEERING DATA

steps. We can define two new parameters (having the units of resistance) and express R_o as a function of the new parameters a and b. We can then use a graphical plot of the function $F_1\ (a/b)$ vs a/b for a very rapid, precise determination of R_o.

We start by defining the parameters a and b and a constant c.

$$a \equiv \frac{nr_p}{\mu + n} \quad b \equiv \frac{E_{bb}^2}{P_p} \quad c \equiv \frac{2}{\pi} - \frac{1}{2}$$

With insertion of parameters, Eq. 2 becomes

$$R_o^2 + \left(4a - bc\right)R_o + 4\left(a^2 - \frac{ab}{\pi}\right) = 0 \tag{3}$$

which, after solution of the quadratic and rearrangement, takes the final form

$$R_o = \frac{c}{2} b \left[\left(1 - \frac{4}{c}\frac{a}{b}\right) + \sqrt{1 + \frac{4}{c^2}\frac{a}{b}}\right] \tag{4}$$

After the constants are inserted, the relationship plotted in the graph becomes

$$F_1\left(\frac{a}{b}\right) \tag{5}$$

$$= 0.06831\left[\left(1 - 29.28\,\frac{a}{b}\right) + \sqrt{1 + 214.3\,\frac{a}{b}}\right]$$

Design Procedure

Given: $e_{b\ min}/e_{c\ max}, \mu, r_p, E_{bb}, P_p$.

Step 1. (a) Compute $n = e_{b\ min}/e_{c\ max}$ or (b) Set $n = 1$ for optimum case.

Step 2. Compute $a = nr_p/(\mu+n)$, $b = E_{bb}^2/P_p$, and a/b.

Step 3. From the graph, read $F_1\ (a/b)$ for the computed value of a/b.

Step 4. Compute $R_o = bF_1\ (a/b)$.

Sample Calculations

Given: An 833A triode with $\mu = 35$ and $r_p = 2{,}215$ ohms. $E_{bb} = 4{,}000$ v and $P_p = 400$ w.

Step 1. Set $n = 1$ for maximum power output

Step 2. $a = (1)\ (2{,}215)/(35 + 1) = 61.53$
$b = 16(10)^6/400 = 40{,}000$ $a/b = 0.00154$

Step 3. From the graph, for $a/b = 0.00154$, $F_1(a/b) = 0.1440$

Step 4. $R_o = 40{,}000 \times 0.1440 = 5{,}760$ ohms. ■ ■

Acknowledgment

The author wishes to acknowledge the work of Nicholas T. Neapolitakis of the Department of Electrical Engineering at Illinois Institute of Technology. Mr. Neapolitakis derived equations leading to Eq. 2 in this article.

NEW LITERATURE

Digital Circuitry 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 32 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.

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 micromicroammeters, 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.

Feedback Control Units 275

Brief descriptions of unique, high-performance feedback control hardware are provided in this six-page brochure. Included are: test equipment, sliderules, 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., 145 Elm St., Mamaroneck, N. Y.

Electronic Template

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.

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.

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., Cohu 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 293

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, 24 State St., Mankato, Minn.

Television Manual 294

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 295

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 296

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 297

A four-page summary brochure on the company's adustment 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 298

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 2047, Alhambra, Calif.

NEW LITERATURE

Batteries 299

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 300

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 301

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 302

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 303

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 Cycolac 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

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.

IDEAS FOR DESIGN

Dual Filter, Phase Detector From Frequency Discriminator 742

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.

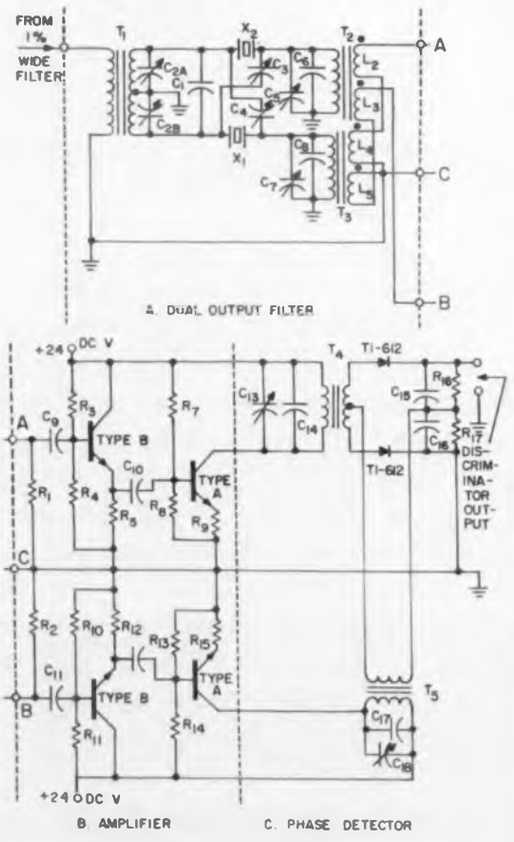
First, the circuit allows both the reference channel and the signal channel to the phase detector to be virtually as narrow in bandwidth as the system-signal requirements allow. This reduces noise output from the phase detector to a minimum.

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.

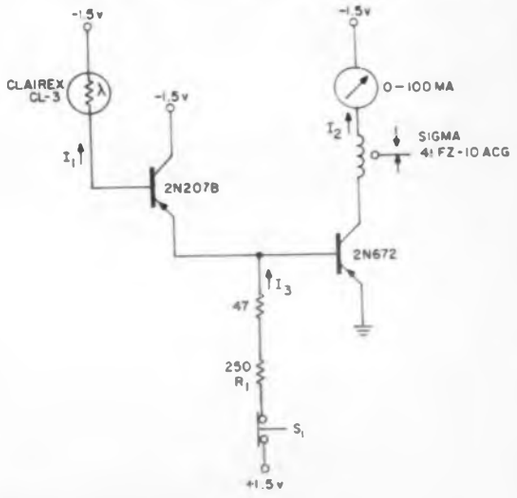


Dual-output filter (A), connected to phase detector (C) through an amplifier (B) at points indicated, forms useful frequency discriminator.

Photoelectric Circuit Operates With High Light Resolution 745

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 I_2 approaches the change in photocell current I_1 times the product of the β's for the two transistors. However, biasing current, I_3, allows quiescent current, I_2, to be set at some nominal, below-saturation level even in the presence of a relatively high ambient light level at the photocell.



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 R_1 is decreased so that I_2 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 I_2). By momentarily depressing S_1 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.

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.

$50 "Most Valuable of Issue" Award for Stabilized Regulator Circuit

Robrecht Bosselaers, senior engineer with Raytheon Co., Needham Heights, Mass., has won ELECTRONIC DESIGN's thirteenth $50 Most Valuable of Issue Award.

Mr. Bosselaers receives the award for his Idea for Design in the August 16 issue which described how a conventional two-transistor voltage regulator can be stabilized by the addition of an emitter follower.

How You Can Participate

Rules For Awards

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards: All engineer readers of ELECTRONIC DESIGN are eligible.

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.

SEVENTH ANNIVERSARY AWARDS

IDEAS-FOR-DESIGN *Entry Blank*

Ideas-for-Design Editor
ELECTRONIC DESIGN
850 Third Ave.
New York 22, N. Y.

Idea (State the problem and then give your solution. Include sketches or photos that will help get the idea across.)

(Use separate sheet if necessary)

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.
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Name _____ **Title** _____

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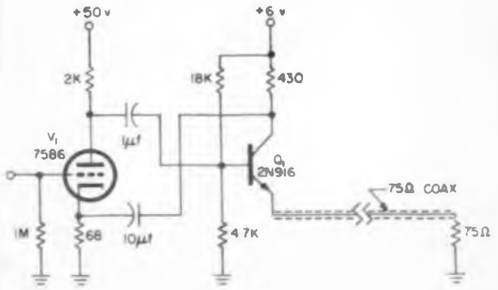
For Additional Entry Blanks, circle **750** on Reader-Service Card.

IDEAS FOR DESIGN

Small Test Probe Uses Hybrid Isolation Amplifier 749

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_1, is coupled to the base of Q_1. 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_1 to the cathode of V_1. 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_1. 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_1. 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 746 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:

$$R' = R_3 + \textit{input resistance of } T_1$$

then the circuit's frequency of oscillation is:

$$f_o = \frac{1}{2\pi C\sqrt{3RR_L + R'R_L + 3R^2 + 3R'R}}$$

For this oscillating frequency the required transistor β is:

$$\beta_{req} = 11 + \frac{10R'}{R} + \frac{3R_L}{R} + \frac{R'R_L}{R^2} + \frac{9R}{R_L} + \frac{14R'}{R_L} + \frac{2R'^2}{R^2} + \frac{6R'^2}{RRL}$$

These equations can be simplified somewhat by making the substitutions:

$$M = \frac{R_L}{R} \text{ and } K = \frac{R'}{R}$$

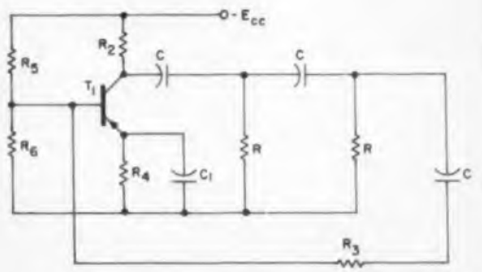
Thus, the required β is:

$$\beta_{req} = 2K^2 + 10K + 11 + M(3+K) + \frac{1}{M}(9+14K+6K)$$

and the frequency of oscillation is:

$$f_o = \frac{1}{2\pi CR\sqrt{K(M+3)+3(M+1)}}$$

Frequency is varied by adjusting R'.



Variable frequency oscillator is variable over range of 5:1 to 20:1.

David R. Olsen, Engineer, Western Development Laboratories, Philco Corp., Palo Alto, Calif.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 746.

BOOKS

Radio Transmitters
Laurence F. Gray and Richard Graham, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 480 pp, $12.50.

Practical analysis of transmitter operation including data on transmitter test measurements and maintenance.

Transmission of Information
Robert M. Fano, MIT Press and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 389 pp, $7.50.

Graduate level discussion of the foundations and major results of information theory.

ABC's Of Computers
Allan Lytel, Howard W. Sams & Co., Inc., 1720 E. 38 St., Indianapolis 6, Ind., 128 pp, $1.95 (paperbound).

Basic, "self-teaching" introduction to electronic computers.

Analytical Techniques For Non-Linear Control Systems
John C. West, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 225 pp, $5.75.

Deals with methods for analyzing feedback control system behavior when amplitude nonlinear elements dominate the performance. A minimum amount of linear servomechanism theory is used.

Foundation For Electric Network Theory
Myril B. Reed, Prentice-Hall, Inc., Englewood Cliffs, N. J., 354 pp, $13.

Stresses the topology of network systems. Using resistive networks only, the presentation is based on linear graphs and matrices.

Transformers
Alexander Schure, Editor; John F. Rider Publisher, Inc., 116 W. 14 St., New York, N. Y., 88 pp, $2.

The 1961 Aerospace Year Book
Aerospace Industries Association, Inc., American Aviation Publications, 1001 Vermont Ave., N. W., Washington 5, D. C., 486 pp, $10.

Progress In Dielectrics, Vol. III
J. B. Birks and J. Hart, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 295 pp, $10.

An Introduction To The Theory and Practice Of Transistors
J. R. Tillman and F. F. Roberts, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 340 pp, $8.

NAB Engineering Handbook
A. Prose Walker, Editor; McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 1005 pp, $27.50.

Elements of Nuclear Engineering
Glenn Murphy, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 215 pp, $7.50.

A Treatise on the Differential Geometry of Curves and Surfaces
Luther Pfahler Eisenhart, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 500 pp, $2.75 (paperbound).

High Frequency Applications of Ferrites
J. Roberts, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 166 pp, $4.85.

Wave Propagation In A Turbulent Medium
V. I. Tatarski, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 285 pp, $9.75.

Principles of Illumination
H. Cotton, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 530 pp, $12.

Optimum Use of Engineering Talent
American Management Association, 1515 Broadway, New York 36, N. Y., 420 pp, $9. (AMA members: $6.)

Thirty one executives describe their management techniques and their solutions for the problems of managing technical personnel.

Numerical Methods For Science and Engineering
Ralph G. Stanton, Prentice-Hall, Inc., Englewood Cliffs, N. J., 288 pp, $9.

Numerical methods are discussed and then applied to the solution of practical problems.

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^{13} 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 $R_V - L_A$, 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.

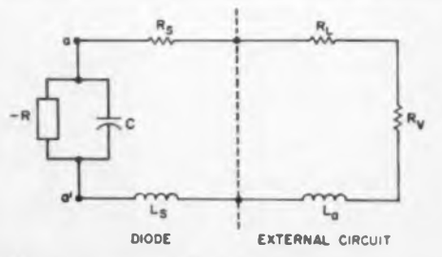


Fig. 1. Equivalent circuit of tunnel diode with tuning element represented by R_V and L_a.

Limitations Diodes

The net admittance of the circuit of Fig. 1 at the terminals $a-a'$, is zero if:

$$L_e = R R_e C \qquad (1)$$

and

$$\omega_0 = \frac{1}{RC}\sqrt{\frac{R}{R_e} - 1} \qquad (2)$$

where

$R_e = R_S + R_L + R_V$ and $L_e = L_S + L_A$

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, $f_o = 320$ mc for C = 1 nf and $R_e = 0.2$ ohm; and $f_o = 10$ Gc for $C = 15$ pf and $R_e = 0.5$ ohm.

The capacitance of the tunnel diode is given, for germanium, by:

$$C = 0.045\, r^2 \text{ (nf)} \qquad (3)$$

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_s, 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

GERMAN ABSTRACTS

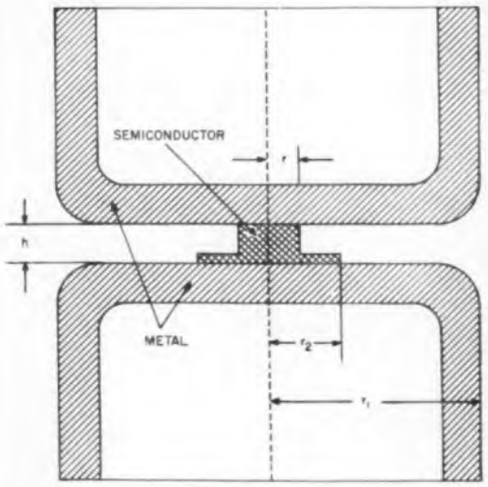


Fig. 2. Construction of a microwave tunnel diode.

Analog Output Circuit For A Decimal Decade

Electronic counters occasionally require analog output circuits for single decades. A suitable resistance matrix is shown in the figure. It is assumed that the resistance of the indicator, R_1, is large compared to the resistances of the matrix (R_1 through R_5). Also, the resistances of the conducting tubes or transistors are negligible compared to the matrix resistances. The equation for the output voltage E has the same form as that of a decade consisting of four flip-flops. This equation is:

$$E = E_4 - [A_1 (E_1 - E_0) + A_2 (E_2 - E_1) + A_3 (E_3 - E_2) + A_4 (E_4 - E)]$$

variables, the optimum current density for maximum f_o is given by:

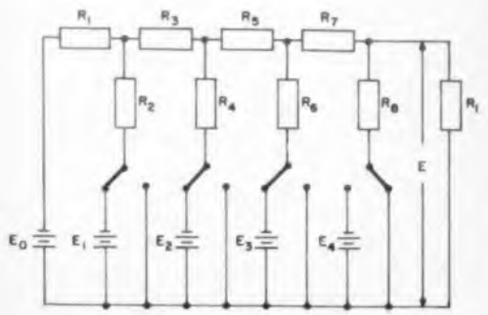
$$J_{opt} = 11\ f_o \text{ amp/mm}^2 \qquad (4)$$

where f_o is in gigacycles. Thus, for $f_o = 10$ Gc 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:

$$h = 0.0316 \left[\sqrt{(34.5/f_o) + 1} - 1\right] \text{mm} \qquad (5)$$

Consequently a 10-Gc upper frequency limit corresponds to $h = 0.035$ mm, the smallest size which appears to be practical.

Abstracted from an article by M. Muller, Nachrichtentechnische Zeitschrift, *Vol. 14, No. 4, April 1961, pp 165-169.*



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

$$R_1 = R_2 = R_4 = R_6 = R; \quad R_5 = R_8 = R/2$$

$$R_R = 2R, \qquad R_7 = 0$$

Abstracted from an article by H. Wachholz, Elektronische Rundschau, *Vol. 15, No. 1, January 1 1961, pp 25-26.*

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 ferrimagnetic-garnet materials were studied. Two millimeter-wave generation experiments using nickel-zinc ferrite and Ferroxplans 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-Radar 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.*

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, $8.10. 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, Melabs, Palo Alto, Calif., May 3, 1961, 35 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, 43 pp, $6.60. Order AD-256421 from OTS, Washington 25, D. C.*

The new EDC makes it easier than ever before to locate and obtain information about recently released electronic products. Improvements suggested by readers include:

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- ***An entirely new section-"Index to New Products by Manufacturer." Use it to scan a given company's new product activity.***

EDC is Electronic Design's 27th Issue.

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 Howell, 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, 45 pp, $4.60. Order AD-260112 from OTS, Washington 25, D. C.*

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. *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-260459 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.*

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.

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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.

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1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	287	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
9	19	29	39	49	59	69	79	89	99	109	119	129	139	149	159	169	179	189	199	209	219	229	239	249	259	269	279	289	299
300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	581	591
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	572	582	592
303	313	323	333	343	353	363	373	383	393	403	413	423	433	443	453	463	473	483	493	503	513	523	533	543	553	563	573	583	593
304	314	324	334	344	354	364	374	384	394	404	414	424	434	444	454	464	474	484	494	504	514	524	534	544	554	564	574	584	594
305	315	325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475	485	495	505	515	525	535	545	555	565	575	585	595
306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	576	586	596
307	317	327	337	347	357	367	377	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	537	547	557	567	577	587	597
308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	578	588	598
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	579	589	599
600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800	810	820	830	840	850	860	870	880	890
601	611	621	631	641	651	661	671	681	691	701	711	721	731	741	751	761	771	781	791	801	811	821	831	841	851	861	871	881	891
602	612	622	632	642	652	662	672	682	692	702	712	722	732	742	752	762	772	782	792	802	812	822	832	842	852	862	872	882	892
603	613	623	633	643	653	663	673	683	693	703	713	723	733	743	753	763	773	783	793	803	813	823	833	843	853	863	873	883	893
604	614	624	634	644	654	664	674	684	694	704	714	724	734	744	754	764	774	784	794	804	814	824	834	844	854	864	874	884	894
605	615	625	635	645	655	665	675	685	695	705	715	725	735	745	755	765	775	785	795	805	815	825	835	845	855	865	875	885	895
606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796	806	816	826	836	846	856	866	876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797	807	817	827	837	847	857	867	877	887	897
608	618	628	638	648	658	668	678	688	698	708	718	728	738	748	758	768	778	788	798	808	818	828	838	848	858	868	878	888	898
609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799	809	819	829	839	849	859	869	879	889	899

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For employment brochures give home address
Home Address ______________ City ______________ Zone ______ State ______

For Change of Address:
Old Company Name ______________________

Old Company Address ______________ City ______________ Zone ______ State ______

☐ I Do Design Work
☐ I Supervise Design Work
☐ I Do No Design Work

ELECTRONIC DESIGN · ONE DAY SERVICE USE BEFORE DECEMBER 20, 1961

Name Title

Company

Company Address City Zone State

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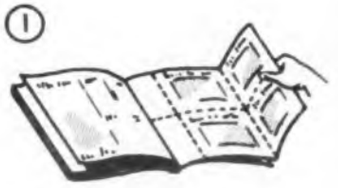
① 

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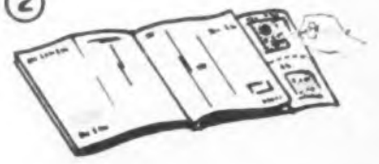
② 

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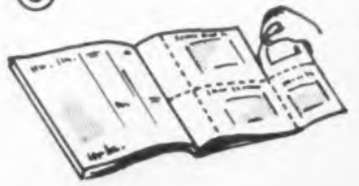
③ 

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In continuous commercial service, the 7801 delivers:

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