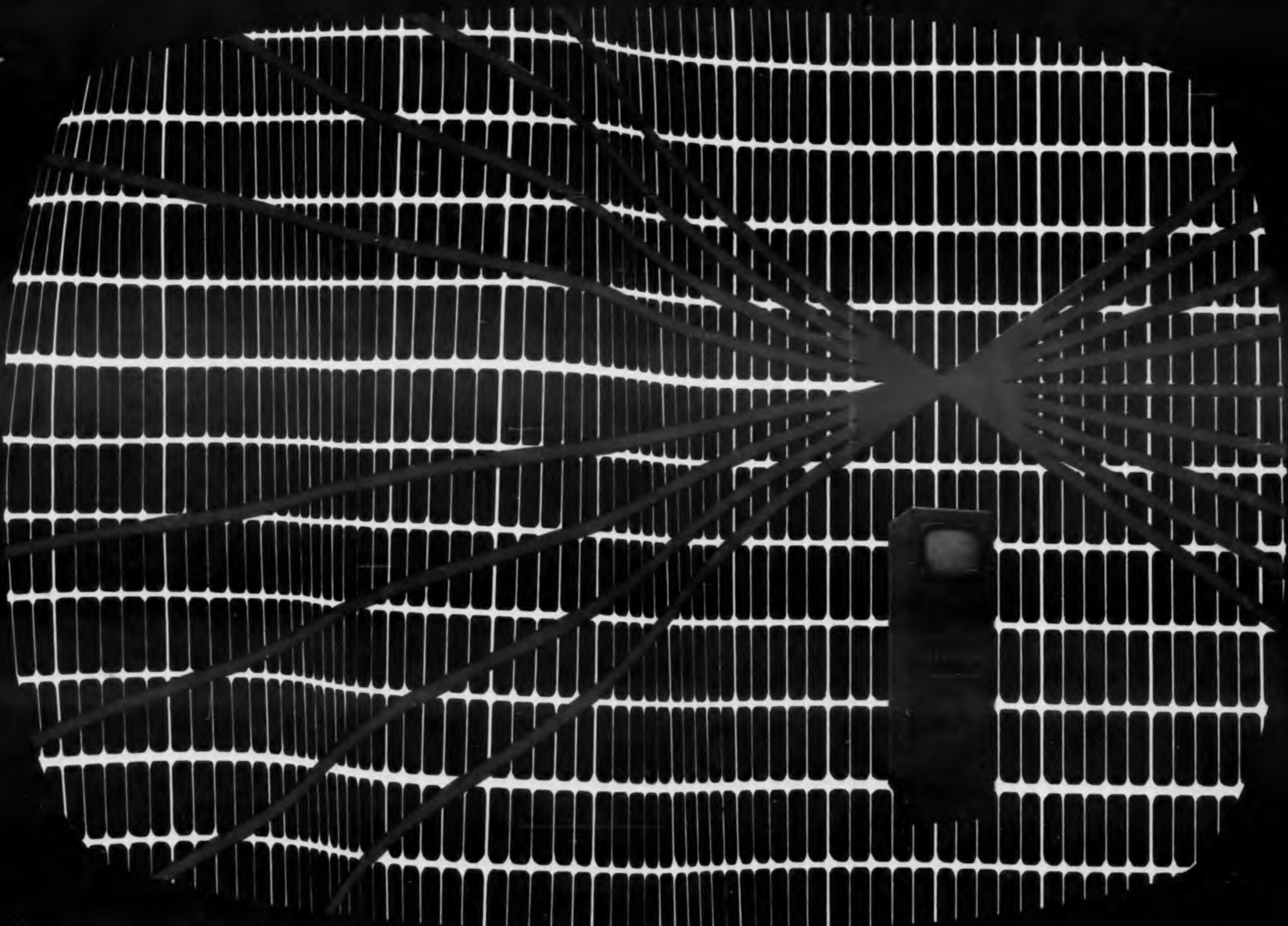
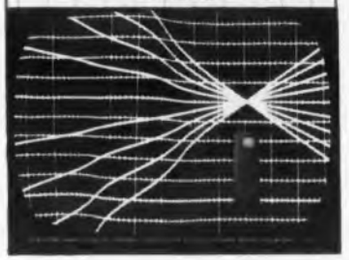
ELECTRONIC DESIGN

JUNE 21, 1961



ELECTRONIC GRAPH PAPER IN 8-CHANNEL DISPLAY GIVES ACCURATE READING DESPITE DISTORTION . . . . . p 54

ELECTRONIC DESIGN



COVER: External disturbances affect grid lines as well as signals in a new crt-display system, so calibration remains accurate. Our artist has captured the effect of such distortion in the left part of the cover.

Selected Topics for this Issue

Index of Articles

January 4 through June 21, 1961
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ELECTRONIC DESIGN · ONE DAY SERVICE

USE BEFORE AUGUST 2nd, 1961

Name _____ Title _____

Company _____

Company Address _____ City _____ Zone _____ State _____

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New hp 431A Power Meter

New hp Thermistor Mounts assure hp 431A Therma

hp 478A Thermistor Mount

This wide-range, temperature compensated coaxial mount covers 10 MC to 10 GC, with no tuning required. Closely matched thermal environments for the two thermistor pairs for use with the dual bridge hp 431A assure excellent tracking, even under thermal shock. The hp 478A as used with the hp 431A provides high accuracy and virtually drift-free operation.

SPECIFICATIONS

Frequency Range:	10 MC to 10 GC
SWR:	Less than 1.5 (less than 1.3, 50 MC to 7 GC)
Power Range:	1μw to 10 mw (with hp 431A)
Elements:	Four 100-ohm, negative temperature coefficient thermistors permanently installed.
Price:	$145.00

W
T

X-Band Mount, 8.2 to 12.4 G
perature tracking with the hp 4
ence of thermal shocks. No tu
usual freedom from drift is as
close temperature tracking a
ful matching of thermal envi
thermistors.

SPECIFICATIO

Frequency Range:	8.2 to 12.4 GC
Power Range:	1μw to 10 mw
SWR:	Less than 1.5
Elements:	Two permanently ins coefficient thermistor
Waveguide Size:	1" x 1½"
Price:	$145.00

tability, 1 μw to 10 mw coverage, in rowave power meter ever produced!

: less than 2 μw/°C
cy on all ranges

g zeroes all ranges

ate

:order output

:able operation

This new ϟ Power Meter makes continual zero-setting a thing of the past, even on the 10 μw range, with extreme temperature stability and a single zero-set covering all 7 ranges. You get a completely usable 10 db sensitivity premium over previously available equipment.

New, specially designed temperature compensated thermistor mounts are used with the ϟ 431A. The ϟ478A Coaxial Mount covers 10 MC to 10 GC, and the ϟ X486A Waveguide Mount covers X-Band.

A dual balanced bridge technique and careful design and construction keep dc power in one bridge equal to the unknown rf power in the other. The dc power is then metered. High heat conductivity materials and matched thermistors in close proximity in the 478A and 486A mounts provide extremely close thermal tracking. Thus ambient temperature effects are automatically balanced out and the meter remains zeroed, even in the presence of thermal shock.

These advantages combine to make the ϟ 431A unusually useful for instantaneous microwave power measurements. Microwave power standards measurements can be made to a high accuracy and resolution by using the dual bridge of the ϟ 431A as a transfer device. A dc calibration input jack permits precise dc calibration of the thermistor mount. The grounded output jack will then drive an appropriate digital voltmeter for increased resolution. In addition, the grounded output jack, combined with the nearly drift free operation of the 431A, makes reliable long term recordings of microwave power.

The ϟ 431A also has an optional rechargeable battery pack which will give up to 24 hours of completely portable operation, as well as regular ac line operation while recharging.

SPECIFICATIONS

Power Range:	10 μw to 10 mw full scale in 7 ranges. Also calibrated from −30 to +10 dbm
Accuracy:	±3% of full scale on all ranges
Overall Thermal Drift:	Less than 2 μw/°C (includes meter and 478A/486A Mounts)
Operating Impedance:	100 or 200 ohms, negative, for operation with above Mounts
Recorder/Voltmeter Output:	Phone jack on rear with 1 ma into 2,000 ohms or less
Calibration Input:	Binding posts on rear for calibration of bridge with precise dc standards
Power:	1½ watts, 115/230 v ± 10%, 50-1000 cps
Dimensions:	7½" wide, 6½" high, 12½" deep. Weight 10 lbs.
Price:	$345.00

mal Stability

ϟ 486A Waveguide Thermistor Mount

4 GC, provides close tem-
ϟ 431A, even in the pres-
lo tuning is required. Un-
is assured with extremely
ıg achieved through care-
environments for the two

ATIONS

ly installed 100-ohm negative
nistors for each bridge

or perhaps your power measuring requirements can be met by these ϟ meters

ϟ 430C Microwave Power Meter — 0.02 to 10 mw

This laboratory-proven meter gives instantaneous rf power readings direct in dbm or mw, 10 MC to 40 GC with ϟ proven bolometer mounts available now. ϟ 430C operates with any bolometer operating at 100 or 200 ohms, positive or negative temperature coefficient. Fully adjustable biasing current to 16 ma available to bring bolometers to their operating range. Five power ranges are selected with a front-panel control, full scale readings of 0.1, 0.3, 1, 3 and 10 mw. Also continuous readings —20 to +10 dbm. Accuracy is ±5% of full scale reading. Dimensions, (cabinet) 7½" x 11½" x 14"; (rack mount) 19" x 7" x 13½" behind panel. Price, ϟ 430C $250.00 (cabinet); ϟ 430CR, $255.00 (rack mount).

ϟ 434A Calorimetric Power Meter — 10 mw to 10 w

Here's the fastest, easiest means yet devised to measure powers accurately from 10 mw to *10 w*, dc to 12.4 GC! No barretter, thermistor, external terminations or plumbing are required. Measurements are as simple as connecting to a 50 ohm type N front panel terminal and reading directly. Only two front panel controls (range and zero); seven meter ranges for full scale readings of 0.01, 0.03, 0.1, 0.3, 1.0, 3.0 and 10 w. Also provides continuous readings —30 to +10 dbw. Accuracy ±5% of full scale (includes dc calibration and rf termination efficiency but not mismatch loss). Greater accuracy can be achieved through appropriate techniques. Dimensions, (cabinet) 20½" x 12½" x 14¾"; (rack mount) 19" x 10½" x 13½". Price, ϟ 434A, $1600.00 (cabinet); ϟ 434AR, $1,585.00 (rack mount).

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5. Bracket Assembly (MA-2115)
6. Illuminator (MA-2118)
7. Horizontal Adapter (MA-2042)
8. Riser Assembly (MA-2041)
9. Force Gage (MA-2031)
10. Electrode Aligner (MA-2102)
11. Precision Wire Cutters (MA-2052)

Not Shown: Visor (MA-2116)
Swing Pedal—15 lb. (MA-2022)

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CIRCLE 4 ON READER-SERVICE CARD

CONTENTS FOR JUNE 21, 1961 VOL. 9 NUMBER **13**

ELECTRONIC DESIGN Hayden Publishing Company, Inc.
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Coming Next Issue

Transistor types are growing and growing. And just keeping up with them becomes harder and harder—unless you're smart and consult ELECTRONIC DESIGN's Annual Transistor Data Chart. The ninth yearly edition of this easy-to-read aid—a "must" for design engineers who must select transistor types—appears in *ED*'s July 5 issue. You'll depend on it more than ever this year. Transistor types have soared—over 60 per cent above last year's total. The Annual Transistor Data Chart lists the specifications for more than 1,700 types. Be sure to consult it.


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CIRCLE 5 ON READER-SERVICE CARD

Disk Files in Race for 'Fastest With Mostest'

New IBM Unit, the 1301, Tops Original Model Built in 1956 And Is 4th Big Advance in Disk Storage in Less Than a Year

George Rostky
Associate Editor

A NEW disk file has joined the race to provide vast amounts of digital storage with very fast access times. The newcomer is the IBM 1301 storage unit, the fourth important development in disk files in less than a year. It is IBM's dramatic advance from its first important disk-storage unit, the IBM 350, introduced in 1956.

The 1301 is similar to the original 350 in that it uses 50 disks, of 24-in. diam, rotating in horizontal planes. But there the basic similarity ends. The 1301 uses 50 positioners rather than one or two, thus cutting maximum access time from 800 to a trifle more than 210 msec. Disks in the 1301 rotate at 1,800 rpm rather than 1,200, reducing the maximum access time on an individual track from 50 msec to about 33.

Track density has been raised from 100 to 250 tracks per disk surface, raising the storage from 5 million — or 10 million with double-density recording — to 50 or 56 million. Each character is of 6 or 7 bits. The number of characters and the number of bits per character vary, depending on the particular computer system with which the file is to be used.

All four disk-storage units introduced in the last year provide substantial improvements in speed, storage and flexibility over the original IBM 350 file.

The 350, often called the Ramac (because it was originally designed for the Random Access Method of Accounting and Control system, Model 305) has 50 magnetic-coated metal disks rotating in horizontal planes at 1,200 rpm. A single access arm moves up or down to select the appropriate disk, then moves in to the appropriate track. An additional access arm can be provided, so one can be reading or writing while the other is moving to the next disk.

With 200 tracks per disk — 100 on each surface — and with 500 characters per track, the Model 350 can store 5 million 6-bit characters. Maximum access time to a bit on a track, once the head is positioned on that track, is 50 msec. But since the access

Original IBM 350 has 50 disks rotating at 1,200 rpm and single positioner which must be moved to appropriate disk.

Telex I, in artist's rendition, is first of new disk files to use independent head positioning for each disk. First unit will be delivered within a few weeks.

Bryant 4000 file can have from one to 20 disks. Positioning arms, shown with three heads, can have as many as six.

Four Recent Disk Files Compared with IBM 350

Disk File	No. of Disks	Disk Diam (in.)	Speed (rpm)	Tracks per disk Surface	No. of Positioners	No. of Heads	Storage (10^6 char.)	Max. Access (msec.)
IBM 350	50	24	1,200	100	1 or 2	1 or 2	10	800
Telex I	16	31	1,200	256	16	64	22	250
Telex II	64	31	1,200	256	64	256	88	200
Bryant 4000	20	39	900/1,200	768	40	240	100	167
IBM 1301	50	24	1,800	250	50	100	50/56	210

IBM 1301 has fork-like positioning arm between each pair of disks. Magnetic read/write heads are at the end of the arms. Lower head reads information on upper side of lower disk while upper head reads lower side of upper disk.

RCA 361 disk file, announced late in 1960, does not really belong with other recent files in terms of storage capacity or access speed. It is most unusual though, in that individual record disks can be easily removed and exchanged. With 128 6-7/8-in. diam records, the file can store 4.6 million 6-bit characters. Average access time to a selected block is a rather long 4.25 sec.

arm may have to move past 49 disks before it can move into the selected track on the selected disk, maximum access can be as high as 800 msec.

Telex and Bryant Disk Files Ended 4 Years of Status Quo

Four years elapsed before a significant advance was made in the art of disk memories. Then Telex, Inc., announced the Telex I and Telex II mass-memory modules (*ED*, Aug. 17, 1960, pp 32-33). With separate positioning arms for each disk and two read/write heads for each disk surface, the Telex files offered drastically reduced access times — down to a maximum of 200 msec for the Telex II.

Larger disks (31-in. diam compared with 24 in. for the IBM Ramac), higher bit densities, and as many as 64 disks increased storage capacity for the Telex II to 88 million 7-bit characters.

Soon after the Telex advance Bryant Computer Products announced its Series 4000 disk files. These memories, with from 1 to 20 disks of 39-in. diam, could store from 5 million to more than 100 million 6-bit characters with a maximum access time of 167 msec. Disks, mounted in vertical planes, rotate at either 900 or 1,200 rpm. Six or more read/write heads on each disk surface substantially reduce access times.

The need continues for vast amounts of random-access storage with very small access times. IBM's 1301 is viewed as another answer, but certainly not the final one. ■ ■

NEWS

Dust Is Accelerated To 10 Km Per Sec

Van der Graaf Unit Helping Probe Effect of Meteorites on Satellites

TO STUDY the effects of micrometeorites on satellites, investigators are accelerating micron-sized particles to velocities of 10 km per sec. The particles gain their velocity through positive charging and injection into a 2-megavolt Van der Graaf generator.

Previous systems provided velocities on the order of only 2 km per sec, according to researchers at Space Technology Laboratories, Canoga Park, Calif., where the experiments are being conducted.

Dr. J. F. Friichtenicht, head of the company's artificial meteorites section, reported that the hypervelocity particle research system had been set up to measure the effect of small meteorites on satellites. In the immediate region of the earth, meteorites are said to travel at velocities ranging from 11 to 74 km per sec.

Besides measuring the frequency of collision, micrometeorite detectors measure the intensity and spectrum of the light flash generated by particle impact, the ionization caused by the impact, and the acoustical energy generated by impact. Space Technology Laboratories hopes relationship will be discovered between light flash, ionization and acoustical energy, and the physical parameters and composition of the particles.

Other techniques for accelerating particles to hypervelocities include shaped charges, where the charge explodes and tears a liner

Two megavolts accelerate micron-size particles in test and calibration unit for micrometeorite detectors, set up by Dr. Joseph F. Friichtenicht, above, of Space Technology Laboratories. A Van der Graaf generator, used in the acceleration process, is behind the dark lead shielding at left.

into small pieces that impact on the target; light-gas guns, in which a gas is exploded into a small chamber with a diaphragm that bursts suddenly; and simpler techniques that inject energy into particles by electric or magnetic fields.

Van der Graaf Generator Can Fire Single Particle Rather Than Cloud

The advantage of the Van der Graaf generator system over shaped charges is its ability to fire one discrete particle rather than a cloud, Dr. Friichtenicht asserts. The light-gas gun is good for heavy-particle research: it fires particles 0.25 to 0.5 in. large in size, but it would destroy any target placed in front of it, making it useless for meteorite-detector calibration.

In Dr. Friichtenicht's technique, the Van der Graaf generator is enclosed in a chamber filled with high-pressure gas. A detector measures the charge and velocity of the particle as the latter passes on its way to the target area.

"By measuring the charge and velocity of the particle, we can compute its mass," Dr. Friichtenicht says. "The detector element is a cylinder with a given capacitance to ground. As the particle passes through the cylinder, it induces a charge on it. By measuring both the amplitude and the duration of the charge, we can calculate the charge on the particle and, of course, its velocity."

Former research using Van der Graaf generators has involved 120-kv sources, Dr. Friichtenicht reported, which gave particles velocities on the order of 2 km per sec. The 2-megavolt Van der Graaf generator, he said, provides particle velocities of 10 km per sec, approaching the velocities of real micrometeorites near the earth. ■ ■

Tiny Transistor Walkie-Talkie Designed For U.S. Citizen Band

A miniature transistorized walkie-talkie, designed for the United States Citizen Band market, has been developed in Japan.

Called a Transi-Phone by its developers, Iwata Electric Co., Ltd., the instrument measures 4-7/8 by 2-3/4 by 1-3/4 in. and weighs 12 oz. It is equipped with eight 1.5-v batteries and an antenna. For short-range communication in the 27-mc band, it has a range of approximately 1/2 to 1 mile.

Electronic Importers and Exporters Co., Inc., of Long Beach, Calif., is expected to be appointed sole agent for the U.S. market.

Spread-Spectrum Com System Uses Modified PPM

Martin's Digital Racep, High-Speed Facsimile and Teletype Links Among Equipment Demonstrated at Military Convention

Alan Corneretto
News Editor

BY MODIFYING conventional pulse-position modulation techniques, communication engineers have developed an asynchronous, discrete-address digital system said to be capable of providing mobile telephone-type voice service for up to 700 users. In the system, a single wideband channel is used simultaneously by subscribers on a random-access basis without synchronization.

The system, called Racep, for Random Access and Correlation for Extended Performance, (*ED* April 26, 1961, p 4), does not require the reference signal and synchronizing oscillator usually needed for ppm. This feature is said to save about 50 per cent of the pulses required for comparable ppm service. Martin Co., which developed Racep, has built a demonstration system and is constructing a slightly different version for possible test by a military agency.

Racep, displayed and described at the 15th Annual Convention of the Armed Forces Communications and Electronics Association in Washington, D. C., June 6-8, works as follows for voice operation:

The speech waveform is sampled and converted to the modified pulse-position modulation in a diode network. Each ppm pulse is address-coded by transmitting it as a group of three sub-pulses. Each of the sub-pulses is transmitted at a different carrier frequency in a time-frequency matrix. Time-delays corresponding to the desired address-code are inserted by conventional means between the sub-pulses prior to transmission.

The current system uses a 4-mc band in the vhf region.

At the receiver, detection of a transmitted pulse group is accomplished by detecting the energy envelope of each sub-pulse and inserting complementary delays. The signals are then coincidence gated. Because the receiver is fixed in the time and frequency-pulse system, all sub-pulses must be present in the proper time slots for the full ppm pulse to be present at the output of the decoder.

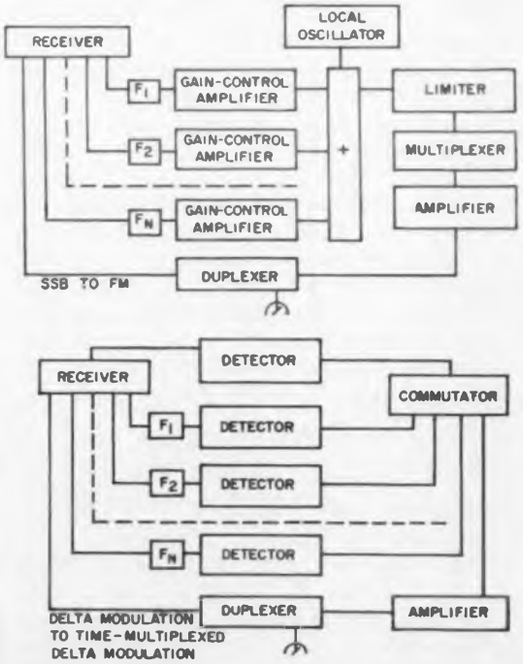
Pulses at the decoder output are fed to a nonsynchronous ppm demodulator that re-

Two approaches to spread-spectrum communications. Racep, left, is asynchronous, random-access, discrete-addressed system using modified ppm and 4-mc bandwidth. Cherokee, right, uses pseudo-noise sequence cross-correlation techniques and nearly 1 mc of bandwidth. Developmental Cherokee also operates as standard fm system.

Cooling chamber with 1/12 cu ft capacity maintains internal ambient from 0 to 100 C.

Controller maintains temperature of 20 to 30 C with 0.5-C accuracy in a −20 to +55 C ambient.

Thermoelectric cooler for transistors maintains case temperature at 35 C.



Signal processing of two types is being studied for communications satellite under development at ITT. System above accepts a number of independent ssb channels to phase-modulate a local carrier with this intelligence and retransmit it. Processing must be done at very-low-phase excursions to minimize cross-talk. More rugged method below receives voice samples in the form of delta modulation on a number of channels. Detection is easy because data is digital.

generates the original speech signal. The width of the pulses used is narrow in relation to the sampling period. This allows many signals from different transmitters to occupy the same channel with minimum cross-talk. A variation of ppm was chosen because of the relatively high efficiency of this modulation technique, Martin reports.

The low-duty-cycle system is said to provide the advantages of both spread-spectrum and discrete-addressed systems. These advantages are relatively high freedom from interference and jamming, efficient use of spectrum and operational flexibility.

Transponder capability is claimed for Racep. Its basic design is said to allow a simple automatic transponder operation by tieing the receiver output, after all logic and processing stages, to the transmitter input just prior to address encoding. For full duplex transponding, duplicate address encoding and decoding would have to be provided, Martin reports. This would be done in the receiver by duplicating one AND-gate circuit. In the transmitter, two sets of delay-line taps from one delay line would be used with inhibit gates on each, so that both sets of taps and addresses could be used, though not at the same time.

The company envisages unattended transponder versions of Racep forming relay circuits that span great distances.

Current versions of the system have a command over-ride feature that permits one command set to interrupt all normal traffic and simultaneously address all receivers, including those not in use at the time. Nets and conferencing can also be provided by the equipment, Martin says.

Noise-Correlation Spread Spectrum Equipment Displayed at Convention

At the Washington conference Martin also showed a developmental communications set based on pseudo-noise sequence cross-correlation spread-spectrum techniques. This system, called Cherokee, represents another wideband approach to spectrum conservation and message security.

The system transmits with about 1 w going to the antenna for radiation over nearly 1 mc. Power available to a conventional receiver from the transmitter is only about 1 to 2 per cent of that which would be available from an ordinary transmitter, Martin reports. Therefore the signal appears in the conventional receiver as low-level noise over a wide frequency spectrum.

The system, which uses cross-correlation techniques for signal detection, is said to be

near-optimum in transmitter power conservation. It provides a large ratio of spectral bandwidth to information bandwidth, according to the company. Cherokee is claimed to have a ratio of 16 db.

ITT Suggests Frequency-Division Scheme for Synchronous Communications Satellite

In a paper delivered at the convention, William Glomb of ITT Federal Laboratories, Paramus N. J., reported on a communications satellite concept that the company is developing and has proposed to the Federal Communications Commission. In its elementary form, the system would handle 1,000 channels of simplex traffic at 40-db signal-to-noise ratio per channel. The active repeater in a stationary orbit would have the following parameters:

Rf bandwidth, 60 mc; ground-receiving system temperature, 145 K; noise in 60-mc band at receiver, −99 dbm; carrier-to-noise ratio at threshold, 12 db; signal at receiver, −87 dbm; path loss, 117 db; signal radiated by satellite 30 dbm, 1 w;

At these parameters the cost per channel mile works out to $10 a voice channel, Mr. Glomb said.

The weight of the satellite would be 175 lb. It would be launched by an Agena B rocket.

For duplex and multichannel operation, ITT suggests a frequency-division modulation system. Rather than achieve this by providing repeaters for each direction in each trunk, the company proposes to program the ground transmissions to arrive at preassigned, non-overlapping time intervals. The overlapping would be at a rate that would not significantly affect circuit delay. Bursts of pulses would be interleaved. This would require storage for 100 msec, or for about 5,000 bits, in each channel. Readout would have to be at a 50-megabit rate, Mr. Glomb reported.

Lofti Experiment Confirms Usefulness Of Very Low Frequencies for Space Links

The low frequency trans-ionospheric satellite, Lofti, launched into a highly eccentric orbit in February of this year, provided evidence of the versatility of vlf, according to Dr. R. L. San Souci, Sylvania Electronic Systems, Amherst, N. Y., who discussed trends in communication systems at the convention.

He said that 18-kc time-and-frequency-standard transmissions sent from the ground were received in the satellite at all times

High-speed facsimile scanning and recording system operates at 190 sq in. of copy per min, with 96-line resolution. Alden system uses 24-kc channel.

and at all heights. On several occasions, the signal levels of the 30-kw transmissions exceeded the 10,000-μv-per-meter saturation level of the receiver.

High-Speed Facsimile Equipment Operates at 960 RPM with 19-in. Tape

A facsimile scanner and recorder capable of operating at 960 rpm, the equivalent of 9 in. per min, and using standard 19-in. wide paper, was shown by Alden Electronic and Impulse Recording Equipment Co., Inc., Westboro, Mass. Resolution is 96 lines per in., the company states. It reports that the relatively high-speed is a result of using a resilient helix in conjunction with an endless-loop electrode for charging the paper.

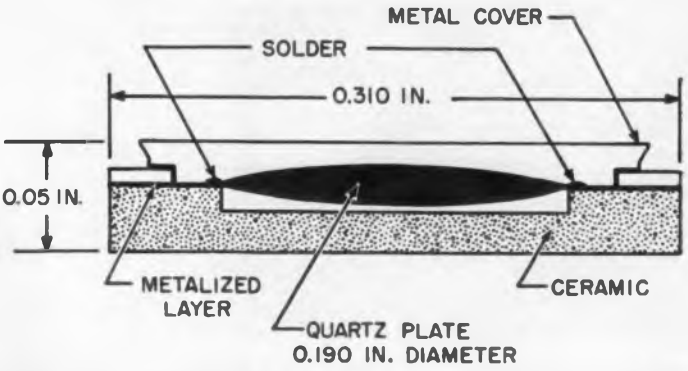
Thermoelectric Coolers Developed by Texas Instruments Displayed

Prototype thermoelectric coolers developed by Texas Instruments, Inc., Dallas, were shown publicly for the first time at AFCEA. On display were a transistor cooler, a temperature controller, and two cooling chambers. The company reported that as soon as power-supply problems were solved, which is expected to be soon, it will market these units. All are Peltier devices.

The transistor cooler was developed for the Navy's Bureau of Ships and is in use at TI cooling transistors on a developmental production line. It is reported capable of maintaining case temperature at 35 C while dissipating 300 mw of thermal power at an ambient temperature of 85 C.

The company's temperature controller is said to be accurate to ± 0.5 C from 20 to 30 C in an ambient temperature ranging from -20 to $+55$ C.

One cooling chamber shown, with a capacity of 1/12 cu ft, reportedly drops temperature from 24 C to 1.5 C in 11 min with no internal heat load. ■ ■



RCA 10-mc microminiature quartz-crystal assembly consists of a 0.190-in.-diam quartz plate soldered to a multiple-level ceramic plate containing metalized contacts. A metal cover plate is then ultrasonically soldered to the ceramic body. The parameters are C_o = 3.5 pf, C_1 = 0.01 pf and R_s = 15-20 ohms.

Micromin Quartz Crystals Developed

RCA Tells 15th Frequency Control Symposium Of Its Success in Filling Gap in Equipment

MICROMINIATURE assemblies requiring one or several quartz crystals will no longer be hampered by a lack of these devices in suitably reduced size, the 15th Annual Frequency Control Symposium in Atlantic City, N. J., was told.

Robert E. Bigler of the Radio Corp. of America, Surface Communications Div., Cambridge, Ohio, outlined progress by his company in developing quartz crystals for the Signal Corps Micro-Module Program. Engineers at the symposium heard up-to-date reports on atomic and molecular resonance effects and devices, the results of vlf clock synchronization checks and gains in quartz crystal stability and circuitry.

The target of the RCA quartz-crystal efforts was a device having a minimum height of 0.050 in. and over-all dimensions in agreement with the standard 0.310 by 0.310 in. micromodule wafer. The initial design, developed by Midland Manufacturing Co., proved the feasibility of producing quartz crystals covering 7 to 70 mc on fundamental and overtones. But because of a need for solder-seal rings, the original design was judged poor in terms of production feasibility. RCA, Mr. Bigler related, then designed a ceramic package to eliminate the solder-seal problem.

Sealing the micromodule holders has presented the greatest problem, he reported. Use of a transistor housing overcomes some major problems at the expense of reduced quartz plate size; moly-manganese metalization in controlled firing atmosphere has given the best results to date. Units fabricated to date have withstood the shock and vibration requirements specified in MIL-C-3098B.

Solid vs Gas-Discharge Methods For Optical Masers Compared

Dr. W. Kaiser of Bell Telephone Laboratories, Murray Hill, N. J., commenting on progress in optical masers, compared solid vs gas-discharge excitation techniques. Beam sharpness of 0.5 min has been realized with gas discharge and 3 min with a solid medium, he said. Line narrowing or $\nu/\delta\nu$ is on the order of 10^{-10} with gas, compared with 10^{-6} for solid. Up to 10-kw pulsed output has been obtained from solid devices; gas-discharge techniques have permitted continuous operation with 10-mw output. Solid devices have

been operated at room temperature, 300 K, to as low as 4 K, while satisfactory performance is possible at room temperature with gas discharge, Dr. Kaiser reported.

VLF Geographical Mapping System Compares Favorably With Radar

The feasibility of world-wide synchronization of atomic clocks (WOSAC) to within 1 sec was a Signal Corps project conducted in 1959-60. Paul Brown of the Army Signal Corps R&D Laboratory told the symposium that vlf propagation studies confirmed the prediction that E-W velocities below 18 kc were higher than W-E velocities. Also, there is some evidence, he said, that nonreciprocity is not eliminated for NS-SN signal paths, as previously assumed.

A comparison for vlf distance measurements with geographical distances measured by radar mapping showed agreement within 1 per cent over the United States continent, with large discrepancies over certain areas of the Pacific, Mr. Brown said. Additional time is needed, he added, to analyze the enormous data collected, and a full report will be available in late summer. ■ ■

NEWS

Infrared Radiation of Stars Being Charted as Navigation Aid

The infrared radiation of known stars is being charted in a new star atlas for use in developing systems for space navigation.

The project, the first part of which will be completed in about six months, is being conducted by Eastman Kodak Co., Rochester, N. Y., under contract with the Army Rocket and Guided Missile Agency, Redstone, Ala. This is the first time equipment has been available for such sensitive infrared mapping, Kodak reports.

Special sensing equipment made by Kodak and attached to a 69-in. reflecting telescope at Ohio State University is recording the radiation. Thus far the work has yielded the first stellar information ever obtained in the middle-wavelength portion of the infrared spectrum. New equipment is now being built for recording longer wavelength radiation.

One purpose of the Kodak program is to determine the relations between a star's visible radiation and its infrared radiation. Astrophysicists have recently theorized that the celestial sphere may contain large numbers of very cool stars, invisible to the eye but detectable in the infrared. Kodak is now considering extending its work to build an infrared photometer that will have a wide enough field of view to search for these "cold" stars.

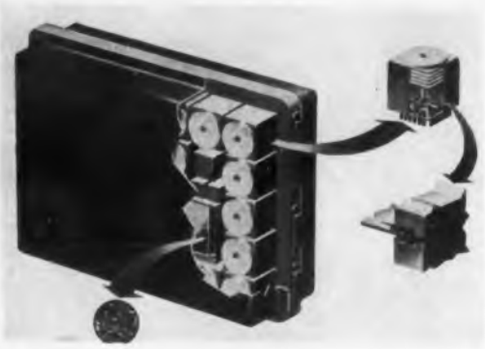
Molecular Digital Computer In Design at Westinghouse

A miniature digital computer that would use functional blocks is reportedly under development at Westinghouse Electric Corp.'s Air Arm Div., Baltimore.

To be ready for testing in about 18 months, the computer is planned to have an expandable random-access memory of 1,600 bits. It would weigh 14 lb, displace 0.265 ft, and be capable of about 50,000 operations per sec —hopefully.

Called Mol-E-Com, the molecular computer would be used in guidance systems, radar processing, fire control and similar applications. The company reports that its main advantage would be its high reliability, despite the 10-to-1 reduction in size it would make possible.

The basic unit of the computer would be functional blocks of etched germanium, about



Molecular computer weighing 14 lb would use modules of functional-block stacks for logic and other functions. Memory would be random-access, expandable store of 1,600 bits. Though a core memory is shown in this artist's conception, final version of computer may incorporate another type.

3/4 in. sq and approximately 1/64 in. thick. Each of these would provide separate electronic functions. The basic units would be stacked in modules; the modules would be packed together to provide all the switching, amplification and logic functions required.

In a separate announcement, the company reported that it has formed a semiconductor molecular electronics department to develop, manufacture and market molecular electronic functional blocks. The new department is headed by F. M. Heddinger, former assistant to the general manager of the company's semiconductor department.

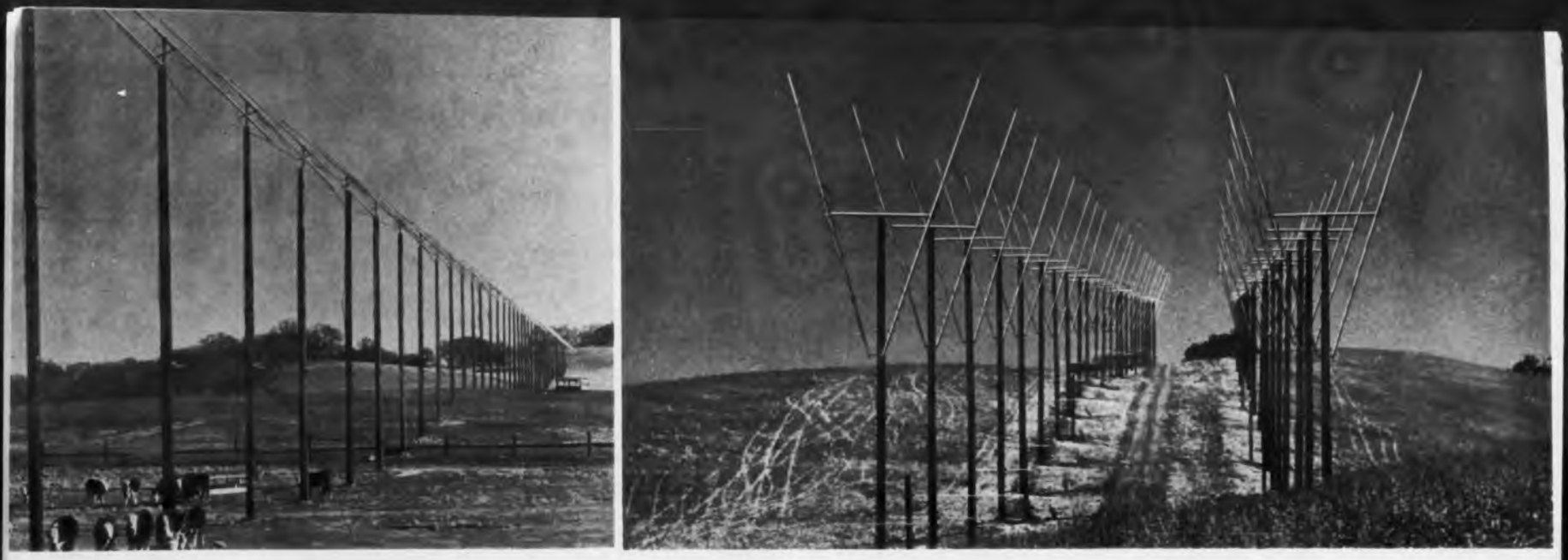
Giant Radio-Radar Telescope Due for Completion in 1962

A radio-radar telescope with a 1,000-ft-diam reflector is expected to be ready for Defense Dept. solar-system observations by next February.

The telescope, designed by Cornell University, Ithaca, N. Y., is now under construction near Arecibo, Puerto Rico. It will make possible study of the upper atmosphere, space and the solar system by both radar methods and the sending and receiving of radio signals.

The estimated costs are $4.1 million for the reflector and feed system, with the overall project expense put at $6.5 million—much less than for similar sending and receiving installations, according to Cornell.

Lower costs are reported possible because the designers are placing the reflector in a natural bowl for easy construction and because the reflector is stationary. The telescope is pointed by rotating and translating the line feed.



NEWS

Antenna "farms" erected by Stanford University and Stanford Research Institute. Array at left consists of 96 yogi antennas on two rows of poles. At right is an array of 50 log-periodic antennas, which will be used in radar astronomy to transmit and receive signals from the sun, moon and planets.

Antenna Array Heralded as Alternative to Huge Dish

Coherent Groups of Small Paraboloids Are Cheaper and Easier To Build, and Provide Greater Flexibility for Tracking Objects

DISH "farms"—large, coherent arrays of small parabolic antennas—may soon replace giant parabolic antennas for many applications. The arrays would be composed of antennas of about 10 ft diam or possibly up to 28 ft, as against single paraboloids larger than 28 ft diam (some as large as 600 ft).

The advantages of decentralization, according to antenna makers pioneering in this area are impressive. The arrays, they say, would:

- Be cheaper and less difficult to build.
- Offer extremely high resolution.
- Provide greater maneuverability in tracking and surveillance work.
- Give the military an antenna system that could be "hardened" against nuclear attack and possibly be useful in countering enemy ballistic missiles.

Military and Civilian Studies Made; Phase Control Is a Key Problem

Military interest in the development is evidenced by the activity of special committee set up by the Joint Chiefs of Staff to investigate communications problems. Companies active in the field, or looking closely at it, include Bendix Air Arm Div., International Telephone and Telegraph, Jet Propulsion Laboratories, Sperry Gyroscope Co., Lincoln Laboratory of the Massachusetts Institute of Technology, Stanford Research Institute, Stanford University, Electronic Specialty Co., and Canoga Electronics Corp.

Problems in the design of the new antenna systems include the electromechanical positioning of all the antennas and keeping the phase from each individual transmitter-receiver additive. The positioning problem, according to industry sources, should be readily soluble.

Stanford University's Dr. Ronald Bracewell says the key problem is phase control. At Stanford's 32-antenna farm, phase monitoring is accomplished by means of gas-discharge tubes in the transmission lines. Accurate phase measurements at 9.1 cm over an aperture of 1,339 wavelengths are necessary.

The laboratory's cross-antenna has a beamwidth of one-twenty-fifth of a degree. Dr. Bracewell reported. So narrow is it that the Fresnel region extends 80 km into space. Determination of the beam solid angle is impossible using high-flying aircraft—they don't fly high enough. Stellar or planetary bodies are used instead.

Many phase-control techniques are available to the antenna designer, ranging from variable-delay filters in the transmission lines to gas-type "plasma" phase shifters, ferrites, varactor diodes and mechanical "trombones." Joe G. McCann, vice president and director of engineering at the Canoga Electronics Corp., Canoga Park, Calif., points out that electron-beam parametric amplifiers may be excellent for the purpose. Another technique that has been carefully investigated and seems promising is modulation of the helix of a traveling-wave tube, says Stanford Research Institute's Richard Honey.

In discussing the advantage of dish arrays over large parabolic dishes, Donald W. Moore, director of engineering at the Electronic Specialty Co. in Glendale, Calif., cited mechanical and economic factors.

"Big dishes," he said, "become intolerably expensive to build after a certain diameter —100 ft dishes seem to be the largest practical. Moreover they're useles for anything

Radio telescope consisting of 32 small reflectors is shown with Prof. Roger Bracewell, director of the antenna farm project at Stanford.

but tracking of very slow-moving objects, like stars. They require railroad trains to move, and when their azimuth is changed, they warp, twist and torque, throwing one part of the antenna out of phase with the other. Temperature differentials caused by sunlight and partial shading are a big problem, even when the antenna can be enclosed."

Hardening antennas against nuclear blasts is made much easier with dish farms, Mr. Moore said. "A fundamental advantage exists," he noted. "The height required by the individual antennas is much less than the height of a comparable single-aperture antenna. Construction to withstand blast effects or submerged standby antenna elements, which emerge and replace damaged elements after each blast, are both more easily implemented with the multiple-antenna system approach."

One important potential for future dish farms is the concentration of large amounts of radio-frequency energy at some distance from the array. According to Mr. Moore, this would make it possible to vaporize chaff released by an enemy intercontinental ballistic missile to prevent interception. ■ ■

NEWS

Tunnel Amplifiers: What Lies Ahead?

Caltech Experimenting With Metal; Philco Developing Germanium Unit

Thomas E. Mount
West Coast Editor

NEGATIVE-resistance devices have historically given way to stable three-terminal amplifying devices. Therefore, says Dr. Carver A. Mead, Professor of Engineering at the California Institute of Technology, tunnel diodes, too, will be replaced by triodes.

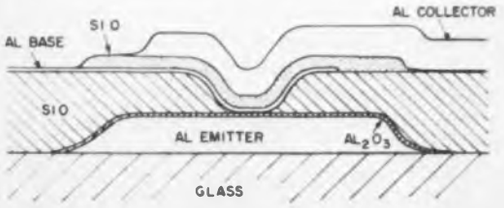
He concludes that tunnel-emission amplifiers and metal-interface, cold-cathode vacuum emitters have a great potential for future electronics.

Philco Corp. has already announced a working tunnel-emission amplifier, still in the development stage (*ED*, June 7, p24).

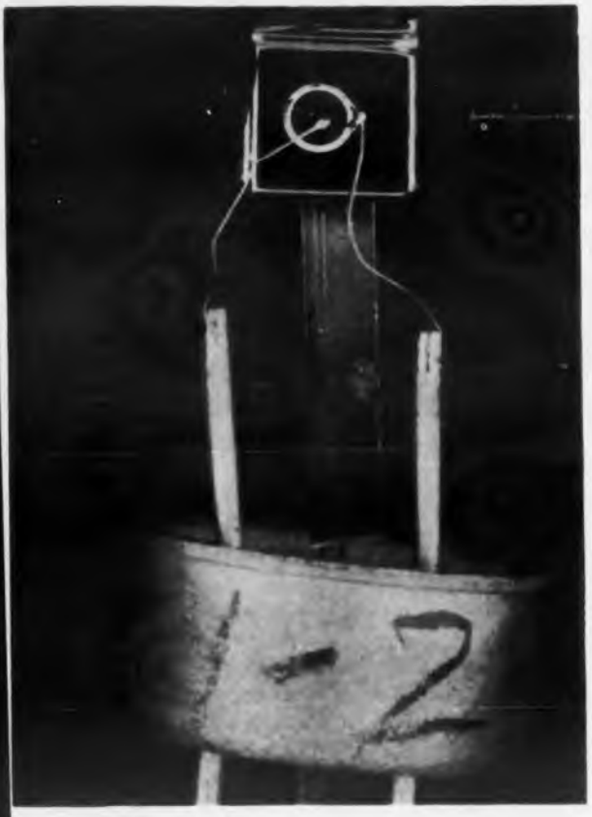
"With minority carrier devices, you typically restrict yourself to current densities on the orders of the doping of the semiconductor material," Dr. Mead says. "Majority carrier devices like tunnel amplifiers, which use metals, have the ultimate in current-density potential. Semiconductors are an interim-stage device in this respect.

"It seems silly to use semiconductors as a source of tunneling electrons, since you want as large a source of electrons as possible. Moreover frequency response in a transport device is essentially limited by the number of majority carriers available.

"Once interest in a negative resistance is abandoned, it becomes clear that semiconductors are of little value; their carrier densities are quite low. Metals with very large electron densities can be used as a carrier



Early tunnel-emission amplifier designed by Dr. Carver Mead of the California Institute of Technology used simple injection of electrons into aluminum by quantum mechanical tunneling through aluminum oxide film.



Philco's metal interface amplifier is enlarged four times to show construction of experimental device. Power gain at room temperature has been achieved with these devices.

source, with insulators providing the necessary forbidden region."

Unlike Caltech, Philco Is Using Germanium Substrate as Collector

The Philco device, unlike the Caltech amplifiers, uses a germanium substrate as the collector.

"Our tunnel-emission amplifiers are an order of magnitude less efficient," Dr. Mead admits, "but on the other hand we have been directing our efforts toward understanding the physics of the phenomenon rather than build devices."

Use of germanium in the new amplifiers will be discontinued eventually, Dr. Mead predicts. "While it provides a lower work function and gives fair efficiency to the devices now," he says, "it does contribute a series resistance that should be eliminated, and presents problems when trying to operate elevated temperatures."

The chief problem in the design of tunnel-emission amplifiers, Dr. Mead asserts, is an "almost total" lack of knowledge at present

NEWS

of the pertinent properties of materials, both metals and insulators, and a great need for suitable techniques for fabricating the desired structures. "We were lucky to have stumbled on aluminum first," he says.

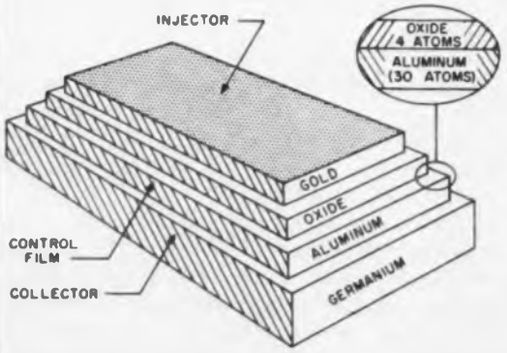
Required in the materials are chemical stability (films are thin, so the metals used should not diffuse through the insulators), reasonably large electron mean free path, high conductivity and high-temperature capability. "In a large number of metals the mean free path of electrons is quite long, so that's not a big problem," according to Dr. Mead.

Tunnel-Emission Amplifiers First Publicized in 1959

The first report on tunnel-emission amplifiers was written by Dr. Mead in 1959. Early triodes were prepared. Aluminum was evaporated on a glass substrate, in the form of a stripe 5 mm wide, and was anodized to the desired oxide thickness—from 50 to 100 A. To avoid field concentrations at the edges, silicon monoxide was evaporated over all but a 1-mm stripe in the center.

Thin (about 300 A) aluminum base layer stripes 1 mm wide were evaporated through a mask, which allowed them to extend to the left so contact could be made. A thin film (about 100 A) of silicon monoxide was then evaporated over the central part of the assembly, and finally thick aluminum collector stripes were evaporated in registry with the base stripes, but extending to the right. Contact to all regions was made with pure indium solder.

In the Philco tunnel-emission amplifier an



Four layers are used in Philco's tunnel-emission amplifier. The gold and aluminum oxide are analogous to the emitter of a transistor, the aluminum film similar to a transistor base, and the germanium a collector. The thickness of the base is much smaller than the mean free path of electrons entering this region from the gold emitter.

aluminum film about 100 A thick was evaporated on the etched surface of a 1 ohm-cm, n-type piece of germanium. This created a collector surface barrier at the interface, according to a report by James Spratt, Ruth Schwartz and Walter Kane of the Philco's Research Div. A thin oxide film was then formed on the surface of the aluminum film. A film of gold was evaporated over the oxide to serve as a source of electrons.

The electrons from the gold can pass through the oxide film only by a quantum mechanical tunneling through the forbidden region. They arrive in the base metal at an energy above its Fermi level. If the base metal is thin enough, the electrons will arrive at the next barrier with no loss of energy.

The next barrier, at the interface between the aluminum and the germanium, is of a height less than the electron energy; the carrier passes through into the collector and contributes to the current in the collector circuit. Lower energy electrons in the metal film cannot pass the barrier, so the collector current is dependent only on the properties of the "hot" electrons. ■ ■

Navy Accepts Helicopter Simulator

The Navy has accepted delivery of its first helicopter flight and weapons system simulator. The training device duplicates on the ground the full performance of the all-weather HSS-2 Sikorsky helicopter. The HSS-2 is equipped with AN/AQS-10 sonar and is designed as an advanced system for antisubmarine warfare. The simulator, developed by Melpar, Inc., Falls Church, Va., will be used to train tactical crews in communications, navigation, antisubmarine research procedures, target tracking, detection and classification, and delivery of weapons.

CIRCLE 19 ON READER-SERVICE CARD

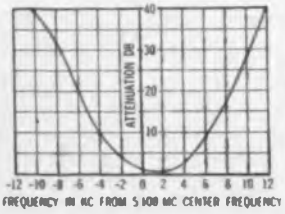
Itek

Crystal Filters do Wonderful Things

A toast to Itek for a wonderful thing . . . Itek Crystal Filter 968B, with a near-Gaussian attenuation characteristic makes possible a 10,000 channel receiver! In antenna circuits, this 5 MC Filter optimizes pulse response, minimizes overshoot, and eliminates adjacent channel interference.

Perhaps you don't need a Gaussian crystal filter. But could you use the ingenuity that built one? Could Itek technical leadership help you?

Of course, the world's largest and most complete selection of stock filters is available, too. Choose from more than 3,000 Itek-Hermes designs.



Write for free Brochure "WEESKACFAACP" or, What Every Engineer Should Know About Crystal Filters At A Cocktail Party. You'll enjoy it.

Itek Electro-Products Company

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CIRCLE 20 ON READER-SERVICE CARD

WASHINGTON REPORT

John J. Christie
Washington Editor

HARD DECISIONS FOR THE FCC

The crucial problem facing the FCC as it moves toward establishing a basis for commercial satellite communications is how to provide adequate inducement for hardware manufacturers to stake their maximum capabilities in the program.

This problem has been made acute by the commission's tentative decision to limit participation in a joint venture to the common communications carriers.

The FCC has guaranteed that by competitive bidding and other requirements it will prevent the manufacturing divisions of the common carriers from achieving a preferred position in the procurement of hardware for construction and maintenance of an operational system. But this still leaves open the vital question of the noncarrier's role in the developmental stage.

It is generally conceded that at least a two-year period of research, test and evaluation of proposed satellite communications systems will elapse before even a tentative decision as to the initial operational one can be made.

GE, which has petitioned the commission to reconsider its decision favoring an all-carrier enterprise, stated the proposition bluntly when it posed this question to the FCC: "How would you assure aggressive, total effort in research and development in a system [the proposed joint venture] that is limited by its very nature to only the communications carriers?"

The Next Move by the FCC will be to dispose of GE's petition for reconsideration of the all-carrier-joint-venture decision. Prompt action can be expected. The deadline for filing replies to the petition was June 17.

The commission has indicated it will call for formation of a special industry committee to propose a scheme of ownership and operation. FCC and Justice Dept. representatives probably will sit with the committee as observers and consultants.

Unless the FCC reverses itself, the industry members of the special committee will be representatives of the communications carriers. However, the commission has indicated a willingness to have the manufacturers represented in an advisory capacity to insure fullest consideration of technical capabilities.

General Telephone and Electronics Corp. has suggested that the commission give early consideration to the systems concepts that have been proposed. Although acknowledging that it would be premature to go into technical details, the company notes that an indication of the type of system that might be used for initial operations would be helpful to the deliberations on ownership and organization of a joint venture.

NASA Has a Triple Role to play in the developmental phase of the commercial satellite communications program: working with pri-

vate firms, advising the FCC and carrying out Project Relay, an experimental low-altitude active system that should provide highly useful data on the effect of space environment on electronic components.

The additional sum of $50 million requested by the Administration for NASA's satellite communications activities in fiscal 1962 will all be devoted to aiding private projects. Presumably the funds will be used primarily to provide launching and tracking services for experimental satellites.

NASA officials expect the agency to work intimately with the joint venture until what they describe as a "transitional operational system," limited in capacity but with some day-to-day capability, is in operation.

PATENT ISSUE COMPROMISE

Westinghouse may have come up with a solution to the problem facing Congress over what to do about patent rights to inventions arising out of Government-financed R&D.

It has proposed legislation under which the Government would acquire patent rights during the first five years of R&D activity in any trail-blazing field of technology. In the succeeding five-year period patentable discoveries directly related to the same field would be subject to compulsory licensing. Thereafter rights would be acquired by the contractors making the inventions.

Otherwise—except where national security and safety considerations are clearly involved, as in nuclear energy and outer space—contractors would be assured patent rights for commercial exploitation, with the Government getting royalty-free, nonexclusive licenses. In effect, the proposal would give legal status to the liberal policy that the Dept. of Defense pursues by administrative action. The department recently revised its policy along the same lines by requiring contracting officers to withhold patent rights from contractors in new fields of R&D where a monopoly patent position might otherwise result.

From a Congressional standpoint, the Westinghouse proposal has two virtues: (1) It would circumscribe the conditions under which contractors stand the best chance of gaining a commercial advantage under patents earned at Government expense; and (2) It would provide precise criteria by which all Government agencies could determine when and when not to retain rights.

*A **Reversal of Position*** on patent rights by NASA is further indication that a solution is possible without going overboard. NASA no longer wants legislation that would give it a patent policy compatible with that of the Defense Dept. Such legislation was voted by the House last year, after the space agency had contended that its patent regulations appeared too restrictive and could jeopardize its ability to command the services of best qualified firms. The legislation died in the Senate.

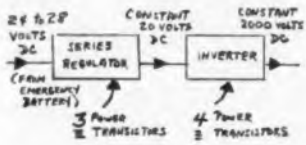
Meanwhile NASA has discovered that it has sufficient administrative flexibility under existing law to satisfy contractors' legitimate claims to patent rights. The agency reports encountering no industry resistance on patent grounds and at a time when its contracting activities are sharply increasing.

Actually NASA seems to be more aware of the economic implications of patent rights than other agencies. Under its regulations, contractors who are granted rights are subject to having them revoked if they fail within five years to develop their inventions or make them available for licensing.

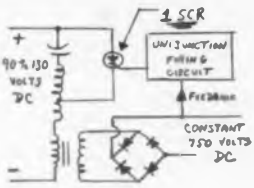
rectifier components news

Let Morgan Do It . . .

Not Henry, Frank or Helen, but Morgan Circuit . . . the one that can save you SIX semiconductor switches if you have to convert varying DC voltages to fixed AC and/or DC voltages. The old fashioned way is to go through clumsy double steps of regulation and then inversion with power transistors, as shown in the following piece of highly sophisticated artwork:



A total of *seven* power transistors . . . and if *one* fails, you're dead. BUT, with Morgan you use *one* SCR and get far greater reliability, a much simpler circuit at far less cost, thusly:



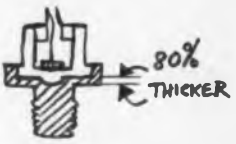
For more information, write to Section 23F17 and ask for application note 610.5.

Did it ever occur to you that if you're building your own rectifier stacks you're going to an awful lot of unnecessary trouble and expense? Add up the time, labor and cost of making your own heatsinks, assembling, clearing fouled up wiring, testing, etc., etc., and compare it with the price of pre-assembled, pre-tested, guaranteed ready to use G-E rectifier stack assemblies. You'll be surprised!

Torque About Strength!

The base of our 4JA5 silicon low current rectifier is about as strong as the mind of man and the limits of nature will allow. It comes to our attention, however, that on rare occasions the muscleman type can crack the silicon wafer with excessive torque on the wrench. (Please, *never* use force when a longer wrench will do the job properly.) We've even heard of a square-peg-in-a-round-hole type who mounts the unit in an oversized hole, and that's no help either.

But this *will* help:



That's right, we've increased the vital stud dimension from 1 mm thickness to 1.8 mm (approx.), to prevent this kind of accidental damage. Just one more example of our ceaseless, unrelenting, determined, dogged and always sincere effort to anticipate your problems and to continually increase quality.

Maybe We're Impulsive...

but the Morgan circuit in the first item brings up the subject of "inverter-type" SCR's in general, and the fact that they can be used profitably *anywhere* an SCR is turned off by the charge on a capacitor or by an electrical impulse. Like, for instance:

● DC static switches ● DC to AC inverters ● Frequency changers ● DC to DC converters ● Morgan circuits ● DC chopper circuits and voltage regulators ● SCR flip flops ● Current limiting circuit breakers

In these circuits, inverter type SCR's improve system efficiency, voltage regulation, speed of response, and reduce the size and weight of commutating components for the SCR. Right? Right!

Now comes the pitch. (You didn't think our impulsiveness was entirely without self-interest, did you?) To the best of our knowledge, G-E inverter type SCR's are the only standard units on the market with published specs for *maximum turn-off time*. As a matter of fact, we're even ready to furnish you FREE a comprehensive report on turn-off time, what it means, and how it's measured. Just drop a line to Section 23F17 and ask for "Turn Off Time Characterization and Measurement of Silicon Controlled Rectifiers." Write today; you'll make Ray Dyer and George Houghton very happy. (They wrote it.)

Rectifier Components Department, General Electric Company, Auburn, N.Y. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 150 E. 42nd St., N.Y. 17, N.Y.

GENERAL ELECTRIC

CIRCLE 21 ON READER-SERVICE CARD

Military Eyes New Com Gear

Submarine and space antennas, facsimile and telemetry equipment were in the spotlight at the recent convention of the Armed Forces Communications and Electronics Association in Washington. These devices and dozens of others on display would make it possible, the armed forces hope, to command and control far-flung military units. The complexity of equipment and systems shown indicated that maintaining reliable control is becoming increasingly difficult. *For more news of the meeting, see p. 8.*

Digital data transceiver designed for modem applications is capable of serial transmission of binary data at rates up to 4,800 bits per sec over high-quality lines, and rates up to 2,400 bits per sec over regular switched telephone voice facilities. The Hughes Aircraft Co. modem codes into four orthagonal phases. It weighs 75 lb and measures 7 by 19 by 18 in.

Developmental fm/fm transmitter for new telemetry system planned for Saturn rocket operates between 225 and 260 mc. Power output is in the 3-to-5-w range. Texas Instrument unit is all solid-state except for final frequency stages, where ceramic Timms are used in power output. Compartmentalized printed circuits in module at top are, left, first and second doublers and, right, oscillator. Lower module has three ceramic tubes.

Log-periodic antenna formed on nose cone has a frequency range of from 2,200 to 9,800 mc. Maximum directive gain is about 6 db each way —E plane 50 deg, H plane 80 deg. The antenna, designed by Martin Co., may be single or dual phase with linear or circular polarization.

Single-sideband diversity receiver operates at 2 to 30 mc over any of 10 pretuned channels. Unit is being delivered to the Air Force for Operation Quick Fix—a modernization of global communication system. Hughes Aircraft system is designed to operate in quadruple diversity mode.

Wide-frequency-range antenna for submarine use employs helix for tuning from 2 to 32 mc. Designed by Hoffman Electronics Corp., the antenna is capable of handling up to 5 kw. Whip is shown partially retracted; entire assembly can be retracted into conning tower in 40 sec.

Advertisement

Crimped Coax Hyfen Connector

ME7X-1 Rack and Panel Coax Hyfen

Utilizing the HYFEN® crimp-type snap-lock principle, the Omaton Division of the Burndy Corp. has developed a completely new solderless connector for joining coax or shielded cable. This connector is a revolutionary development because it simplifies a process which was extremely complicated involving many parts.

The versatility of the snap-lock principle of the HYFEN is utilized and allows contacts to be snap-locked into and out of receptacles as needed. The connector itself allows rapid connecting and separation of circuits, either in multiple or singly. The connector has already been adapted for use in a rack and panel HYFEN—the ME7X-1, and in a modular terminal block, the MODULOK®. Other variations can be made available. These two are already in use in critical circuits. The coax HYFEN matches the characteristics of the cable over a wide frequency range. In crimping this connector, the contacts can be located in any circumferential position relative to the crimping dies. This crimp, a measurable quality control, is made quickly and uniformly by high speed precision installation tooling.

This crimp-type connector prevents the possibility of heat damage to either insulation or conductors. In addition, the design provides for firm cable strain relief. The speed and ease with which this connector can be installed are additional features.

Burndy Corporation,
Norwalk, Connect.

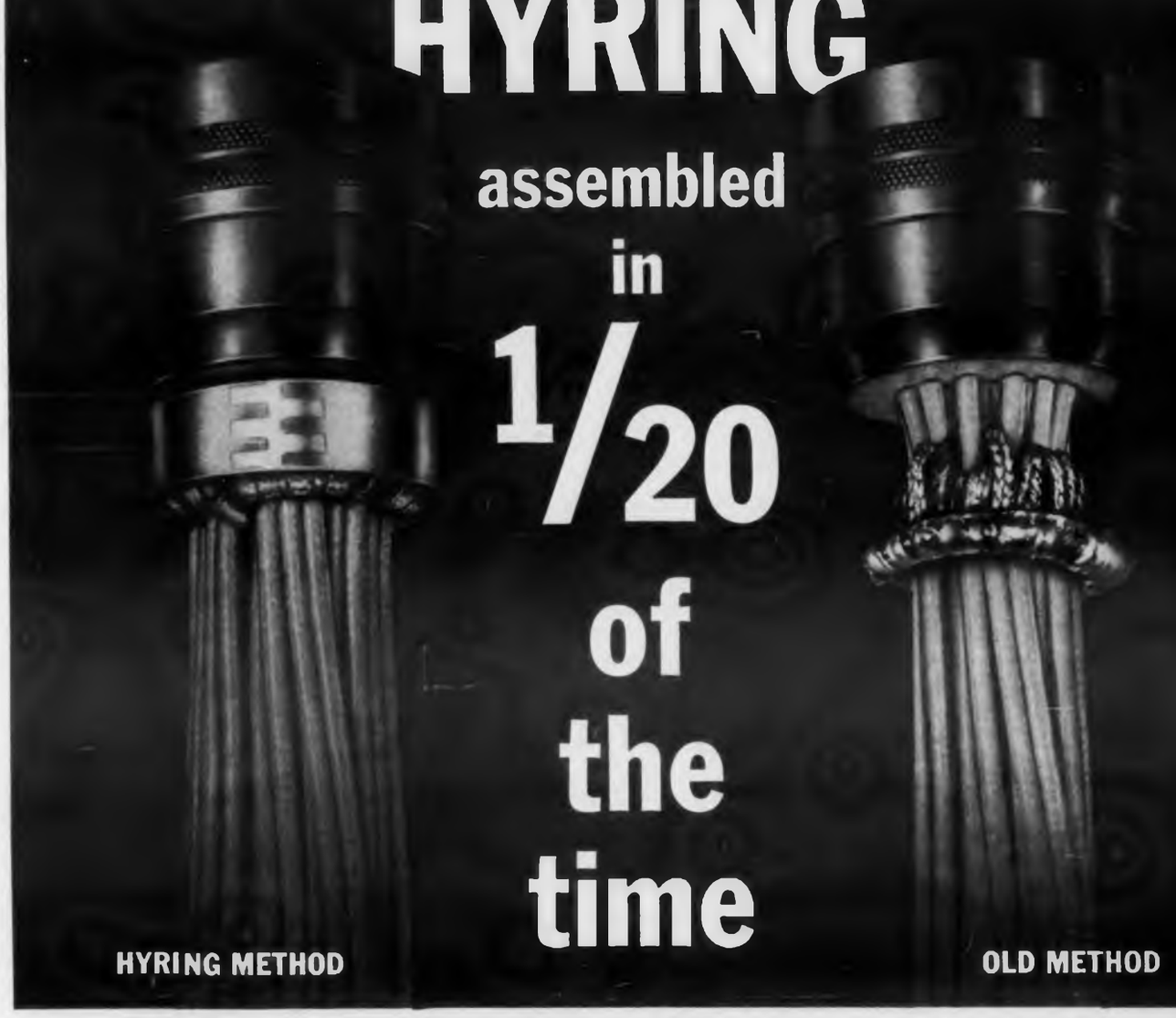
CIRCLE 22 ON READER-SERVICE CARD

CIRCLE 23 ON READER-SERVICE CARD ➤

it changed the ground rules for commoning shielded wires

HYRING®

assembled in 1/20 of the time



Completed cable assembly. Outer HYRING is slipped forward and positioned over conductor shields and ground wire. Assembly is crimped in Y34C HYPRESS.

With the HYRING technique, grounding the shields for a 61 cable connector has reduced the operation to 1/20 of the time previously required and has been changed from 61 separate solder operations to one simple crimp. Result is extensive cost-saving on missiles like the Pershing and Saturn.

Burndy engineering developed extra large tool-installed HYRINGs for this type application, utilizing knowledge and background gained from development and long experience with HYRING and UNIRING® product lines.

OMATON DIVISION

BURNDY

61-2

NORWALK, CONNECT. BICC—BURNDY Ltd. Prescot, Lancs., England In Continental Europe: Antwerp, Belgium TORONTO, CANADA

NEWS

2 Major Companies Drop Receiving-Tube Business

Increased use of transistors plus heavy domestic and foreign competition have been blamed by Philco's Landsdale Div. and CBS Inc.'s Electronics Div. for their decision to discontinue receiving-tube production.

Clarence H. Hopper, president of CBS Electronics, indicated that tube operations would be terminated by the end of this month. The company will concentrate on semiconductors, micro-electronics, sophisticated electronic tubes and other electronic products.

William J. Peltz, vice president and general manager of Philco's Landsdale Div., announced that receiving-tube production would be abandoned in favor of a build-up in transistor production. He said the division's tube-making equipment would go up for sale "almost immediately."

Viewing Unit Uses Infrared

Compact, light-weight unit, called the Metascope, consists of optics, infrared image converter tube, battery, solid-state power supply, infrared flashlight, and carrying case. The flashlight projects a beam of infrared light, which although invisible to the human eye, is easily detected by the Metascope. The soldier looking through the device sees objects illuminated by the infrared beam as though he were using a standard flashlight. The self contained transistorized unit, developed by Varo Inc., Garland, Tex., uses a 1.3-v battery.

attention diode users: if someone has removed your copy of Hughes' informative new brochure on silicon diodes, just circle 249 on reader service card, or write

Hughes Semiconductor Division • Box 278 Newport Beach, California

SILICON ALLOY DIODES–
RELIABILITY BY DESIGN

Characteristics, applications and key types of today's most widely used diode family. Number three of a series

attention diode users: if someone has removed your copy of Hughes' informative new brochure on silicon diodes, just circle 249 on reader service card, or write

H

Hughes Semiconductor Division • Box 278 Newport Beach, California

Silicon Alloy Diodes— Reliability by Design

The silicon alloy process is by far the least complex and one of the most thoroughly studied processes in the semiconductor industry. It is a well known fact that Hughes is one of the oldest, if not *the* oldest name in the manufacture of semiconductor glass diodes. These years of experience have brought about a family of silicon alloy products using one of the most reliable p-n silicon junction manufacturing techniques known today.(1) The simplicity of the process lends itself to excellent control of the product line, continuous reproduction of product distribution and electrical characteristics, and the least probability of process shifts and device degradation.

What does this mean to the design engineer using these products in the design and fabrication of electrical equipment? It will give him the assurance that there is a product that has been in existence for years, guaranteeing continuous reproducability, availability and interchangeability—a product which has had reliability designed into it through years of conscientious effort to improve quality and to meet the ever increasing market demands.

Of late, many new manufacturers using a variety of manufacturing techniques have come into existence. It should be remembered, however, that it isn't the process complexity or nomenclature which determines the quality or reliability of a diode, but the ability to control and produce a reliable device containing the optimum required electrical characteristics. Examine the following 1N types registered by Hughes; all were developed and parameters arrived at with ess in mind.

(1) S. H. Barnes, (Hughes Aircraft Company), "Silicon Junction Diodes Sealed in Glass," AIEE, January, 1954.

E. M. Baldwin and J. A. Mates, (Hughes Aircraft Company), "Silicon Junction Diodes," E.C.C., May, 1955.

Quality and Reliability Co

All Hughes silicon jected to a one hu procedure as follo humidity cycling, 2(and mechanical insp bility testing.

In existence now conductor Division fications from custo every conceivable st and qualification te in some cases for the mean time to .0002% per 1000 h

Daily surveillanc ance with MIL-E- are performed on product lines.

Hughes' Silicon Alloy Diode Families and Types

The variations of the silicon alloy process can be separated into six basic product model categories.

1. GENERAL PURPOSE DIODES (100mA @ +1V illustrated)
2. RECTIFIERS (200mA @ +1V illustrated)
3. HIGH CONDUCTANCE COMPUTER DIODES (200mA @ +1V illustrated)
4. LOW CONDUCTANCE COMPUTER DIODES (4mA @ +1.5V illustrated)
5. ULTRA FAST COMPUTER DIODES (5mA @ +1V illustrated)
6. CAPACITOR DIODES (typical forward conductance illustrated)
7. ZENER DIODES (typical forward conductance illustrated)

Mean forward and reverse characteristics are shown in graph form denoting the various areas of performance each silicon alloy family typifies.

NOTE: Detailed specifications on all Hughes silicon diode types are available upon request—see back cover for address of Hughes representative nearest you.

SILICON ALLOY FAMILY COMPARISON

Fig. 1—Forward Current vs. Forward Voltage

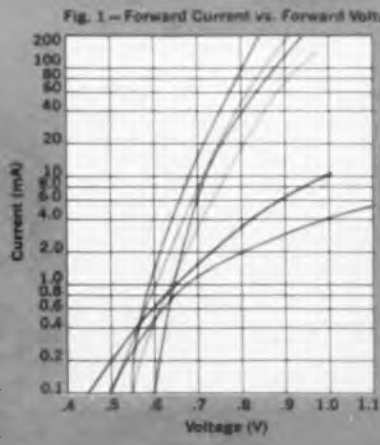
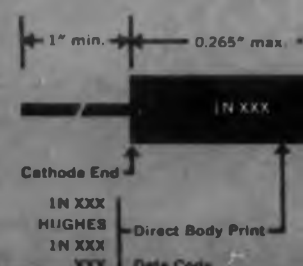


Fig. 2—Reverse

Fig. 3—Revers

PHYSICAL DIMENSIONS—
Note: Unless specified otherwise, 1N and HD types are direct body printed, however upon request.
1) Color bands can be used for 1N and HD types.
2) If special body markings or codings are required, allow additional .008" for outside body diameter.



t with the silicon alloy proc-

ad
y Controls

licon diode models are sub-
hundred percent testing
follows: temperature and
ng, 200°C heat soak, visual
l inspection, and back insta-

now at the Hughes Semi-
ision are hundreds of speci-
customers requiring almost
ble stabilization, acceptance,
ion testing criteria, striving
for reliability goals with
to failure rate as low as
hours operation.
illance programs in accord-
L-E-1D or MIL-S-19500B
on Hughes silicon diode

SON

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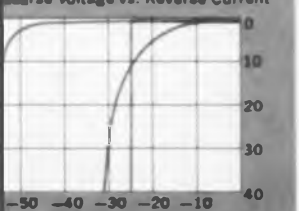
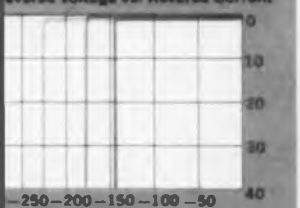
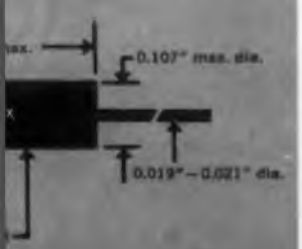


everse Voltage vs. Reverse Current





GENERAL DESCRIPTION

ELECTRICAL CHARACTERISTICS

APPLICATIONS

HUGHES EIA REG. TYPES

General Purpose Diodes: The general purpose silicon alloy diode is the oldest line of Hughes® silicon diodes, primarily noted for its high forward conductance, medium breakdown voltage, extremely low leakage currents at high and low temperatures and "zener type" stable hard back characteristics. Where applications require a rugged and reliable glass package diode type capable of meeting MIL standards and requiring low leakage, high temperature capabilities, this silicon diode device is highly recommended.

Forward currents are available of over 200 mA at one volt while back voltages at 100 μA are available up to 300 V. The room temperature leakage currents at 80% of the breakdown voltage can be as low as a few millimicroamperes; and at 150°C as low as a few microamperes. The recommended storage temperature range is −80°C to +200°C.

Clippers, clampers, low frequency detectors (≦ 100K), logarithmitic elements, stabistors, series circuit compensators, and circuit protection.

1N456 1N461
1N457* 1N462
1N458* 1N463
1N459* 1N464
*JAN Versions Available

Rectifiers (Glass Package): Through the proper selection of materials and processes and the use of pressurization techniques, a new line of high voltage and high conductance silicon alloy rectifier types are available in the compact glass package. Where ruggedness, stability and dependability are important at both high and low temperatures and at high voltage operational conditions, this family type is outstanding.

Forward currents range from 10 to over 200 mA at one volt while the Working Inverse Voltages (WIV) can be as high as 1000 V. Static leakage currents at 25°C and 80% of the WIV are generally less than 1.0 μA and under 60 cps operating conditions at maximum Io and WIV are generally below 10 μA. The maximum storage temperature range is −65°C to +200°C.

Bridge rectifiers, stacked rectifiers, clippers, clampers, high voltage transient arc suppressors.

1N846 thru 1N889

Low and High Conductance Computer Diodes: The silicon alloy computer diode combines the features of the general purpose diodes with that of "fast recovery" high level switching to form one of the most versatile diodes on the market. Its ruggedness and dependability can best be demonstrated by its ability to meet MIL-S-19500B or MIL-E-1D as Single-Service type approval.[2]

The latest advancements in special processing techniques make available silicon alloy computer diodes which feature, along with the previously mentioned capabilities, a low stored charge and millimicrosecond reverse recovery times in low level switching circuits.[3]

[2] 1N658 Signal Corp. Mil-E-1/1160
1N662 Signal Corp. Mil-E-1/1139
1N663 Signal Corp. Mil-E-1/1140
1N643 Signal Corp. Mil-E-1/1171

[3] Lumatron, Tektronix Sampling Scope or EGG Traveling Wave Scope.

Forward currents are available over 200 mA at one volt while back voltages at 100 μA run above 200 V. Room temperature leakages are as low at .025 μA at 80% of Es and at −20 V are as low as .010 μA. High level reverse recovery in a JAN 256 circuit switching 30 mA to −35 V recovering to 400K are available in less than 0.3 μsec. Storage range −65°C to +200°C; operational up to 150°C.

Core drivers, logic gates, modulators, detectors.

1N625 1N658†
1N626 1N837
1N627 1N837A
1N628 1N838
1N629 1N839
1N643† 1N840
1N643A 1N841
1N662† 1N842
1N662A 1N843
1N663† 1N844
1N663A 1N845
†Non-registered Hughes Types

Ultra Fast Computer Diodes: This [illegible] is a "[illegible]" silicon ultra fast computer diode. Never before has there been a device with both ultra fast turn on and reverse recovery characteristics. No practical means are available for observing the transient turn on response normally characteristic of a semiconductor device. This [illegible] recovery time for this diode using a sampling or travelling wave scope[4] is in tenths of [illegible]. The small capacitance at zero bias can only be equalled by that of a germanium point contact. Because of these inherent characteristics this device has a rectification efficiency well above 50%, the highest for any silicon diode.

[4] Sampling scope switching 10 mA to −6V recovering to 3 mA ≦ .5 mA.

Forward conductance at one volt range from 2 to 5 mA while back voltages at 100 μA are available up to 30 V. Leakages at −5V at 25°C are less than 1 μA. Storage temperatures is −60°C to +125°C while operating temperatures can go as high as +100°C.

RF modulators, demodulators detectors, high frequency radar, UHF communications, high frequency response test equipment, computer circuitry, reference diodes.

HD5000
HD5001
HD5002
HD5003
HD5004

Capacitor Diodes: The silicon capacitor is an evaporated aluminum alloy junction diode making use of the fact that variations in bias voltages vary the junction capacitance. By controlling and properly selecting materials and processes, a complete range of capacitance and maximum operating voltages are obtained.

Capacitance range available is 6 to 240 μμf with maximum bias voltages variations up to 150 V. Q's are available up to 400 @ 5 mc while tracking variations of a particular type is less than 1% over the useful voltage range from one unit to another. The temperature coefficient of capacitance at −4 V is .03%/°C.

Electronic remote tuning, AFC, RF oscillators, frequency multiplication.

1N950# 1N953#
1N951# 1N954#
1N952# 1N955#
1N956#
Pending Registration

Zener Diodes: This is the ideal diode for circuit components which require very low leakage and minimum dynamic impedance in the avalanche region. The Hughes® zener diode is a reliable and dependable alloy junction device perfectly suited for rigid electrical applications in circuits where quality, space and weight are premium items.

Low noise in the avalanche region at 1 mAdc or greater. Low dynamic impedance throughout the voltage range of 2 to 30 volts for premium units. Power ratings up to 400 mW at 25°C. Moderate capacitance over the voltage range of 2 to 30 volts. Adaptability as a tuning condensor over the bias range of +0.35 volt in the forward region to within 90% of the avalanche region. Very low leakage (hard back) until the avalanche point is reached. Minimum temperature coefficient change with variation in power levels. Very close tolerance package size distribution. Storage temperature range of −80°C to +200°C. Operating temperature range of −65°C to +175°C.

Voltage regulators, noise suppressors, clippers, shapers, limiters.

1N702† thru 1N725 with "A" versions available.
1N761† thru 1N769
1N465† thru 1N475 with "A" versions available.
1N1313† thru 1N1319
1N1929† thru 1N1937
†Non-registered Hughes Types

Purchasing Do's and Don'ts

DON'T specify a device that does not exist for your circuits—although this will motivate research and development groups to design better products for the future...the immediate result is long delay in quantity delivery. Be sure you can wait if your requirement is exotic.

DON'T specify inferior products for economical purposes resulting in unreliable circuit performance. This practice creates a vicious reject and replacement cycle between manufacturer and user.

DON'T buy from manufacturers whose facilities are not adequate for testing to rigid military specifications and whose production quantity delivery is questionable.

DON'T attempt to buy reliability by specifying breakdown voltages far in excess of those required. There may be some exceptions, however, this is a very expensive practice. DO buy reliability—not reliability by safety factor!

DO make sure that the diodes you buy meet the manufacturer's advertised and registered specifications.

DO make sure your 1N diode type is "registered" with EIA, not "reserved." When using types with a "reserved" status, the manufacturer may alter his specifications at will.

DO make sure the leakage currents are measured at a reverse voltage as high as your present requirement demands.

DO remember that reliability has to be designed in the diode; it cannot be tested in. No amount of testing will undo poor design. However, it is important that the manufacturer have a sound quality assurance program to insure that the reliability is actually there.

DO make sure that a diode that is to be used as a switch meets your speed requirements by actual test in your circuit; this is the only true test. Manufacturers often show values for switch-speeds that are optimized.

DO be sure to get the leakage currents you actually need. Specify the measurements which match most closely your actual circuit requirements.

DON'T guess what the parameters will be if your circuit is for intended high temperature operation, but DO get the proper data from the manufacturer.

Silicon Alloy Diode Trends at Hughes

Constantly striving to keep ahead of the semiconductor industry and abreast of the latest processing techniques, Hughes R&D and Engineering are presently involved in the following programs.

- MICROSEAL* component packaging
- Special surface treatments with emphasis on stability and reliability
- Double diffused computer diodes with reference to high currents, voltages and power dissipation capabilities
- Micro-microsecond recovery times
- Micro-microamp leakage currents
- Epitaxial growth techniques

*Trademark – Hughes Aircraft Company

The foregoing information has been gathered from the Hughes Semiconductor Division's reports and records on the silicon alloy diodes, compiled with the cooperation of Hughes' staff of skilled engineers. • Pioneer in the semiconductor field, Hughes has continued as a top developer and producer of the most advanced semiconductor devices. The Newport Beach plant, with its third of a million square feet of floor space, houses all of the facilities necessary for every phase of design, development and production of diodes, transistors, rectifiers, special devices and semiconductor materials. • *For further information call or write your nearest Hughes Semiconductor Sales Office. Or write: Hughes Semiconductor Division, Marketing Dept., 500 Superior Ave., Newport Beach, California.*

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GE Stereo Radio Adapter To Use A Single Compactron

General Electric is developing a stereophonic fm radio adapter with only one Compactron (multiple tubes in one envelope). The device will enable the fm radio in stereophonic phonograph sets to receive new stereo radio broadcasts.

The stereo decoder, being built by GE's Electric Tube Dept. at Owensboro, Ky., will be placed between the fm tuner of the radio and the stereo amplifier of the phonograph to produce stereo sound.

Following the Federal Communications Commission's recent decision to permit fm stereo broadcasting, GE has stepped up its development of Compactron multi-function devices for use in stereo equipment. The company reports it has 12 possible designs for entirely new fm stereo radios, each of which would use from five to seven Compactron devices.

Sapphires Protect Solar Cells

Transparent man-made sapphires and solar cells are attached to a developmental model of a communications satellite by engineer R. J. Nielsen of Bell Telephone Laboratories, Murray Hill, N. J. The sapphire slices, brazed to platinum sidebars and soldered to a ceramic base, are employed to protect the cells from radiation. These materials are used because they all have similar thermal expansion. The protection is expected to enable the satellite to operate for 10 years or more, relaying communications overseas.

◀ CIRCLE 249 ON READER-SERVICE CARD

NEWS

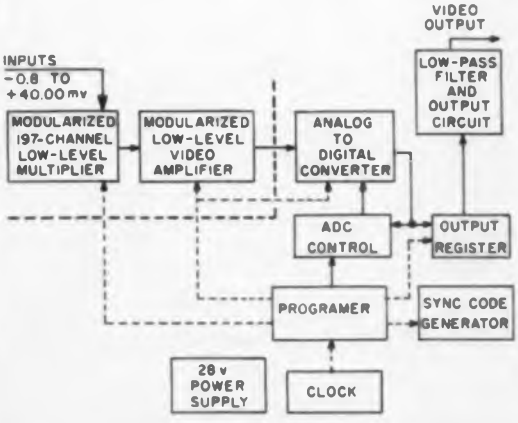
Developmental Telemetry System Uses a Digital Servo Loop

A NEWLY developed airborne pulse-code-modulation subsystem uses a digital servo loop to null out system drift and thereby provide high accuracy. According to the designers, Texas Instruments' Apparatus Div., Dallas, the use of feedback voltage correction helps hold subsystem inaccuracy to ±0.4 per cent, of which about half is contributed by quantization processing.

The loop consists of taking the output from an analog-to-digital converter, which goes to an output register, and sending it through an adc control unit where signal drift of the converter and low-level amplifiers is detected and compensated for. A correction signal is then returned to the analog-to-digital converter. This is done once for every frame being transmitted.

Another feature of the subsystem is said to be its low-level switches. These consist of an input filter and a four-transistor differential input. They provide 20-μv offset from 0 to 70 C, Texas Instruments says. To achieve this performance, the designers found it necessary to match transistors by computer techniques. A computer was used to compare the change in V_{BE} with temperature change; transistors that showed similar slopes were selected and matched into sets. Each amplifier was individually canned in Mumetal.

The system, which has 197 input channels,



Developmental pcm telemetry system has feedback from analog-to-digital converter to adc control unit, so that error voltages may be nulled and accuracy preserved. System inaccuracy is said to be no more than ±0.4 per cent. In addition to normal modularization, system is packaged, so that low-signal level stages, shown separated by heavy dotted line, are isolated from logic stages, which use high-level pulses.

was offered when proposals were solicited for the telemetry system for Titan II, but a pcm system designed by Epsco, Inc., was accepted by the military. Texas Instruments completed the development of its system. It says that with slight modification its system is suitable for many telemetering applications. ■ ■

FAA Selects Technical Consultant For Air-Traffic-Control Program

Auerbach Electronics Corp. of Philadelphia has been designated a technical consultant to the air-traffic-control program of the Federal Aviation Agency.

The company will examine the functions and technical characteristics of equipment presently being procured by the Government. It will recommend tests and performance levels to be achieved with such equipment as the central data processor, flight-strip printer and loaders, automatic tabular bay consoles, flight-plan entry devices, and data-transfer devices.

TRW Tests Thermionic Converter

Thermionic converter, developed for Thompson Ramo Woolridge's Tapco Div., delivers about 13 per cent efficiency at the 200-w power level, according to company test results. Engineer observes the thermionic diode enclosed in bell jar which provides a space environment. The high-power, light-weight power source, developed by Thermo Electron Engineering Corp., Cambridge, Mass., uses electron bombardment.

NEWS

Silicon Planar Transistor Will Be Used in AF Minuteman Missile

The 2N 1613 silicon Planar transistor, developed by Fairchild Semiconductor Corp. Mountain View, Calif., has been accepted for use in the Air Force Minuteman missile.

The Planar transistor will replace Fairchild's silicon mesa 2N 697 in the second and third phases of the $1.5-million, three-phase Minuteman reliability developmental program.

The Autonetics Div. of North America Aviation, Inc., is the prime contractor responsible for Minuteman's inertial guidance, flight control and ground-checkout equipment. Minuteman is a solid-fuel missile program.

Medical Electronics Conference Slated July 16-21 in New York

The 1961 International Conference on Medical Electronics will be held July 16-21 in the Waldorf-Astoria Hotel in New York City.

It will be a combined meeting of the Fourth International Conference on Medical Electronics and the 14th Annual Conference on Electrical Techniques in Medicine and Biology.

The program will deal with areas common to the engineering, medical and biological fields.

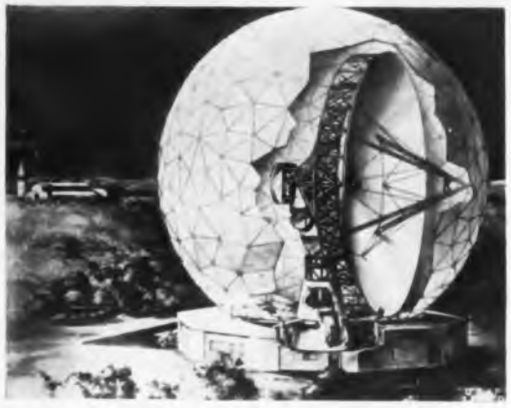
The conference is sponsored by the Joint Executive Committee on Medicine and Biology (IRE, AIEE, ISA) under the auspices of the International Federation for Medical Electronics.

New Radio Facility to Help AF Evaluate Space Communications

A radio research facility employing a 120-ft saucer-shaped antenna is being built for the Air Force in Tyngsboro, Mass., for global communications and space studies.

The equipment is designed as a test bed for development of large, ground-based transmitting and receiving equipment that will be needed to operate high-capacity satellite-relay systems for round-the-world communications.

The facility will probe the troposphere



Radio research facility to be built for the Air Force in Tungsboro, Mass., employs a 120-ft saucer-shaped antenna. The facility will be used for global communications and space studies.

and ionosphere and study atmospheric irregularities that may limit radio-antenna performance. Answers will be sought to such questions as: How narrow a beam can actually be produced? How accurately can it be aimed?

North American Aviation Inc., Columbus, Ohio, is building the antenna system. Lincoln Laboratory of the Massachusetts Institute of Technology will operate and evaluate the facility for the Air Force.

New Eye Movement Measurer Used in Visual Behavior Studies

Currents of electricity produced by movements of the eye are being measured and recorded with the latest version of EMMA (Eye Movement Measuring Apparatus).

Developed by EMI Electronics, Ltd., of England, the portable, transistorized model, powered by a dry battery, is providing scientific data about visual behavior.

The eye acts as a tiny battery, with a positive voltage at the cornea and a negative one at the retina. When the eye looks straight ahead, the voltages are in balance; an electrode attached to the skin at the side of the eye socket will register zero.

When the eye moves in any direction, the voltages are out of balance. The resulting sum or difference voltage is picked up by the electrode, amplified by the equipment and either displayed on a cathode-ray tube or used to drive pen recorders, which produce a continuous trace of the horizontal and vertical movements.

NEWS

TV Microscope and Computer Are Teamed to Analyze Blood

Rapid, automatic analysis of human blood samples is envisioned in a new system—experimental thus far—that links a television microscope to a digital computer.

Called Cellscan by its developer, Perkin-Elmer Corp. of Norwalk, Conn., the system is being perfected for the Atomic Energy Commission to measure the effect of radiation on workers in nuclear-energy environments.

"To date," says Kendall Preston Jr., spokesman for Perkin-Elmer, "no good index has been found which measures the physiological changes produced in humans by low-level radiation, but medical workers suspect that the incidence of binucleate lymphocytes in the peripheral blood stream is an index of damage."

Blood cells are divided into two major classes: red cells, called erythrocytes; and white cells, called leucocytes. White cells may be broken down into two kinds: Lymphocytes and granulocytes, the latter outnumbering the former about two to one.

Sometimes lymphocytes are found with two nuclei instead of one. Medical researchers believe that the incidence of the binucleate lymphocytes—called "bilobes"—increases in proportion to the amount of low-level radiation damage in humans. The normal incidence of bilobes in man is about one in a million total blood cells. Current measurement practice is for the technician to sit in front of a microscope and count for several hours.

Cellscan Differentiates Between One Blood Cell and All Others

The Cellscan system scans a blood sample and differentiates between bilobes and all other blood cells. The closed-circuit TV microscanner delivers a binary video image (with "1's" representing any blood cells in the field of view) to the computer, where the image areas comprised of contiguous "1's" are counted and sized.

The computer output is an image histogram for the particular cell. To produce the histogram, the computer goes through a "shrink" process: it stores the binary image and then operates sequentially on each image bit, causing binary "1's" in the periphery of any contiguous group of "1's" to be changed to "0's." Several passes are made.

Details of Cellscan were given by Mr.

Preston at the Western Joint Computer Conference in San Francisco. The first model, he concedes, requires more than a month of continuous operation to process a single blood sample.

"An input to the system of about a quarter of a billion bits would be gathered in scanning a blood sample," he observed. "This input is reduced to a quantity of bilobes in a sample, which can be represented by a five-bit word.

"Even if the present system efficiency is improved to the maximum, the ratio of input to output would be of 1,000 to 1."

However, by using microwave logic techniques and obtaining a better grasp of pattern-recognition problems, Mr. Preston said, the company hopes to turn out a system capable of processing a sample in 15 min.

Wafers Polished Electrochemically

Three germanium wafers that have been polished electrochemically are examined by researcher. In the polishing technique semiconductor slices are mounted on a nonconducting disk. After electrical contact is made to the slices, the latter are placed on a polishing wheel over which an electrolyte flows. When the wheel rotates, a film of electrolyte separates and automatically maintains the semiconductor at a relatively constant distance from the wheel. Dilute potassium hydroxide is the electrolyte used for germanium, and dilute hydrofluoric acid is used for silicon. The technique was developed by Bell Telephone Laboratories, Murray Hill, N. J.

NEWS

Strategic Air Command Gets $15-Million Data Processor

A $15-million data-processing system called Finder has been delivered to the Air Force Strategic Air Command.

Designed and developed by Melpar, Falls Church, Va., under subcontract from Convair, Fort Worth, the system can correlate and analyze military data, prepare printed reports, charts and graphs, and display material in five colors on large TV screens.

Finder occupies about 7,000 sq ft of floor space and contains a modified Burroughs 220 General Purpose Computer, together with 89 Melpar-designed racks and consoles.

Data Stored On Magnetic Drums With 31.5-Million-Bit Capacity

Data to be processed are received on magnetic tape or punched cards. After code conversion the data are transferred to a file of seven magnetic drums with a capacity of 31.5 million bits.

A summary of data of immediate interest is automatically prepared on an auxiliary drum of 450,000-bit capacity. On command this summarized data is displayed on a large screen cathode-ray tube for operator analysis and decision. Upon completion of the analysis, the data are automatically returned to the drum file with notations of the operator's decisions.

Deflection Amplifiers Produce 2,400 V With a Rise Time of Less Than 1 μsec

New operational and deflection amplifiers had to be developed to implement the high presentation speeds and required accuracy

Data-processing system delivered to Strategic Air Command occupies 7,000 sq ft of floor space, can correlate and analyze military data, prepare printed reports, charts and graphs, and display material in five colors on large TV screens.

of these displays. In particular, the deflection amplifier is capable of producing a 2,400-v output with a rise time of less than 1 μsec, and a settling time (to 0.05 per cent) of 3.5 μsec. The operator selects and marks data with electrically generated cursors or a light brush.

The electromechanical plotter has a plotting surface of 70 in. x 55-3/8 in. and plots a point anywhere on this surface with a maximum error of plus or minus 0.5 per cent.

Built about NOR-logic modular circuits, the system is completely transistorized, with the exception of the Burroughs computer.

Assembly of Micromodules Planned by 2 Companies

Alternate methods of assembling micromodules are being devised by P. R. Mallory & Co., Inc. of Indianapolis, and Paktron of Alexandria, Va., a division of Illinois Tool Works.

Under development at RCA, micromodules (stacks of encapsulated ceramic wafers with electronic components mounted on them) are part of a program sponsored by the Army Signal Corps. The program's goal is to produce small, lightweight, reliable communications and data processing systems for use on the battlefield.

The first phase of the program required that RCA establish the feasibility of the micromodule concept. This was accomplished by designing, building and testing thousands of modules embodying several hundred different circuits. The present phase requires that a production capability be fully developed on an industrywide basis.

Tape-Recorded Lessons Turn Unskilled Workers into Skilled

Tape-recorded instructions are permitting unskilled laborers in factories in West Germany to do work that is ordinarily done by skilled help.

The technique, introduced by Telefunken, Gmbh, one of Germany's transmitter manufacturers, is an experiment that so far has shown good results. The workers listen to tape-recorded orders and explanations over earphones.

Application of the technique is now confined principally to wiring and soldering of equipment, but other uses are envisioned.

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CIRCLE 35 ON READER-SERVICE CARD

EDITORIAL

The Need for Better Information Management

Duplication of effort in R&D and poor planning out of ignorance are the consequences of inadequate management of scientific information.

Senator Hubert H. Humphrey has said that the Federal Government's methods of managing scientific information (generated by its $8.1 billion investment in R&D) contribute to "tragic and intolerable waste of men, money and material." The Senator is a subcommittee chairman of the Senate's Committee on Government Operations.

A 286-page report by the committee recommended:

- That an ultimate objective be to record pre- as well as post-publication data so that a project could be traced from inception to completion.
- That professional societies cooperate by disseminating information on research in process.
- That studies be made of scientist's information-gathering patterns so that existing services can be improved.
- That the Department of Defense move forward on its DD 613 System making sure that both research and development projects are included to avoid duplication.
- That results from cancelled contracts be included in information indexing systems.

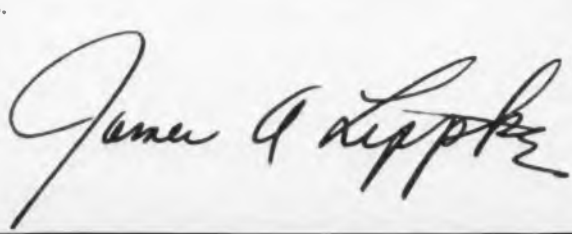
The committee report criticized lost effort in the failure to salvage results from cancelled contracts that totaled more than $2 billion in the last three years. It estimated unintentional duplication runs as high as 10 per cent. Unknown duplication in the electronics area alone may cost $200 million annually the report notes. It also scored lack of interagency cooperation but noted a trend toward improvement.

Every engineer who has tried to search the literature is aware of the problem. Yet it is frightening to think of even more information being indexed and made accessible if the form of the reports is not considerably improved. The 10 per cent duplication of original effort may be less expensive than reading quarterly reports that say nothing.

We strongly urge that studies be made on what to index as well as how to index. We also urge you to express your views on this subject to Senator Humphrey.

Congrats to the Symposium Committee of PGMTT

In addition to lining up their usual fare of papers on significant research, this year's committee did an outstanding job in arranging a clinic on system and receiver noise performance. The clinic's purpose was to stamp out much of the "noise" made on the subject of noise. Under the leadership of W. W. Mumford, five of the nation's experts put their heads together to present before its session a clarifying written report on definitions and measurements. Congratulations.



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CIRCLE 36 ON READER-SERVICE CARD

Accurate Simulation of Nine Common Nonlinearities

Analog computers, particularly the small desk-top types, are becoming almost as common as slide rules in many areas of electronic design, but the problems engineers want to solve are becoming less and less amenable to straightforward linear analysis. Author Addison Langill presents nine circuits to answer this growing need. Three of the circuits, the multivibrator, the symmetrical quantizer, and the solenoid valve, are believed to be original with the author.

Addison W. Langill, Jr.
AC Spark Plug
The Electronics Div. of General Motors
El Segundo, Calif.

ANALOG simulation of the discontinuous nonlinearities associated with practical electronic and electromechanical components is becoming a commonplace necessity. It is difficult to take advantage of an analog computer in control systems design unless the nonlinearities in the system can be accurately simulated. But, while many schemes for introducing nonlinearities into analog computer set-ups exist, their lack of precision is often a limiting factor in the over-all usefulness of the simulation. Techniques developed in recent years employing the "idealized diode" have, on the other hand, proved especially effective in mechanizing reliable and accurate discontinuous nonlinearities.

The diagrams usually presented in analog computer text are based on the ability of the standard diode to function as a perfect switch, i.e., a two-terminal network element with zero forward and infinite backward impedances. This assumption leads to an inexact representation of the required nonlinearity and may result in a misleading over-all system simulation.

Idealized Diode Uses Operational Amplifier

To minimize the usual diode inaccuracies, the characteristic silicon diode transfer function (Fig. 1a) may be greatly improved by the process of idealization with a high-gain amplifier as shown in Fig. 1b. While semiconductor diodes are indicated, the results apply equally well to the use of thermionic diodes.

The functioning of the idealized diode is as follows: For negative inputs, the amplifier output is shorted directly back to the grid through D_1, but, due to the diode forward breakdown voltage level, a slight positive potential exists at P_1. This residual voltage is greatly attenuated through the back impedance of D_2 in series with R so that the system output, P_2, remains essentially at ground potential. For all positive inputs, the system provides a unity gain.

This idealized diode can be applied to a wide variety of nonlinear discontinuous simulation applications:

1. Limiters

The inelastic limiting of a system variable can be simulated with two idealized diodes arranged as in Fig. 2.

The diodes D_1 and D_2 conduct for $E_{in} \geq a$ and $E_{in} \leq -b$, respectively. This network is superior to the conventional output shunt limiter in that a sharp cutoff is obtained and the limit does not vary as a function of input voltage.

For symmetrical clipping, the conventional diode bridge of Fig. 3 is often employed. A constant amplitude can be obtained in this conventional circuit since the diode characteristics do not influence system performance during the limiting condition. In this sense, the circuit resembles a pair of idealized diodes. For zero input, any small offset voltages appearing at the output of A-4, due to a mismatch in dropping resistors or diodes may be permanently nulled through the addition of a bias potentiometer P_B. The potentiometers P_1 and P_2 are adjusted experimentally to obtain the desired limit.

2. Dead-Space Simulation

Dead-space or threshold may be mechanized by two idealized diodes as shown in Fig. 4. A distinct advantage is that the system is very nearly at ground potential throughout the dead band. This substantially reduces the over-all problem of drift.

3. Absolute Value

The network of Fig. 5 generates an absolute value because amplifier A-5 can act as a polarity detector. An absolute value of the opposite sign is obtained simply by reversing the directions of D_1 and D_2.

4. Flip-Flop and Comparator

In the flip-flop circuit of Fig. 6, the initial output shunt limiter is employed only to

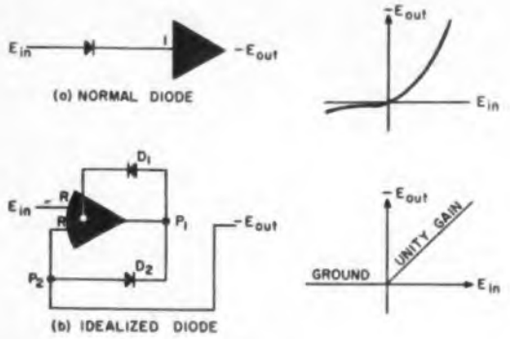


Fig. 1. Idealized diode (bottom) uses two diodes and an operational amplifier. It is not subject to the nonideal effects of the actual diodes as is the usual diode limiter (top). As shown the circuit is compatible with REAC, GEDA and PACE computers; but with some EASE computers, a grounded potentiometer may have to be added in D_1 path.

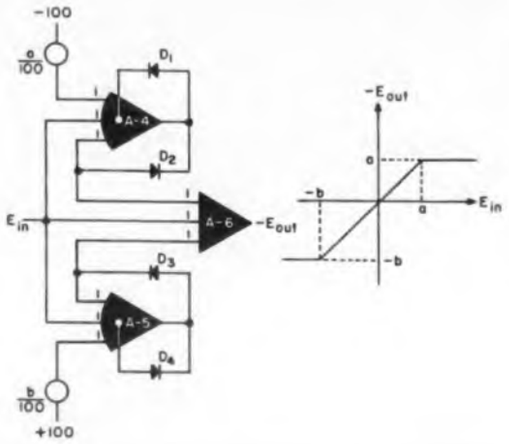


Fig. 2. Inelastic limit simulation needs two idealized diodes, one for each limit.

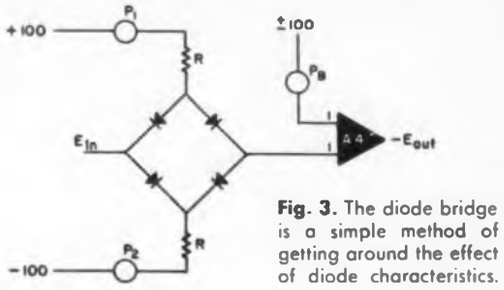


Fig. 3. The diode bridge is a simple method of getting around the effect of diode characteristics.

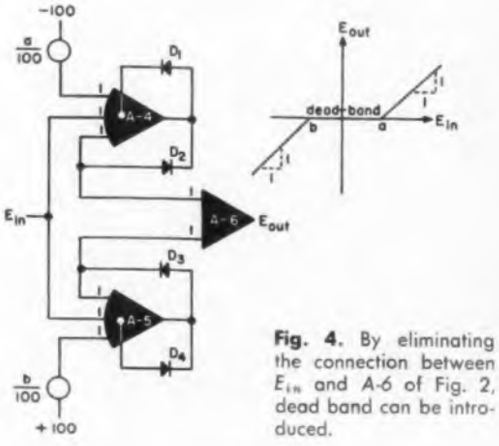


Fig. 4. By eliminating the connection between E_{in} and A-6 of Fig. 2, dead band can be introduced.

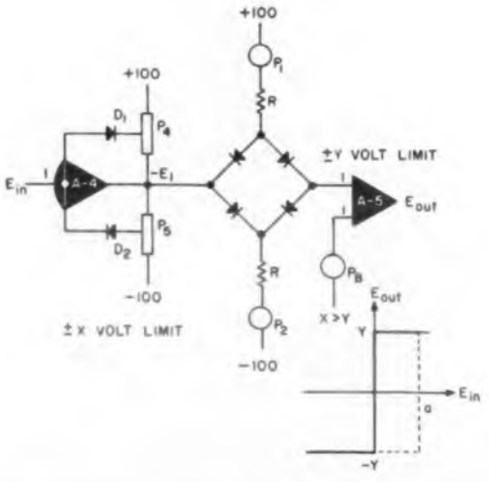


Fig. 6. Flip-flop response is obtained by this limiter-diode bridge combination. Bias can be used to shift operation to "a" for comparator use.

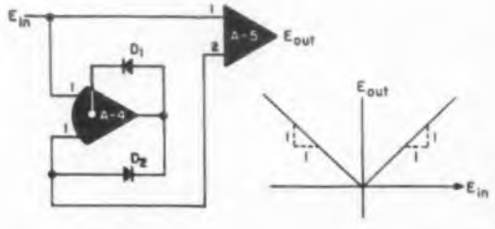


Fig. 5. Absolute value can be generated by this circuit because A-5 acts as a polarity detector.

prevent amplifier *A-4* from overloading while the diode bridge provides an accurate output amplitude limit.

The system differs from those previously described in that *A-4* is operating in the high-gain mode (no feedback resistor) while potentiometers P_4 and P_5 are ungrounded. The operating characteristics associated with this mechanization are as follows:

Assume *A-4* to be excited by a very small amplitude negative polarity input. When multiplied by the open-loop amplifier gain (-50×10^6 for a typical large computer), a large positive voltage appears at the output terminal. Amplifier saturation is prevented by the arm of P_5 sensing (at some predetermined level) a positive potential. At this point, D_2 conducts and maintains E_1 at an approximately constant value.

The bridge limiter, functioning as a pair of idealized diodes, clips the input and produces a constant output *Y*. Potentiometers P_1, P_2, P_4 and P_5 are adjusted by trial and error.

The comparator, whose input-output relationship is presented in Fig. 6 (dotted lines on graph of $E_{in} - E_{out}$ transfer function), is obtained with a flip-flop biased to operate about point *a*.

5. Polarized Double-Throw Relay

Four idealized diodes are needed for polarized double-throw relay simulation of Fig. 7. Since the output shunt limiters must be employed as protection against amplifier saturation, the process of diode idealization is accomplished with isolation amplifiers *A-6* and *A-7*. The bridge again produces a constant limited output. Important in its own right, the relay simulation circuit also pro-

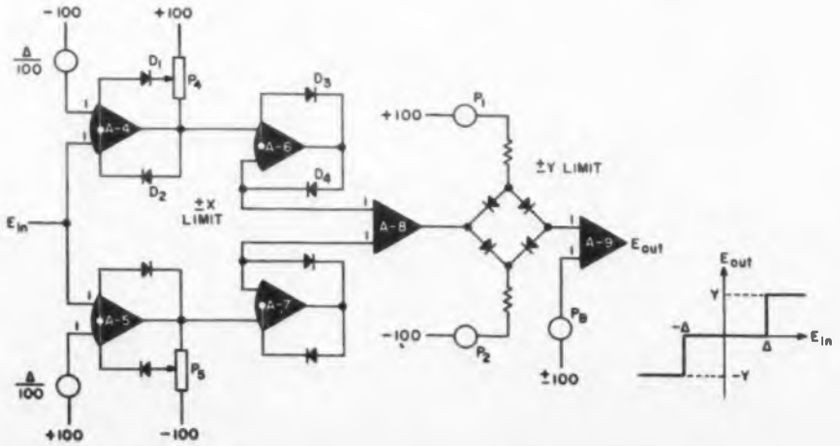
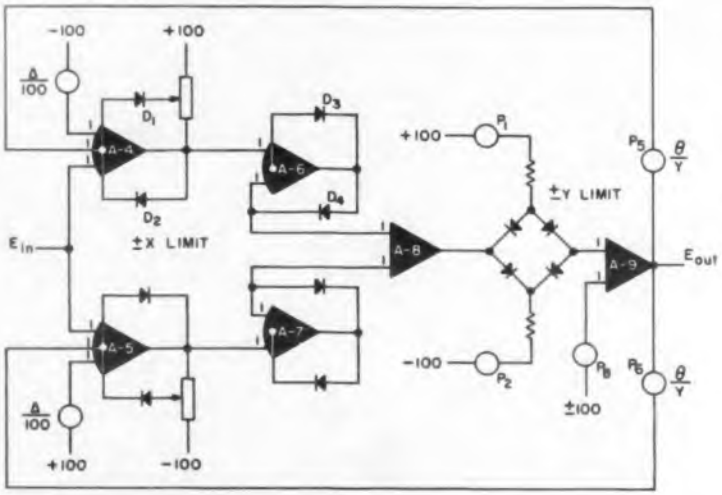
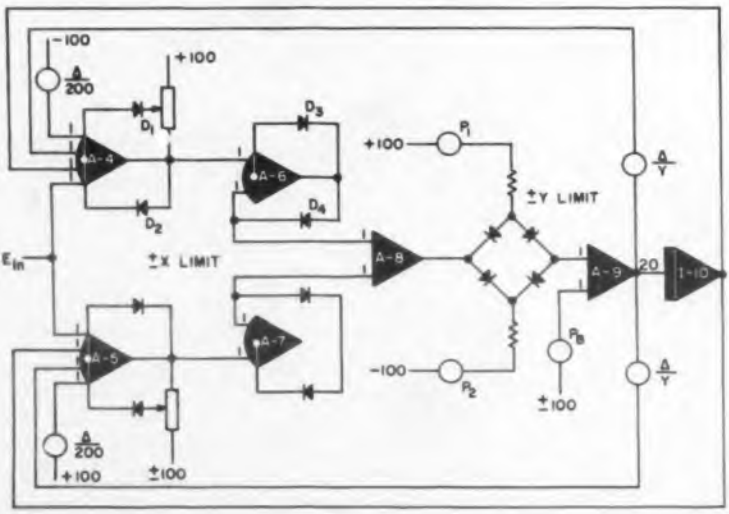
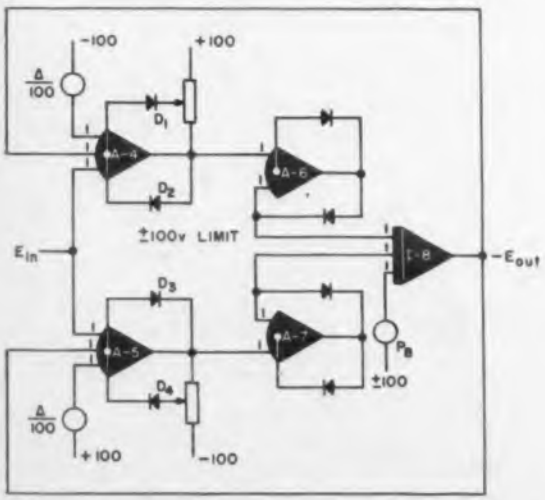


Fig. 7. Ideal diodes and bridge simulate a polarized double-throw relay.







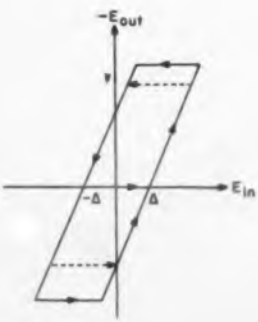


Fig. 10. Backlash is produced by another variation on the theme of Figs. 7, 8, and 9.

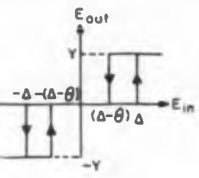


Fig. 8. Four idealized diodes, a bridge, and additional feedback paths transform the relay simulation of Fig. 7 into a solenoid valve simulation.

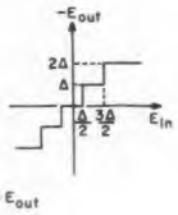


Fig. 9. Quantizer simulation goes another step beyond the solenoid valve simulation of Fig. 8.

vides a basic building block for the creation of many additional diode networks.

6. Solenoid Valve

An accurate solenoid valve representation is required for the effective analysis of typical bang-bang controllers. A combination of two valves, operating in parallel, results in the relationship indicated in Fig. 8.

This network functions in the following manner: consider an input, initially at ground, but increasing in the positive direction. As E_{in} slightly exceeds the dead-space Δ, D_1 and D_4 begin conducting. Positive feedback is employed, such that the limited output voltage, acting through potentiometer P_5, effectively reduces the *A-4* bias to a value of $\Delta - \theta$. Should the input voltage now be decreased, the system returns to the dead-zone at this new signal level. Thus both dead-space and hysteresis characteristics have been generated without the use of relays.

7. Quantizer Simulation

The process of symmetrical quantization can be approximated through an extension of the Fig. 8 configuration. As observed in Fig. 9, the addition of integrator *I-10* provides a negative feedback path through the solenoid valve simulation circuit. As E_{in} exceeds the preset threshold level $\Delta/2$, a step of magnitude Y is produced at the *A-9* output terminal as previously described. Positive feedback through P_3 reinforces the step until the output of *I-10* has increased by the quantization magnitude Δ, at which time the system returns to the dead-space. As the input is increased, the integrator output changes in approximate steps as shown.

Because of the relatively high integrator gain required, the circuit is subject to drift difficulties while functioning within the dead-

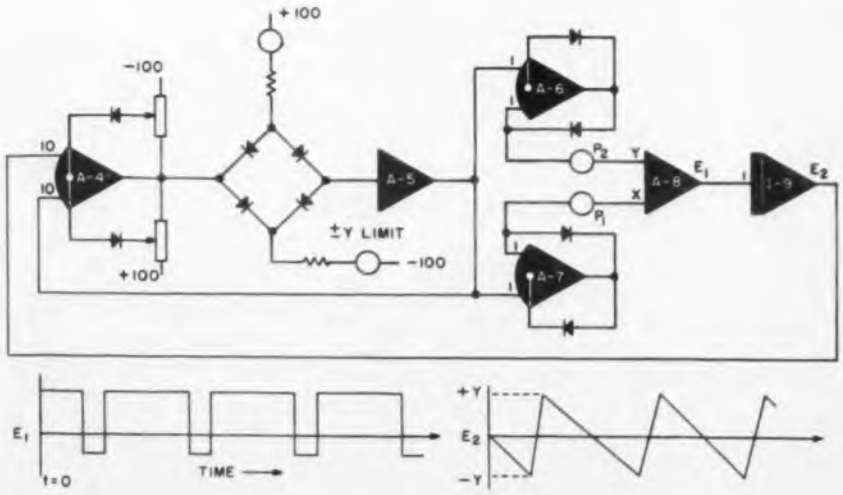


Fig. 11. A free-running multivibrator is simulated by this analog set up.

zone. Although the use of idealized diodes tends to minimize this effect, potentiometer P_R may be adjusted, in the computer "Operate" mode, to balance the amplifier drift characteristics.

8. Backlash

The combination of a polarized relay network, Fig. 7, and a simple first order lag results in the backlash circuit of Fig. 10. Because of the low integrator gain and the use of idealized diodes, the system is essentially insensitive to drift. To illustrate, the configuration has been placed in the deadband and allowed to remain in this condition for intervals in excess of 10 minutes with no noticeable difficulties.

The backlash network is similar in operation to the quantizer representation previously discussed. Assume that a positive-going ramp is applied at the input junction. As the input reaches the dead-space bias, a step of approximately 100 v is generated at the output of *A-6*. The high gain input amplifier *A-4* acts to maintain the relationship, $-E_{out} \cong E_{in} - \Delta$. This approximation is almost exact, since the effective system time constant is small.

If the input signal is now reversed, the system output remains constant until *A-5* is activated. The output is then governed by the expression, $-E_{out} = E_{in} + \Delta$.

9. Free-Running Multivibrator

A combination of an integrator, positive feedback, and the idealized diode technique will mechanize the simulation of a free-running multivibrator with unsymmetrical amplitude and frequency, Fig. 11.

The circuit is free-running in that no input signal is needed to drive the system. For illustration, assume a positive noise spike appears as an input to *A-4*. The positive feedback loop reacts instantaneously to produce a step at *A-5*, which is integrated by *I-9*. At some time, determined by the values of P_1, x and Y, the output of *I-9* just exceeds that of *A-5*. The polarity of *A-5* now switches and the integrator reverses direction, generating a positive-going ramp with slope equal to P_2yY. The circuit variables, E_1 and E_2, are also shown in Fig. 11.

The specific discontinuous nonlinearities considered in this paper by no means exhaust the available supply. However, the more common mechanizations have been outlined. These should suffice for the majority of control systems simulations. Those discontinuities not included may usually be generated by combinations and simple extensions of those shown. ■ ■

How to Measure A Potentiometer's Incremental Transfer Function

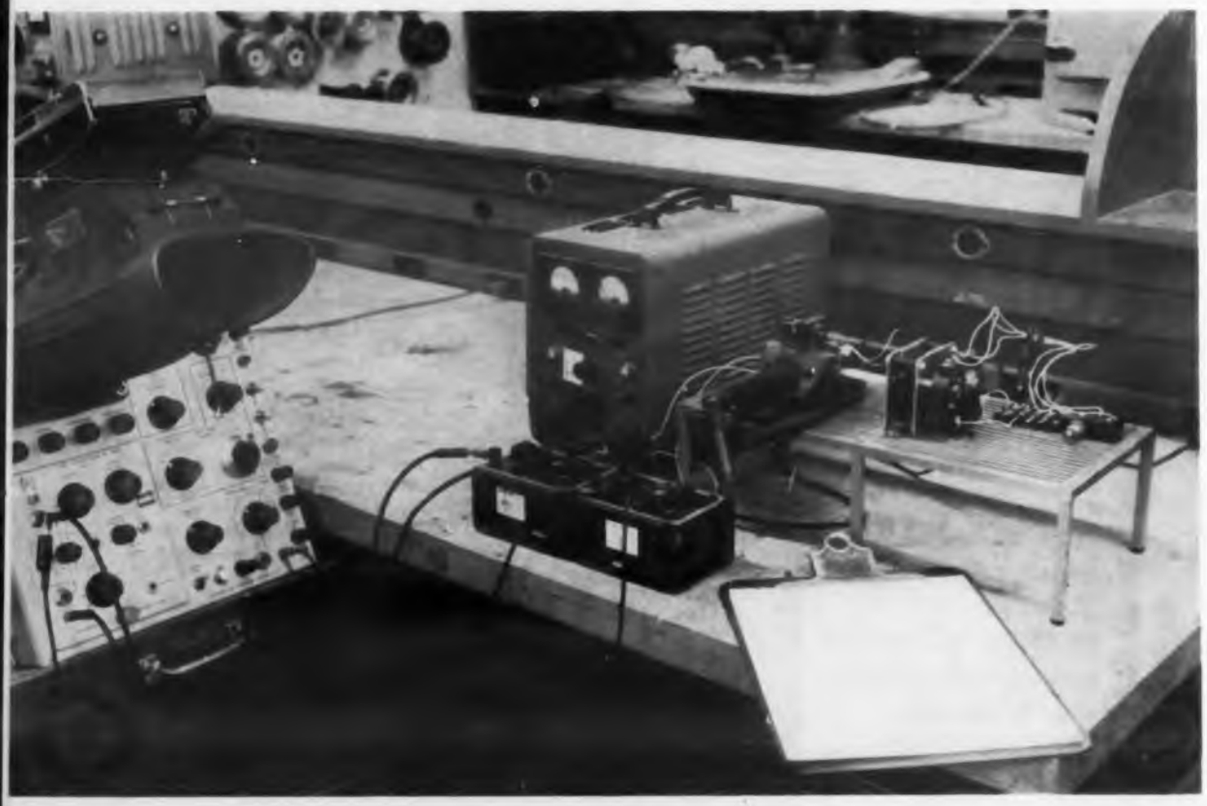


Fig. 1. The pot being tested for incremental linearity is clamped in a vise and its shaft driven at 1 rpm by a motor via a clutch. After differentiation by the R-C decades, the pot output is displayed on the oscilloscope. Penwriter recorders can also be used at the low frequencies produced by the 1-rpm shaft speed.

Most servo designers are quite familiar with the measurement of over-all linearity in precision potentiometers. Fewer engineers are aware of the need for measurements of incremental linearity. Yet variations in this parameter can cause servo system hunting.

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THE derivative of a potentiometer's output can be as important as the potentiometer's steady-state voltage when the potentiometer is used in a high-performance servomechanism. Although the potentiometer may be quite linear over-all, if large gradient variations exist for small rotation angles, the potentiometer may actually contribute to servo system instability.

In Fig. 2, the curve for potentiometer *A* always lies within the independent linearity tolerance limits; however, note that at certain shaft angles, curve *A*'s incremental voltage gradient is considerably different than the ideal slope. On the other hand, though potentiometers *B* and *C* do not remain within the independent linearity tolerances, they would actually be better from a servo system's stability standpoint.

Therefore, for potentiometers for servo systems where frequency response or stability is a problem, the incremental linearity should also be controlled.

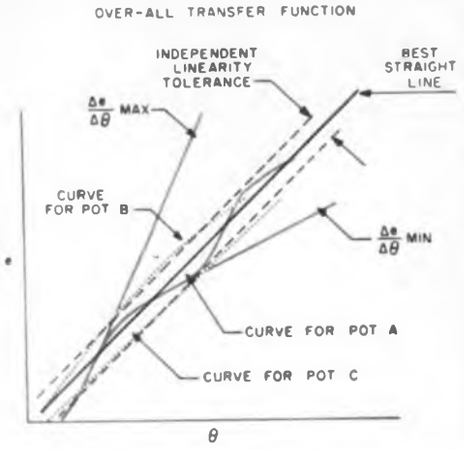


Fig. 2. Having a small voltage gradient may be as important as staying within the independent linearity tolerances.

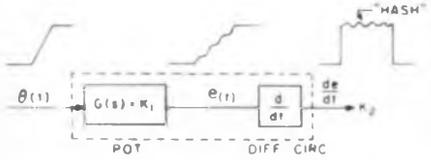


Fig. 3. Block diagram defines incremental linearity. The "hash" on the pulse resulting from a ramp input is the measure of incremental linearity.

The potentiometer's incremental transfer function may be measured directly by placing a constant voltage across the potentiometer's end taps, rotating the shaft at a constant rate, and differentiating the wiper output.

The differentiated output will be proportional to the transfer function, as shown by the block diagram, Fig. 3. With the proper choice of shaft rotation rate (input ramp) and differentiating circuit time constants, the transfer function can be readily measured and engineering limitations can be placed on the variations (which amount to the "hash" on the output) from the ideal value (see Fig. 4).

The procedure used to determine the parameters for the typical application shown in Fig. 1 will be used as an example. In this case, laboratory tests indicated that an angular rate of approximately 1 rpm was best for a 100-K, single-turn, conductive plastic potentiometer (this effect is not just a matter of the wire-to-wire variations on wound potentiometers). A higher rate required a short time constant for the differentiating circuit, which not only required a high-speed recorder but was more susceptible to 60- and 400-

cps pick-up in the measuring system. Lower angular rates produced smaller output signals which were difficult to measure.

The nominal differentiating circuit time constant, τ, was determined from both the potentiometer rotation time, T, and the incremental angle concerned, which was approximately 1/2 deg

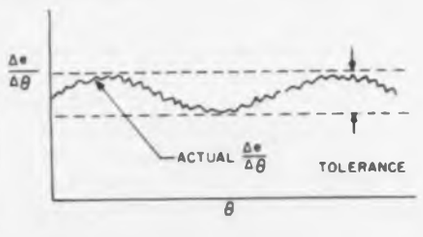
$$T = 60 \text{ sec/revolution}$$

$$\frac{\tau}{0.5^\circ} = \frac{T}{360^\circ}$$

$$\tau = 0.5(60)/360 = 83.3 \text{ msec}$$

For a good ramp output voltage from the potentiometer when the wiper is moved at a linear rate, the wiper current, i_2, must be a negligible part of the potentiometer current, i_1, (Fig. 5). As shown by the following equations, i_2 is proportional to the value of the capacitor, C, and the maximum allowable ca-

Fig. 4. Tolerances for incremental linearity variations can be set up on scope grid and used to check vendor potentiometers.



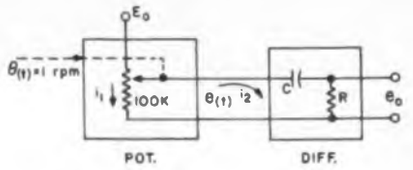


Fig. 5. Circuit diagram of test set-up: i_2 should be a negligible part of i_1.

pacitor value is determined by the maximum allowable wiper current.

$$K = \frac{E}{T} = \frac{E}{60} \text{ volts/sec}$$

$$e(t) = K\theta(t) = Kt = i_2R + \frac{1}{C}\int i_2 dt$$

$$\mathcal{L}\, e(t) = \frac{K}{s^2} = I(s)R + I(s)\,\frac{1}{Cs}$$

$$= I(s)\left(R + \frac{1}{Cs}\right)$$

$$I(s) = \frac{K}{s^2\left(R + \frac{1}{Cs}\right)} = \frac{K}{Rs\left(s + \frac{1}{RC}\right)}$$

$$\mathcal{L}^{-1} i(t) = \frac{K}{R}\,RC\left(1 - e^{\frac{-t}{RC}}\right)$$

$$i_2 = KC\left(1 - e^{\frac{-t}{\tau}}\right)$$

($I_2 = KC$, where I_2 is the nominal steady-state wiper current.)

Arbitrarily letting I_2 be one per cent of I_1:

$$I_2 = 0.01 i_1 = 0.01\,\frac{E}{10^3} = \frac{E}{10^5}$$

$$KC = \frac{E}{10^5}$$

$$C = \frac{E}{K}\,(10^{-5}) = \frac{E}{E/60}\,(10^{-5})$$

$$= 6\mu\text{fd maximum}$$

$$R = \frac{\tau}{C} = \frac{83.3\,(10^{-6})}{6\,(10^{-6})} = 13{,}900\Omega$$

The set-up shown in Fig. 1 was used to check the incremental linearity of a potentiometer supplied to Robertshaw-Fulton Controls Co. for use in a flight control subsystem of the F-106 Delta Dart aircraft. ■ ■

How to Use Ripple-Current Ratings Of Aluminum Electrolytics

There's nothing terribly involved about selecting the right aluminum electrolytic for a given application. Yet many engineers do only half the job. In this article, M. T. Reese, a man who knows capacitors, shows how to determine the adequacy of a given capacitor.

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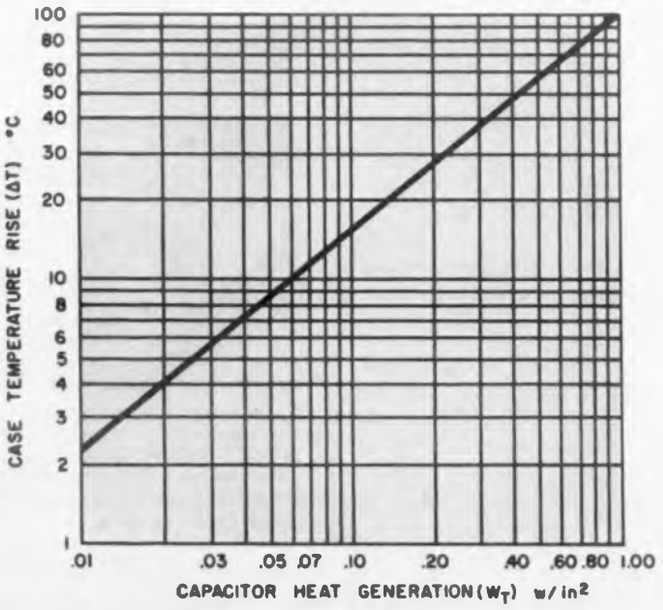


Fig. 1. Capacitor case temperature rise above ambient for different levels of internal heat generation due to ripple and leakage currents.

ALUMINUM electrolytic capacitors have become so commonplace that many circuits engineers take them for granted. These engineers tend to specify capacity and voltage rating and assume that no further study is required. Unfortunately, in many cases, inadequate understanding of the electrolytic leads to a poor choice and the capacitor does not do the best job of eliminating ripple or it fails early.

Many factors are involved in the ripple-current ratings of aluminum electrolytics. Of these, two properties of the capacitor rate foremost consideration—impedance and heat dissipation. An understanding of these two properties can help the circuit designer select a capacitor for a desired ripple rating.

Capacitor Terminal Impedance Is Complex, Unilateral, Nonlinear

The impedance of the capacitor is

$$Z = R - jX_c = R - j\frac{1}{2\pi f C}$$

where Z is the complex impedance at the terminals of the capacitor expressed in ohms and phase angle, R is the equivalent series resistance of the capacitor, and C is the capacitance. Its associated reactance is X_c.

These quantities are measured at temperatures and frequencies which will be encountered in the specific application.

It is well to keep in mind the nature of these impedances as they apply to the electrolytic capacitor, especially to a polar type. The terminal impedance can be nonlinear; it also tends to be unilateral, i.e., not the same in both directions unless a very low signal voltage is used in measurement or a dc bias is applied. The unilateral nature of the impedance can change the relationship between voltage drop, current, and impedance compared with that normally used in sinusoidal circuit analysis.

Nevertheless, for most calculations, accurate data can be obtained for impedance measurements if signal voltages below 100 mv are used, so this approach is recommended because of its simplicity compared with alternative bias arrangements. Impedance should be measured only after tests have shown that dc leakage is no more than about $0.01\sqrt{CV}$ ma.

Steady-State Heat Generated Must Be Dissipated Continuously

If W_T represents the total steady-state power in the capacitor, the heat generation due to ripple current and leakage current is

$$W_T = I_r^2 R + VI_L \qquad (1)$$

where I_r is the ripple current, R the series-resistance portion of the capacitor impedance, V the applied voltage, and I_L the steady-state dc leakage current.

Under steady-state operation, the heat generated in the capacitor must be dissipated continuously to the surrounding ambient. This is accompanied by a rise in case temperature denoted by ΔT. This temperature rise above the ambient, necessary to dissipate heat under rated application conditions, may be approximated by

$$\Delta T = 103\, W^{0.83} \qquad (2)$$

W in w/sq in. is found by dividing W_T (Eq. 1) by the capacitor case-surface area. ΔT is expressed in deg C. Fig. 1, a plot of this relationship, shows that 0.06 w/in.^{2} corresponds to a 10 C case rise above ambient. This particular set of values is noted because it is a common operating limit point.

In addition to the case rise above ambient

there is also a temperature gradient from the hot spot at the inside of the capacitor roll to the outside of the case. As a practical matter, the temperature difference from this gradient will be in the general range of 2 C to 5 C for roll constructions, case sizes, and heat-generation rates in normal use. Therefore, good accuracy in estimating the hot-spot temperature will be obtained by assuming a 5 C temperature difference when case-heat dissipation rates are no more than 0.1 w per square inch of surface area.

The maximum internal hot-spot temperature is obtained by adding the case temperature rise, the internal temperature rise to the hot spot, and the ambient temperature. This total temperature is then used to estimate capacitor life and evaluate suitability of this temperature as an operating point.

Lower Ambient Temperature Allows High Case Rise

Typical ripple-current ratings of capacitors rated for a 65 C ambient are based on a 10 C case rise and 5 C maximum internal rise which yield a total top temperature of 80 C. Acceptance life tests are sometimes made at 85 C without ripple currents to check the adequacy of designs for maximum temperatures which may be encountered.

If in a given application the ambient temperature is less than rated, additional ripple current can usually be permitted.

A general rule-of-thumb is to permit a 5 C increase in case rise for each 10 C decrease in ambient temperature. Such a rule is conservative in that it provides allowance for a higher hot-spot-temperature rise and with it an extra margin of safety above normal when increasing ripple-current ratings.

The 10 C case rise and the 80 C hot-spot temperature are selected as a best compromise between operating life and the maximum possible heating ratings. A 10 C decrease in average temperature will approximately double capacitor life expectancy.

As the temperature is raised, case temperature rises much above 10 C may result in excessive temperature gradients and hot spots in the capacitor. Also, at higher temperatures, leakage current increases sharply, accompanied by a correspondingly increased rate of gas generation, and in extreme cases, by runaway thermal conditions. Measurement of the capacitor-core temperature under actual operating conditions is the best assurance that a balance in these factors is obtained.

A further limitation on the ripple-current rating is the current carrying capability of the tab connections. For tabs used on computer-size capacitors this current limit is about 10 amp per tab for continuous operation at a current density of 2,000 amp/sq in. of tab cross-section.

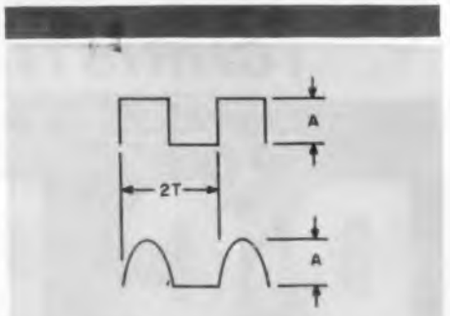


Fig. 2. Approximate Fourier analysis for square waves and half sine waves gives the following. For the square wave Dc component = A/2 Fundamental frequency = 1/2T, Fundamental rms voltage component = 0.45 A, Third harmonic rms component = 0.15 A, Fifth harmonic rms component = 0.09 A, Seventh harmonic rms component = 0.064 A. For the half sine wave: Dc component = 0.318 A, Fundamental frequency = 1/2T, Fundamental rms voltage component = 0.354 A, Second harmonic rms component = 0.15 A, Fourth harmonic rms component = 0.03 A.

AC, Flowing Into Cathode, Increases Oxide Formation

In addition to heating, the ripple current through the capacitor impedance produces an rms voltage drop of $V_r = I_r Z$. During the discharge half of each cycle, current flows into the cathode of the capacitor so the cathode becomes, to some degree, positive with respect to the electrolyte. This can result in increased oxide-film formation on the cathode of a polar capacitor even though no reversal of total circuit voltage exists at the capacitor terminals. The prime factors which influence this action are the relative impedance of the capacitor and load, the magnitude of the ripple current, and the series resistance of the electrolyte connection to the cathode.

Increased oxide-film formation on the cathode is to be avoided for three reasons. First, oxide formation decreases the capacitance. Second, it results in gas generation in the capacitor. Third, the electrolyte is decomposed.

The least costly way to reduce the effect of cathode formation is to provide an etched cathode having increased available surface area. Then any given voltage results in a higher cathode capacitance compared to that with an unetched cathode foil. When this cathode is combined with a given anode it causes less capacitance drop at the terminals than occurs with unetched cathodes. Gas generation and electrolyte change due to any formation are only slightly affected.

A second means of preventing oxide-formation effects is to provide a cathode already formed to a voltage greater than that which must be tolerated in service. Such a capacitor is termed a semipolar capacitor. All three effects of cathode formation are then eliminated, but the available capacitance in a given case size is reduced and cost is increased. The nonpolar capacitor has a cathode formed to the same voltage as the anode and has about half the capacitance in a given case size as a polar capacitor of the same rating.

Unetched Cathodes Are Suitable When RMS Voltage Drops Are Small

As a general rule, and within the limitations of heating, unetched cathodes are suitable when the rms voltage drop across the capacitor does not exceed 5 per cent of the applied dc voltage. Etched cathodes are generally suitable for ripple voltages up to 10 per cent of the applied dc voltage. Beyond this value of ripple voltage or for heavy discharge applications, a semipolar or nonpolar capacitor is usually needed.

Pulse loads may be treated as a special case of the general methods applied to ripple-current-rating determination. Fourier analysis of the capacitor current or voltage wave will yield the ripple-current components in both frequency and magnitude. Each component may then be used with the capacitor impedance at that frequency to determine the capacitor heating. Then the loss at each frequency can be added to obtain total heating.

Instead of such detailed analysis, an approximation is usually sufficient for square pulses by considering the pulse to consist of a dc component plus only the fundamental and third harmonic components. As a first approximation to a square pulse, the fundamental frequency is determined from the duration of the pulse, T, from $f = 1/2T$.

In magnitude, the dc component of the square wave in Fig. 2 is the value that equalizes the areas in the wave above and below this value. The rms value of the fundamental component is 45 per cent of the peak-to-peak amplitude of the pulse while the rms value

of the third harmonic is 15 per cent of the pulse amplitude. This assumes that pulse *OFF* times and *ON* times are equal.

Heating Calculations Required For Each Harmonic Component

Heating calculations are made for each harmonic component by first determining the current at that frequency, $I_f = V_f/Z_f$. Watts loss then is calculated from $W_f = I_f^2 R_f$. For heating calculations, the total watts loss equals the sum of the losses at each frequency.

It is also necessary to take into account the duty factor on pulsed loads since the duration of the pulse may be small relative to the time between pulses. The product of twice the *ON* time of a pulse and the rate of occurrence is the duty factor. The duty factor multiplied by the calculated heating for a continuous repetitive pulse gives the actual heating which can be used for temperature-rise calculations.

Sample Design Calculations For Capacitor Selection

1. From the capacitor impedance and desired current, calculate the watts heating the capacitor.

Example: A typical 10,000 μf, 50 vdc unit, in a 3 in.-diam x 4-1/8 in.-long case, has an impedance at 120 cps of $0.052 - j\,0.133$ ohm. Heating, with 0.1 ma dc leakage and 6.6 amp at 120 cps ripple current is

$$W_t = I^2R + VI_l = (6.6)^2\,0.052 + (50)(0.0001) = 2.26 \text{ w}$$

2. Determine the case-temperature rise to dissipate the wattage for the case size considered.

Example: W/sq in. $= 2.26/39 = 0.058$ w/in.^{2}.

From Fig. 1 the case rise would be 9.6 C.

3. Compare the case rise to 10 C: if under 10 C it is satisfactory; if over 10 C the operating ambient which can be tolerated is 10 C below the rated ambient for each 5 C case rise greater than the standard of 10 C.

Example: The 9.6 C rise calculated is satisfactory for 65 C operation.

4. Check that the ac voltage drop across the capacitor when carrying the desired ripple current is less than that for which the particular capacitor type is intended—to prevent undesirable cathode formation or current overload.

Example: $Z = 0.052 - j\,0.133 = 0.143 \angle -69°$ ohm. Ac voltage $= 0.143 \times 6.6 = 0.94$ v or 1.88 per cent of the 50 vdc rating. This is satisfactory for all cathode types. ■ ■

Currently Available Triode-Pentode Tubes

J. H. Robb
General Electric Co.
Receiving Tube Dept.
Owensboro, Ky.

THE FOLLOWING list of triode-pentodes is intended to provide a convenient reference for comparison between types in this group. Only the simplest relationships, obtainable from published data, are included and they should be taken as approximations rather than conclusive facts. For example, two types may be described as similar except for basing, yet their high frequency performance may be quite different. Thus, the list is intended as a handy guide; refer to manufacturers' data sheets for more complete information and check availability of specific types before designing around them. The list includes some older types which may no longer be available.

Television Oscillator - Mixers
(Types Similar to 6X8)

Type	Basing	Comments
5X8 6X8 9X8 19X8	9AK 9AK 9AK 9AK	Single cathode; as compared with U8, has slightly lower dissipation ratings, and triode has slightly lower Ib, Gm; same μ
5AT8 6AT8 6AT8A	9DW 9DW 9DW	Rebased X8; lower pentode Cgp
5CG8 6CG8 6CG8A	9GF 9GF 9GF	Rebased X8; slightly lower pentode Cgp than the AT8

Television Oscillator - Mixers
(Types Similar to 6U8)

Type	Basing	Comments
5U8 6U8 6U8A 9U8A	9AE 9AE 9AE 9AE	Triode μ = 40 Pentode Gm = 5,000 Separate cathodes
5BE8 6BE8 6BE8A	9EG 9EG 9EG	Rebased U8 (suppressor connected to triode cathode)
5BR8 6BR8 6BR8A 9BR8	9FA 9FA 9FA 9FA	
5CL8 6CL8 9CL8	9FX 9FX 9FX	Tetrode rather than pentode; similar to U8
5CL8A 6CL8A 19CL8A	9FX 9FX 9FX	Higher pentode zero-bias plate current and Gm than CL8; same basing, but actually the CL8A is a pentode with suppressor internally connected
5CQ8 6CQ8	9GE 9GE	Similar to CL8; different basing
5EA8 6EA8 19EA8	9AE 9AE 9AE	U8 basing with CL8A characteristics
5EH8 6EH8	9JG 9JG	Similar to EA8; different basing
5EU8 6EU8	9JF 9JF	Similar to EA8; different basing
5FG7 6FG7	9GF 9GF	U8 based like CG8
6678	9AE	6U8 for Mobile Service
7643	9DC	Basing same as U8, Triode μ = 20
7731	9AE	U8 for instruments

Triode-Pentodes with Video or IF Amplifier Pentode Sections

Type	Basing	Comments
5AN8 6AN8 6AN8A	9DA 9DA 9DA	Triode μ = 19; pentode similar to U8, slightly sharper cut-off
6AU8 8AU8	9DX 9DX	Triode μ = 40; higher pentode dissipation rating than AN8
6AU8A 8AU8A	9DX 9DX	Higher pentode zero-bias plate current than AU8
5AV8	9DZ	Rebased 5AN8
6AW8	9DX	Triode μ = 70; pentode —higher Gm than AU8
6AW8A 8AW8A	9DX 9DX	Controlled zero-bias Ib Controlled zero-bias Ib
6AX8	9AE	6U8 triode; pentode similar to 6U8
6AZ8	9ED	AN8 triode; semi-remote cut-off pentode
5B8	9EC	Similar to AV8 and AN8; rebased
6BA8	9DX	Triode μ = 18; AW8 pentode
6BA8A 8BA8A	9DX 9DX	Controlled zero-bias Ib Controlled zero-bias Ib
6BH8 8BH8	9DX 9DX	Triode μ = 17; AU8 pentode
6CH8	9FT	Similar to AN8; different basing
5CM8 6CM8	9FZ 9FZ	Triode μ = 100; AN8 pentode
5CR8 6CR8	9GJ 9GJ	Triode μ = 22; pentode similar to AN8
6CS8	9FZ	Rebased 6CR8
12CT8	9DA	AU8 triode and pentode; AN8 basing
6CU8	9GM	AN8 triode and pentode; rebased
6CX8 8CX8	9DX 9DX	Triode similar to AU8; higher dissipation and higher Gm pentode than AU8
5DH8	9EG	10C8 triode (μ = 53); pentode similar to 10C8; rebased
6EB8 8EB8 10EB8	9DX 9DX 9DX	Triode μ = 100 (higher Gm than CM8); pentode similar to CX8, higher Gm
6GN8 8GN8	9DX 9DX	Similar to EB8—Controlled Plate-Knee Characteristics
7258	9DA	Similar to 6AN8—for Mobile Service

Miscellaneous Applications

Type	Basing	Comments
15A8	8GS	Vertical deflection oscillator—amplifier (octal base)
6AD7G	8AY	Audio phase inverter and power amplifier
12AL8	9GS	12-v auto; space-charge grid tube
12B8GT 25B8GT	8T 8T	RF or IF amplifier (radio); not like the 5B8
10C8	9DA	Vertical deflection oscillator—amplifier; higher μ triode, lower dissipation ratings than 15A8
12DY8	9JD	12-v auto; signal-seeker pentode
6DZ8 9DZ8 12DZ8 18DZ8 35DZ8		Audio
12EC8	9FA	12-v auto VHF oscillator—mixer
6F7	7E	Oscillator—mixer
5FV8 6FV8	9FA 9FA	Similar to CL8-A—pentode rated for TV vertical-oscillator service
6FY8 12FY8 25FY8 50FY8	9EX 9EX 9EX 9EX	Audio
6GE8	9LC	Voltage regulator service
5GH8 6GH8	9AE 9AE	Similar to EA8—pentode rated for TV horizontal-oscillator service
6GJ8	9AE	Similar to CL8-A—pentode rated for TV horizontal-oscillator service
18HB8 35HB8	9ME 9ME	Audio
6HC8 17HC8	9EX 9EX	Vertical oscillator-amplifier 9-Pin T-9 bulb
6HF8 10HF8	9DX 9DX	AW8 triode—CX8 pentode
1V6	1V6	Oscillator—mixer
7059	9AE	12-v mobile—similar to U8
7060	9DA	12-v mobile—BH8 pentode, AU8 triode
7199	9JI	Audio—similar to AN8—different basing
7716	9DX	EB8 triode—CX8 pentode 13.6 v heater—mobile
7734	9LC	Electronic regulator service

How Much Do Components Limit Converter Performance?

Bernard M. Gordon, President
Bruce K. Smith, Vice-President
Epsco, Inc.
Cambridge, Mass.

Astute engineers often question the accuracy and stability claims of new equipments. In this article they can find good grounds and good justification for their questions. In justifying the limitations they suggested for A/D converters in their article, "How to Specify Analog-to-Digital Converters," (ED, May 10, p 36), Bernard Gordon and Bruce Smith present here the accuracies and stabilities one can expect of basic components.

IN THE last analysis, components—basic, simple components—are at the heart of any equipment. As such, they constitute the ultimate limit on equipment performance. The limitations indicated for A/D converters in "How to Specify Analog-to-Digital Converters" (*ED*, May 10, p 36), were by no means arbitrary. They are based, ultimately, on the performance of today's components.

It is important to realize that there is no single answer to a question such as, "What is the most stable resistor one can obtain today?" The stability obtainable with a resistor designed for and used in low speed or semistatic applications (i.e., where inductance and stray capacity have no significance in the application) is much greater than that obtainable in a resistor wound for minimum inductance and minimum capacitance as required and used in high-speed, precision applications. (A wirewound resistor is often a very close approximation to a distributed constant delay line.)

Similarly, it is much more difficult to obtain stability when there are severe volume and weight requirements. Therefore, when considering the limiting factors, one must exercise judgment and flexibility in terms of specific design applications.

Typical unsaturated chemical cell:

Temperature range: 10 to 35 C.

Initial calibration absolute accuracy: 0.002 per cent approximately. (0.0005 per cent at Bureau of Standards.)

Long-term stability, one year: 0.01 per cent approximately, assuming no current drain.

Temperature Coefficients: 4 ppm per deg C.

Highest quality Zener reference diode, temperature-compensated, and driven by precision current source:

Temperature range: 10 to 70 C.

Initial calibration absolute accuracy: 0.002 per cent approximately. (0.001 per cent at Bureau of Standards.)

Long-term stability: 0.01 per cent approximately, assuming stable current source (0.001 per cent for one week.)

Temperature Coefficient: 5 ppm per deg C for Zener diode itself plus 3 ppm per deg C for variations in a good current source.

Low-speed resistors:

Initial calibration absolute accuracy: 0.002 per cent.

Temperature coefficients: 1 to 3 ppm per deg C (for restricted ranges only).

Long-term stability: 0.003 per cent approximately.

Resistors can be matched to temperature coefficients and initial relative accuracies almost one order of magnitude greater.

High-speed resistors:

Initial calibration absolute accuracy: 0.002 per cent for very short period, but 0.005 per cent for all practical purposes.

Temperature coefficients: 2 to 3 ppm per deg C (for restricted ranges only).

Long-term stability: 0.01 per cent.

Resistors can be matched to temperature coefficients and initial relative accuracies about a factor of three better.

Special germanium transistors in saturation mode:

Initial voltage drop: 200 μv (selected units), 1,000 μv (typical nonselected).

Temperature coefficients of saturated voltage drop: approximately 1 μv per deg C.

Special silicon transistors in saturation mode

Initial voltage drop: 500 μv (selected units), 1,500 μv (typical unselected).

Temperature coefficients of saturated voltage drop: approximately 1 μv per deg C.

Silicon diodes used as switches:

Initial voltage drop: approximately 0.7 v

Long-term stability: 1 to 2 mv with constant current.

The over-all accuracy of a converter must be considered to be the expected limit of the sum of the long-term errors from all sources contributing to the over-all measurement. A look at some of the error contributions show this.

Voltage Reference Source .....0.002 to 0.01%
Input Network or Buffer Amplifier ...0.003%

Comparator		±0.1 mv approx.
Most Significant Digit Network	0.003%	±0.1 mv approx.
Sum of All Other Digits Network	0.003%	±0.1 mv approx.
*Total relative error in worst case	0.009%	±0.3 mv
In rms expected case .	0.006%	approx.

*Note: The sum of the relative errors does not include the error contributed by the voltage reference source.

However, such limits of accuracy can only be achieved with laboratory-like care and precision under the most carefully controlled temperature conditions and by the most meticulous design of the over-all networks and circuitry.

Further insight into the state of the art may be obtained by a review of the table which illustrates what can be obtained with currently available converters and shows the generally inverse relationship between speed and accuracy.

Maximum Conversion Rate	*Specified Accuracy*	
5,000/sec	0.01%	relative +
	0.01%	reference
15,000/sec	0.03%	absolute
44,000/sec	0.05%	absolute
160,000/sec	0.2%	
5,000,000/sec	0.5%	
30,000,000/sec	1.0%	

When such units are used as digital-analog converters, the available accuracies may be improved by a factor of two, and the speeds of operation may be multiplied approximately by the number of binary bits carried in the conversion (except for the last model).

Based on their experience during the past five years, the writers are occasionally amused to observe new entries into the field of digital voltmeters or analog-digital converters advertising in bold statements the availability of such units with 0.003 per cent accuracy. While it is possible to occasionally obtain individual instruments where the fortunes of the laws of chance yield extreme accuracies for short periods of time and under specific combinations of temperature and humidity, in general such accuracies are not predictable on a sound engineering basis.

In light of the foregoing, it seems likely that until such time as the laws of physics are revised and/or unforeseen technical breakthroughs occur in the voltage-reference or precision-resistor fields, the state of the art of over-all converter accuracy will hold at 0.01 per cent. On the other hand, recent state of the art developments have pushed the speeds of available converters skyward to 30,000,000 conversion per second. ■ ■

External disturbances distort signals and "graph paper" alike so reading accuracy is not impaired.

Calibrated Multi-Channel Display System Features "Electronic Graph Paper"

ACCURATE, electronically generated coordinate lines eliminate errors in measuring up to eight simultaneous variables on the face of a 17-in. crt. With coordinates in exactly the same phosphor plane as the signals, there is no possibility of parallax error. Any drift or distortion affects signals and coordinates alike, so accurate readings can always be taken.

The model 5934 display system, manufactured by George A. Philbrick Researches, Inc., 127 Clarendon St., Boston, is intended primarily for measuring the outputs of analog computers and simulation systems. But it serves well as a general-purpose readout for displaying a wide variety of stimuli and their responses.

The coordinate presentation, on the medium-persistence P-7 phosphor, includes 100 vertical timing lines with each fifth line intensified, and each 10th line further intensified. Twenty-one brightening pulses on every vertical sweep form the horizontal, voltage-calibrating lines which scale displays from −100 v to +100 v.

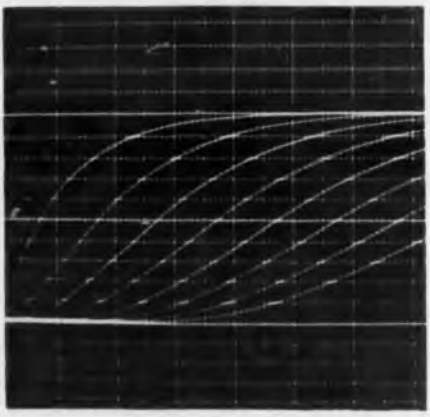
If higher sensitivity is required, an amplifier manifold containing eight dc amplifiers can be added. Each amplifier can be adjusted to provide gains of either polarity at 1, 2, 5, or 10. An external offset signal can be used to position any signal vertically.

During a vertical sweep, which takes place every 62.5 μsec, a brightening pulse forms a spot on the screen for each input signal. Since the same vertical sweep samples all eight input signals as well as the reference voltages, the display is highly accurate in voltage as well as time. Timing accuracy is inherently 0.02 per cent; voltage accuracy is 0.1 per cent. In both cases accuracies are further limited to the resolution of best available crt's.

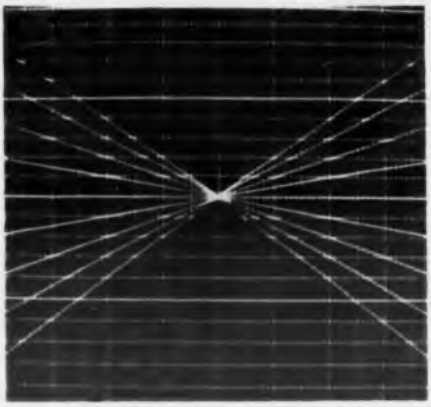
The horizontal sweep can be adjusted to provide 11 full-screen display periods ranging from as low as 25 msec to as high as 50 sec.

The display system can synchronize the beginning and end of an external signal to the start and finish of a selected display period. The beginning of its display period can be synchro-

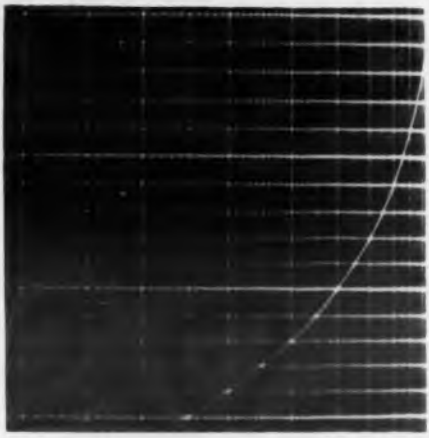
Signals and horizontal lines are formed by brightening pulses in vertical scan.



Simultaneous display of step response of eight, cascaded, first-order lags.



Outputs of eight separate integrators, each integrating different constant signals and starting from different initial conditions. All are synchronized with horizontal sweep.



Electronic "semi-log paper" results when an exponential voltage instead of the internal ramp drives the horizontal sweep.

nized by an external signal. Or the system can be used in a cross-plot mode wherein one or more signals are plotted against another signal, rather than against time. In this case, either set of coordinate lines or both can be eliminated by front-panel switching.

Front-panel switches are also available to turn off any signal or to provide a choice of two intensity levels for each signal. Hence, any signal can be singled out for observation.

The display system, available on 2- to 4-week delivery, costs $9,800. The eight-amplifier manifold sells for an additional $1,000. A 4 x 5 Polaroid camera will soon be available for use with this system.

For more information on this system, turn to the Reader-Service Card and circle 251.

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where stability is vital

RED/LINE timing relays guard against extreme heat

In the high cycle motor generators produced by the Bogue Electric Mfg. Co., the stability of the thermal relay is a vital operating factor. That is why Bogue design engineers selected G-V Red/Line Thermal Timing Relays over all others to delay the operation of the water pressure protective circuit while water pressure is built up in the cooling coils during starting of the motor generator. The Timing Relay then inserts the protective circuit and thus dangerous extremes of heat are avoided, insuring the efficient performance of the generators. **So, at Bogue the high quality of G-V Timing Relays is "paying off".**

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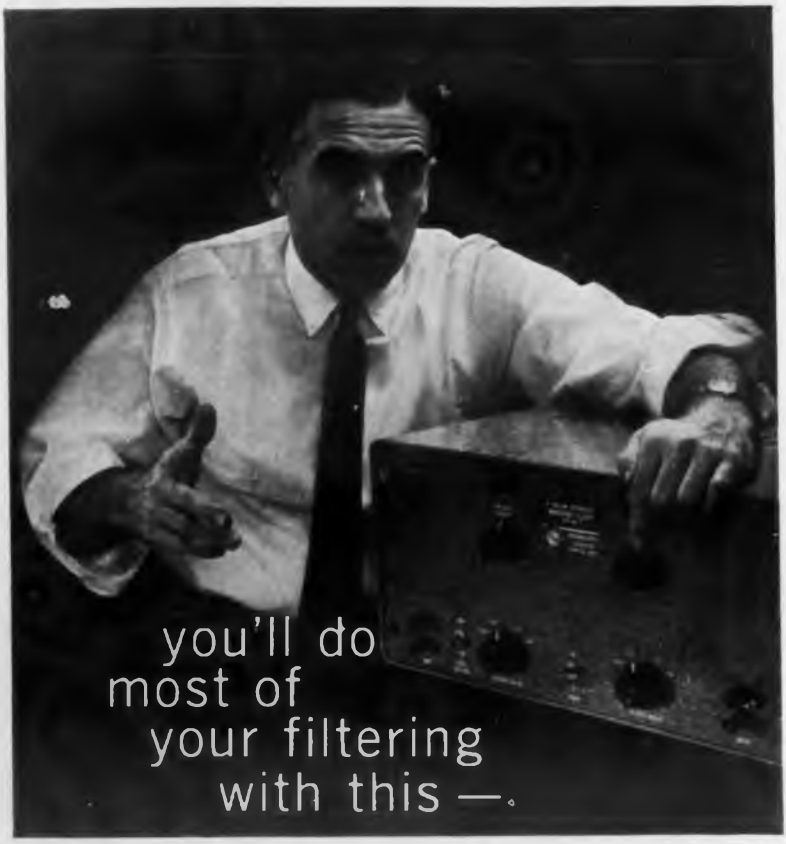
G-V

G-V CONTROLS INC
Livingston, New Jersey



because only the 330-M is continuously variable from 0.2 cps to 20 kc!

Now you can cover the complete frequency range from sub-audio through audio with one convenient variable electronic filter! Its bandwidth covers the most widely used frequencies in circuitry design, testing, measurement and research. The 330-M can replace — in a 17" x 8" x 12" size — banks of fixed filters, and massive inductors and capacitors.

More than this most frequently used bandwidth, the 330-M band-pass filter offers rapid attenuation beyond the cut-offs. Unwanted signals are attenuated up to 80 db, and maximum attenuation is *maintained* at all frequencies beyond cut-off. Low cut-off, high cut-off and center frequency are all continuously variable. Cut-off frequency dials are single log-scale, direct reading. Band switches give frequency ranges in five decades. Attenuation is 24 db per octave outside the pass-band, reaching 70 db in less than three octaves. Signal-to-noise ratio is greater than 80 db.

Write for full information on this wide-band, light-weight band-pass filter. Its convenient coverage of low frequencies through audio, and direct reading, continuously variable cut-offs give you real work-load flexibility. Other Krohn-Hite band-pass filters include Models 330-A (0.02 to 2,000 cps), 310-AB (20 to 200,000 cps); and rejection filters as well. *Also, Krohn-Hite Oscillators, Amplifiers and Power Supplies.*

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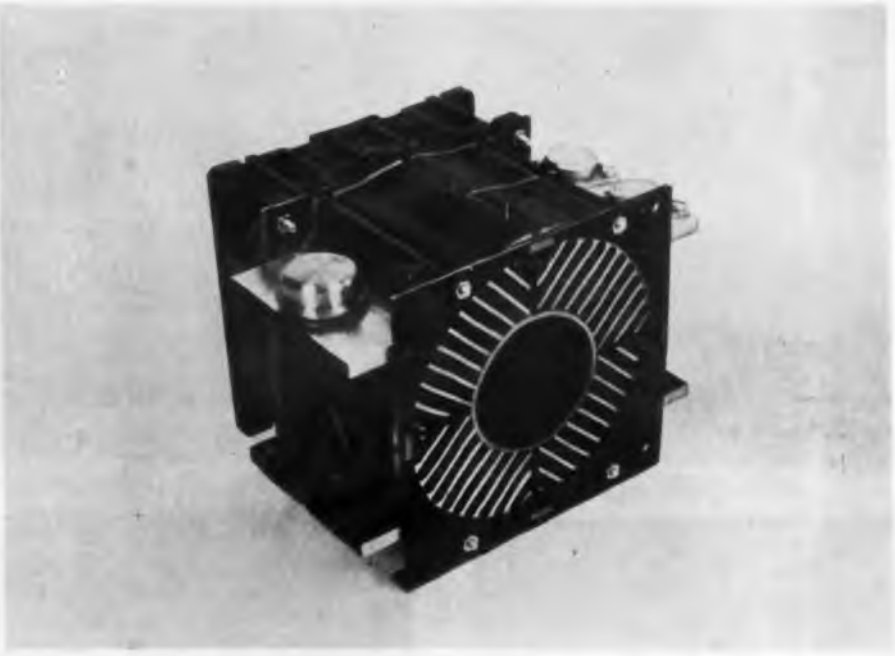
CIRCLE 47 ON READER-SERVICE CARD



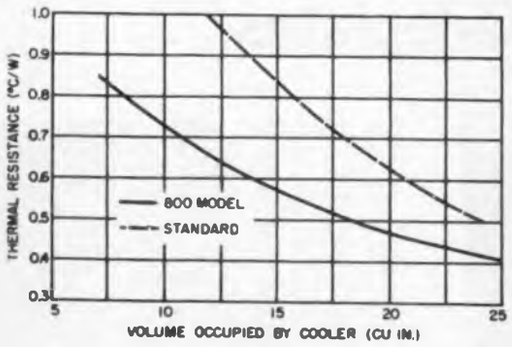
Forced-Convection Cooler Has Modular Design

ADAPTATION of natural-convection heat dissipators to fan and ducting for forced-convection cooling of semiconductor devices, accompanied by problems of proper match for best airflow, is made unnecessary by the introduction of the model 800 forced-convection cooler. Modular design provides for flexibility in meeting a great variety of applications.

Manufactured by Wakefield Engineering, Inc., Delta-T Div., 414 Main St., Wakefield, Mass., the package consists of modular building blocks of extruded aluminum fin quadrants and matching fan. Ducting design assures tight constriction of air flow to the fin surfaces. Its superiority over standard natural-convection heat dissipators in terms of volume required for adequate cooling indicates that its use should be considered in applications where more than 100 w must be dissipated, or those where ambient temperatures will exceed 50 C.

The cooler assembly has an annular air inlet conforming to the frontal dimensions of the Rotron Muffin fan and its equivalents. The air stream is confined to the annular frontal opening by a plastic tube inserted in the center of the assembly. Another fan, made to military specifications, is also available for use with the assembly. Although the motor on this fan is a standard type, and extends from the fan housing, no additional space is required since the motor fits into the center of the cooler assembly.

Considerably lower thermal resistances are obtained in a given volume by the 800 package as compared to the standard ducted-dissipator assemblies. Commonly, extruded dissipator strips measuring about 4-3/4 in. wide by 1-1/4 in. high are mounted



Curves compare thermal resistance of modular assembly with standard ducted-dissipator assembly in terms of volume required to reach a given value.

in a rectangular duct arrangement and matched to a blower. A 15 cu in. volume is required for such an assembly to achieve a thermal resistance of 0.85, which the model 800 reaches in 7 cu in. Thermal resistance of 0.5 is reached at 18 cu in., and 0.4 with 28 cu in. of the modular package.

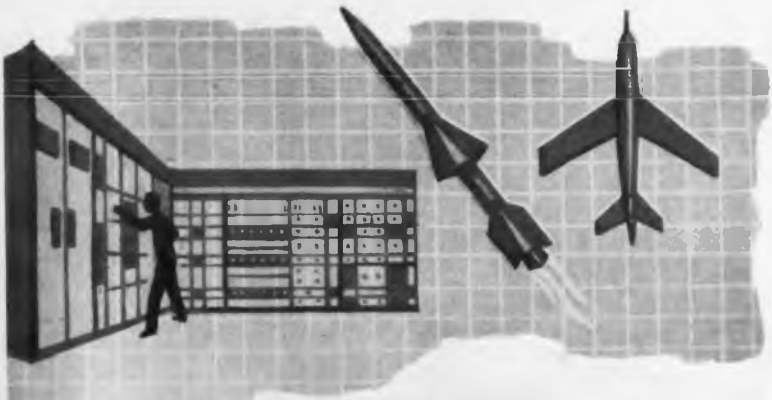
Power semiconductors requiring accommodation for feed-through leads are mounted on a shelf extending from the fin quadrant. Stud-mounting semiconductor devices are mounted directly on the type B coolers, eliminating the thermal resistance of the shelf. An additional tapped hole can be provided in the B units to permit electrical connection to the cooler. The coolers may be electrically isolated from one another and from ground, or they may be grounded by leaving out the intervening insulators. From four to 16 semiconductor mounting stations may be provided.

In production quantities, typical eight-station models of the modular package cost $35 each. Evaluation samples are available immediately, with eight-week delivery stated for large quantities.

For more information on these modular forced-convection coolers, turn to the Reader-Service card and circle 253.

AEROVOX

CAPACIBILITY*



HIGH-TEMPERATURE

METALLIZED PAPER CAPACITORS

P123ZN— rated at 50 VDC. Full voltage rating to +100°C. Rated from 150 VDC to 600 VDC. Full voltage to 100°C and to +125°C at 75% of voltage rating.

P323ZN— full rated voltage to 125°C.

P30ZN (bathtub) and **P09ZN** (rectangular). Full rated voltage to 125°C.

Designed specifically to meet critical operating requirements, Aerovox metallized paper capacitors offer many important advantages, including minimum size for space-tight applications... reliability and long service life... low radio frequency impedance... and a wide range of case styles for operation to +125°C **without voltage derating.**

Aerolene® impregnated units are available in the temperature ranges shown at left:

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*Capaci-bility An Aerovox characteristic. Capability to design, develop, and manufacture capacitors to best meet customers' requirements.

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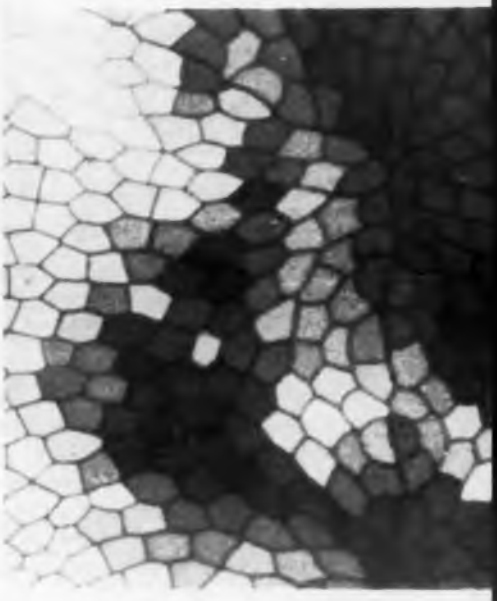
CIRCLE 49 ON READER-SERVICE CARD

Cathode-Ray Tubes Have Fiber Optic Faceplates



Photomicrograph of fiber optic bundles

CATHODE-ray tubes with fiber optic faceplates eliminate the need for a lens system to photograph displays. Over six million "light-pipes" contained in a 1-7/16 in. fiber optic cathode-ray tube carry light from excited phosphors directly to the outside surface of the tube without introducing parallax.

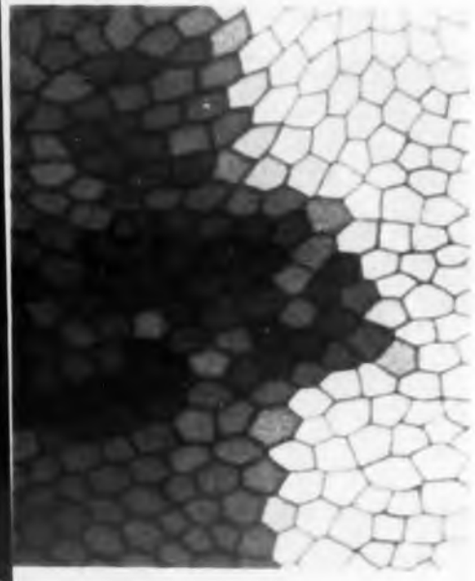
Until now radar mapping systems, and others in which oscilloscope traces were photographically recorded, required lens systems to focus the light coming from the phosphors located at the back of the faceplate. The short persistence P16 phosphor used with this systems is rich in ultraviolet light which is highly attenuated by the use of a lens system.

The new fiber optic cathode-ray tube, developed by the Allen B. DuMont Laboratories, Inc., of Clifton, N. J., gives about 60 per cent light transmission efficiency compared to approximately 6.3 per cent efficiency realized when using conventional lens systems. The fiber optic faceplates are supplied by Mosaic Fabrications, Inc., Southbridge, Mass.

The K2160 tube has fibers 10-micron thick with a one-mil spot size. The individual fibers are clad with a thin glass coating having a lower refractive index than the fiber glass. This gives an internal reflection property which sends light down the inside of the tube with very little escaping through the sides. The fibers are fused together and extruded to get compact bundles.

Because of the higher light transmission of the fiber optic tube, much lower beam currents can be used to achieve brightness equivalent to, or better than, that possible with ordinary faceplates. High resolution can be achieved in the DuMont tube with beam currents of 2 or 3 μamp. This allows transistorized drivers to be used, resulting in an additional saving of weight.

Although first availability of these tubes is 1-7/16 in. in diameter, DuMont states it can provide tubes very



showing a miniature picture.

quickly in sizes up to 5-in. in diameter. They will undertake development programs for large size display tubes where the matter of parallax is of major consideration, as in radar and large screen plotting and position indicators.

The new tubes give very high resolution for digital readout. In direct photographic printing from the face of the tube, light sensitive materials are exposed, by direct contact methods, to the surface of the tube. Essentially this tube development provides a facsimile system with a higher resolution than a television system.

The K2160 tube has a fiber optic faceplate which is 1/8-in. thick and costs $950 each in quantities of five. Since the price goes up with the volume of fiber optics needed, and the thickness increases with the diameter of the tube, prices do not increase at a linear rate.

For more information on this fiber optic cathode ray tube, turn to the Reader-Service Card and circle 252.

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.

DC Microvoltammeter Offers Wide Range 256

Full-scale ranges from 100 μv to 1 kv and 1 μa to 1 amp are provided by the 203A dc microvoltammeter. Accuracy is within $\pm 3\%$ of full scale on all ranges. Zero-center meter has mirror backing. Up to 84 db of over-all negative feedback is applied to input, assuring gain accuracy and input stability. The meter may be used as a low-drift dc amplifier, providing 80 db gain.

Kin Tel Div. of Cohu Electronics, Inc., Dept. ED, Box 623, San Diego 12, Calif.

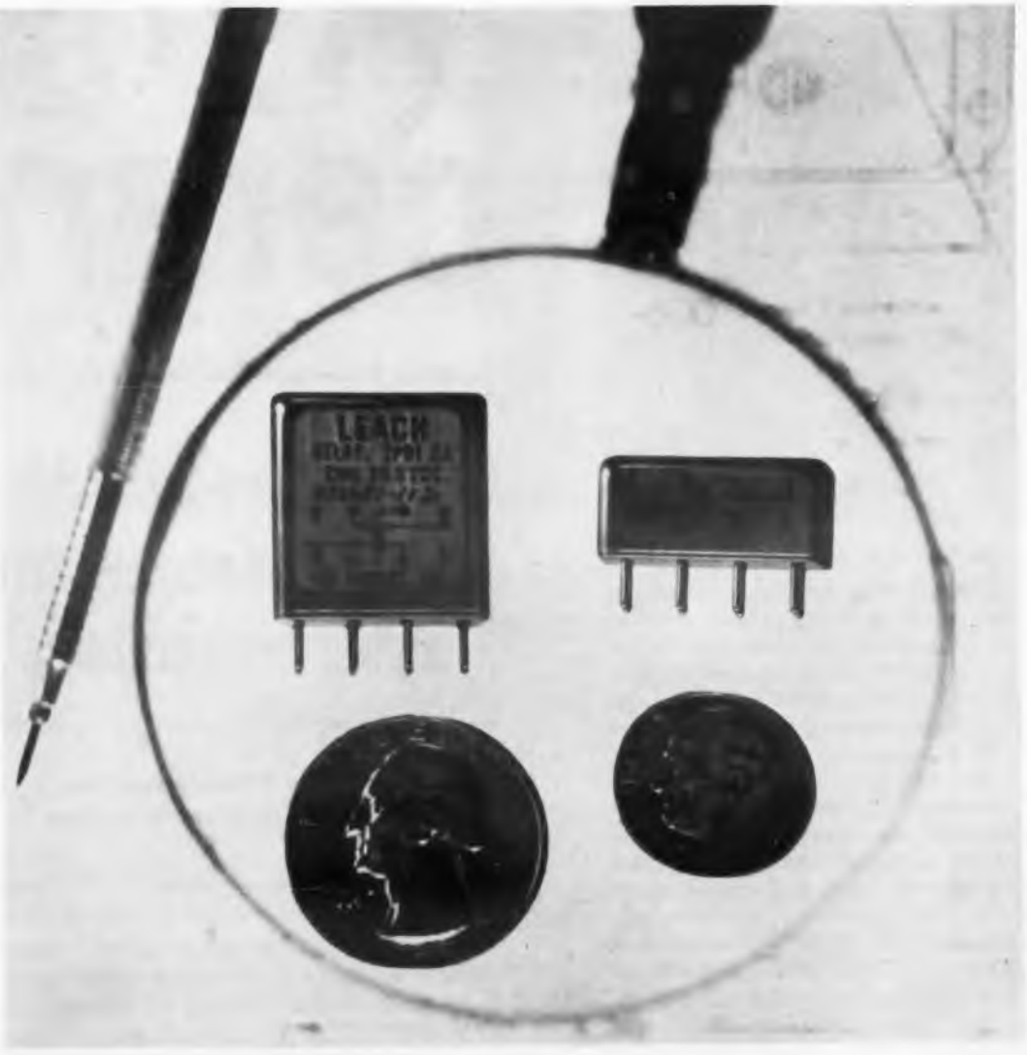
***P&A:** $750; 1 week.*

Bar Graph Oscilloscope Displays 48 Channels 255

Continuous and simultaneous display of 48 input channels is provided by bar graph oscilloscope model 220. Selective vertical gain, zero suppression control, automatic alarm system, and an electronic calibration grid line add to its versatility. Included are input delta-switch commutator, selective thermocouple reference junction, and input junction box. Instrument is built for stable and accurate continuous service.

Advanced Technology Laboratories, Dept. M-1, Dept. ED, 369 Whisman Road, Mountain View, Calif.

***P&A:** $3.750; stock.*



Crystal Can Relay Occupies 0.128 Cu In. 257

Crystal can relay M-250 is small enough to be installed vertically on circuit boards without increasing thickness of the package. The single-coil device is made for operation on 26.5, 12, and 6 v dc; the 2pdt contacts are rated at 2 amp resistive, 26.5 v dc. Operate and release times are 0.006 sec max each, operating life 100,000 cps at rated load. Ambient temperature range is -65 to $+125$ C, weight 0.35 oz. Relay withstands 20-g vibration and 50-g shock.

Leach Corp., Relay Div., Dept. ED, 5915 Avalon Blvd., Los Angeles 3, Calif.

***Availability:** 8 weeks, production quantities.*

Silicon Diodes Have Fast Recovery — 258

Designed for fast computer logic circuits, silicon diode type DW 120 has 4-nsec reverse recovery and 400-ma forward current at 1 v. Piv is 100 min, reverse current 0.025 μa max at 75 v. The companion DW 130 is identical except for minimum forward current of 50 ma at 1 v, and the low capacity of 4 pf at 0 v.

Delta Semiconductors, Inc., Dept. ED, 835 Production Place, Newport Beach, Calif.

P&A: *DW 120, $4; DW 130, $5, 1 to 99; stock.*

Zener Diode Rated at 50 Watts — 259

Silicon diffused-junction Zener diodes 1N-3305B through 1N3340B cover 6.8 through 100-v range with standard tolerance of 5%. The 50-w diodes are housed in a DO-5 11/16-in. stud package. Units are thoroughly tested to assure stable operation and reliability under severe environmental conditions. All mounting hardware is included.

Dickson Electronics Corp., Dept. ED, 248 Wells Fargo Ave., Scottsdale, Ariz.

P&A: *$6.25 to $11.75, 1 to 24; stock.*

NEW PRODUCTS

Output Transformer 563

Variable output transformer model VOT-1, operating from 115-v, 60-cps or 400-cps line, provides selection of any output voltage to 120 v in 1-v steps. Rated at 1 amp continuous duty, output is isolated from input.

Magnetico, Inc., Dept. ED, 6 Richter Court, East Northport, L. I., N. Y.

DC Rate Gyro 576

Withstands vibration of 10 g and shock of 50 g for 6 to 12 msec on any axis. Type RG-30 rate gyro has an accuracy of 1% to 2% full scale and a damping factor of 0.5 ±0.1. Service life is 1,000 hr for the motor, 10^5 cycles for the potentiometer.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

Electrical Taps 612

Strength is 4,500 v. Designed for Class B temperatures No. 54 electrical tape is a polyester film coated on one side with transparent thermosetting, pressure-sensitive adhesive. Tensile strength is 30 psi; insulation resistance is 1 x 10^6 meg; corrosion factor is 1.

Minnesota Mining and Manufacturing Co., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.

AC Rate Gyro 549

For high-altitude use, type RG01-0105 rate gyro is 1.2 in. in diameter, 2.94 in. long and weighs 8 oz. It withstands temperatures of −65 to +160 F, vibration of 10 g, and shock of 50 g for 6 to 12 msec on any axis. Accuracy is 1% to 2% full scale. Damping factor is 0.5 ±0.1.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

Incremental Encoder 566

Produces 1,024 pulses in one turn with an accuracy of ±1/2 bit. Model IMI 15-210 encoder provides a slewing rate of up to 3,000 rmp with a 100-kc carrier. It may be used as a bidirectional device by feeding into an up-down counter. Outputs may be adjusted over a wide range.

Data Tech, Dept. ED, 238 Main St., Cambridge 42, Mass.

Control Transformers 579

Open-unit transformers MTA and MTC, designed for machine tool control, operate on 115, 230 or 460 v, 60 cps, single phase, and are available in ratings from 50 va to 5 kva. Type MTA allows control circuit isolation for grounded or ungrounded circuits. Type MTC is used with solenoid, contactor, or relay coils demanding high in-rush currents.

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

Compression Glass 578

For hermetic sealing of end seals, hermetic connectors. Comprex 40 compression glass provides: annealing point of 440 C, softening point of 644 C, thermal expansion coefficient of 87.5 x 10^{-7}, density of 2.57, power factor of 0.21, dielectric constant of 6.5, loss factor of 1.37.

Mansol Ceramics Co., Dept. ED, Belleville, Md.

Heat-Sink Oven 557

Variable heat-sink oven series 900 is designed to thermally stabilize power-dissipating circuitry. Three models have ratings of 1, 3, and 10 w, with heater power ratings of 7, 14, and 28 w. Operating ambient temperature is −55 to +60 C.

Viking Industries, Inc., Dept. ED, 21343 Roscoe Blvd., Canoga Park, Calif.

Availability: *30-day delivery.*

Coaxial Termination 550

For 50-ohm systems, model 908A coaxial termination has a standing wave ratio of less than 1.05 from dc to 4,000 mc. Power rating is 1/2 w avg, 1 kw peak. It has a type N male connector, is 2 in. long and weighs 3 oz.

Hewlett Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

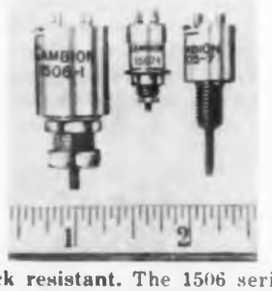
P&A: *$35; 2 weeks.*

Relay Socket 556

Diallyl phthalate socket for miniature relays has rear-entry, snap-in contacts. Size is 1.34 x 0.35 x 0.36 in. Socket has 8- and 10-contact configurations, five mounting styles, and crimp pot accommodations for 20, 22, and 24 AWG wire. Voltage breakdown is 3.5 kv dc at sea level; contact rating is 5 amp. Requirements of MIL-C-26636 are met.

Viking Industries, Inc., Dept. ED, 21343 Roscoe Blvd., Canoga Park, Calif.

Wound, Shielded Coils 567



Are shock resistant. The 1506 series wound, shielded coils have standard winding on LS10 forms with inductances of 1 to 20 μh. Series 1507 can have 0.11 to 3.5 mh. The first type is 2-7/64 in. high; the second type, 1-1/8 in. Coils are stud mounted with tuning slug accessible from only the stud end.

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

P&A: *$0.40 ea; from stock.*

NEW PRODUCTS

Circuit Breaker 619

Snap-blade model SMB circuit breaker is designed for use in continuously running motors where the ration between the running overload and locked rotor current is small. Dc types are furnished for 6 to 24 v and handle rotor currents of 10 to 70 amp with trip times of 2 to 20 sec. Ac types handle 115 v and 15 to 60 amp, rotor current.

Sylvania Electric Products Inc., Dept. ED, Ipswich, Mass.

Gaseous Rectifier Tubes 554

Xenon-filled gaseous rectifier tubes types 6013/3B and 5892/6B are said to have improved voltage and peak current ratings, a wide ambient temperature range, rapid warm-up time and a large overload capacity.

Cetron Electronic Corp., Dept. ED, 715 Hamilton St., Geneva, Ill.

Low-Frequency Standards 615

For 400 to below 60 cps. A typical unit for 400-cps use is stable to within ±0.001%. A variety of temperature ranges, input and output voltages, mountings, terminals, dimensions and weights can be furnished to meet customer requirements.

Monitor Products Co., Dept. ED, 815 S. Fremont Ave., South Pasadena, Calif.
P&A: *$150; 6 to 8 weeks.*

DC High-Voltage Relay 565

Contacts break up to 5,000 v rms at 200 ma. The HV series relay is designed for making and breaking high-voltage circuits of low current-carrying capacities. Contact arrangements are: 1A, spst NO double make; 1B, spst NO double break; 1C, spdt double break. Dielectric strength is 6,000 v rms, terminal to ground; 500 v rms, coil to ground.

Elgin National Watch Co., Dept. ED, 2435 N. Naomi St., Burbank, Calif.

Servo Amplifier 564

Gain of 100,000 with input impedance of 10 K is offered by servo amplifier model 1037. Occupying 1 cu in., the unit can drive a 40-v, two-phase motor of up to 3-1/2 w input. Silicon transistors are used in the 1-oz amplifier. Operating temperature range is −55 to +125 C at the mounting base.

Melcor Electronics Corp., Dept. ED, 48 Toledo St., South Farmingdale, N. Y.
P&A: *$230; 30 days.*

Terminal-Type Connectors 553

Have 36 wire-wrap contacts. For use with printed circuitry, series 145-50 terminal-type connectors can be furnished with mounting studs, mounting holes, or with right-angle pins, mounting studs and threaded inserts. Rating is 7.5 amp max. Text voltage is 3,000 v rms at sea level, 650 v rms at 70,000 ft; breakdown voltage is 4,500 v rms at sea level, 1,000 v rms at 70,000 ft.

Continental Connector Corp., Dept. ED, Woodside 77, N. Y.

Silicon Rectifiers 616

For 1,000 to 3,000 piv range. Sealed in a glass package 0.1-in. in diameter, types 1N3282 through 1N3286 silicon rectifiers have a current rating of 100 ma at 25 C, low forward-voltage drop and maximum junction temperature of 150 C.

Motorola Semiconductor Products Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.
Availability: *stock.*

VLF Receiver 551

For calibration of local frequency standards by comparison with WWVL and NBA broadcasts. Comparison accuracy of model DY-5842 receiver is better than 1 part in 10^9 in 1-hr test time. It may also be used for vlf field measurements. It has 1-μv sensitivity, five crystal-controlled channels from 14 to 60 kc, carrier level meter, recorder output and power consumption of 3 w.

Hewlett-Packard Co., Dept. ED, 395 Page Mill Road, Palo Alto, Calif.
P&A: *$1,615; 18 weeks.*

Film Adhesive 613

High-strength, thermosetting film adhesive Scotchweld AF-110 provides a metal-to-metal shear strength of 4,700 psi at 75 F and over 4,000 psi at 180 F. It resists shock and vibration as well as water, oils, fuels and salt spray. Cure temperature is 325 to 450 F; pressure required is from 10 to 25 psi.

Minnesota Mining and Manufacturing Co., Dept. ED, 900 Bush Ave., St. Paul, Minn.

Silicon Digital Modules 575

Operate from 4 to 10 mw per logic stage. Series SM digital modules include a bistable multivibrator, a diode NOR gate, a power driver, a monostable multivibrator and an astable multivibrator. These compatible 100-kc building blocks can be used in large data processing systems or small logic and control units. Temperature range is −10 to +100 C; weight is 12 g.

Delco Radio Div., General Motors Corp., Dept. ED, Kokomo, Ind.

Logic Elements 552

For severe environments. Pico-Bit logic elements can be furnished for nine different functions, including AND, OR, drive and binary

count. Operating frequency limit is 250 kc. They can be used at −55 to +125 C, at 0 to 100% RH, at unlimited altitudes and under severe shock and vibration.

Di-An Controls, Inc., Dept. ED, 944 Dorchester Ave., Boston 25, Mass.
***P&A:** $50 to $125; 45 days.*

Brush Clips 555

Quick-disconnect germinal assembly for brushes has silver-plated beryllium copper clips, straight or with 90-deg bend. Spring is stainless steel, spade terminals are silver-plated copper. The assemblies will carry a continuous current of 150 amp.

National Carbon Co., Dept. ED, 270 Park Ave., New York 17, N. Y.

VHF Transistor 618

Miniaturized version of the 2N1255, the 2N1699 Pancake transistor is designed for amplifier applications in the vhf range. It is about one-tenth the size and weight of the TO-33 unit and offers improved power dissipation. It meets the environmental requirements of MIL-S-19500B.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N. Y.

Power Supplies 622

Convection-cooled power supplies of LA series provide 20 to 105 v dc at 2, 4, and 8 amp, with panel heights of 3-1/2, 7, and 10-1/2 in. respectively. Rated for continuous operation at 50 C ambient, models have line regulation better than 0.05% or 8 mv from 105 to 140 v ac, load regulation better than 0.10% or 15 mv from zero to full load.

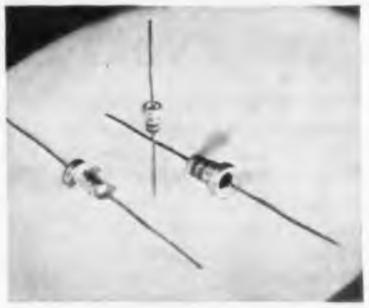
Lambda Electronics Corp., Dept. ED, 515 Broad Hollow Road, Huntington, L. I., N. Y.

Lead Telluride 595

Single crystal and polycrystalline lead telluride is available in p-type and n-type material. Bismuth telluride is also stocked.

Semi-Elements, Inc., Dept. ED, Saxonburg Blvd., Saxonburg, Pa.
***Price:** $0.50 per g.*

TRANSISTORS—Shown here in magnification is a Mesa transistor with fine gold wire. Handy & Harman manufactures this whisker wire to exact tolerances and highest purity standards. The cap is gold plated from Handy & Harman fine gold anodes. Photo courtesy of Western Electric.



CAPACITOR CANS—These tantalum electrolytic capacitors are completely leaktight and highly resistant to corrosion. The containers that are also used to seal the liquid and internals are drawn from Handy & Harman fine silver sheet. Photo courtesy of Fansteel Metallurgical Corporation, North Chicago, Ill.

CAPACITORS—Electrodes in these solid-state porcelain capacitors are formed from silver paste derived from Handy & Harman silver flake. Other types of capacitors for high-temperature applications have lead wires of Handy & Harman Consil 998, a nickel-bearing alloy. Photo courtesy of Vitramon, Incorporated, Bridgeport, Conn.

NEW PRODUCTS

Converter Amplifier 581

Single-channel, phase-sensitive model CE-1 converter amplifier is for use with potentiometers or ac variable-permeance and differential transformer transducers. It provides 1-kc carrier frequency to the transducer bridge, amplifies and demodulates the bridge output providing ±10 v dc full scale. A continuous and step attenuator provides gain ratios of 25, 50 and 100.

Crescent Engineering and Research Co., Dept. ED, 5440 N. Peck Road, El Monte, Calif.

Shrinkable Tubing 522

Requires 7 sec of heat at 275 C to form a tight, mechanical bond. Alphlex shrinkable tubing is irradiated, flame-retardant, thermally stable. It is available in 25 4-ft. lengths in sizes 24 to 4. It remains stable at temperatures from −67 to +275 F.

Alpha Wire Corp., Dept. ED, 200 Varick St., New York 14, N. Y.

Switch Kits 580

Monoplanar switch kits provide means of constructing more than 1,000 multipole, multiposition, multicircuit switch combinations on a flat surface. Assembly is 30% to 80% smaller than built-up types. Custom versions have the entire circuit printed on the switch plane. Model 610 is shorting, model 611 nonshorting.

The Ucinite Co., Dept. ED, Newtonville, Mass.

P&A: *$23.75; stock.*

Stripped Wires 585

Wires as fine as AWG 36, stranded or solid, with most types of extruded insulation including Teflon, can be stripped with 1/16 in. at each end, leaving as little as 1/2 in. insulation. Short jumper wires have a tolerance of ±1/64 in. for stripping and over-all length.

Manger Electric Co., Inc., Dept. ED, Miller St., Stamford, Conn.

Panel Meter 594

Interchangeable with 2-1/2 in. round meters, panel meter No. 1025 has a shadow-free polystyrene case. It has accuracy within 2%, scale length 2-1/2 in.

Burton-Rogers Co., Sales Div., Dept. ED, 42 Carleton St., Cambridge 12, Mass.

Servo Amplifier 582

Gain is 100,000; input impedance is 10 K. Model 1037 servo amplifier drives a 40-v, two-phase servomotor of up to 3.5-w input; it uses silicon transistors; weight is 1 oz; volume is 1 cu in. Operating temperature range is −55 to +125 C.

Melcor Electronics Corp., Dept. ED, 48 Toledo St., South Farmingdale, L. I., N. Y.

P&A: *$230; 30 days.*

◀ CIRCLE 55 ON READER-SERVICE CARD

NEW PRODUCTS

Angle Indicator 610

Three-channel remote angle indicator is used for readout of inertial platform orientation. Sensitivity is ±2 min deviation from null to any angle; over-all accuracy is 5 min. Repeatability is 2 min. Each channel has its CX-type remote angle sensor which feeds directly into a CT resolver. Test points on the 3-1/2-in. front panel monitor CX output for each channel.

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

Control Amplifier 603

Sensitive control amplifier model 4955D has up to 50% more operating range than former models. Proximity switch system is formed with the amplifier, any standard sensing head, and connecting cables. A 30-w line voltage regulating transformer is included for switch stability.

Electro Products Laboratories Inc., Dept. ED, 4500 N. Ravenswood Ave., Chicago 40, Ill.

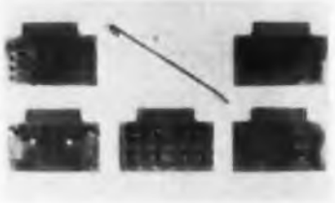
Digital Voltmeters 607

Plug-in accessories for the 6000 series of digital voltmeters and volt-ratio meters include ac-dc converter, dc preamplifier, and input assembly. The meters measure voltages from 1 mv to 999.9 v in three ranges with an accuracy of ±0.01%, ±1 digit. Input impedance is 10,000 meg at balance on the 9.999 v dc range.

Cimron Corp., Dept. ED, 3047 Jefferson St., San Diego 10, Calif.

Price: *$930 to $2,230; plug-in units, $750 and $830.*

Analog-to-Digital Converter 601



High stability, conversion rate, and input impedance are coupled with low power consumption and cost in the ADC-1B analog-to-digital converter. Unit has 15-bit resolution; BCD or binary conversion, with serial and parallel output formats; and Nixie display of digital output. Only five different circuit cards are used in the solid-state instrument.

Systems Engineering Laboratories, Inc., Dept. ED, Fort Lauderdale, Fla.

Fiber-Glass Cloth Tape 611

For Class B insulation in motors and generators and for sealing hot-air ducts and fire walls. Permacel 21D fiber-glass cloth tape has a tensile strength of 100 lb per in. width and becomes more firm when heat is applied. Rolls are 1/2 in. wide, 66 ft long.

Permacel, Dept. ED, New Brunswick, N. J.

Silicon Rectifiers 621

Four types are offered. Coaxial models have ranges from 250 ma at 50 piv to 22 amp at 800 piv. Stud-mounted and ceramic-insulated stud types range from 1.6 amp at 50 piv to 40 amp at 800 piv. Modular units range from 3 amp at 6.5 piv through 30 amp at 120 piv.

Raytheon Co., Dept. ED, Lexington 73, Mass.

Mobile Computer 606

Designed for multiple users in large engineering departments, the DE-60 M computer is mounted on four wheels. Input and output units are recessed in top-surface wells. Programing unit is located at the front, arithmetic center is accessible from rear.

Clary Corp., Dept. 691, Dept. ED, 408 Junipero St., San Gabriel, Calif.

P&A: *$21,000; 60 to 90 days.*

Static Inverter 602

Rated at 600 va, solid-state inverter model W-1605 operates from 25 to 31 v dc, 32 amp, and provides 115/200 v, 400 cps ±1%, three-phase delta/wye sinusoidal power. Distortion is less than 5% total rms, regulation within 1% at full load. The 27-lb inverter withstands severe environmental stresses.

Electrosolids Corp., Dept. ED, 13745 Saticoy St., Panorama City, Calif.

Vaneaxial Blower 560

Output is 95 cfm. Vaneaxial blower VAX-4 provides 95 cfm at 2.5 in. of water at sea level, and 140 cfm at 2.1 in. of water at 25,000 ft. Standard power is 200 v, 400 cps, 3 phase. The blower is 4.15 in. in diameter by 2.5 in. long; weight is 2 lb.

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

Level Indicator 562

Accuracy better than 1% is provided by the 959 series capacitance-type level indicator. The instrument accepts signals from up to six different probes, which may be located at varying distances up to 1,000 ft. The all-electronic system uses solid-state plug-in circuits.

Magnetic Instruments Co., Inc., Dept. ED, Thornwood, N. Y.

Character Generator 584

Rate is 50,000 characters per sec; resolution is 100 TV-picture elements per character. The VIDIAC 3SG-10 character generator has 64 alphanumeric characters and symbols, supplied in eight simple core matrices. It accepts information in digital form.

CBS Laboratories, Dept. ED, High Ridge Road, Stamford, Conn.

Wirewound Resistors 587

Range is 1 ohm to 15 meg. Series 0 encapsulated, wirewound resistors have a temperature coefficient range of 0.001% to 0.0001% per deg C, standard accuracies to 0.005%, matching or ratio accuracies to 0.002%, rise time as low as 0.05 μsec. Power range is 0.15 to 2.5 w.

Kelvin Electric Co., Dept. ED, 5907 Noble Ave., Van Nuys, Calif.

Attenuator Probe 590

Usable with most oscilloscopes, probe type 4290 has 10:1 fixed attenuation. Designed to handle input voltages of 1,200 v, it operates with instruments having bandwidths up to 60 mc. Termination is BNC connector.

Instrument Sales Dept., Allen B. DuMont Laboratories, Div. of Fairchild Camera and Instrument Corp., Dept. ED, 750 Bloomfield Ave., Clifton, N. J.

P&A: *$25; delivery from stock.*

CIRCLE 56 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Tip Cleaner 597

Soldering iron tip cleaner uses specially processed sponges to clean the entire tip point area in one pass. The Lerloy cleaner is said to double tip life by preventing oxidation and assuring proper heat flow.

Engineering and Electronic Devices, Inc., Dept. ED, 1024 N. McCadden Place, Los Angeles 38, Calif.

Brush Blocks 592

Stability, uniformity, and consistency are claimed for the series 200 molded brush block line. Blocks are dimensionally stable up to 400 F, and have a low coefficient of expansion. The blocks are used with all types of slip ring assemblies.

Electro-Tec Corp., Dept. ED, 10 Romanelli Ave., South Hackensack, N. J.

Silicon Rectifiers 588

Low power silicon rectifiers of 1N536 series are made in ratings to 750 ma max forward current and range 50 to 1,000 piv. Fused, double-diffused construction provides low forward voltage drops and low reverse currents. Rectifiers operate at −65 to +165 C without heat sinks. Military specifications are met.

Westinghouse Semiconductor Dept., Dept. ED, Youngwood, Pa.

Core Magnet Meters 599

With D'Arsonval movement and high torque-to-mass ratio, the 1-1/2 and 7-in. core magnet meters, called Magne-Cores are available in a wide range of dc voltage and currents as well as rectifier ac types, including VU meters. They require no adjustment when mounted on either magnetic or nonmagnetic panels.

Pace Electrical Instruments Co., Dept. ED, 70-31 84th St., Glendale 27, N. Y.

◀ CIRCLE 63 ON READER-SERVICE CARD

Epoxy Resin 589

For filament winding. With a viscosity of 2,000 to 4,000 centipoises at room temperature, Bakelite epoxy ERL-0500 is well suited for filament-wound structures. The resin has a long pot life and may be cured at high temperature.

Union Carbide Plastics Co., Div. of Union Carbide Corp., Dept. ED, 270 Park Ave., New York 17, N. Y.

Impulse Counter 593

With plug-in mechanism. Counter 725 is designed to open or close a switch after a preset number of counts. Two spdt 5-amp switches are provided. Count speed is 400 per min, count range 80 counts. Reset time is 1/3 sec. Case mounts in one opening 3-1/8 in. in diameter; mechanism may be removed and replaced in 5 sec.

Eagle Signal Co., Dept. ED, 202-20th St., Moline, Ill.

Power Supply 598

Output is to 50 v dc, continuously variable, at 0 to 1.5 amp. Model 5015 power supply offers: regulation, 15 mv or 0.05%; ripple, less than 500 μv rms; response time, less than 50 μsec for 100% step change in rated load. Input is 105 to 125 v at 55 to 440 cps, 120 w.

Power Designs Inc., Dept. ED, 1700 Shames Drive, Westbury, N. Y.

Price: *$229.50.*

DC Level Detector 596

Tunnel diode dc level detector responds within 10 μsec for protection of transistor circuitry. Solid-state output or relay closure is provided when preset voltage level is exceeded. Available normally on or off, the device handles voltage levels from 5 to 50 v, current of 0.5 amp. Time delay up to 1 sec can be provided.

Crydom Laboratories, Inc., Dept. ED, 12850 Western Ave., Garden Grove, Calif.

P&A: *$114 to $219; 2 to 3 weeks.*

CIRCLE 64 ON READER-SERVICE CARD

NEW PRODUCTS

Low-Voltage Power Supply 571

Current output is 3 amp for normal continuous duty, 5 amp for intermittent duty. Type 79549 power supply has a maximum output of 11 v ac and 7 v dc. It operates small motors, electromagnets, electroanalysis experiments and charging batteries.

Central Scientific Co., Div. of Cenco Instruments Corp., Dept. ED, 1700 Irving Park Road, Chicago 13, Ill.

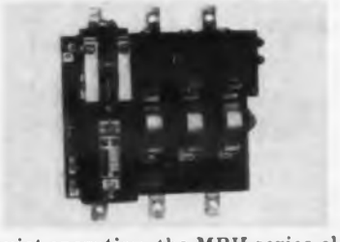
Price: *$21.90.*

Temperature Chamber 573

For missile, aerospace components. Model C-106 carbon-dioxide cooled temperature chamber provides −100 to +500 ±0.5 F. Test volume is 640 cu in. Temperature control is by means of a controller with resistance bulb sensor which anticipates on a proportioning basis, the actual set-point and effects minimum variation in temperature over the full range.

Wyle Laboratories, Inc., Dept. ED, El Segundo, Calif.

Electrical Contactors 574



For quiet operation, the MPH series electrical contactors are held, open or closed, mechanically to eliminate hum. Sizes are 30, 75 and 100 amp rated at up to 600 v ac for noninductive loads, 277 v for lighting loads. A molded epoxy coil is used.

Zenith Electric Co., Dept. ED, 152 W. Walton St., Chicago 10, Ill.

Wirewound Potentiometer 568

Dissipates 15 w at 25 C with a maximum operating temperature of 265 C. Model 3030 wirewound potentiometer is for power supply or other electrical-circuit applications. Resistances are 10 ohms to 10 K; nominal resolution is 0.6%; weight is 0.9 oz; dimensions are 1.07 x 0.52 x 1.27 in.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

Price: *$8 to $10.*

Millivolt Source 572

Output is 0 to 100 mv, in two ranges. The emv millivolt source is a secondary laboratory standard for calibration of instruments with high-impedance input. Accuracy is 0.1% of full scale output voltage. Noise output is less than 0.1 mv across the output terminals or from either output terminal to ground. Supply is Zener-diode regulated.

Westronics Inc., . .pt. ED, 3605 McCary, Fort Worth 10, Tex.

Glass Zener Diodes 548

Rated at 400 mw, these glass Zener diodes have a dynamic impedance as low as 5 ohms at I_z of 20 ma and a temperature coefficient of −0.062% to +0.06% per deg C. Types 1N746, 1N759, 1N746A and 1N759A are available with 5% or 10% tolerance.

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

P&A: *$2.60 to $4.00; from stock.*

NEW PRODUCTS

Miniature Relays 561

With 80-mw sensitivity, the 90N series of miniature relays are suited for dry circuit to high-level switching. The 4pdt relays conform to and exceed MIL-R-5757D. Minimum life is 100,000 operations at 2.0 amp resistive, 28 v dc or 115 v ac.

Iron Fireman Manufacturing Co., Electronics Div., Dept. ED, 2838 S.E. Ninth Ave., Portland 2, Ore.

Shield Chamber 558

Portable shield chamber is used for noise-free measurement on the work-bench. Isolation transformer unit provides ac power to circuitry in the chamber. Magnetic alloy construction assures 40-db shielding at power-line frequencies.

Topaz Transformer Products, Inc., Dept. ED, 4995 Weeks Ave., San Diego 10, Calif.

Cryogenic Thermometer 559

Germanium probes combine with potentiometric recorders for measurement of low temperatures. Model 341 probe provides readings convertible to Kelvin temperatures from 40 to 1 K. Model 342 provides readings for the hydrogen range, 18 to 28 K. Calibrated, uncalibrated, and standardized versions are made.

Texas Instruments, Inc., Industrial Products Group, Dept. ED, P. O. Box 6027, Houston 6, Tex.

AVAILABLE FROM STOCK!

C. I. C.
PRECISION FILM POTS

You can have any of these precision film pots on their way to you within hours. No need to wait for "custom" pots.

LINEAR SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Linearity
1/2"	1K	± .5%
	10K	± .5%
	50K	± .5%
7/8"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
1-3/32"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
2"	5K	± .25%
	20K	± .25%
	50K	± .25%
	5K	± .1%
	20K	± .1%
	50K	± .1%
3"	5K	± .1%
	20K	± .1%
	50K	± .1%
	5K	± .05%
	20K	± .05%
	50K	± .05%

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Conformity
1-3/32"	10K	± .75%
	20K	± .75%
2"	10K	± .25%
	20K	± .25%
3"	10K	± .15%
	20K	± .15%

LINEAR MOTION FILM POTENTIOMETERS

Size	Resistance	Stroke	Linearity
1" Sq.	10K	1" Stroke	± .5%
	20K	1" Stroke	± .5%
	10K	2" Stroke	± .25%
	20K	2" Stroke	± .25%
	10K	3" Stroke	± .1%
	20K	3" Stroke	± .1%

WRITE OR CALL IN YOUR ORDER! POTENTIOMETERS WILL BE IN YOUR PLANT WITHIN 24 HOURS!

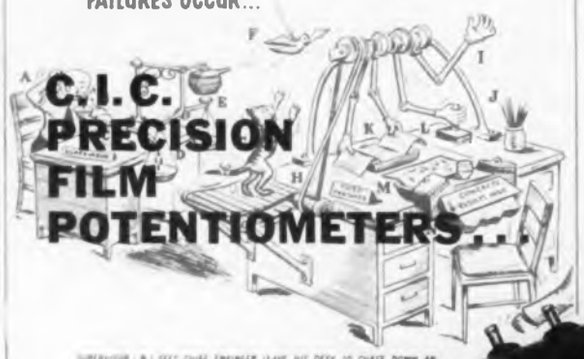
FIRST IN FILM POTS

CIC

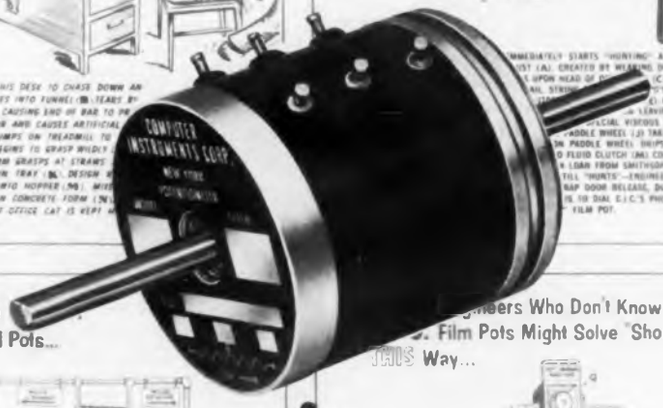
COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 61 ON READER-SERVICE CARD

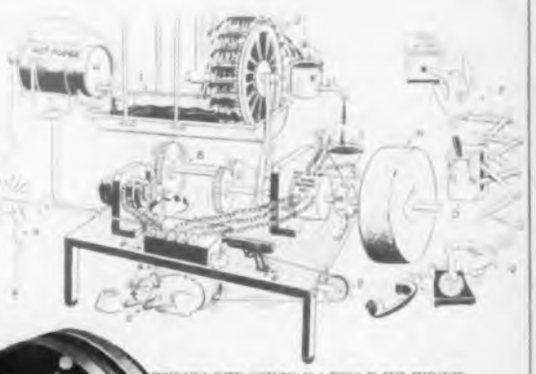
HERE'S ONE WAY
TO GET WORK DONE WHEN WIRE-WOUND POT FAILURES OCCUR...



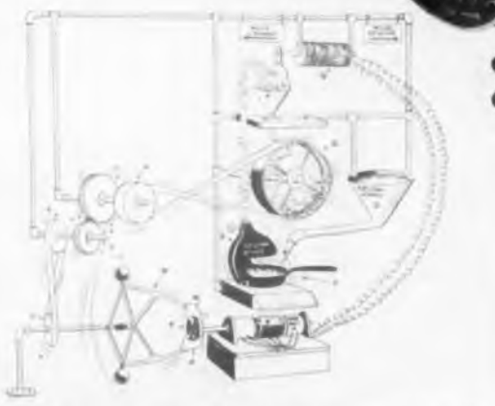
C.I.C. PRECISION FILM POTENTIOMETERS...



HERE'S ONE WAY TO SOLVE SERVO "HUNTING" PROBLEMS...



How To Improve Response
Servos Using Wire-Wound Pots...



...neers Who Don't Know About
... Film Pots Might Solve "Short-Life" Pot Problems
THIS Way...

THE EASY SOLUTION TO ALL POT PROBLEMS

*Only **C.I.C.** Film Potentiometers can meet your most demanding specifications because they feature:

- **Infinite Resolution**
- **Inherent Reliability**
- **Precision Linearity**
- **Low Operational Noise**
- **Multi-Million Cycle Life**

Write for Your **FREE** Copy, Today . . .

This booklet presents some novel "fixes" for frantic users of **wire-wound pots** who just can't tolerate the resulting problems. More important — you'll find the one good solution to **all** pot problems.

COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVENUE • HEMPSTEAD, L. I., NEW YORK

"first in film pots"

CIC

CIRCLE 62 ON READER-SERVICE CARD

NEW PRODUCTS

Transistor Tester 605

In-circuit test of all transistors is possible with transistor tester TR-110. Set tests ac gain or dc current gain and leakage, reads beta, and measures diode forward-backward ratio.

Sencore, Dept. ED, Addison, Ill.

***Price:** $49.50.*

Power Supplies 623

Provide 75 to 330 v dc. Three models of the LA series of transistor power supplies are rated at 0.8, 1.5, and 3.0 amp; panels are 3-1/2, 7, and 10-1/2 in. high respectively. Voltage range is 75 to 330 v dc. Line regulation is 0.05% or 8 mv from 105 to 140 v ac; load regulation is better than 0.10% or 15 mv.

Lambda Electronics Corp., Dept. ED, 515 Broad Hollow Road, Huntington, L. I., N. Y.

Thermosetting Plastic 617

Can be spot magnetized to provide any pattern within a molded plastic part. This thermosetting plastic includes nonconductive ferrite-power fillers capable of retaining temporary or permanent magnetic charge. Polarity of the magnetic field may be oriented in any direction. The compound has been tested beyond 400 F.

Mesa Plastics Co., Dept. ED, 12270 Nebraska Ave., Los Angeles 25, Calif.

Panel Handles 608

Offset at 45 deg, these handles extend 1-1/2 in. from panel. Handles 1254, brass, and 1255, aluminum, are 4 in. high; diameter is 1/4 in.

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

***P&A:** $0.90, black oxide, 100 to 249; stock.*

Pressure Transducer 600

For airborne applications. Model 179 pressure transducer measures fluid and gas pressures from 0 to 50 psia or psig. Accuracy is 0.25% over a wide temperature range. Housing is stainless steel. The device resists acceleration and vibration of missile flight. It can be used with a constant-voltage or constant-current system.

Taber Instrument Corp., Dept. ED, 107 Goundry St., North Tonawanda, N. Y.

DC Amplifier 614

Delivers 100 w from dc to 25 kc. This dc amplifier will deliver 200 v, open circuit, 1 amp. short circuit. It can be used for driving solenoid or voice-coil type actuators in magnetometer experiments and for other applications where a bipolar output is required. It is designed for rack mounting.

Micro Gee Products, Inc., Dept. ED, 6319 W. Slauson Ave., P. O. Box 1005, Culver City, Calif.

Tantalum Capacitors 577

Straight-wall, wet-anode tantalum capacitors meet MIL-C-3965B type CL-64 and CL-65. L-type units range from 1.7 to 330 μf at 4 to 125 v with tolerances to 10%. They are suited for missile, airborne, and mobile use. Cases are 3/16 in. in diameter by 29/64 in. long, 9/32 by 41/64 in. and 3/8 by 49/64 in.

ITT Components Div., International Telephone and Telegraph Corp., Dept. ED, 815 San Antonio Road, Palo Alto, Calif.

Preset Counter 570

Has 4-BCD counting decades. Model 145 single-sequence, preset counter is for general-purpose laboratory and industrial applications. Input frequency response is to 50 kc. Models with 2 to 5 decades and with dual-sequence presetting can also be furnished.

Electronic Counters Inc., Dept. ED, 155 Eileen Way, Syosset, L. I., N. Y.

NEW PRODUCTS

Log-Linear Plotter 569

Machine plotting on log-log, semi-log or linear paper is done with model 110 keyboard and converter unit. Both axes have log ranges from 1 to 7 cycles and a 4-digit keyboard. Conversion accuracy is 0.1% log and 0.05% linear.

King Scientific Co., Dept. ED, 315 Bucknell Road, Costa Mesa, Calif.

P&A: *$3,850; 60 to 90 days.*

Switching Transistors 620

For up to 50-kc operating frequency, types 2N1954 through 2N1957 germanium pnp transistors have a gain of 20 at 1 amp with operating voltages to 60 v. Electric cut-off current is 20 μa max at 20 v; emitter cut-off is 10 μa at 15 v. Power dissipation is 200 mw at room temperature in air; 350 mw with heat sink.

Raytheon Co., Semiconductor Div., Dept. ED, 215 First Ave., Needham, Mass.

P&A: *$1.20 to $1.80; stock.*

Harmonic Filter 604

Operating at 215 to 260 mc, uhf harmonic filter model 280 serves as the rf output fitting for a pressure-tight transmitter. Insertion loss is less than 0.5 db below 260 mc, 50 db above 450 mc; vswr is 1.5:1. Weight is 4 oz, size 1-1/2 x 1-1/4 x 1-1/4 in.

Adams-Russell Co., Inc., Dept. ED, 200 Sixth St., Cambridge 42, Mass.

P&A: *$135 to $112; stock to 4 weeks.*

Accuracy is Our Policy . . .

The description of the cabinet cooling panel, model PF-5, manufactured by Deltron, Inc., which appeared on page 90 of the May 24 issue of ELECTRONIC DESIGN was in error. The availability of the unit was given as 90 days; it is available from stock.

FOR TECHNICAL ASSISTANCE AND SERVICE CONTACT THE TRANSITRON FIELD OFFICE NEAREST YOU AS LISTED BELOW.

BALTIMORE, Maryland
2319 Maryland Ave.....CHesapeake 3-3220

BOSTON, Massachusetts
168-182 Albion St.
Wakefield, Mass.....245-5640

CAMDEN, New Jersey
227 S. Sixth St.....WOodlawn 6-2877

CHICAGO, Illinois
6641 W. North Ave.
Oak Park, Ill.....VIllage 8-5556

CLEVELAND, Ohio
14625 Detroit Ave.
Lakewood, Ohio.....ACademy 1-9191

DALLAS, Texas
511 Braniff Airways Bldg
Dallas 35, Texas.....FLeetwood 7-9448

DAYTON, Ohio
379 W. First St.....BAldwin 4-9651

DENVER Colorado
First National Bank Bldg.
621 Seventeenth St.....AComa 2-1686

DETROIT, Michigan
2842 West Grand Blvd.....TRinity 5-2440

KANSAS CITY, Missouri
Wirtham Bldg.
31st and Troost Sts.....VAlentine 1-1819

LOS ANGELES, California
6362 Hollywood Blvd.
Hollywood 28, Calif.....HOllywood 2-2381

NEWARK, New Jersey
1060 Broad St.....MArket 3-3151

ORLANDO, Florida
#10 Jacklind Bldg.
205 E. Jackson St.....CHerry 1-4526

PHOENIX, Arizona
2727 North Central Ave.....CRestwood 7-3366

ST. PAUL, Minnesota
Griggs-Midway Bldg.
1821 University Ave.....MIdway 6-1891

SAN DIEGO, California
3620 30th St.....CYpress 7-3708

SAN FRANCISCO, California
535 Middlefield Rd.
Palo Alto, Calif.....DAvenport 1-2064

SEATTLE, Washington
3466 East Marginal Way.....MAin 4-0783

SYRACUSE, New York
2360 James St.....HOward 3-4502

WINSTON-SALEM, North Carolina
Nissen Building
310 W. Fourth St.....PArk 3-0363

Transitron
electronic corporation
wakefield, massachusetts
Sales offices in principal cities throughout the U.S.A. & Europe
cable address: Tranlec

CIRCLE 67 ON READER-SERVICE CARD

CIRCLE 68 ON READER-SERVICE CARD ➤

Transitron

SILICON CONTROLLED RECTIFIERS

augmenting the industry's broadest line

With the addition of the 50 Amp Silicon Controlled Rectifier, Transitron now offers the industry the broadest line of Controlled Rectifiers available on the market today.

Research and development efforts during the past year have already produced an impressive array of types which include the following series:

TSW31S SERIES (TO-18 package).....operating current range to 200mA
TCR251 SERIES (TO-5 package).....operating current range to 1 amp
2N1595 SERIES (TO-5 package).....operating current range to 1 amp
2N1600 SERIES (7/16" hex package)...operating current range to 3 amps
TCR505 SERIES (7/16" hex package)...operating current range to 5 amps
TCR510 SERIES (11/16" hex package) operating current range to 10 amps
TCR520 SERIES (11/16" hex package) operating current range to 20 amps

NOW AVAILABLE — NEW 50-AMP CONTROLLED RECTIFIER

The latest addition to the Transitron line — the 50 Amp Silicon Controlled Rectifier — is a three-terminal, four-layer device designed to control very large load currents with small gate current signals. A mechanically rugged and electrically stable device, the new Controlled Rectifier is provided in the 1 1/16" hex base stud-mounted package and is hermetically sealed. Wherever high power handling ability is required, the 50-Amp Silicon Controlled Rectifier will find wide application ranging from frequency changing to welding control.

TCR550 SERIES (1 1/16" hex package)
operating current range to 50 amps

Type	Min. Peak Reverse Volt. and Min. Forward Breakover Volt. (volts)	Max. Average Forward Current at 90°C case (amps)	Package Configuration
TCR4050	400	50	1 1/16" hex
TCR3050	300	50	1 1/16" hex
TCR2050	200	50	1 1/16" hex
TCR1050	100	50	1 1/16" hex
TCR550	50	50	1 1/16" hex

Requires 50mA to turn on 50 Amp

For information on any or all of Transitron's line of Controlled Rectifiers, call or write today for Bulletin TE-1356.

WHY BIAS CONTROLLED RECTIFIERS?

Pioneering in *new* application techniques, Transitron application engineers have assembled information which demonstrates how "gate biasing" will improve the circuit reliability of the SCR. This informative booklet, entitled "The Biasing of Silicon Controlled Rectifiers and Switches," deals individually with *each* of Transitron's Controlled Rectifiers and Switches. It is an indispensable aid to the design engineer seeking *longer life* and *greater stability* in higher temperature applications . . . It's yours for the asking.

MEET US AT THE WESCON SHOW—BOOTH NOS. 3502-3504

Transitron T.
electronic corporation
wakefield, melrose, boston, mass.

NEW PRODUCTS

Maser Supply 471

Optical maser power supply model 275 is capable of furnishing energy up to a total of 20,000 J, at variable voltages from 1 to 5 kv. Flash lamp is triggered through thyratron circuitry. Ruby maser mounting accessories can also be furnished.

Electro Powerpacs, Inc., Dept. ED, 5 Hadley St., Cambridge 40, Mass.

Logarithmic Amplifiers 428

With linear output change from logarithmic input change, these logarithmic amplifiers also provide normal detected outputs. Models 230LL and 230LLV provide clear readings at all levels within a specific range. They can be used in radar systems to prevent display overloading and in range-determining systems.

Instruments for Industry, Dept. ED, 101 New South Road, Hicksville, N. Y.
Availability: *4 to 6 weeks.*

Voltage Calibrators 449

For in-flight use. The VC series of solid-state, voltage calibrators provide steps of 0, 25%, 50%, 75% and full calibration voltage input. The step period is 0.01 to 0.2 sec ±10%. Accuracy is ±5 mv from −20 to +85 C. Output impedance is 100 ohms. Reference supply is 10 ma at 5 v; power input is 28 v at 0.75 w.

Applied Electronics Corp. of N. J., Dept. ED, 22 Center St., P. O. Box 43, Metuchen, N. J.

AC Power Supply 446

Output is 900 cps ±0.001%; outputs of 300 to 5,000 cps are also available. Model GE-S-7-100 power supply drives four two-phase gyro motors and records voltage and current for one phase of each motor. An eight-channel recorder charts phase voltage with a sensitivity of 0.01% per cm.

Behlman Engineering, Dept. ED, Burbank, Calif.

Rate Gyro 467

Floated rate integrating gyro C70 2523 001 is designed for inertial navigation applications. Angular momentum is 500,000 g-cm² per sec; vertical drift is 0.003 deg per hr, azimuth 0.015 per hr. Flange mount is located at gyro center of gravity.

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

Tape Punch 431

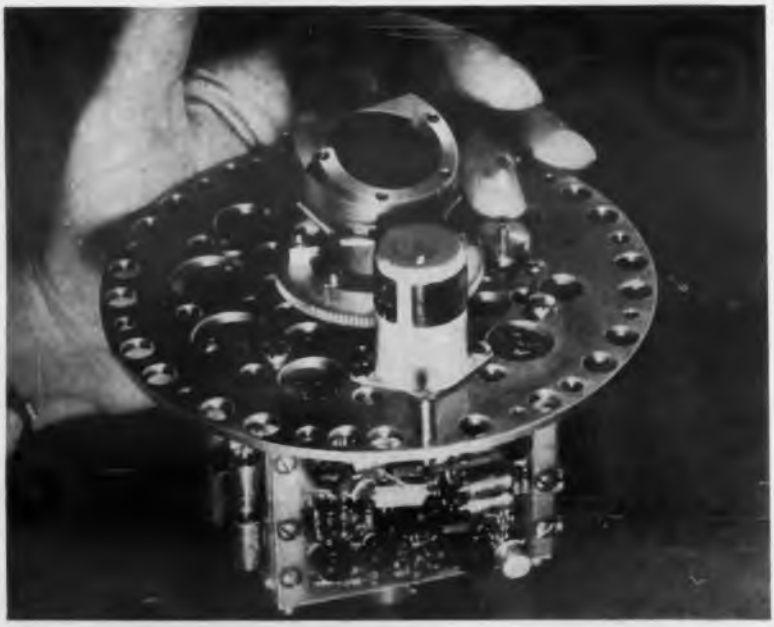
Parallel-wire type. Model 28 LARP off-line tape punch serves as a slave unit in data and message communications systems. Operating at 20 characters per sec, it can be furnished for 5, 6, 7 or 8-level operation. It is electromechanically operated and has a 65-w synchronous motor.

Teletype Corp., Dept. ED, 5555 Touhy Ave., Skokie, Ill.

Bristol choppers help first U.S. Astronaut maneuver space capsule

Four Bristol Syncroverter* choppers formed a vital part of the infrared horizon sensors manufactured by Barnes Engineering Company, Stamford, Conn., and carried aloft in NASA's MERCURY capsule by the first U.S. astronaut to reach outer space.

The Bristol choppers function as sensitive phase detectors in the sensors as they establish a horizontal reference plane for the vehicle.



Infrared Horizon Sensor undergoes rigorous optical, mechanical, and electrical checks at Barnes Engineering Co. One Bristol chopper is located in foreground, in front of gear.

Bristol Syncroverter* choppers, noted for low noise, long life and high reliability, are finding a vital place in more and more missile guidance systems, as well as in analog computers, d-c amplifiers, and test equipment for industrial applications. More than 200 models available. Write for complete details.

The Bristol Company, Aircraft Equipment Division,
151 Bristol Road, Waterbury 20, Conn.
A Subsidiary of American Chain & Cable Company, Inc.

ACCO

T.M. Reg. U.S. Pat. Off. 1.4

BRISTOL... engineers for precision, builds for reliability

CIRCLE 70 ON READER-SERVICE CARD

NEW PRODUCTS

AC Motors 448

Are size 11 with 4-3/8 in. diameter. These types of ac motors are offered: low-slip induction; torque; single, dual and three-speed hysteresis motors. Horsepower is from 1/150 at 900 rpm to 1/3 at 3,300 rpm. Operation is on 60 or 400 cps at 115, 120 or 208 v. Housing is aluminum.

Ashland Electric Products, Inc., Dept. ED, 32-02 Queens Blvd., Long Island City 1, N. Y.

Accelerometer 440

Two-axis accelerometer B2400-01A is an accurate and stable level sensor. Sensing element is an inverted pendulum captured by a force-balance servo loop. At zero tilt angle, current flow is ± 0.2 μa max and increases linearly to 350 ± 0.23 μa at 2 deg of tilt or ± 0.035 g.

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

Rack-Panel System 390

For subdividing panels into units smaller than 19 in. The Pan-L-Dapter rack-panel system offers frames 5-1/4, 7 or 8-3/4 in. deep by 19 in. wide. Panel dividers are 1-3/4 to 8-3/4 in. wide. Panels are 1/8-in. anodized aluminum.

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

P&A: *frames, $15; dividers, $2 to $3; from stock.*

Capacitance Bridge 447

Range is 0.001 to 10 μf with increments of 0.001 μf. Designed for high-speed automated testing of capacitors, model 8529 capacitance bridge provides high, normal and low indications by three pilot lights. Connections may be provided for automatic reject and classifying devices.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Vertical Sensing Element 466

Low cross-coupling error is a feature of the C70 1808 000 vertical sensing element. Verticality is adjustable to 2 arc min; repeatability is 3 arc min. Full scale output is reached at 0.75 deg tilt angle. Excitation frequency is 400 cps.

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

Limit Detector 419

For go/no-go use with test equipment. Model 1013 limit detector has a relay which is sensitive to 5-μv difference between test output and reference supply. Phase-sensitive, the unit can operate on an increase or decrease of voltage. Test cycle is completed in 100 msec.

Aerotronic Associates, Dept. ED, P. O. Box 367, Contoocock, N. H.

Linear Accelerometer 442

For extreme environments. Linear accelerometer C70 2407 has an input range of ±1 g to ±30 g, with output to ±10 v at 400 cps. Threshold and resolution is 0.0001 g max. The 7-oz unit withstands vibration to 30 g up to 2 kc, and shock to 100 g. Diameter is 1-3/8 in., length 2.35 in.

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

Instrument Differential 385

For computers and control applications, precision-balanced instrument differentials provide clearance circles down to 1/2 in. Backlash is 8 min or less; break-away torque is 0.1 to 0.3 oz-Shaft diameters are 0.0779, 0.0935, 0.1248, 0.1873 or 0.2498 in. with over-all lengths to 6 in.

Instru-Lec Corp., Dept. ED, 520 Homestead Ave., Mt. Vernon, N. Y.

CIRCLE 72 ON READER-SERVICE CARD

CIRCLE 73 ON READER-SERVICE CARD ➤

THESE SNAP-IN CONTACTS

OF CEC's 500C CONNECTORS

ASSURE AN AVERAGE VOLTAGE DROP

OF LESS THAN 3 MV AT 5 AMPERES

Low contact resistance makes CEC's line of 500C miniature electrical connectors ideal for dry circuit applications. These rectangular connectors are designed to exceed the requirements of MIL-C-8384A.

The series is available in a range of 14 to 104 contacts with mounting hardware for flush or surface installation, straight or right-angle cable entrance and guide-pin or jackscrew mating. The size 20 contacts of the line accommodate AWG wire sizes 20 thru 26.

Write for Bulletin CEC 4004-X4.

Data Recorders Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF **Bell & Howell** · FINER PRODUCTS THROUGH IMAGINATION

NEW PRODUCTS

Noise Sources 411

Random noise sources in three series provide outputs with Gaussian amplitude distribution. The 812 series has nine selected ranges between 3 cps and 50 kc. Model 813 has a single fixed range, with a cut-off rate of 6 or 12 db per octave. The 814 series provides custom-shaped spectra for simulation of specific noise environments.

H. H. Scott, Inc., Instrument Div., Dept. ED, 111 Powdermill Road, Maynard, Mass.

P&A: *Model 812, $95 ea; delivery from stock.*

Wire Holder 433

For electronic components. The Quik-Loc holder is for use with resistors, capacitors and diodes having wire pigtail leads. It accommodates wires from 0.005 to 0.063 in. in diameter.

Augat Bros., Inc., Dept. ED, 33 Perry Ave., Attleboro, Mass.

IR Collimator 407

For calibration and testing. Off-axis IR radiation collimator model 6-101 can be used to calibrate and test instruments and detection systems. When used with a radiation reference source, the device will simulate the characteristics of an infinitely distant target. Angular resolution is 0.2 mil.

Barnes Engineering Co., Dept. ED, 30 Commerce Road, Stamford, Conn.

◀ CIRCLE 74 ON READER-SERVICE CARD

Meter Adapters 410

Milliohmmeter and ammeter adapters are now included in the 260 adapter line. Model 657 combines with the 260 to measure resistance values down to 0.001 ohm; model 661 plugs into the 260 or 270 meter to measure 0 to 1, 2.5, 10 and 25 amp.

Simpson Electric Co., Dept. ED, 5200 W. Kinzie St., Dept. ED, Chicago 44, Ill.

Price: *657, $39.95; 661, $17.95.*

Digital Computer 438

Has 4,095-word memory. Each word has 40 bits. The Recomp III digital computer uses 32 standard commands and 5 compacted floating-point commands. Standard input or output is at 10 characters per sec. With auxiliary equipment input can be 600 characters per sec and output, 150.

Autonetics, Div. of North American Aviation, Inc., 9150 E. Imperial Highway, Downey, Calif.

Electrodynamic Shaker 408

Full chamber or piggy-back installations are possible with model 300 shaker. Temperature range is −100 to +350 F; no limit is placed on humidity or altitude. Frequency range is 5 to 3,000 cps. Maximum load for 10 g is 450 lb, for 20 g 200 lb. Armature weighs 49.5 lb with coolant.

Ling-Temco Electronics, Inc., Dept. ED, 1515 S. Manchester, Anaheim, Calif.

CIRCLE 75 ON READER-SERVICE CARD ▸

NEW PRODUCTS

Gain Test Set 470

Measurement at 20 mc of grounded emitter current gain is provided by test set model 1828. Gain ranges are 0 to 3, 10, and 30. The set is available with and without built-in, regulated bias supplies for npn and pnp transistors.

Dynatran Electronics Corp., Dept. ED, 178 Herricks Road, Mineola, N. Y.

P&A: *$520 to $820; 30 to 60 days.*

Binding Posts 429

Current capacity is 30 amp; working voltage is 1,000. These five-way binding posts have Lexan polycarbonate-resin molded parts which offer noncorrosiveness, self-extinguishing capabilities, resistance to oils, and high impact strength from −100 to +275 F.

Superior Electric Co., Dept. ED, 83 Laurel St., Bristol, Conn.

P&A: *$0.40; from stock.*

Servo Amplifier 443

Semiconductor servo amplifier C70 3516 001 operates from 250 to 1,800 cps, providing 3.5 to 9.0 w output. Input signal is 40 v rms. Output circuit is class B, push-pull type. Volume is 3.8 cu in., weight 6 oz.

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

Photoelectric Tape Reader 432

Is bidirectional. Model PTR-71 photoelectric tape reader handles all standard tape widths and up to 8 channels in strip, loop, or reel modes at speeds to 100 ips. Stop-start ratings are 1 and 3 msec, independent of tape speed. A start-stop rate of 120 operations per sec is possible in either direction.

Omnitronics, Inc., Dept. ED, 511 N. Broad St., Philadelphia 23, Pa.

Universal Ratio Set 427

For precision calibrating of potentiometers, Wheatstone bridges and resistance standards. Model 4393 six-dial universal ratio set has an error limit of 0.002% for dial changes of 100 ohms or more at 25 C. Below 100 ohms, accuracy is within two steps on the 0.001 dial.

Leeds & Northrup Co., Dept. ED. 4934 Sten-

Coaxial Cable 500

Phase shift of 20 ppm per deg C is claimed for polyethylene-dielectric coaxial cable. Temperature range is 10 to 32 C. Cable conforms to electrical and environmental requirements of MIL-C-17C.

Times Wire and Cable Co., Inc., Dept. ED, Wallingford, Conn.

Gyro Test Table 501

Precision miniature gyro test table CO56425-015 is made for servo, rate, and tumble testing. It consists of a precision servoed table assembly, a tilting and positioning mechanism, an autocollimator and optics, and a rigid mounting base for supporting the standard collimator together with provisions for leveling and north-south alignment.

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

Decade Line Corrector 430

Adjustment is to ±0.1%. Model DLC1005 decade line corrector consists of three variable transformers individually connected to three buck-boost fixed-ratio transformers. Output-voltage dials provide 10%, 1% and 0.1% buck to boost.

Superior Electric Co., Dept. ED, 83 Laurel St., Bristol, Conn.

P&A: *$150; from stock.*

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■ terminals	■ joints and bends
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■ Portable . . . Air-Operated . . . Laboratory Accurate . . . Available in Ranges up to 500 Lbs. ■ Write for Bulletin 750e.

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CIRCLE 78 ON READER-SERVICE CARD

NEW PRODUCTS

Silicon Transistors 502

In TO-5 package. Silicon alloy transistors 2N2002 through 2N2007 provide low offset voltages at three base currents, low leakage at 25 and 65 C, and saturated dynamic impedances. Matched pairs are available to standard tolerances of 50 μv over a wide range of base currents. The TO-5 units are useful in commutating, demodulating, and high-speed chopper applications.

National Semiconductor Corp., Dept. ED, Danbury, Conn.

Transducer Indicator 450

Uses dc excitation, permitting interchangeability of load cells and readout equipment and eliminating errors due to varying lengths in transmission and connecting cables. Model TI-2 transducer indicator measures the output of bonded, strain-gage type load cells.

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

Tape Handlers 503

High-speed, bi-directional, with 10-1/2 in. reels. Model 4588 tape handler accepts 1,000 ft of 5- to 8-level, 4-mil tape interchangeably at speeds to 150 characters per sec. Model 4599 has a speed of 250 characters per sec. Both are designed for rack mounting; weight is 35 lb.

Digitronics Corp., Dept. ED, Albertson Ave., Albertson, L. I., N. Y.

Tin Clad Metal 504

For use in diode manufacturing, this tin clad metal replaces platinum whisker wires. It consists of a layer of pure tin or tin doped with antimony, bonded metallurgically to nickel or nickel iron. Bonding is without the use of bonding agents at the interfaces.

Composite Industrial Metals, Dept. ED, 235 Georgia Ave., Providence 5, R. I.

Accuracy is Our Policy . . .

A description of tubular capacitors on page 117 of the May 10 issue erroneously specified values as ranging from 10 to 1,000 μf rather than the correct range of 10 to 1,000 pf. Designated series CT 10, the ceramic capacitors are made by Gulton Industries, Inc., Metuchen, N. J.

X-Y Recorders 505

With ac or dc input. Model 2D-2 and rack-mounting model 2DR-2 recorders make X-Y plots on chart 11 x 17 in. Operating with either ac or dc input, the instruments have pen speeds of 20 ips for each axis. Input voltage ranges are calibrated in 16 steps from 0.5 mv per in. to 50 v per in. on each axis.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

Computer-Output Adapter 506

Converts outputs for X-Y plotters. This plug-in adapter accepts incremental computer-output signals and converts them to signals for digital X-Y plotters. It provides the proper termination for the computer-output lines and can return a signal to the computer to request the next pulse. Adapters can be furnished for a number of standard, medium-scale computers.

California Computer Products, Inc., Dept. ED, 8714 Cleta St., Downey, Calif.

P&A: *$700 to $1,250; 1 week to 90 days.*

Two-Lamp Ballast 507

Outdoor, nonweatherproof ballast type 670-189 operates 1,500-ma, rapid-start lamps types 72PG17 and 72T12/SHO. It operates at temperatures as low as −20 F and is UL listed. Dimensions are 19-3/8 x 3-1/8 x 2-5/8 in.

Sola Electric Co., Basic Products Corp., Dept. ED, Elk Grove Village, Ill.

Thyratron Tube 508

Output of 3.2 amp dc is provided by thyratron type NL-734/5544. Maximum piv and forward voltage is 1.5 kv. Filament draws 11.5 amp at 2.5 v. Peak anode current is 40 amp. Tube is made for welding and motor control. Over-all height is 7-1/2 in. including pins.

National Electronics, Inc., Dept. ED, Geneva, Ill.

NEW PRODUCTS

Heavy-Duty Cabinet 509

Steel or aluminum. These vertical-chassis cabinets are designed for use where short lead lengths and accessibility to components are essential. Construction withstands shock and vibration. Refrigerated or forced-air cooling systems are built in. Cabinets are sealed against dust and humidity.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood 1, Calif.

***Availability:** 30 to 40 days.*

Silicon Transistors 510

In TO-18 package. Silicon alloy transistors 2N923 through 2N928 replace several TO-5 units. Leakage current is 25 na max. The 2N924 has a beta of 24 to 70; 2N927 and 2N928 have BV_{EBO} of -80 and BV_{CEO} of -70. Low noise and good amplification at low currents make this series ideal for front end applications.

National Semiconductor Corp., Dept. ED, Danbury, Conn.

Ferrite Memory Core 511

Memory cycle is 6 μsec; access time is 2.5 μsec; buffer cycle is 3 μsec. Type RQL ferrite memory core has capacities of 1,024, 2,048, 4,096, 8,192, 16,384 and 32,768. Word lengths are 8 to 60. The unit is nonsynchronous.

Ampex Computer Products Co., Dept. ED, P. O. Box 329, Culver City, Calif.

Beryllium-Copper Strip 512

Heat-treated type 190 beryllium copper strip has a tensile strength of 190,000 psi. Material is ironed to a high degree of flatness and offers uniformity between lots as well as for each coil. Uses are in electronic, instrument and temperature-control applications.

The Brush Beryllium Co., Dept. ED, 5209 Euclid Ave., Cleveland 3, Ohio.

Accuracy is Our Policy . . .

The description of the type 310 semiconductor test set manufactured by Owens Laboratories, Pasadena, Calif., which appeared on page 115 of the May 10 issue of ELECTRONIC DESIGN was not complete. It should have read: Internal dc supplies will furnish up to 30 v and 100 ma. Leakage test potentials up to 600 v are available at lower currents.

Bernoulli Disks 437

Capacity is 500,000 or 200,000 bits. The BD-500 and BD-200 Bernoulli disks consist of thin, flexible Mylar recording tape mounted on a shaft which spins it between a stabilizing plate and a backplate with read-write heads. Storage capacities can be doubled by adding a second disk and head assembly to the original shaft.

Laboratory for Electronics, Inc., Dept. ED, 1079 Commonwealth Ave., Boston 15, Mass.

Time-Delay Relay 459

Range is 25 to 500 msec. Type G-59704 time-delay relay is for gound support, commercial or industrial uses where shock and vibration requirements are not critical. Timing accuracy is ±10% at a fixed voltage. Unit is available for 28 or 12 v dc or for ac operation.

Guardian Electric Manufacturing Co. of California, Inc., Dept. ED, 5575 Camille Ave., Culver City Calif.

Thermoelectric Modules 400

For Power generation. These thermoelectric modules have conversion efficiencies of up to 6% over a range of 0 to 200 C. Materials an modules are a Bismuth telluride alloy. Uses include supplying power for tunnel diodes. They can operate from catalytic combustion of hydrocarbon fuels.

Materials Electronic Products Corp., Dept. ED, 990 Spruce St., Trenton, N. J.

Epoxy Compound 441

Has good moisture resistance. Eccocoat D30 epoxy-resin dip coating compound provides a strong adhesive surface coat for transformers, capacitors and other components. It does not run or drip during oven cure cycle.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

Price: *$6 for 2-lb kit.*

CIRCLE 83 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Silicon Power Transistors 513

Have 50-mc beta frequencies, collector ratings to 100 v and high-current gain (H_{FE} is 45 min at I_C of 1 amp at 15 v). Operating temperature is to 200 C. These diffused silicon power transistors include device types 2N389, 2N424, 2N1660, 2N1661, 2N1662 and non-EIA types.

Tyco Semiconductor Corp., Dept. ED, Waltham, Mass.

Availability: *from stock.*

Scintillation Assembly 514

Integral photomultiplier tube and scintillating detector assemblies type NRM are light-tight and magnetically shielded. Scintillator and window material and thickness are specified by the user. Assemblies are offered with NaI (T1) and other detectors.

National Radiac Inc., Dept. ED, 475 Washington St., Newark 2, N. J.

Semiconductive Polyethylenes 515

Used in cable making, three polyethylenes incorporate conductive materials. Type DFDA-0520, used as voltage stress relief shielding in high-voltage cables, has resistivity of less than 1-1/2 ohm per cm.

Union Carbide Plastics Co., Div. of Union Carbide Corp., Dept. ED, 270 Park Ave., New York 17, N. Y.

Price: *$0.50 to $0.65 per lb.*

Temperature Transducer 516

For jet engine inlet air duct temperature monitoring, type 2477 transducer has resistance held to ±0.25% at −15 F. Ambient range is −65 to +300 F. Time constant is less than 8 sec. Maximum altitude is 80,000 ft.

Trans-Sonics, Inc., Dept. ED, P. O. Box 328, Lexington 73, Mass.

Titanium Anodes 517

Platinum-plated titanium anodes, called Platanodes, may be substituted for solid platinum in rhodium, acid gold, platinum, palladium and rhenium plating solutions. Plate is bonded firmly and directly to the titanium base. Standard sizes are 3 in. wide in any length with 1 x 3-1/2 in. tail.

Technic, Inc., Dept. ED, P. O. Box 965, Providence, R. I.

Full-Wave Bridges 464

Output is to 600 v, 1.5 amp in this line of silicon full-wave bridge assemblies. They are designed for original circuit applications in solid-state power supplies. Stud-type mounting serves as positive or negative output terminal.

Erie Resistor Corp., Electron Research, Inc., Dept. ED, 644 W. 12th St., Erie, Pa.
P&A: *$2.75 to $4.50; 14 days.*

Insulating Adhesive 396

Resistance is 1,000 meg. P-168 adhesive, based on a synthetic polymer, has a chloride ion concentration of 2.5 ppm and a sulfate ion content of 5 ppm. It is noncorrosive to silver.

Pemco Adhesives, Inc., Dept. ED, W. Township Road, Auburn, Ind.

Data System 353

Acquisition of data from many remote locations is provided by the DL-210 system. Up to 50 remote stations can be connected to one central recording station. Data are recorded with time and date on punched tape or punched cards. Error-checking facilities are provided.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

Marine Alternator 403

Rating is 40 amp. Designed for a 6- or 12-v system with positive or negative ground, the 6000 marine alternator system has a built-in silicon-diode rectifier and enclosed slip-ring design.

The Leece-Neville Co., Dept. ED, 1374 E. 51st St., Cleveland 3, Ohio.

CIRCLE 86 ON READER-SERVICE CARD ▶

NEARLY PERFECT SWITCH

(And we don't mean a shell game)

HERE ARE THE FACTS IN A NUTSHELL . . .

- High breakdown ratings — 50 to 80 volts
- Two point control of current/voltage offset parameters
- Matched pairs to standard tolerance of 100 μv
- 10 million-to-1 minimum "off" to "on" resistance ratio
- Typically 30,000 megohms reverse resistance
- Typically 50 ohms forward resistance
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Don't gamble — you put <u>your</u> experience on the line when specifying for analog computers, D.C. amplifiers, electronic commutators and multiplex equipment.

Sperry now offers you a complete series of silicon transistors for single use or matched pairs that have the <u>best combination</u> of chopper characteristics — plus an extra margin of safety which provides true design flexibility.

Type Number	BV_{CEO} (Volts)	BV_{CES} (Volts)	BV_{EBO} (Volts)	V_{P2} (max) Offset Voltage (mV)	I_{P1} (max) Offset Current (mμA)	Price 1 — 99	PRICE 100 — 999
2N1917	—8	—25	—25	1.0	1.0	$ 9.75	$7.50
2N1918	—8	—25	—25	3.0	3.0	7.80	6.00
2N1919	—18	—40	—40	2.0	1.0	12.35	9.50
2N1920	—18	—40	—40	3.0	1.5	8.77	6.75
2N1921	—50	—50	—50	4.0	2.0	5.20	4.00
2N1922	—80	—80	—80	4.0	2.0	6.50	5.00

Write for 16 page Technical Application Bulletin #2107 and new Chopper transistor data sheets on types 2N1917 through 2N1922.

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NEW PRODUCTS

Strain Gages 409

Weldable, stabilized strain gages are made of phenolic-bonded constantan foil for operation to 500 F, and ceramic-bonded nichrome V foil for temperatures to 750 F continuous. Phenolic types are available with compensation to ±1 ppm per deg F from 50 through 250 F. All types have a nominal resistance of 120 ohms.

Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., Dept. ED, Waltham 54, Mass.

Humidity Cabinet 518

Moisture addition is accomplished without lag by the In-Steam generator of this humidity cabinet. Air circulation is uniform. Heat selector switch is provided. Cabinet is equipped with wet and dry bulb indicating controller; interior is stainless steel. Chamber is sized to customer specifications.

Forma Scientific, Inc., Dept. ED, Box 649, Marietta, Ohio.

Current Source 465

Range is 10^{-13} to 10^{-4} amp. Having an extended-range switch, model CS-53 current source is designed for calibrating electrometers at high levels of accuracy. It is suited for applications in industrial and military programs. Design is compact.

Gyra Electronics Corp., Dept. ED, Washington & Elm Sts., P. O. Box 184, La Grange, Ill.

P&A: $375; from stock.

◀ CIRCLE 87 ON READER-SERVICE CARD

DC Amplifier 398

Is rated at ±10 v at ±10 ma output and drives a load of 5 μf. Model 101A solid-state dc amplifier has the following applications: digital processing systems, preamplification and isolation for strip-chart recorders, general laboratory bridge null detector and low-level analog instrumentation.

Neff Instrument Corp., Dept. ED, 1088 E. Hamilton Road, Duarte, Calif.

Limit Switch 458

For aircraft use, type 61574 plunger-type limit switch is an spdt replacement for the double-pole MS24331. Operating force is 6.7 ±2.2 lb; release force is 3.5 lb min; pretravel is 3/16 in. max; overtravel is 0.25 in. max; weight is 0.125 lb. Ratings are 5 amp, resistive, and 3 amp, inductive, at 28 v dc or 115 v ac.

Haydon Switch, Inc., Dept. ED, Waterbury 20, Conn.

Accelerometer 462

For adhesion mounting. Model 2226 accelerometer weighs 2.75 g, is 3/8 in., hex, and 21/64 in. high. Voltage sensitivity with 180-pf external capacity is 5 mv peak per g peak; resonance frequency is 25 kc; cross-axis sensitivity is 5% max; temperature range is −65 to +350 F.

Endevco Corp., Dept. ED, 161 E. California Blvd., Pasadena, Calif.

Gas-Liquid Pumps 434

With adjustable speed and flow rate. The Peristaltic-action gas-liquid pumps are offered in two types. One has a maximum flow rate of 15 ml per min for water and 30 ml for gas. The other has rates of 600 ml per min for water and 35 ml for gas.

American Instrument Co., Inc., Dept. ED, 8030 Georgia Ave., Silver Spring, Md.

CIRCLE 88 ON READER-SERVICE CARD ➤

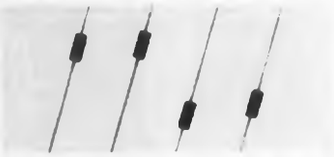
NEW PRODUCTS

3-Phase Generators 530

Variable frequency 3-phase generator model 150-3 has a frequency range of 45 to 2,000 cps and a total power output of 480 va. Other models have outputs from 10 va through 3,000 va.

Industrial Test Equipment Co., Dept. ED, 55 E. 11th St., New York 3, N. Y.

Film Resistor 531



Carbon film resistor model EM 10 is rated at 1/10 w at 70°C. Size is 0.270 x 0.110 in. diameter. Resistances range from 10 ohms to 100 K, with 1% tolerance. Enclosed in molded diallyl phthalate, the device meets the requirements of MIL-R-10509C. Leads are 26 AWG wire.

Mepco, Inc., Dept. ED, 37 Abbett Ave., Morristown, N. J.

Silver-Gold Cleaner 532

Removes tarnish or oxide discoloration on silver, gold and alloys. This electrical-components-grade silver and gold cleaner is a liquid requiring no special devices for application.

Margar Manufacturing Labs, Inc., Dept. ED, 159 Marjorie Dr., Buffalo 23, N. Y.

Price: *$7 per gal.*

Insulated Thermostat 533

Is rated at 1.5 amp, 115 v ac or 3 amp, 28 v dc. Model DR-SS thermostat has a standard differential of 1 C, max; it can be supplied with a maximum differential of up to 4 C. The case is insulated by means of two glass-seal solder terminals.

Chatham Controls Corp., Dept. ED, 102 River Road, Chatham, N. J.

Silicon Rectifier 439

Piv is 600, rms supply voltage is 420 and dc reverse voltage is 600. Military type 1N547 is similar to the popular style with the same number, but meets MIL-E-1/1083A. Operating frequency is 100 kc; temperature range is −65 to +165 C.

Radio Corp. of America, Semiconductor and Materials Div., Somerville, N. J.

Size 8 Synchros 406

Three stator and two rotor types are included. Primary voltage is 11.8 or 26 v. Housings are of aluminum or stainless steel. Types CM010021-07, CM010029-07, CM010121-07, CM010321-07 and CM010421-07 have 5, 7 or 10 min of error from electrical zero.

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

Multi-Turn Potentiometers 435

Range is 25 ohms to 250 K. Resistance tolerance is ±5%; linearity tolerance is ±0.5%. Models 8000, 8100 and 8200 multiturn potentiometers are for bushing mounts with 1/8 or 1/4 in. shaft or servo mounts.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

Rhenium A Plating Salts 436

For high-temperature use. Rhenium A plating salts are for applications in contacts and sealed relays. Rhenium has low arc erosion, fair electrical conductivity and stable contact resistance. Rhenium solutions offer constant current efficiency over a wide range of current densities.

Technic, Inc., Dept. ED, P. O. Box 965, Providence, R. I.

CIRCLE 200 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Printed Circuits 523

Use 97% alumina base with fired molybdenum-manganese circuit pattern. A typical printed circuit in this series measures 2-1/2 x 5 in. with a thickness of 0.06 in. It provides 42 slots for mounting components. The wiring is bonded to the ceramic base and cannot be removed without destroying the ceramic, which withstands 20,000 psi.

Ceramics International Corp., Dept. ED, Mahwah, N. J.

Flaw-Detecting Device 524

For ferrous materials. This 14-lb, ac-dc flaw and crack detector is a powerful, U-shaped, two-pole electromagnet which can be energized from a 6 or 12-v battery or from a 110-v outlet through a built-in rectifier. In use the device is placed so that the two poles bridge the area to be examined. An area of 72 sq in. can be covered in one test.

Westinghouse Electric Corp., X-Ray Dept., Dept. ED, P. O. Box 416, Baltimore 3, Md.

Digital Computer 525

Has 24,000-word drum memory, expandable to 52,000 words. The GARDE computer is designed for monitoring, logging and processing of steam-plant operational data in power stations. The system includes operator's control panel, electric typewriters for logging data, and a built-in program for routine calculating and checking of turbine-generator operations.

General Electric Co., Computer Dept., Dept. ED, Deer Valley Park, Phoenix, Ariz.

P&A: *about $200,000; 10 months.*

Torque Motors 526

Dry-coil torque motors are offered in four types: model 121 has a stroke of ±0.005 in. and an output force of 2.5 lb; model 122, ±0.007 in. with 5 lb; model 123, ±0.01 in. with 8 lb; model 124, ±0.015 in. with 13 lb. Suitable for missile use, motors stand up to 6,000-psi working pressure between working fluid and motorproper.

American Measurement & Control, Inc., Dept. ED, 240 Calvary St., Waltham 54, Mass.

Programing Cylinder 527

Electro-hydraulic cylinder series 80 develops output voltage proportional to stroke increment. Transducer mounted within the cylinder is pressure balanced and not sensitive to position. A constant feedback signal emitted by the transducer prevents overshoot and hunting, assuring accurate duplication of the originally programed operation.

Guerin Engineering, Inc., Dept. ED, 23255 Woodward Ave., Ferndale 20, Mich.

Encapsulated Chokes 528

Range is 1.1 to 120 μh fixed inductance. Designed to meet or exceed MS 91189, the 2950 series of encapsulated chokes is for use in applications in radar, countermeasures, fire-control, and transmitting and receiving equipment. Encapsulation in epoxy resin provides environmental protection.

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

Power Supplies 529

With outputs of 100 to 500 ma. The TR series portable, dc power supplies are offered in four models providing to 100 v at 100 ma, to 18 v at 1 amp, to 36 v at 200 or at 500 ma. Line or load regulation is 0.1% or 10 mv. Features include continuously variable current limiting, programmability, remote sensing.

Electronic Measurements Co. of Red Bank, Dept. ED, Eatontown, N. J.

NEW PRODUCTS

Signal Simulator 534

For PCM checkout. Model 208A signal simulator provides both series and parallel outputs in RZ, NRZ or NRZI form. Bit rate may be set at 50 to 200,000 bits per sec; frame length may be 1 to 256 words; word length is to 16 bits.

Electro-Mechanical Research, Inc., Dept. ED, Sarasota, Fla.

***P&A:** $8,000; 90 days.*

Booster Amplifier 535

Cathode-follower type booster amplifier is for analog computer, simulator, control and instrument driving applications. Designated type BST/M, it provides a full 200-v output from −100 to +100 v dc from a high-impedance input signal. It may be operated continuously at 30 ma at maximum output voltage.

Embree Electronics Corp., Dept. ED, West Hartford, Conn.

***P&A:** $35; 10 days to 2 weeks.*

Air-Flow Monitor 536

For fume hoods. Model 500 air-flow monitor provides buzzer and red-light warning signals when air flow is reduced below safe limits. A Teflon probe in the fume-hood wall transmits information to the control unit through a Teflon-fiberglass cable. A time delay is incorporated in the basic circuitry.

Waber Electronics, Inc., Dept. ED, Hancock & Somerset Sts., Philadelphia 33, Pa.

Printed-Circuit Connectors 537

Series 600-2 printed circuit connectors have 40 contacts with 0.05-in. center-to-center spacing; are mounted in molding 1-11/16 in. long. They are rated at 1 amp, for sea-level test voltage of 900 rms.

DeJur-Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N. Y.

Power Supply 538

Variable frequency power source LDS-1500 gives 50 w with better than 0.01% amplitude stability and only 0.1% harmonic distortion. Output is continuously variable from 0 to 1.5 kv and 0 to 15 amp, at any frequency between 20 and 20,000 cps.

Krohn-Hite Corp., Dept. ED, 580 Massachusetts Ave., Cambridge 39, Mass.

***P&A:** $3,850; 6 to 8 weeks.*

Mica Parts 539

Punched segments and molded rings for commutators are made of Zeta-Mica, a low-cost material with high dielectric properties. It consists of muscovite mica splittings bonded with natural or synthetic binders.

The Macallen Co. Inc., Dept. ED, Newmarket, N. H.

Relay Series 540

Low-cost, sensitive relays of the 4325 series are suited for industrial, commercial and military uses. Units have coil impedances to 5 K for the 50-mw size, providing pull-in at 3.2 ma and drop-out at 0.5 ma.

The Lionel Corp., Dept. ED, Hoffman Place, Hillside, N. J.

NEW PRODUCTS

Electrical Thermometer 418

Fahrenheit-centigrade scale is provided on model T-1 electrical thermometer. Accuracy is 1/2% to 3/4% of total range. Uses include surface temperature measurements of components and maintenance checking of motor and bearing temperatures.

Ameresco, Dept. ED, 7 Center Ave., Little Falls, N. J.

Delay Lines 417

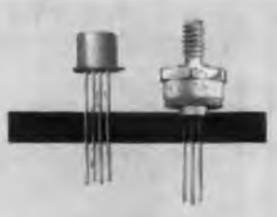
Delay to risetime ratio is 50 in a package volume of less than 6 cu in. This electromagnetic delay line is part of a series of 500-ohm lines having delays of 0.6 to 1.45 μsec and maximum risetimes of 30 nsec. They are for use in ground-control equipment.

Andersen Laboratories, Inc., Dept. ED, 501 New Park Ave., West Hartford 10, Conn.

Airborne Commutator 416

Has 30 channels. Designed for airborne general-purpose telemetry, this commutator maintains output levels within ±0.5% of full scale. Linearity is ±0.1% of full scale on output for an input from 0 to 5 v dc. Cross-talk is less than 0.25%. Weight is 20 oz.

Arnoux Corp., Dept. ED, 3522 Meier St., Los Angeles 66, Calif.



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Milgray Electronics, Inc.
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REctor 2-4400

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Elmar Electronics
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TEmplebar 4-3311

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Electronic Specialties Co.
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Almac Electronics Corp.
8301 Maynard Ave.
PArkway 3-7310

WASHINGTON, D.C.
Electronic Wholesalers, Inc.
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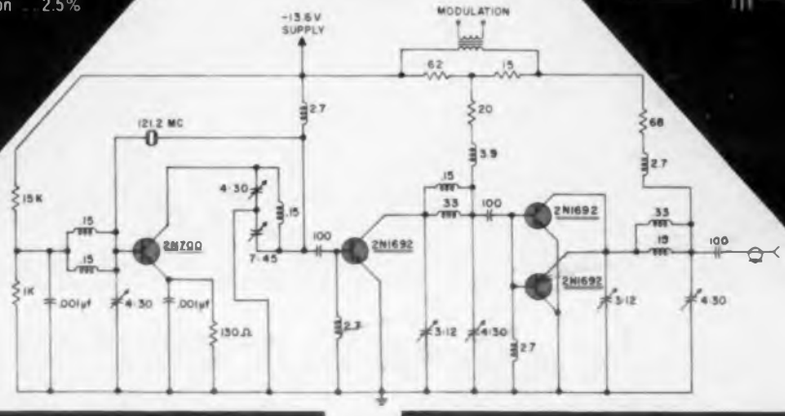
A TRANSISTORIZED 120 MC AIRCRAFT AM TRANSMITTER

PERFORMANCE—

Supply Voltage	13.6 V
Supply Current	155 mA
Peak Power Output	1.5 W
Average Power	500 mW
Efficiency (overall)	26.5%
Envelope Distortion	2.5%

MOTOROLA MESA CIRCUITRY CUTS SIZE... SAVES WEIGHT ...INCREASES RELIABILITY



The transmitter circuit shown above provides more effective coverage than most conventional tube transmitters with higher RF power. Designed for airborne communications, it demonstrates only one of the many possible UHF-VHF applications for Motorola Germanium Mesa transistors.

The remarkable achievement of Motorola Mesas in critical missile/space equipment proves their ability to contribute substantially to total circuit reliability. Designed for applications to 1000 mc, Motorola Mesas are ideal for a wide range of communications applications. And, they are available in quantity, for immediate use.

For Complete Data on the Transistorized Transmitter shown above request Special Report No. 34 from your Motorola District Office or write Technical Information Department, Motorola Semiconductor Products Inc., 5005 East McDowell Road, Phoenix 8, Arizona. If you desire technical Data Sheets on the devices listed above, please request by "type number".

MOTOROLA GERMANIUM MESA AMPLIFIER TRANSISTORS

TYPE NO.	V_{cb} volts	V_{ce} volts	P_D mW	PG. @ f typical	P_o @ f typical	Case
2N700	25	20	75	24 db @ 70 mc	50 mW @ 70 mc	TO-17
2N700A	25	25	75	26 db @ 70 mc	55 mW @ 70 mc	TO-17
2N700A-Sig C	25	25	75	26 db @ 70 mc	55 mW @ 70 mc	TO-17
2N741	15	15	300	22 db @ 30 mc	200 mW @ 30 mc	TO-18
2N741A	20	20	300	22 db @ 30 mc	250 mW @ 30 mc	TO-18
2N1561	25	25	3W	8 db @ 160 mc	5 W @ 160 mc	—
2N1562	25	25	3W	7 db @ 160 mc	4 W @ 160 mc	—
2N1692	25	25	3W	8 db @ 160 mc	5 W @ 160 mc	stud
2N1693	25	25	3W	7 db @ 160 mc	4 W @ 160 mc	stud

Immediate Availability — All Motorola Mesa amplifier transistors are available from your Motorola Semiconductor Distributor.

MOTOROLA DISTRICT OFFICES:
Belmont, Mass. / Burlingame, Calif. / Chicago / Clifton, N. J. / Dallas
Dayton / Detroit / Glenside, Pa. / Hollywood / Minneapolis / Orlando, Fla.
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MOTOROLA
Semiconductor Products Inc.
A SUBSIDIARY OF MOTOROLA, INC.
5005 EAST McDOWELL ROAD • PHOENIX 8, ARIZONA

CIRCLE 101 ON READER-SERVICE CARD

NEW PRODUCTS

Servo Amplifier 351

For 3.5-w servomotors. Transistorized servo amplifier model 930 measures 1 x 1-19/32 x 1-3/16 in. Input impedance is 250 K, output 50 ohms. Ambient temperature range is −55 to +125 C. Power is 28 v dc. Unit withstands MIL-E-5272 environments.

Control Technology Co., Inc., Dept. ED, 41-16 29th St., Long Island City 1, N. Y.

Insulating Paper 394

Is chemically, electrically clean. Made from selected cotton cuttings, Duro-X insulating paper is available in rolls 46 in. wide and in gages of 0.007 to 0.03 in. Able to stretch without rupture, it can be drawn, formed, shaped, embossed and cuffed. It can be used in motors, generators and welding equipment.

Rogers Corp., Dept. ED, Rogers, Conn.

Laminate 356

Heat stable laminate has good punchability. Stock can be punched or sheared cold without delamination, cracking or hole breakout. Stock is available in thicknesses of 1/16 in. to 5/8 in. in standard sheet sizes of 36 x 72 in. and 24 x 36 in. Heavy sheet stock in standard thicknesses of 3/4 in. to 2 in. is also available.

The Glastic Corp., Dept. ED, 4321 Glenridge Road, Cleveland 21, Ohio.

Price: *$0.65 to $0.58 per lb, 300 lb or more.*

◀ CIRCLE 102 ON READER-SERVICE CARD

Variable Capacitors 359

For vhf use. Capacitance range for the CT-60 series is 4 to 19 pf. Working dc voltage is 500 v. Units are supplied with a keyed and threaded center bearing for ease of mounting, and rotor terminals on either side of the ceramic base for flexibility or wiring. Military specifications are met.

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

Spectrum Analyzers 395

Having banks of 100 or 420 filters, these spectrum analyzers analyze, display and record complex wave forms. Model MRFR 30-9 uses 100 3-cps filters to analyze any 300-cps band from 5 cps to 10 kc. Sampling rate is 30 scans per sec. Resolution is 8 cps; dynamic resolving range is 35 to 40 db. Model MRFR 30-11 has 420 filters, analyzing any 1,260-cps band from 5 cps to 10 kc.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.

P&A: *$5,500 and $15,975; 90 days.*

Billboard Indicator 352

Miniature lighted billboard indicator model L5950 measures 1.124 x 0.312 in. Legend is readable only when indicator is lit. Rating is 0.04 amp at 28 v, 0.08 amp at 14 v, or 0.2 amp at 6 v. Two MS25237 lamps are retained by spring clips.

Controls Co. of America, Control Switch Div., Dept. ED, 4218 W. Lake St., Chicago 24, Ill.

NOW...

a miniature tube that gives you

50,000

Gm at 35 Ma

new **Amperex**®

Double Frame Grid

wide band pentode

Type 7788... **designed for use as a broadband amplifier in radio and TV relay systems, coaxial telephone lines, radar equipment and oscilloscopes**

OUTSTANDING FEATURES:

- 50,000 micromhos at 35 Ma
- 410 mc figure of merit
- Equivalent noise resistance: 60 ohms, triode connected; 100 ohms pentode connected
- Both control and screen grids of frame grid construction (an Amperex first!) for reduced microphonics; minimum spread in characteristics; and lower screen grid current which contributes to short and long term stability
- The 7788 is an Amperex Premium Quality (PQ) tube designed for 10,000 hours life
- It is available in production quantities

ask Amperex *about frame grid tubes for your particular application*

Amperex Electronic Corporation

230 Duffy Avenue, Hicksville, L. I., New York

In Canada: Philips Electronics Industries Ltd., Tube, Semiconductor & Component Depts., 116 Vanderhoof Avenue, Toronto 17, Ontario

For original use . . . For incorporation into laboratory equipment . . . In 55- to 400-cycle systems. The Trans Electronics Model RS305A Power Supply provides voltage regulation of .05% load and .05% line over the entire 225- to 325-volt range. Operating current range 0-50 ma, continuous duty, with filament output of 6.3 volts CT AC @ 3 amps. Units feature low ripple and noise (5 mv peak to peak); fast recovery time (25 to 50 microseconds). Three versions of Model RS305A offer, respectively, modular construction in package 5 x 4⅛ x 6½ inches; rack-mounting; and rack-mounted models with 3¼-inch meters, in case with 3½-inch panel height. Input is 105-125 volts AC.

SPECIFICATIONS

model*	voltage range	current ma	filament volts/amps	price
RS-110				$108.00
RR-110	0-100	0-100	6.3/3	133.00
RM-110				169.00
RS-205				55.50
RR-205	150-225	0-50	6.3/3	80.00
RM-205				115.00
RS-217A				87.50
RR-217A	150-225	0-175	6.3/8	112.50
RM-217A				147.50
RS-305				55.50
RR-305	225-325	0-50	6.3/3	80.00
RM-305				115.00
RS-317				87.50
RR-317	225-325	0-175	6.3/8	112.50
RM-317				147.50
RR-450	+300-400	0-50	6.3/2	155.50
RM-450			6.3/1.5	196.00
DUAL TRACKING	—300-400		6.3/1.5	
RR-473	+300-400	0-25	6.3/2	140.00
RM-473			6.3/1.5	175.00
DUAL TRACKING	—300-400		6.3/1.5	
RS-505				81.50
RR-505	300-5002	0-50	6.3/3	106.50
RM-505				141.50
RR-303	0-300	0-500	6.3/15	320.00
RS-303	0-300	0-500	6.3/15	360.00
RR-550	300-500	0-500	6.3/15	310.00
RM-550	300-500	0-500	6.3/15	350.00

TRANS ELECTRONICS, Inc.

7349 Canoga Avenue
Canoga Park, California Diamond 0-3333

CIRCLE 104 ON READER-SERVICE CARD

NEW PRODUCTS

Subcarrier Oscillator 426

Linearity is ±0.75% of bandwidth and frequency deviation is ±7.5% of center frequency. Model RA-10 oscillator is available for operation on all standard IRIG bands. Amplitude modulation is within ±5% of output signal level throughout bandwidth.

Lome Electronics, Inc., Dept. ED, 8526 N. New Braunfels, San Antonio 9, Tex.

Control Relay 414

For industrial power machines. Type 4AA3-1 control relay provides time delays for positive mechanical and friction clutch systems. Rating is 15 amp max. It can be used as an anti-repeat relay with a timed holding circuit or as a timed holding circuit for another anti-repeat relay.

Minneapolis-Honeywell Regulator Co., Micro Switch Div., Dept. ED, Freeport, Ill.
Price: *$43.15.*

Positioning Instrument 422

Accuracy is 0.25 sec rms. Model 296C optical-mechanical positioning instrument, with micrometer increments of 0.1 sec, has an angular displacement of 16.7 min. The angular movement is horizontal around a vertical axis. Uses include inertial guidance systems, tracking equipment, rotation tables and antenna mounts.

Ferranti Electric Inc., Dept. ED, Industrial Park No. 1, Plainview, Long Island, N. Y.
Availability: *30 days.*

Centrifugal Blower 399

Nominal output is 350 cfm. Up to 200 cfm can be delivered against 1-in. water pressure. Type 2EB412 blowers are for use where many components or reduced venting areas increase internal pressure. Available in 7-in. panel height with 19-in. width, they meet applicable Mil specs. A washable filter is used.

McLean Engineering Laboratories, Inc., Dept. ED, P. O. Box 228, Princeton, N. J.

Limit Switches 354

For military or commercial applications, these limit switches operate at a pressure of 2-1/2 to 5 lb. Pretravel is 0.120 max. Model W20064 is rated at 0.30 v dc, 15 amp resistive. The W20050 is rated at 12.8 v dc, 10 amp normally open or 1 amp normally closed, inductive load.

Controls Co. of America, Control Switch Div., Dept. ED, 4218 W. Lake St., Chicago 24, Ill.

High-Torque Mechanism 405

For airborne applications. Type AM-50 high-torque mechanism is a self-winding, moving coil type of meter movement with an internal permanent magnet. It has a high torque-to-weight ratio and fast response. Metal shell enclosure provides maximum protection against dirt and damage.

International Instruments, Inc., Dept. ED, 88 Marsh Hill Road, Orange, Conn.

Insulation Tubing 401

With identification codes, thermo-branded for clarity. Idensulation insulation tubing is produced in a wide range of standard materials, including the shrink-on type. Stock items are in ASTM sizes 24—1-1/2 in. imprinted with standard codes.

Manger Electric Inc., Dept. ED, N. State St., Stamford, Conn.
Availability: *from stock.*

CIRCLE 106 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Panel Meters 355

Rectangular panel meters in series 1900 are made in cases of clear plastic or Bakelite, with optional 1% or 2% accuracy. Types include ac and dc ammeters, milliammeters, microammeters, and voltmeters. Shielded, unshielded, and ac iron-vane movements are available. Case sizes are 4-1/2, 5-1/2, and 7-1/2 in., with 100-deg arc scales.

Daystrom, Inc., Weston Instruments Div., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N. J.

Power Supply 402

Provides 5 to 25 v dc, continuously adjustable. This power supply has a current output of 0 to 250 ma, 1% line and road regulation, and less than 1 mv ripple. It is for rack or bench use on development work with transistorized circuits, for bridge applications and for regulating heating application

Lehigh Valley Electronics, Dept. ED, Allentown, Pa.

Price: *$130.*

General-Purpose Relay 358

For printed circuits. Type WP is a general-purpose relay designed for direct mounting on printed-circuit boards. It is available in contact voltages of 28 v dc at 5 amp or 115 v ac, in either spdt or dpdt. Coil can handle up to 250 v ac at 1 to 2 va and up to 125 v dc at 0.5 to 2 w.

Globe Electrical Manufacturing Co., Dept. ED, 1729 W. 134th St., Gardena, Calif.

Availability: *2 to 4 weeks, depending on quantity.*

Saturable Core Reactor 423

Has no air gaps, permitting a low magnetizing current and a low noise output. The range of the 15-kva, single-phase saturable core reactor is about 27% to 98%, depending upon resistive load.

Nothelfer Winding Laboratories, Inc., Dept. ED, P. O. Box 455, Trenton, N. J.

DC Amplifier 424

For telemetry systems, model 1100 instrument amplifier accepts low-level dc signals from thermocouples, strain gages or photocells. It operates into voltage-controlled, subcarrier oscillators. Linearity is ±2%.

Lumen, Inc., Dept. ED, P. O. Box 905, Joliet, Ill.

P&A: *$150; 8 weeks.*

Circuit Breaker 420

Withstands 50-g shock as well as vibration and temperature extremes. Series C-500 circuit breaker has these ratings: 50 v dc and 120 v rms at 60 or 400 cps; 50 ma to 15 amp. Circuit types are series, shunt or relay. Delays can be short, long or instantaneous. Weight is 2 oz.

Airpax Electronics, Inc., Cambridge Div., Dept. ED, Cambridge, Md.

P&A: *$9.75; from stock.*

CUSTOMIZE EFFICIENCY & ACCURACY WITH triolab BUILD-IN INSTRUMENTS...

BEFORE . . . 3 external instruments were used to measure AC and DC voltages . . . cluttered, tedious, wasteful, subject to error.

AFTER . . . 3 trio/lab miniature VTVMs integrally built-in now are always on hand to measure just the parameters you designate.

the industry's pioneer complete line of

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MILITARY

for MIL-T-21200B & MIL-T-945A applications.

Model 102 (formerly B series) ruggedized single-range AC VTVMs $160.

Model 103 (formerly C series) ruggedized multi-range AC VTVMs $272.

Model 106 (formerly G series) ruggedized single or multi-range DC VTVMs from $136.

Model 107 (formerly J series) ruggedized low-level multi-range DC VTVMs $450.

COMMERCIAL

Model 104 (formerly E series) Single-range AC VTVMs $99.50

Model 109-1 low-level multi-range AC VTVM $199

Model 105 (formerly F series) single or multi-range DC VTVMs from $84.50

Model 130-1 1% accuracy AC VTVM $150

By building-in trio/lab panel-mounting instruments you . . . customize test systems, set-ups and instruments; save space (average model is 4" x 4" x 4"); save time with at-a-glance monitoring; save money; make monitoring foolproof ("go/no-go"); improve system reliability; increase overall design freedom. Choose from many "standard" or "special" models — or consult us for new designs for your needs. Write for free "how to" Engineering Guide.

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Plainview, Long Island, N. Y. • TWX HKVL 1186
OVerbrook 1-0400 Area Code 516
Export: EMEC, 127 Grace St., Plainview, N. Y.

CIRCLE 108 ON READER-SERVICE CARD

NEW PRODUCTS

Logic Blocks 412

Complete series is offered for functions such as flip-flop, pulse shaper, gate circuits, inverter amplifier, and emitter follower. For use in industrial control and digital equipment, these logic blocks have reliability built into them as a complete circuit.

Amperex Electronic Corp., Icoma Div., Dept. ED, 230 Duffy Ave., Hicksville, L. I., N. Y.

Voltage-Controlled Oscillators 425

For 400 cps through 2.3 kc, center frequencies. Model 329 voltage-controlled oscillator has a linearity of ±0.75% of bandwidth, or better. Total harmonic distortion is 0.5% max. Output voltage is 3 v rms; output impedance is 5 K from low-pass input filter.

Lome Electronics, Inc., Dept. ED, 8526 N. New Braunfels, San Antonio 9, Tex.

Synchro Bridges 413

Accuracies are to ±0.005%. Series A30 1S, A30 1S-CS and A30 2S-CS synchro bridges are formed of precision ratio transformer elements, tapped to permit checking at discrete angular increments of 5, 10 and 15 deg. Applications are: calibration of synchro transmitters, stable platforms, radar boresight azimuth and elevations sensors. Special digitally programed models can be supplied.

Astrosystems Inc., Dept. ED, 220 E. 23rd St., New York 10, N. Y.

***P&A:** $700 to $1,500; 15 to 45 days.*

Phase-Shift Network 415

Time-constant accuracy is ±0.1%. Resistance ratios are accurate to ±0.05%. Temperature range is −55 to +85 C. This RC phase-shift network consists of three resistors and two capacitors. It can be used in plug-in printed-circuit assemblies.

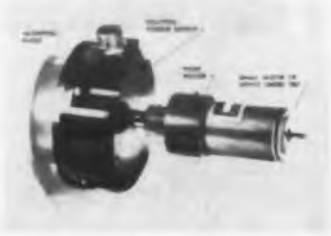
Arco Electronics, Inc., Dept. ED, Community Drive, Great Neck, N. J.
Availability: *4 to 6 weeks.*

Flat Plugs 391

For communications uses. Types S-230 and S-235 flat plugs have 0.206-in. finger diameter and mate with the firm's small-hole phone jacks. They are commercially interchangeable with Mil type PJ-068. Nylon insulation is used between tip, ring and sleeve circuits of finger assembly.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.
Price: *$1.75.*

Torque Sensor 380



Accuracy is 1/4%. Model RTS reaction torque sensor can be supplied with capacities of 0 to 10, 50, 100, 200, 500 and 1,000 oz-in. Uses include measurement of small-motor torque, bearing friction, stepping-switch torque, torsion spring and rotary solenoid torque. It can be used in any position.

Lebow Assoc., Dept. ED, 14857 W. Eleven Mile Road, Oak Park 37, Mich.

Thrust Meter 393

For jet and rocket engines. The Thrustmeter measures gross thrust of more than 8,000 lb and has a total error of within 1% full scale. It consists of a computer, a panel-mounted indicator and a pressure rake. Power consumption is 30 w at 400 cps, 115 v. Total weight is under 12 lb.

Schaevitz Engineering, Dept. ED, Rt. 130 and Schaevitz Blvd., Pennsauken, N. J.

NEW PRODUCTS

Photoelectric Keyboard 386

For binary encoding. The K-144 alpha-numerical photoelectric keyboard permits generation of any 5-, 6-, 7- or 8-bit binary code. It eliminates use of encoding matrices, contacts and switches. When a key is depressed, a shutter modulates a bank of light data channels. The resultant data produces resistive changes in a bank of photoconductors.

Invac Corp., Dept. ED, 14 Huron Drive, Natick, Mass.

Price: *$550.*

Speed Reducer 375

Size 8, coaxial-shaft speed reducer is designed for applications where compactness and light weight are specified. ABEC-7 ball bearings are used throughout, except at end of input shaft. Requirements of MIL-E-5272A are met. Single-ended units can be furnished as custom items.

Planet Instrument, Inc., Dept. ED, 616 S. Lafayette St., Fort Wayne, Ind.

Synchro-Angle Indicator 378

Is self balancing. Model SBI-503 synchro-angle indicator provides a readout of 0 to 360 deg and a response speed of 60 deg per sec. Angular position can be read to 0.1 deg. It operates with size 8 through 15 synchro transmitters. Accuracy is 6 to 10 min of arc. Mil specs are met.

North Atlantic Industries, Inc., Dept. ED, Terminal Drive, Plainview, L. I., N. Y.

Air Blower 357

For equipment cooling. Type D blower is made with a unitized housing construction. Air delivery is 60 cfm for the single unit and 120 cfm for the double unit. Power required is 115 v ac, 60 cps. Other voltages, and 50-cps operation, are available.

Heinze Electric Co., Dept. ED, 685 Lawrence St., Lowell, Mass.

Printed-Circuit Cleaner 397

Removes oxides, light soils and other plating deterrents on copper and copper-alloy printed circuits. Deoxyde formulation is mixed with equal parts of water. It cleans printed circuits by dipping for 30 sec to 5 min.

The Meaker Co., Dept. ED, Nutley, N. J.

Insulated Wire 455

Metal sheathed and ceramic insulated Aer-Opak wire is for atomic energy and aircraft as well as industrial applications. Long lengths with close electrical and physical tolerances can be furnished.

Aero Research Instrument Co., Dept. ED, 315 N. Aberdeen St., Chicago 7, Ill.

Flag Mechanism 404

Is self shielding. Designed for flight instruments, type AM-20 flag mechanism is a moving coil movement with an internal permanent magnet. Movement and magnet are an integral assembly and may be removed from the yoke for maintenance.

International Instruments, Inc., Dept. ED, 88 Marsh Hill Road, Orange, Conn.

CIRCLE 113 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Pressure Transducer 382

For telemetering. This 4.5-oz potentiometer pressure transducer is offered in seven models with ranges of 0 to 100 through 5,000 psia or psig. It has less than ±1% instantaneous ac error during vibration of 50 g at 2,000 cps. Acceleration shift is less than 1% at 100 g. Linearity and hysteresis are as low as 0.5% up to 1,000 psi.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.
***P&A:** $185 to $225; 6 to 8 weeks.*

AC Voltage Calibrator 384

Ranges are 5, 50 and 500 v rms at switch-selected frequencies of 400 cps and 10 kc. Model VC-555A voltage calibrator has a harmonic distortion of 0.05%, short term, or 0.1% max. It is for production-line testing and check-out of precision voltmeters and other instruments.

International Electronic Research Corp., Dept. ED, 135 W. Magnolia Blvd., Burbank, Calif.
***P&A:** $895; 4 to 5 weeks.*

Panel-Mounted Fan 379

Delivers 295 cfm. Model 1PB65W panel-mounted fan pressurizes electronic cabinets with air filtered through a permanent, washable filter It is designed for installation on the outside of racks. The ball-bearing motor meets CC-M-636A specifications; the lubricant meets MIL-G-3278 and withstands —62 to +93 C.

McLean Engineering Laboratories, Inc., Dept. ED, P. O. Box 228, Princeton, N. J.

High-Temperature Resistors 376

Ratings are 1/2 to 10 w; ranges are 0.05 ohm to 200 K. Series T resistors are offered in 10 physical sizes with tolerances of ±0.5 to +5%. They can be used at temperatures to +350 C and are impervious to salt spray, humidity and abrasion, as required by MIL-R-26. Also offered, the TR series with radial leads is for printed-circuit applications.

Omtronics Manufacturing, Inc., Dept. ED, P. O. Box 1419 Peony Park Station, Omaha 14, Neb.

P&A: *$0.35 to $1.65; 1 to 3 weeks.*

Synchronous Induction Motor 392

Pull out torque is 8 oz-in. min in this synchronous induction motor. A single-phase, 60-cps, 115-v, capacitor start-run type, the motor uses 3-μf capacitors. Dimensions are 1.88 in. in diameter and 2.25 in. long.

Task Corp., Dept. ED, 1009 E. Vermont Ave., Anaheim, Calif.

Composition Potentiometers 387

Molded composition potentiometers in AB and AS types are made for commercial and military applications. Ratings are 1/2 w and 2 w, with diameters of 1/2 and 1-5/32 in. respectively. Values range from 50 ohms to 5.0 meg.

Ohmite Manufacturing Co., Dept. ED, 3673 Howard St., Skokie, Ill.

Price: *$1.95 to $5.10.*

Magnetic Trigger-Preamp 377

For triggering thyratrons or controlled rectifiers and other switching elements used in phase-controlled ac power amplifiers and power-control systems. The magnetic trigger-preamplifier is for use in equipment such as temperature controls where failproof operation is required. Typical input for full thyratron power output is less than 5 mv ac into 1,000 ohms. Peak power for triggering rectifiers is 250 mw or more.

Ovitron Corp., Power Controls Div., Dept. ED, 105 River Road, Cos Cob, Conn.

Price: *$139.*

NOW... from Arco

24 HOUR DELIVERY

MIL-T-27A

HST

TRANSFORMERS

EVERY TYPE! EVERY SIZE! EVERY USE!

TYPE MH
Hermetically Sealed Audio Transformers

TYPE TT
Miniaturized Transistor Transformers

TYPE SMH
Miniaturized Hermetically Sealed Audio Transformers

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Hermetically Sealed Magnetic Shielded Audio Transformers

TYPE SS
Space Saving Audio Transformers

TYPES MXA, TXA, MXB, MXC
Highest "Q" Toroids

TYPES PX, PY
Electrostatic Shielded Isolation Transformers

TYPE RM
Sub Miniature Printed Circuit Toroids

TYPES 4RS, RS
400 Cycle and General Application Filter Reactors

TYPE SSM
Sub Miniature Transformers

TYPE UCA
Commercial Grade High Reliability Transformers

TYPE SMO
Sub-Sub Miniature Transformers

The precision quality of HST Transformers combined with Arco's consistent 24 HOUR COAST-TO-COAST DELIVERY SERVICE places the greatest variety of high reliability standard transformers, reactors and toroids at your immediate disposal. All HST Transformers are built and tested to meet MIL-T-27A specifications except for types SS, SMO, SSM and UCA. Complete stocks are available from all Arco branches or from any ARCO-HST Industrial Distributor for instant shipment.

ARCO electronics inc. *Transformer Division*

Community Drive, Great Neck, New York • HUnter 7-0500

BRANCHES

LOS ANGELES
ARCO CAPACITORS INC.
1548 So. Robertson Blvd.
Los Angeles 35, Calif.
CRestview 1-1151

DALLAS
ARCO ELECTRONICS INC.
1339 Crampton St.
Dallas 7, Texas
Riverside 8-0648

Manufactured by

*Dresser Electronics HST Division

CIRCLE 118 ON READER-SERVICE CARD

NEW PRODUCTS

Comparator-Switching Amplifier 374

Plug-in type, designated S-20015-P dc comparator-switching amplifier. When the difference between the input and reference signals exceeds 7.5 mv, the amplifier output switches from zero to greater than 10 v with a 400-ohm load, or greater than 5 v with a 150-ohm load. Input signals greater than 15 v may be applied from dc to over 50 kc.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Road, Nashville 10, Tenn.

Panel Meters 383

Have internal illumination. Miniature panel meters and side indicators have built-in light sources for better readability or for use as a visual alarm system. Meters include 1-in. barrel-diameter type as well as a full line of 1-1/2 in. meters.

International Instructments, Inc., Dept. ED, 88 Marsh Hill Road, Orange, Conn.

Drum Dials and Verniers 421

Diameters are 1.5, 2, 2.5, 3 in. These drum dials and verniers are calibrated for 1, 1.8, 2 and 3.6 deg. Vernier can read 0.1 deg, 6 min or 15 min. Concentricity between inner hole and outside diameter is 0.0015 in. The drum may be open on either side.

Ackerman Engravers, Dept. ED, 458 Broadway, New York, N. Y.

Time-Delay Relay 463

Delay time is 30 sec. Type SI-O1-TD time-delay relay has no moving parts and is rated for 50 million cycles. Supply voltage is 18 to 30 v dc; power required is less than 0.75 w; temperature range is −55 +125 C. The circuit closes within 1 sec after grounding trigger terminal.

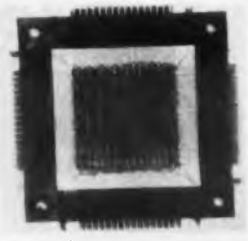
Espey Manufacturing & Electronics Corp., Saratoga Industries Div., Dept. ED, Saratoga Springs, N. Y.

Miniature Tape Recorder 456

For up to 14 channels, in line or interlaced. Model TR-1875 recorder has speeds of 1.875, 3.75, 7.5 and 15 ips and a capacity of 150 ft of 1-mil Polyester tape providing 16 min of recording. It is 4-1/4 in. in diameter, 4-3/4 in. long and weighs less than 3-1/2 lb.

Aero Data Corp., Div. of American Concertone, Inc., Dept. ED, 9449 W. Jefferson Blvd., Culver City, Calif.

Memory Planes 461



For random-access memories. These four-wire, coincident-current memory planes have all matrix terminal connections multiple-wire wrapped and dip soldered. Meeting AQL specs, memory cores are wound on 50-mil centers. Wafer construction is used.

Ferroxcube Corp. of America, Dept. ED, Saugerties, N. Y.

CIRCLE 121 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Bakelite Connectors 360

Rating is 750 v rms, 10 amp. Series 3300 connectors have 18, 21, 24, 27, 30 or 33 contacts. Knife contacts in plugs are cadmium or silver-plated brass; in sockets, phosphor bronze. Backplates are XXXP laminated phenolic meeting NEMA specs. The cap offers protection against moisture and dust, and has high dielectric strength.

Beauchaine & Sons, Inc., Dept. ED, Lakeport, N. H.

Availability: *from stock.*

Metal-Film Resistors 361

Ratings are 1/8 to 1 w. Types 418E, 419E, 420E and 421E metal-film resistors are suited for matching in precision voltage dividers as well as test equipment and digital circuitry. They meet MIL-R-10509C. They have low noise level, negligible voltage coefficient of resistance and high stability.

Sprague Electric Co., Dept. ED, North Adams, Mass.

Single-Sideband Transceiver 369

Has six channels, covering 1.6 to 16 mc. Model SB-6F single-sideband receiver is rated at 135 w. Suited for military as well as commercial applications, it measures 9-1/2 x 18-1/4 x 17 in. and weighs under 50 lb. The SB-6FC antenna coupler is available to couple the transceiver to a 75-ft wire antenna or a 15-ft whip.

RF Communications Associates, Inc., Dept. ED, 13 Canal St., Rochester 8, N. Y.

Transistor Breadboard Socket 373

For use with JETEC 30 transistor. Model XS-T4 surface-mounted, transistor breadboard socket has low-loss, Mica-filled phenolic casting as per MIL-M-14, type MFE. Closed-entry contacts are silver plated, beryllium copper.

Pomona Electronics Co., Inc., Dept. ED, 1500 E. Ninth St., Pomona, Calif.

Epoxy Molding Compounds 389

Arc resistance is to 180 deg. The Epi-All epoxy molding compounds have high dielectric strength and excellent insulating properties. Parts molded from these compounds have dimensional stability, are free from outgassing and withstand temperatures to 500 F. Compounds are shelf-stable for over four months.

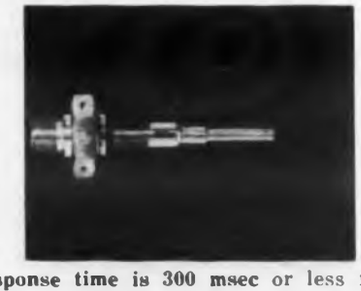
Mesa Plastics Co., Dept. ED, 12270 Nebraska Ave., Los Angeles 25, Calif.

Torque Meter 388

Pad-type torque meter is used in production tests to evaluate hot-fluid hydraulic pumps. All parts withstand 500 F; compensation maintains sensitivity constant to 1% or better per 100 F change. Standard models cover ranges from 1.0 lb-in. full scale to 30,000 lb in. full scale. Gage factor of 50 results in a high signal-to-noise ratio.

B & F Instruments, Inc., Dept. ED, 3644 N. Lawrence St., Philadelphia 40, Pa.

High-Speed Probe 370



Response time is 300 msec or less for one time constant. Suited for use with corrosive media, type 3255 high-speed probe has a CP platinum sensor hermetically sealed in a 316 stainless-steel sheath. Temperature range is −423 to +400 F. The probe is compatible with liquid oxygen.

RdF Corp., Dept. ED, Hudson, N. H.

NEW PRODUCTS

Printed-Circuit Test Jack 371

For right-angle mounting. For use in computers and other equipment with closely spaced circuit boards, this printed-circuit test jack permits testing without removal of adjoining boards. All materials used meet Mil specs. Contact and brass terminals have gold plating over silver plate.

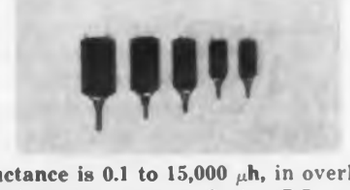
Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.
P&A: *$0.24; from stock.*

Frequency-Deviation Meter 367

Covers entire vhf band. Type FMV frequency-deviation meter has deviation ranges of 0 to 10, 30, 60 and 150 kc. It gives direct readings on frequencies of 20 to 300 mc. Accuracy of frequency range and frequency deviation standard is ±1%. It tests static modulation characteristics, modulation or line-voltage fluctuation, generated carrier drift, frequency deviation and response.

Rohde & Schwarz Sales Co., Dept. ED, 516 Bloomfield Ave., Montclair, N. J.

Tunable RF Coils 368



Inductance is 0.1 to 15,000 μh, in overlapping standard tuning ranges. Series RC and RCP (plug-in) tunable rf coils are for medium and high-Q areas. They meet environmental requirements of MIL-C-15305A, Grade 1, Class B. Cases are epoxy resin.

Relcoil Products Corp., Dept. ED, Spring St. & Rt. 75, Windsor Locks, Conn.
Availability: *3 to 4 weeks.*

Continuous-Loop Recorder 457

For up to 14 channels, model CL-90 continuous-loop, magnetic-tape recorder operates under severe environmental conditions. Speeds are 1.875, 3.75, 7.5 and 15 ips, with a loop of up to 12-ft. Wow and flutter are 1% rms or better under static conditions. Weight is 1 lb.

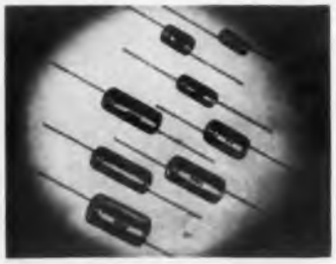
Aero Data Corp., Div. of American Concertone, Inc., Dept. ED, 9449 W. Jefferson Blvd., Culver City, Calif.

Delay Lines 519

Delay is 0 to 5 μsec. This series of miniature, continuously variable delay lines provides: maximum rise time of 0.08 μsec, impedance of 1,000 ohms, attenuation of 1 db max. The variable tap has a resolution of 0.25% of total delay. Operating temperature range is −55 to +85° C and coefficient of delay is better than 150 ppm per deg C.

Andersen Labs., Inc., Dept. ED, 501 Park Ave., W. Hartford 10, Conn.

Polystyrene Capacitors 460



Wvdc is 125 or 500 for polystyrene capacitors covering from 20 pf to 0.025 μf. Leakage resistance is better than 500,000 meg per μf; temperature range is −10 to +70 C; tolerances are 2.5%, 5%, 10% or 20%. Units rated at 25 wvdc for 5,000 pf to 0.1 μf are also available.

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

Price: $35 to $100 per 1,000.

CIRCLE 127 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Servo Amplifier 365

Rated at 3.5 w, this servo amplifier for missile and aircraft applications is suited for use in analog computers, automatic controls, and remote positioning systems. It operates from a 115-v line and has 80% power efficiency. Input impedance is 7,500 ohms; voltage gain is 150. Size is 1 x 1 x 3 in.

The Siegler Corp., Dept. ED, 632 Tinton Ave., Bronx 55, N. Y.

Feedthrough Terminal 366

Has pigtail lead 1-1/2 in. long. Type FT-M-9 miniature feedthrough terminal is for use on printed wiring boards, particularly in computer assemblies. The pigtail lead allows bending to other terminations for point-to-point wiring and can be supplied in various lengths on special order.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N. Y.

Quick-Disconnect Harness 363

Tubes and wires 1/8 in. in diameter or smaller can by harnessed with Flip-Loc clamps. This quick-disconnect harness has a molded insert that insulates and cushions the tube or wire and prevents pinching or chafing. The insert can be neoprene or aromatic-fuel-resistant material.

TA Manufacturing Corp., Dept. ED, 4607 Alger St., Los Angeles 39, Calif.

Carbon-Film Resistors 372

Ratings are 1/10 and 1/8 w for type PT30 and PT55 carbon-film resistors. Tolerance is ±1%, voltage coefficient is less than 0.0002% per v and temperature coefficient is ±0.02% to ±0.05% per deg C. Type PT30 measures 0.156 x 0.09 in. in diameter; type PT55, 0.281 x 0.09 in. in diameter.

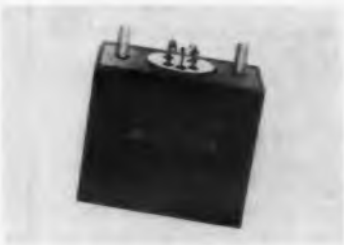
Pryofilm Resistor Co., Inc., Dept. ED, Box 1521, U. S. Highway 46, Parsippany, N. J.

Pulse Simulator 364

For digital and computer circuits. Series 500 pulse simulators present data in serial form of any type of digital coding, simulating digital output of a multiplexer or digitizer in RZ, NRZ and modified NRZ formats. Bit rates are up to 1 mc.

Telemetrics, Inc., Dept. ED, 12927 S. Budlong Ave., Gardena, Calif.

Frequency Detector 452



Linearity is 0.25% or better. For use to 20,000 cps, the Magmeter solid-state frequency detector is for use in tachometry, frequency measurement, instrumentation and telemetry. Drive is line, tube or transistor; output current is 0 to 1 ma; input is 1-w driving power; temperature range is −55 to +72 C.

Airpax Electronics Inc., Seminole Div., Dept. ED, Ft. Lauderdale, Fla.

***Availability:** 1 to 3 weeks.*

how North Atlantic's Phase Angle Voltmeters solve tough ac measurement problems ... in the lab or in the field.

Designed for critical tasks in circuit development, production and testing, North Atlantic's Phase Angle Voltmeters provide direct reading of phase angle, nulls, total, quadrature and in-phase voltages—with proven dependability even under field conditions. Your North Atlantic engineering representative can quickly demonstrate how they simplify ac measurement jobs from missile checkout to alignment of analog computers—from phasing servo motors to zeroing precision synchros and transducers.

Shown below are condensed specifications for single-frequency Model VM-202. Other models include high sensitivity, three-frequency and broadband types.

Voltage Range	**1 mv to 300 v f.s., 12 ranges**
Voltage Accuracy	**±2% f.s.**
Phase Accuracy	**dial: ±1°; meter: ±3% of F.S. degrees**
Signal Frequency	**1 Freq., 30 cps—10 kc**
Input Impedance	**10 megohms**
Reference Input	**100 K, 0.25 v min.**
Meter scale	**3-0-3, 10-0-10 linear**
Phase Angle Dial	**4 scales, 90° (elec.) apart**
Nulling Sensitivity	**2 microvolts (phase sensitive)**
Harmonic Rejection	**55db (with filters)**
Dimensions	**5¼" h. x 19" w. x 7⅞" d.**

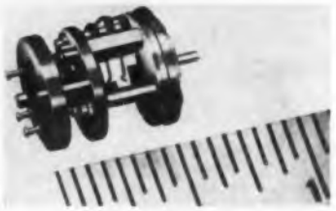
The North Atlantic man in your area has full data on standard and special models for laboratory, production and ground support. Call today for his name, or request Bulletin VM-202.

NORTH ATLANTIC *industries, inc.*
TERMINAL DRIVE, PLAINVIEW, L. I., NEW YORK • OVerbrook 1-8600

CIRCLE 130 ON READER-SERVICE CARD

NEW PRODUCTS

Commutating Switch 453



Weighs less than 3.35 g and occupies less than 1.28 cu cm. Housed in a size 5 can, this rotary commutating switch is for missile applications and is able to stand shock and vibration. Unit shown is a single-pole, 8-position, make-before-break type.

Airflyte Electronics Co., Dept. ED, 535 Avenue A, Bayonne, N. J.

Motor Generator 445

Temperature-controlled motor generator T895-26B operates with excitation frequency of 400 ±20 cps, power input of 6.1 w. Phase variation is ±0.05% in ambient temperatures from −25 to +75 C. No-load speed is 4,500 rpm min, generator output 2.75 v per 1,000 rpm. Harmonic content is 0.010 v. Mounting length is 3.534 in. max, diameter 1.437 in.

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

Servo Amplifier 444

Volume is 1 cu in. Transistorized servo amplifier C70 3148 001 supplies control-phase power for a size 11 servo motor. Signal is 30 v rms max at 400 ±20 cps. Ripple and noise is 0.5 v rms max, nominal gain 2,500. The 1.6-oz amplifier measures 1-1/32 in. max on a side.

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

High-Temperature Connector 381

Is rated for 20,000 psi, 400 F, 3,000 v. The K series connector has a dielectric strength of 3,000 v and a current rating of 8 amp in the K32 type and 10 amp in the K25. Bulkhead feedthrough types, cable and dummy types can be furnished. It withstands effects of oils and salt water.

Keystone Engineering Co., Dept. ED, 6310 Sidney St., Houston 21, Tex.

Stator End Caps 362

For insulating coil end turns on the stators of small motors. These stator end caps are made of glass fabrics formed with phenolic, melamine or silicone resin for all temperature classes.

Stevens Products Inc., Dept. ED, 86-88 Main St., East Orange, N. J.

Availability: *made on order.*

Industrial Relay 469

Rated at 10 amp. 300 v, industrial relay CR 120A provides full terminal accessibility for installation and maintenance. Design eliminates the need for a wiring trough, Panel space required is about 5-5/8 sq in. The relay is available in 2-, 4-, 6-, and 8-pole forms.

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

Test Stand 468

Tumble rate test stand CO5 6452 008 is used to test gyros and other devices requiring precise orientation or rotation. Rotary table locking arrangement permits selection of 0, 90, 180, and 270 deg static angular positions. Thirty heavy-duty, low-noise slip rings provide signal and transfer requirements.

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

NEW PRODUCTS

Polystyrene Capacitors 454

Rated at 500,000 meg/μf at 25 C, these polystyrene capacitors have a standard range of 0.01 to μf, with a capacitance tolerance of ±10%. Style A has a single lead wire on each end; style B, a single lead with grounded case; style C, double lead wire on one end.

Airborne Accessories Corp., Electronics Div., Dept. ED, 1414 Chestnut Ave., Hillside 5, N. J.

Test Sets 520

High-voltage ac and dc test sets conforming to ASTM Specification D-149-59 are suitable for testing dielectric materials and all types of insulated apparatus. The ac line has 15 ratings in two classifications: 2 kva at 20, 35 and 50 kv, and 5, 10 and 25 kva at 50, 75, 100 and 150 kv. The dc sets are available at 5 and 10 ma from 30 to 150 kv.

General Electric Co., High Voltage Specialty Transformer Section, Dept. ED, Holyoke, Mass.
P&A: *$1,250 to $8,500; 6 to 8 weeks.*

Power Supplies 521

Silicon dc power supplies are made for industrial applications in ratings from 0.75 to 75 kw. Line includes general purpose, essential service, and synchronous motor field excitation units. Efficiency is greater than 95% for all types.

General Electric Co., Dept. ED, Schenectady 5, N. Y.
Price: *$500 to $5,850.*

Switching Relays 451

With msec switching time, these switching relays are rated at 15 va max. Life is 20,000 operations at 1/2 amp, 28 v dc, or 100,000,000 operations at 1/4 amp. Temperature range is −55 to +150 C; vibration limit is 0.08 in. or 20 g from 10 to 500 cps; shock is 50 g.

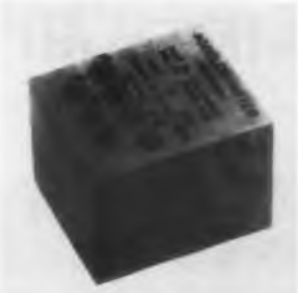
Airpax Electronics Inc., Cambridge Div., Dept. ED, Cambridge, Md.

Illuminated Push-Button 487

Solenoid hold-down keyboard switchlights are made in contact arrangements from spst to 6pst and spdt to 8pdt, each with independent lamp circuits. Energized coil holds push-button in; when coil is not energized, switching action is momentary. Switches are rated at 28 v dc, 50 ma to 5 amp resistive with silver contacts, 1/4 ma to 50 ma with gold contacts. Units may be gauged with other standard switchlights and indicators.

Pendar, Inc., Dept. ED, 14744 Arminta St., Van Nuys, Calif.

Servoed Accelerometer 488



Self-contained amplifier in the PAL-1S and 1P series of servoed accelerometers delivers up to 5 v output. Accuracy is 0.1%, total power requirement 1/3 w. Natural frequency is 600 cps or higher.

Palomar Scientific Corp., Dept. ED, Palo Alto, Calif.

Shielded Plug 482

Flat, shielded 1/4-in. plug saves space in audio equipment. Model No. 228 accommodates two-conductor wire, No. 238 takes three-conductor wire. Cable OD is 0.210 to 0.250 in. Material is steel and brass, nickel-plated.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Minuteman can mean reliability in your rectifier circuits

The successful launching of the Minuteman missile dramatically demonstrates the importance of the super-reliability program that made it possible. General Electric low current 1N540, medium current 1N1204A, 1N2158 silicon rectifiers, and medium current 2N685 silicon controlled rectifier are a vital part of that program. They are used in some of the most critical circuits in the Minuteman.

But how does this mean Minuteman reliability for you? *Every* failure mode analyzed for Minuteman, *every* corrective action taken, *all* the high reliability work done for each of these rectifiers is applied to the entire line of that type of semiconductor.

For Minuteman type of reliability in your low current circuits, specify G-E 1N536-540, 1N547, 1N560-61, 1N1095-96 silicon rectifiers; for medium current circuits ask for 1N1199A-1206A, 1N1341-1348, 1N2154-2160 silicon rectifiers. For medium current silicon controlled rectifier applications, specify the G-E 2N681-689 series.

RECTIFIER COMPONENTS DEPARTMENT, SECTION 23F22, AUBURN, N.Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 135 ON READER-SERVICE CARD

NEW PRODUCTS

Pattern Converter 484

Provides digital data. The RPC pattern converter is capable of converting any display such as oscilloscope, map or chart to digital language for recording on tape or cards. It may be modified to convert any analog display to digital data.

Rabinow Engineering Co., Inc., Dept. ED, Washington 12, D. C.

Wave Generator 489

Sine and square wave generator model G-34 covers 6 cps to 750 kc, providing audio signal output. Sine wave distortion is less than 1/4 of 1%, 20 cps to 20 kc. Square wave rise time is less than 0.15 μsec. Frequency accuracy is $\pm 5\%$. Attenuator is variable to 60 db.

Paco Electronics Co., Inc., Dept. ED, 70-31 84th St., Glendale 27, N. Y.

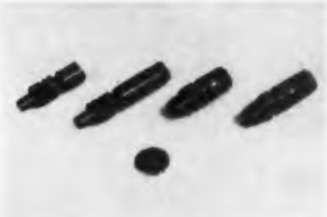
Plug-In Chopper 483

Solid-state plug-in chopper uses an isolating network so that it can be driven from a 400-cps power line. Range is 270 cps to 100 kc, an from less than 1 mv to ± 2 v. Operating temperature is -55 to $+150$ C. Encapsulated in epoxy, the chopper withstands high shock and vibration.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.

P&A: *$110; stock.*

Lamp Assemblies 485



Have 1 million variations. Line of lamp assemblies includes transistor-driven incandescent lamps, a flashing warning lamp, and an oscillator lamp with small average power consumption. Neon network lamps and transistor-driven neon lamps are also made. Any of one million variations can be ordered.

Polytronix, Dept. ED, P. O. Box 53, Manhattan Beach, Calif.

Operational Amplifier 486

Differential operational amplifier SK2-V is designed for continuous service in computing and controlling applications. Open loop gain is 100,000 at dc, unity at 1 mc. Balanced differential input is ±50 v; output is up to 3 ma at ±100 v.

Philbrick Researches, Inc., Dept. ED, 127 Clarendon St., Boston 16, Mass.

Price: *About $100.*

Variable Transformers 479

Rated at 3.75 amp with constant-current loads, variable transformer series 21 units handle up to 5.5 amp with constant-impedance load. Features include: gold alloy plated commutator, functional terminal arrangement with adapters, 3/8-in. shaft, and square base design.

The Superior Electric Co., Dept. 21, Dept. ED, Bristol, Conn.

P&A: *$12.50 to $139.50; stock.*

NEW PRODUCTS

Solder Mask 474

For printed-circuit boards. The Quick-Clip solder mask fits over etched connector contacts on printed-circuit boards to prevent adherence of solder during the dip-soldering process. Width is 13/32 in., length to order from 1/2 to 18 in.

Western Electronic Products Co., Dept. ED, 2420 N. Lake Ave., Altadena, Calif.
***P&A:** $6.50 to $15.00; stock.*

Diplexing Filter 499

Small, lightweight diplexing filter DP-318 is used in an IFF/TACAN system to automatically select one of two antennas on the basis of greater received signal. The system increases effective coverage and reduces the number of antennas necessary. The filter meets rigid electrical and environmental requirements.

Electronic Specialty Co., Dept. ED, 5121 San Fernando Road, Los Angeles 39, Calif.

Temperature Controller 477

With 22-in. scale. The PT temperature controller offers on-off or proportional control from −150 to +1,050 F. Interchangeable 22-in. scales are printed in 1-deg gradations and 300-deg spans, for F and C measurement. One probe handles all ranges. Panel space is 5 x 8 in.

Technique Associates Div. of Duncan Electric Co., Inc., Dept. ED, 1413 N. Cornell, Indianapolis 2, Ind.

Neutron Detector 480

Solid-state neutron detectors have nanosecond response and low gamma sensitivity. Available with areas of 5 and 10 sq mm, the units operate at 25 v. Three-pin arrangement fits standard transistor sockets. Uses include flux monitoring and safety alarm systems.

Solid State Radiations, Inc., Dept. ED, 9926 W. Jefferson Blvd., Culver City, Calif.
***P&A:** $100 to $200 ea; stock.*

Load Cell 498

Tension or compression loads may be measured with hydraulic load cell type ADR-1. Designed for use with a dynamometer, the cell provides hydraulic pressure output directly proportional to applied load. The 16-in. diameter indicator has ranges for 0 to 200 lb compression, and 0 to ±100 and −200 lb tension.

The A. H. Emery Co., Dept. ED, Pine St., New Canaan, Conn.

DC Voltmeter 476

Meets military specifications. Zero-center and zero-left ranges to 300 v are provided by dc voltmeters 305-1 and -2. Accuracy is 2% of full scale. The solid-state, high-impedance instruments require 3-1/2 in. of panel space and weigh less than 1-1/2 lb.

Trio Laboratories, Inc., Dept. ED, Plainview, L. I., N. Y.

Null Detector 497

A high-speed relay is actuated by this null detector when voltage under test is within less than 1 mv of the null point. A chopper-stabilized amplifier is used for stability of zero balance. Relay closure can be used to record null as a function of shaft position, input voltage, or to set off an alarm.

The G. C. Dewey Corp., Dept. ED, 202 E. 44th St., New York 17, N. Y.

NEW PRODUCTS

Servo Valve 473

Electrohydraulic servo valve SV-128 is compatible with all hydraulic fluids, weighs 2 oz, and is 2-1/8 in. long by 1-1/16 in. in diameter. Flow is 0 to 2 gallons per minute. The device has an in-line force feedback system, pressure balanced construction and single nozzle design.

Sanders Associates, Inc., Dept. ED, 95 Canal St., Nashua, N. H.

Teflon Tubing 490

Spiral-wrapped, flexible tubing of Teflon is made with wall thickness of 0.008 to 0.012 in. in sizes 26 through 10, and 0.010 to 0.014 in. in sizes 9 through 7. Service temperature range is −90 to +250 C. Tubing meets the requirements of MIL-I-3190.

Pennsylvania Fluorocarbon Co., Inc., Dept. ED, 1115 N. 38th St., Philadelphia 4, Pa.

Epoxy Laminate 494

Flame-retardant laminate is made in sheets for printed circuit manufacture. Called Fireban 600, the glass-base material is supplied in thicknesses of 0.010 to 2 in., area to 37 x 49 in. Sheets up to 1/16 in. thick may be cold-punched. The copper side will resist 500 F for 20 sec.

Taylor Fibre Co., Dept. ED, Norristown, Pa.

Analog-Digital Converter 472

Absolute accuracy of 1% is provided by model ADC-1 analog-digital converter. Input is ±1 v dc; output is 8-bit binary with sign. Potted in a transformer can, the device measures 4 in. on a side. Ambient temperature range is −55 to +55 C.

Dynamic Systems Electronics Corp., Dept. ED, 2001 N. Scottsdale Road, Scottsdale, Ariz.

***P&A:** $695; 45 days.*

2-Stage Blower 478

Lightweight, compact blower uses a two-stage design to produce 377 cfm at 5.91 in. of water. Three-phase motor is integral. Weight of the blower is 4.2 lb.

Task Corp., Dept. ED, 1009 E. Vermont Ave., Anaheim, Calif.

Flux Remover 496

A safety solvent for flux removal, Vythene-PC is said to dissolve fluxes and salts more effectively than chlorinated solvents. It has no flash point, is low in toxicity, and can be reclaimed.

Tect, Inc., Dept. ED, Northvale, N. J.

Resist Stripper 491

Cold stripper No. 77 quickly removes photo resist from printed circuit boards without coagulation problems. Supplied as a concentrate, the stripper is diluted with low-cost solvent by the user. The nonviscous solution rinses freely.

Shipley Co. Inc., Dept. ED, Walnut Park, Wellesley 81, Mass.

Temperature Transducer 495

Sea water temperature transducer T-4005 has an accuracy and interchangeability of 0.09 C. Range is −5 to 30 C. Designed for indefinite immersion in sea water, the device contains its own bridge circuit.

Trans-Sonics, Inc., Dept. ED, P. O. Box 328, Lexington, Mass.

Panel Meters 475

In four case sizes. The M series of panel meters offer scale lengths of 2.5, 3.34, 4.5, and 7 in. Case is transparent and black molded plastic. Movement is self-shielded. Terminals accept solderless connectors, solder or wrap-around connections.

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

INTRODUCING

Bendix Uni-son

New Unitized Sonic Energy Cleaner

compact—reliable—new low price

For superior cleaning on a sustained production basis, Bendix Uni-son utilizes a solid state generator, fixed tuning, and Omnimite®, the guaranteed-for-life magnetostrictive transducer. Flexibility, full warranty, compact size and low price make Uni-son the most economical sonic cleaner to own, operate, and maintain.

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SONIC ENERGY CLEANING

☐ Please send complete details on Bendix Uni-son.
☐ Please send details on complete Bendix cleaning systems.

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CIRCLE 152 ON READER-SERVICE CARD

NEW PRODUCTS

Pressure Transducer 481

High-temperature pressure transducer P732 is compensated for continuous operation to +600 F. Ranges on gage and unidirectional differential models are from 0 to 2 through 5,000 psi; bidirectional differential model operates in ranges from ±1 through ±100 psi. Combined nonlinearity and hysteresis are less than ±0.75.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Dip Coating 493

Has low viscosity. Encapsulating material No. 141 is a two-part system with pot life of 18 hr min. Initial viscosity is 2,000 to 6,500 centipoises, providing an even, hole-free coating 3 to 10 mils thick. Dielectric strength is 1 kv per mil.

Technical Research Co., Dept. ED, 13535 Monster Road, Seattle 88, Wash.

Zinc Crystals 492

Large single crystals of zinc, weighing over 30 lb, are useful in neutron diffraction and other applications. Diameter is 5 in., height 5 in. or more. Crystals are 99.999+% pure.

Semi-Elements, Inc., Dept. ED, Saxonburg Blvd., Saxonburg, Pa.

***Price:** $100 per lb.*

Recorder-Controller 541

Digital integrator - recorder - controller type CRS accepts the output of analytical instrumentation detectors and converts it to digital recordings of both time of occurrence and relative area of signal peaks. It operates with an input of 100 mv; an input impedance of 10 to 100 K may be specified. Sensitivity is better than 0.1 mv per sec.

Infotronics Corp., Dept. ED, 1401 S. Post Oak Road, Houston 27, Tex.

Silicon PNPN Devices 542

Controlled rectifier TI-40 has a forward current rating of 3 amp, and forward and reverse voltage ratings of 200 v. It is useful in consumer devices and appliances as well as industrial controls. The TI-41 trigger device is a bistable unit in a hard glass diode package. It is rated for a forward breakover voltage of 30 v ±6v with a maximum breakover current of 100 μa.

Texas Instruments, Inc., Semiconductor-Components Div., Dept. ED, P. O. Box 5012, Dallas 22, Tex.

Availability: *stock.*

Magnetic Modulator 543

Low-level, bipolar input current is converted to proportional phase-reversing 400 cps sinusoidal output by model 200 magnetic modulator. Input current range is 0±250 μa, with output of 0 to 3.5 v. Hysteresis is less than 0.1%, linearity better than 2%, noise less than 1/2% of maximum.

Transmagnetics Inc., Dept. ED, 40-66 Lawrence St., Flushing 54, N. Y.

Module Socket 544

Accepts resistor stacks and capacitor stacks. This module socket has NEMA grade XP insulating wafers. Brass contacts are barrel-type, cadmium plated; they are designed to remain firmly in place when module is engaged to socket.

Mandex Manufacturing Co., Inc., Dept. ED, 2614 W. 48th St., Chicago, Ill.

NEED A FREQUENCY?

FREQUENCY SOURCES
RANGE: 10 cps to 10 kcs

WHY LET SOMEONE ELSE DISCOVER ALLEN TYPE C OSCILLATORS?
(and someone does discover these unique transistorized frequency generators for another new application almost every day.)
Allen Type C Oscillators provide THREE IMPORTANT ADVANTAGES:

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The efficient mass-production of high quality frequency sources, indispensable to the success of Allen electronic organs, now contributes to the great flexibility of Type C Oscillator production.
You are invited to investigate this unusual component. Write Dept. 2206 for illustrated technical data.

COMPONENTS DIVISION

Allen ORGAN COMPANY, INC.

MACUNGIE, PA., PHONE WOodring 5-9801
CIRCLE 155 ON READER-SERVICE CARD

NEW PRODUCTS

Plastic Shells 545

For miniature assemblies. High-temperature molded shells of orlon-filled diallyl phthalate measure 1/2 in. wide, 1/2 to 2 in. long in any height from 0.2 to 0.6 in. Wall thickness is 0.030 in. Used for encapsulating miniature assemblies and modules, shells withstand up to 250 F and are flame-resistant.

Wells Electronics, Dept. ED, 1701 S. Main St., South Bend, Ind.
Price: *$0.40 to $1.10 ea.*

Proportional Controller 546

Minimizes cycling. Proportional controller provides dependable off-on process control with minimum cycling, and will not permit process conditions to exceed preset limits. Instrument accuracy is 1/4% of controller span.

Thermo Electric Co., Inc., Dept. ED, Saddle Brook, N. J.

Beta Counter 547

Low-level beta counting system has 4 interchangeable plug-in-units, unitized counting assemblies and 1/4 count per minute rates for 1-in. diameter detectors. Each unit has sample holder, sample detector, guard detector and scaler. Alpha detectors with preamplifiers are also available as accessories.

Nuclear Industries, Dept. ED, 10 Holland Court, Valley Stream, N. Y.
Price: *$5,800 to $7,750.*

Selection Guide:

Lowest Materials Costs for Electronic Enclosures

Richard E. Shafer
Assistant to the President,
Professional Consultants, Inc.
Pasadena, Calif.

THE COST of materials for electronic enclosures can be a significant item, particularly in custom runs. Though an expensive material such as stainless steel is sometimes dictated by specifications, often there is a choice of other less expensive materials, (suitably protected to prevent corrosion).

The problem is to see which material meets most of the design objectives and to balance the performance of the material against its cost. These tables will help the engineer in this performance-vs-cost analysis. Table 1 lists the cost for commonly used thicknesses of enclosure materials. Table 2 provides the strength and stiffness comparisons for selecting the materials which then can be cost-compared in Table 1. ■ ■

(continued on p 138)

Table 1. Cost vs Thickness and Tensile Strength for Enclosure Materials

Property	Material	Calculated Required Thickness"	Available Stock Thickness"	Available Stock Per Sq Ft	
				Wt (Lbs)	Cost (dollars)
Equal Stiffness	Al.6061-T4	0.085	0.090	1.27	0.77
	Mag. AZ31B-H24	0.100	0.100	0.95	1.24
	Low Carb. Steel	0.0598	0.0598	2.5	0.29
	Stain. Stl. 302	0.062	0.062	2.6	1.70
Equal Strength	Al.6061-T4	0.090	0.090	1.27	0.77
	Mag. AZ31B-H24	0.070	0.070	0.67	0.88
	Low Carb. Steel	0.0598	0.0598	2.5	0.29
	Stain. Stl. 302	0.062	0.062	2.6	1.70

Notes

1. Usually the differences in space required by the differences of thickness of different materials which have equivalent strength or rigidity are not significant.
2. Epoxy-fiberglass is not included because it weighs almost as much as aluminum and has approximately one-fifth the modulus of elasticity. This means that a heavier section of epoxy would be required for equivalent stiffness.
3. Finishing costs are not included. Cost of enameling is approximately the same for all these materials. Chemical pre-paint treatments for the low-cost carbon steel should be the lowest cost for Parkerizing or Bonderizing per Mil Spec, about 10¢ per sq ft. Pre-paint treatments for aluminum or magnesium cost approximately 20¢ per sq ft.

Electronic Enclosures (continued from p 137)

Table 2. Strength and Bending Stiffness of Enclosure Materials

Comparison	Material	Form	Thickness	Strength	Stiffness	Weight
Equal Thickness	SAE 1025 Steel		100	100	100	100
	SAE 4130 Steel	Heat Tr. Sheet	100	375	100	100
	Alum. 3003-1/2H	1/2 Hard Sheet	100	44	35	35
	6061-T4	Heat Tr. Sheet	100	44	35	35
	2024-T4	Heat Tr. Shapes	100	111	35	35
	7075-T6	Heat Tr. Sht.	100	183	35	35
	Titanium A-55	Sheet & Bars	100	140	52	57
	C110M	Sheet & Bars	100	275	52	57
	Mag. AZ31-0	Annealed Sht.	100	43	22	23
	AZ31-H24	H. R. Sheet	100	73	22	23
	AZ31	Extruded Bar	100	50	22	23
	ZK60A	Extr. & Aged	100	82	22	23
	AZ80-T6	Ht. Tr. & Aged	100	88	22	23
Equal Strength	SAE 1025 Steel		100	100	100	100
	SAE 4130 Steel	Heat Tr. Sheet	52	100	14	52
	Alum. 3003-1/2H	1/2 Hard Sheet	150	100	120	52
	6061-T4	Heat Tr. Sheet	150	100	120	52
	2024-T4	Heat Tr. Shapes	95	100	30	33
	7075-T6	Heat Tr. Sht.	74	100	14	26
	Titanium A-55	Sheet & Bars	85	100	33	48
	C110M	Sheet & Bars	60	100	12	34
	Mag. AZ31-0	Annealed Sheet	152	100	79	35
	AZ31-H24	H. R. Sheet	117	100	36	27
	AZ31	Extruded Bar	142	100	64	33
	ZK60A	Extr. & Aged	110	100	30	25
	AZ80-T6	Ht. Tr. & Aged	107	100	27	25
Equal Stiffness	SAE 1025 Steel		100	100	100	100
	SAE 4130 Steel	Heat Tr. Sheet	100	375	100	100
	Alum. 3003-1/2H	1/2 Hard Sheet	141	88	100	49
	6061-T4	Heat Tr. Sheet	141	88	100	49
	2024-T4	Heat Tr. Shapes	141	221	100	49
	7075-T6	Heat Tr. Sht.	141	364	100	49
	Titanium A-55	Sheet & Bars	125	215	100	71
	C110M	Sheet & Bars	125	430	100	71
	Mag. AZ31-0	Annealed Sht.	165	117	100	38
	AZ31-H24	H. R. Sheet	165	200	100	38
	AZ31	Extruded Bar	165	136	100	38
	ZK60A	Extr. & Aged	165	222	100	38
	AZ80-T6	Ht. Tr. & Aged	165	238	100	38
Equal Weight	SAE 1025 Steel		100	100	100	100
	SAE 4130 Steel	Heat Tr. Sheet	100	375	100	100
	Alum. 3003-1/2H	1/2 Hard Sheet	285	358	819	100
	6061-T4	Heat Tr. Sheet	285	358	819	100
	2024-T4	Heat Tr. Shapes	285	904	819	100
	7076-T6	Heat Tr. Sht.	285	1,490	819	100
	Titanium A-55	Sheet & Bars	175	420	290	100
	C110M	Sheet & Bars	175	840	290	100
	Mag. AZ31-0	Annealed Sht.	439	831	1,890	100
	AZ31-H24	H. R. Sheet	439	1,429	1,890	100
	AZ31	Extruded Bar	439	965	1,890	100
	ZK60A	Extr. & Aged	439	1,580	1,890	100
	AZ80-T6	Ht. Tr. & Aged	439	1,700	1,890	100

Notes

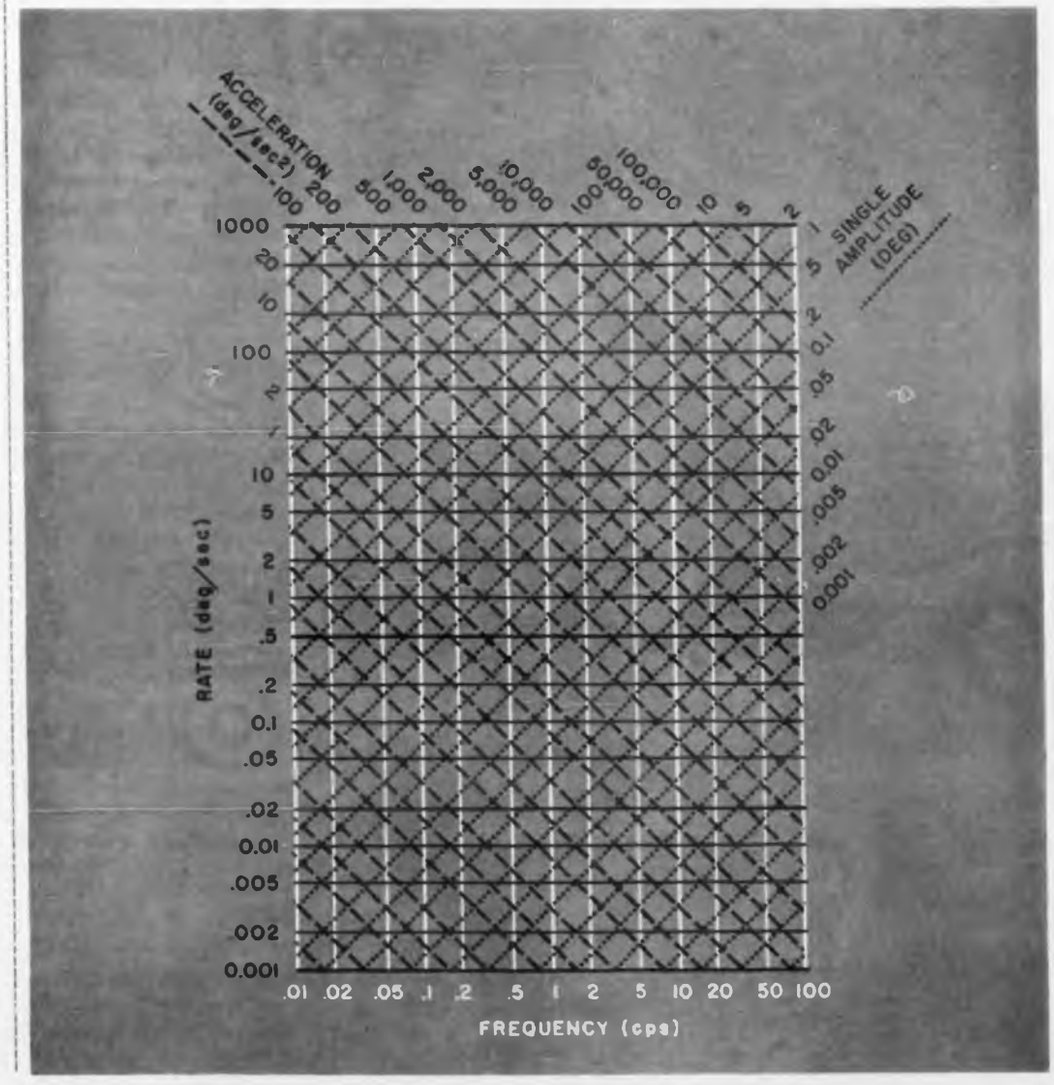
1. Rectangular beams of constant width using SAE 1025 steel and minimum yield strength as comparison basis.
2. Values 100 per cent where shown. Other figures are calculated percentages.
3. Data in Table 2 courtesy Brooks & Perkins, Detroit.

Nomogram Speeds Rate and Acceleration Calculations

Bela J. Losmandy
Chief Electronics Engineer
Micro Gee Products, Inc.
Culver City, Calif.

PARTICULARLY useful for work with rate gyros and angular accelerometers, this nomogram presents four parameters. If any two are given, the other two are quickly determined.

Parameters given are the single-amplitude peak displacement (θ), the peak rate in deg/sec ($\omega\theta$), the peak acceleration in deg/sec/sec ($\omega^2\theta$), and the frequency in cps. ■ ■



THE CALL OF THE TALOS COMES IN LOUD AND CLEAR

through CECO's compact, low noise, telemetering preamplifier

CECO's Model 3010, wide band, telemetering preamplifiers, used aboard the Navy's new CLG-series cruisers, boost air-to-surface signals, minimize noise, reduce output and size requirements of missile transmitters. Used in the AN/UKR-10 telemetering and AN/USQ-11 miss-distance systems manufactured by Aircraft Armaments, Inc., for the Talos, Terrier, and Tartar missiles, the Model 3010 is simple, highly compact and flexible in physical configuration. It is characterized by extremely low noise and stable gain and features new tube types and conservatively rated components for trouble-free operation. CECO specializes in the design and manufacture of amplifiers. For additional information . . . WRITE FOR BULLETIN AB

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CIRCLE 161 ON READER-SERVICE CARD

NEW LITERATURE

Low-Power Tubes 261

Low-power transmitting tubes, series regulators, rectifiers and clipper tubes are discussed in this eight-page booklet. All specifications are charted and diagrams of tube bases and envelope connections are included. Raytheon Co., Industrial Components Div., 55 Chapel St., Newton 58, Mass.

Tube Handbooks 262

Three 12-page handbooks describe cathode subminiature, filamentary subminiature, and gas and vapor tubes. Complete specifications are charted for 340 industrial and military types in the three handbooks. Diagrams of base and envelope connections are included. Raytheon Co., Industrial Components Div., 55 Chapel St., Newton 58, Mass.

Electron Tubes 263

A 32-page booklet describes industrial electron tubes. Applications and electrical characteristics are provided for triodes, tetrodes, hard-pulse tubes, high-vacuum diodes, mercury vapor diodes and vidicon and image orthicon television camera tubes. Included is a section on available electron tube accessories. The Machlett Laboratories, Inc., Springdale, Conn.

Humidity Control 264

Catalog 661, 67 pages, lists hygrometer systems that are adaptable to the majority of humidity measurement and control problems that confront the design engineer. It includes indicating, recording and control systems and lists the components required for each system. Specifications are given for each component. Hygrodynamics, Inc., 949 Selim Road, Silver Spring, Md.

Transformer Cores 265

More than 1,000 wound cores for transformers are listed in the 70-page catalog No. W102. It includes apparent core loss and magnetizing force graphs, electrical and physical data and prices for the listed cores. The catalog is cross indexed. Thomas & Skinner, Inc., 1120 E. 23 St., Indianapolis 7, Ind.

Relays 266

An illustrated bulletin, 20 pages, lists relays, steppers, sensitrols, solenoids, contactors, rectifiers, and related items that are carried in stock. Universal Relay Corp., 42 White St., New York 13, N.Y.

Isotope Chambers 267

Specifications for 19 isotope chambers for gamma radiography are given in a six-page folder. It describes radiography procedures, operation and equipment construction. Monitoring devices, radiography training and consulting and engineering services are also covered. Philips Electronic Instruments, 750 S. Fulton Ave., Mount Vernon, N. Y.

Silver Brazing Alloys 268

Aircosil silver brazing alloy manual ADL-847C, a 24-page brochure, discusses brazing procedures, problems and solutions. Silver brazing alloys are thoroughly discussed along with their applications. Diagrams are included to help select the proper alloy to meet particular industrial needs. Air Reduction Sales Co., Div. of Air Reduction Co., Inc., 150 E. 42nd St., New York 17, N. Y.

Sound System Cables 269

Detailed product and technical data on cable constructions typically used in intercommunication, sound system, public address and related applications are given in the 12-page bulletin No. 33. Included are: cabled, shielded and jacketed 2-7 conductors; twisted pairs, cabled and jacketed 1-27 pairs; twisted pairs and triples. Phalo Plastics Corp., 530 Boston Turnpike, Shrewsbury, Mass.

Tracking Systems 270

Satellite tracking systems and antenna pattern range instrumentation are described in this 20-page catalog. It lists such items as microwave receivers, antenna pattern recorders, antenna mounts, position indicators, radome mounts, source positioners and support towers. Specifications are given for each component. Antlab, Inc., 6330 Proprietors Road, Worthington, Ohio.

Ceramic Tubes 271

Bulletin ETD-2713, 213 pages, contains full technical data on a line of 20 registered and 15 developmental ceramic tube types. Diagrams, graphs, illustrations, a tube selection chart, and typical socket data are included. Bulletin ETD-2134, 52 pages, contains extensive application information as well as data on design, materials, manufacturing, uhf-vhf performance, and reliability. General Electric, Receiving Tube Dept., Owensboro, Ky.

NEW LITERATURE

Ceramic Standards

Standards of The Alumina Ceramic Manufacturers Association, 11 pages, contains a wide range of data relating to the production, design and purchasing of ceramic materials. Included are sections on test methods, design fundamentals, resistance to nuclear radiation and quality assurance standards. *Send $1.00 to Alumina Ceramic Manufacturers Assoc., Dept. ED, 53 Park Place, New York 7, N. Y.*

Rectifier Assemblies 272

Specification sheet ECG 487, a six-page brochure, contains information on how to select a potted rectifier assembly and detailed specifications on rectifier circuits requiring multiple potted blocks. Included are performance charts for various operating conditions. General Electric Co., Rectifier Components Dept., Auburn, N. Y.

Power Supplies 273

Catalog PS361 describes a line of high efficiency, compact, highly regulated dc power supplies. The design principles are explained in this 16-page catalog. Complete specifications are given for 90 power supplies. Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif.

Microwave Components 274

Catalog No. 10, 72 pages, has detailed descriptions of coaxial attenuators, filters, power dividers, terminations, crystal mounts, tuners and other coaxial microwave components. Design sections for each product are included. Microlab, 570 W. Mount Pleasant Ave., Livingston, N.J.

Laminated Plastics 275

A 20-page catalog covers laminated plastics in sheet, rod and tube form. It covers grade selection and description, range of sizes, typical property values and forms. There is a special section on metal-clad grades. Continental-Diamond Fibre Corp., Newark, Del.

Tantalum Capacitors 276

Publication GEA-7227, four pages, describes tantalytic foil electrolytic capacitors. Ratings, electrical characteristics, life test performance data, and basic specification information are included for the 5-K and 6-K lines. Application notes are also included. General Electric Co., Schenectady 5, N.Y.

Instrument Motors

Dimensional drawings, rating charts, wiring diagrams, specifications and photographs of instrument motors are included in the 28-page Bulletin 1M-1. Special sections describe the availability of engineering service, development and testing procedures, typical applications and application guidance. *Write on company letterhead to Bodine Electric Co., Dept. ED, 2500 W. Bradley Place, Chicago 18, Ill.*

Silicon Rectifiers 277

More than 150 different silicon diffused rectifiers are described in a six-page catalog. Illustrations and complete mechanical and electrical specifications cover units ranging from 50 to 600 piv and from 250 ma to 22 amp. Mounting hardware for stud units is detailed. Raytheon Co., Semiconductor Div., 215 First Ave., Needham, Mass.

Diallyl Phthalate Varnishes 278

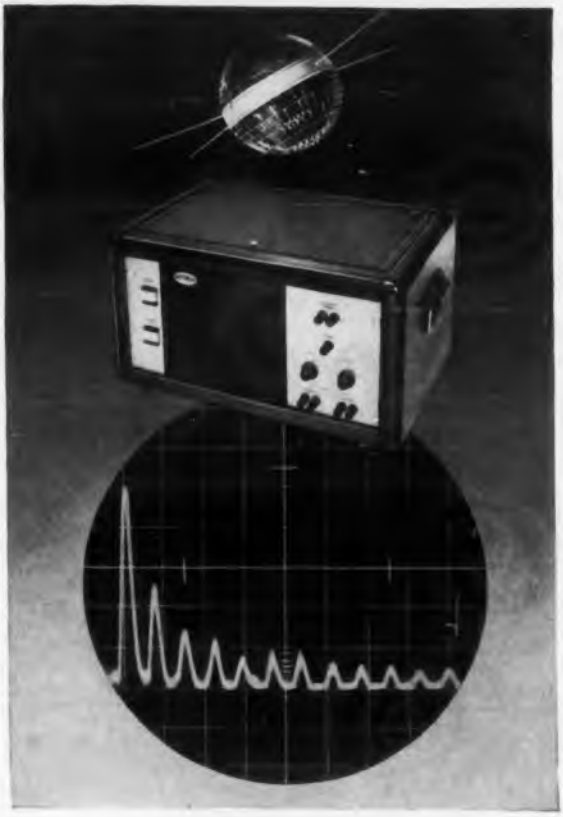
Bulletin No. 32, eight pages, describes the formulation and use of insulating varnishes based on diallyl phthalate resins including coating, sealing, dip encapsulation and laminating applications. It also contains formulas, applications, processing data and resin properties of finished coatings. Food Machinery and Chemical Corp., 161 E. 42nd St., New York 17, N. Y.

Test Instruments 279

Catalog No. 10-1.3, 12 pages, describes instruments for high voltage testing of electronic materials, components and assemblies. Included are dielectric breakdown test sets, Corona detection and measurement equipment and portable kilovoltmeters. Laboratory, quality control and field testing applications are described. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

Heat Radiators 280

Catalog 1-HR, 16 pages, describes more than 72 transistor/diode heat radiators and includes a comprehensive handbook on thermal cooling. Information contained includes: semiconductor installation; formula on thermal runaway; a transistor derating curve and formulas; thermal/electrical analog; formulas on heat dissipation by radiation, convection and conduction. The Birtcher Corp., Industrial Div., 745 S. Monterey Pass Road, Monterey Park, Calif.



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High Sensitivity Spectrum Analysis
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SPECTRUM ANALYZER

Raytheon Rayspan Spectrum Analyzers, through a unique application of multiple filters, can analyze entire spectrums as wide as 33 kc at scanning rates as high as 200 times per second with excellent resolution and a dynamic range of 40 db. Frequencies as low as 8 cps can be identified. Resolution for two equal-amplitude signals is approximately 0.7% or 3% of the analysis band depending on the Rayspan model employed.

Any model can be adapted for use with high speed, helix recorders to provide permanent records of frequency versus real time. A built-in timing pulse generator allows scan-by-scan synchronization of Rayspan with an oscilloscope.

For complete technical data please write to: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

RAYTHEON

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INDUSTRIAL COMPONENTS DIVISION

CIRCLE 168 ON READER-SERVICE CARD

NEW LITERATURE

Power Supplies 281

A step by step procedure for calculation of packaging dimensions for multiple dc outputs is included in the 24-page "DC Power Supply Handbook and Catalog." The catalog details over 200 power supplies and 1,000,000 combinations of kitted modules. Dressen-Barnes Electronics Corp., 250 N. Vinedo Ave., Pasadena, Calif.

Resolvers and Synchros 282

A quick reference, six-page catalog compiling some 200 resolvers and synchros offers fundamental engineering data. Ten basic parameters are covered for each unit. Dimensional drawings and circuit diagrams are included. American Electronics, Inc., Instrument Div., 9503 W. Jefferson Blvd., Culver City, Calif.

AC Motors 283

Bulletin B-2515, 10 pages, illustrates and describes the complete line of Duty Master ac motors from 1 to 2,000 hp. Product features of each motor are clearly outlined and explained. Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio.

Temperature Controls 284

Brief descriptions and specifications are given for 17 different types of temperature controls in the eight-page catalog No. MC-203. Typical applications are also given. Fenwal Inc., Pleasant St., Ashland, Mass.

Digital Modules 285

Catalog H, 12 pages, describes 10- and 16-mc plug-in digital modules, designated H-Pacs. Detailed descriptions of each package contain electrical specifications and functional diagrams. A standard 19-in. bloc, a cooling unit, three power supplies and other miscellaneous hardware are fully described. Computer Control Co., Inc., 983 Concord St., Framingham, Mass.

Capacitors 286

Catalog No. 1961-1, 16 pages, describes and illustrates a complete line of solid state porcelain capacitors and microminiature ceramic capacitors. It includes complete military and commercial part numbers and specifications, typical curves, dimensional drawings and special designs. Vitramon, Inc., Box 544, Bridgeport 1, Conn.

Ceramic Compositions 287

Chart No. 611 lists the mechanical and electrical properties of over 20 ceramics that are most frequently used. Also included are selection charts for ease in ceramic selection. American Lava Corp., Manufacturers Road, Chattanooga 5, Tenn.

Multi-Layer Diode 288

"Introduction to the Shockley 4-Layer Diode" is a six-page folder that gives a working introduction to the operation and application of the Shockley pnpn 2-terminal silicon switch. Twelve basic circuit application schematics are included. Shockley Transistor Div. of Clevite Transistor, Stanford Industrial Park, Palo Alto, Calif.

Rubber Uses 289

"Versatility in Rubber," 12 pages, describes the importance of reviewing molded rubber parts to reduce end product costs and improve product performance. An outline of rubber material types, importance of mold designs and a description of manufacturing processes are also given. Roth Rubber Co., 1854-1866 S. 54th Ave., Chicago 50, Ill.

Control Knobs 290

Over 345 styles of control knobs meeting MIL specifications are described in a permanent wall chart that measures 22 x 34-in. It displays all specifications and includes diagrams, dimensional data and a cross reference to MS91528B. It is printed on washable stock. Raytheon Co., Industrial Components Div., Dept. 2527, 55 Chapel St., Newton 58, Mass.

Aircraft Controls 291

"Controls for Flight," 64 pages, describes over 100 electronic and electromechanical devices and systems for aircraft, missiles and space vehicles. Environmental controls, flight and propulsion controls, temperature controls and accessory components and systems are included. Performance characteristics and specifications are given. United Control Corp., 4540 Union Bay Place, Seattle 5, Wash.

Tunnel Diode 292

Circuit design of the tunnel diode is covered in the 16-page handbook, No. AN-1359A. It describes the theory of tunneling action, various general circuit considerations, simple switching circuits and four common digital circuits. Transitron Electronic Corp., 168 Albion St., Wakefield, Mass.

IDEAS FOR DESIGN

Third $50 "Most Valuable of Issue" Award to Hughes Engineer

Jack McGruder, an engineer in the Circuits Section of the Hughes Aircraft Co., Fullerton, Calif., has won ELECTRONIC DESIGN's third $50 Most Valuable of Issue award.

Readers selected him as the award winner for his Idea for Design, "Tank Circuit Helps Stabilize Quick-Starting Gated Oscillator," which appeared in the March 29 issue.

Cascode Circuit Compensates For Heater-Voltage Sensitivity 742

The effect of shifting heater voltages in dc vacuum-tube circuits can be compensated for by utilizing the very heater sensitivity which is itself undesirable.

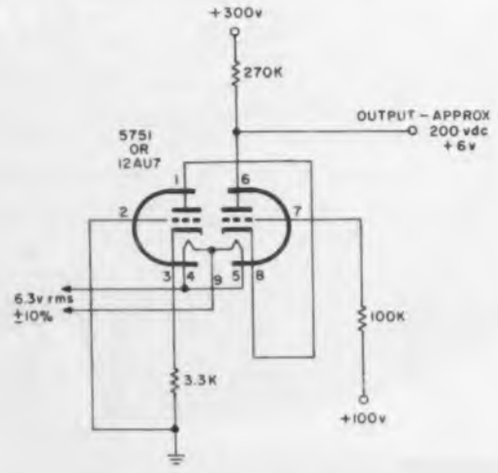
A triode cascode circuit will change its output in response to changes in heater voltage. This output voltage can then be applied to an appropriate point in the circuit to be compensated. Thus, the circuit's response to heater voltage variations can be cancelled out.

The circuit shown is part of the compensation circuit used to stabilize the drift of an integrator circuit. With the components given, the output of the cascode circuit is linear and inverse with heater voltage. Its output changes by approximately 1 v for each 0.1-v change of heater voltage over the range of 6.3 rms ±10 per cent.

In the complete circuit, there may be some need of impedance matching or dc level changing to accomplish the desired result. Also, a sensitivity control could be added so that overcompensation would not occur.

Peter A. Ralatos, Electronic Engineer, Motorola Systems Research Laboratory, Riverside, Calif.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 742.



Output of triode cascode circuit, varying linearly with heater voltage, is used to compensate for heater variations in dc vacuum-tube circuits.

Vote for Ideas Valuable to You

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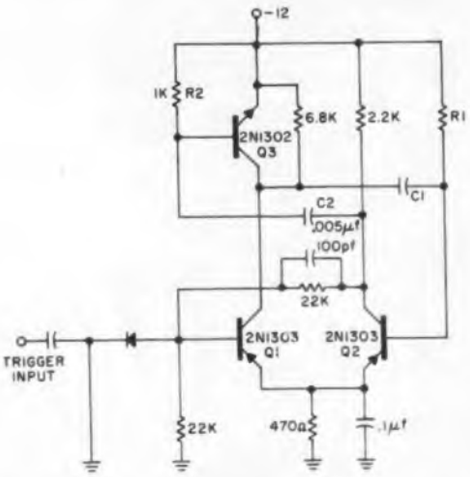
Choose the Ideas which suggest a solution to a problem of your own or stimulate your thinking or which you think are clever.

The Ideas chosen as the most valuable in each issue will be eligible for the $1,000 Idea of the Year award.

So vote for the Ideas you find most valuable. And, after you've voted, why not send in an Idea of your own?

Extra Transistor Reduces Turn-Off Time in One-Shot Multi 747



Rapid turn-off times are obtained in this monostable multi by using transistor Q_3 to help discharge timing capacitor C_1 at the end of the pulse period.

Turn-off time of a monostable multi can be reduced considerably by adding a transistor to regeneratively discharge the timing capacitor at the end of the pulse period. The circuit, shown in the figure, has operated with rise and fall times of 0.1 to 0.2 μsec on pulse widths of 1 μsec to 15 msec.

In the conventional multi, the fall time on the output collector depends on both the load resistor and the timing capacitor. If the unit is recycled before the capacitor is discharged to its quiescent condition, the pulse width will no longer remain constant. The new pulse width will depend on the amount of charge the capacitor still holds.

At the end of the pulse period, the voltage on the collector of Q_1 decreases, while the collector voltage of Q_2 increases. The R_2C_2 combination differentiates the positive-going voltage and applies it to the base of Q_3.

As Q_3 conducts, the left-hand side of C_1 is forced towards the −12-v supply—the quiescent condition.

The differentiating circuits are adjusted to completely discharge C_1, thus preparing the multi for recycling. In addition, the circuit can maintain both long output pulse periods and short turn-off times without having to increase the value of R_1.

Robert W. Allington, Engineer, Ampex Instrumentation Products Co., Redwood City, Calif.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 747.

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.

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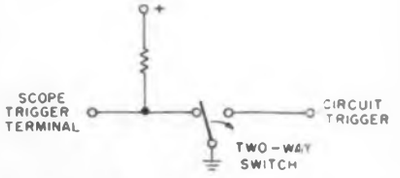
IDEAS FOR DESIGN

Mechanical Switch Triggers Scope, Helps Center Display 745

The one-shot operation of a slow-speed circuit had to be observed on an oscilloscope. It was necessary to delay the operation of the circuit with respect to the scope trace in order to center the display.



Plunger switch triggers scope trace, then, after several milliseconds delay, triggers the circuit whose output is to be observed. Output waveform is thus centered on scope display.

A mechanical, two-way switch was used to first trigger the sweep and then trigger the circuit, whose output was connected to the scope's vertical deflection plates. The time for the switch to move between its two positions was on the order of milliseconds. This was sufficient time for the trace to move to a convenient position on the screen.

The switch, an ordinary plunger-type light switch, was connected as shown in the figure. Initially, the scope trigger is grounded via the switch. The instant the plunger leaves the scope contact, the trigger terminal is made positive through resistor R, thus triggering the trace. During the time the plunger is traveling between its contacts to trigger the one-shot circuit, the trace moves to a more central position on the screen.

D. J. Grover, Design Engineer, Remington Rand Univac, Bluebell, Pa.

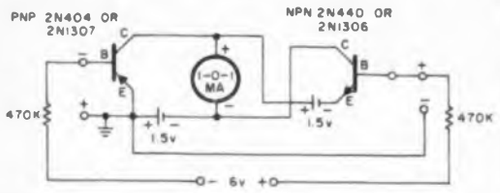
If this Idea is valuable to you, give it a vote by circling Reader-Service number 745.

Current Amplifier Increases Null Meter Range 737

A meter-indicating device to respond to ± 5 v was needed, and needed quickly. No instrument was on hand that could handle such voltages.

The problem was solved by using a pnp and an npn transistor as a current amplifier to drive a center-zero 1-ma meter which was available.

The resultant circuit, shown in the figure, worked very well. No switch is required for the batteries, since, when the initiating voltage is removed, battery current is only a few



Range of 1-ma center-zero meter is increased by driving it with transistorized current amplifier. Circuit was used to indicate ±5-v levels.

microamperes. The device could also be used as a tuning meter for an fm receiver.

L. C. Pochop, Electronic Engineer, U. S. Naval Ordnance Laboratory, Corona, Calif.

If this idea is valuable to you, give it a vote by circling Reader-Service number 737.

Modified Formula Helps Calculate Q More Accurately 744

When measuring the Q of large capacitors on a Q-meter it is necessary to use the series method and the formula:

$$Q_x = \frac{Q_1 Q_2 (C_2 - C_1)}{Q_1 C_1 - Q_2 C_2} \qquad (1)$$

Where: Q_1 is the initial Q reading.

C_1 is the initial capacitance reading.

Q_2 is the reading with the unknown in the circuit.

C_2 is the capacitance reading with the unknown in the circuit.

The C_1Q_1 and C_2Q_2 products are often very large and their difference very small. This results in large errors of the final calculated Q. By making the following operations on the formula, the accuracy of the calculation can be considerably improved.

Working with the denominator only:

$$\Delta Q = Q_1 - Q_2 \qquad (2)$$

$$\Delta C = C_2 - C_1$$

$$Q_1C_1 - Q_2C_2 = Q_1C_1 - [(Q_1 - \Delta Q)(C_1 + \Delta C)]$$

$$= Q_1C_1 - (Q_1C_1 - \Delta QC_1 + Q_1\Delta C - \Delta Q\Delta C)$$

$$= \Delta Q(C_1 + \Delta C) - Q_1\Delta C$$

Q_x then becomes:

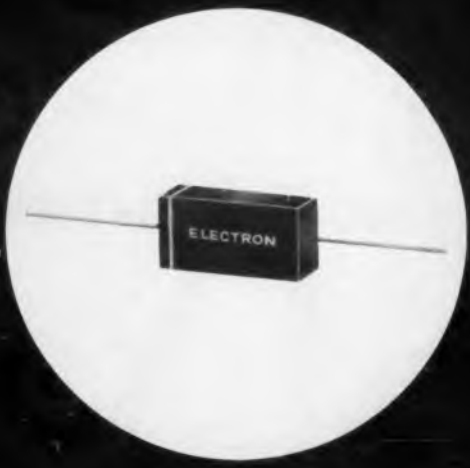
$$Q_x = \frac{Q_1 Q_2 \Delta C}{\Delta Q(C_1 + \Delta C) - Q_1 \Delta C} \qquad (3)$$

The effect of this rearrangement is to remove the large Q_1C_1 product so that the required difference is taken between smaller numbers.

Marvin C. Kerber, Engineer, AVCO Corp. Electronic and Ordnance Div., Cincinnati, Ohio.

If this idea is valuable to you, give it a vote by circling Reader-Service number 744.

Electron Products | BW and BWE
High Voltage Capacitors



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Dissipation Factor:	1.0% max. @ 25°C
Test Voltage:	200% of rated voltage

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Narrow-Band Filter Relies On Demodulating Circuit 749

A novel narrow-band filter was designed which operates by synchronously demodulating the input signal, filtering the resulting dc voltage and then remodulating at the desired frequency. The output signal is a square wave with zero phase shift.

The fundamental frequency is fixed by a square-wave reference signal which helps to demodulate and remodulate the input. This reference does not affect the phase or frequency of the filtered signal.

Operation of the filter can be described by referring to the basic circuit, (a).

With the input and reference signals in phase, and the signal polarity positive, the double-pole relay will be in the position shown. During this first half cycle capacitor C_1 charges positively.

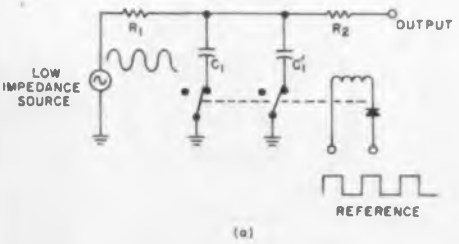
During the second half cycle, when the relay is de-energized, C'_1 charges negatively. The cycle is then repeated until the capacitors are charged to the peak value of the input signal.

The time required to achieve this peak charge depends on the time constants R_1C_1 and $R_1C'_1$. In turn, this determines the bandwidth of the filter.

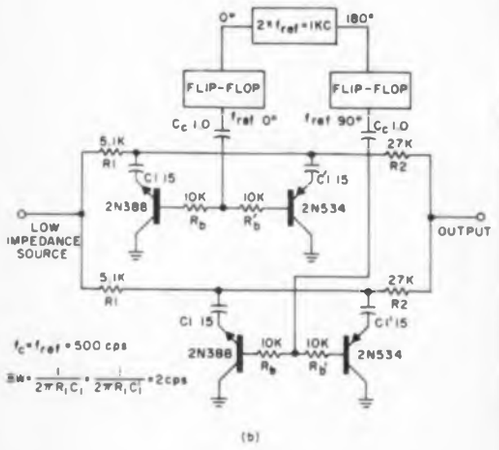
The output signal is obtained by alternately reading the charge voltage of C_1 and C'_1 through a large resistance, R_2. The output signal is, therefore, a square wave with a frequency and phase that is identical to the input signal.

The complete synchronous filter is shown in (b). Circuit parameters are for a center frequency of 500 cps.

A second section is paralleled to the basic circuit, with the reference signal of this section shifted 90 deg in phase. This eliminates



(a) Basic circuit of narrow-band filter indicates how square-wave reference is used to help demodulate input signal. Output signal is obtained by alternately reading the charge voltages on the capacitors.



(b)

(b) Complete filter schematic gives parameters for fundamental output frequency of 500 cps.

the need for a particular phase relationship to exist between the input signal and the reference. The reference frequency need only be close enough to the input signal frequency so that they are both within the filter bandpass.

The 90-deg phase shift is achieved by dividing a reference signal at twice the desired frequency. The output of the two multivibrators are 90 deg apart since their inputs are 180 deg apart.

Other methods for obtaining the 90-deg phase shift may be used; the choice will depend on the particular filter application.

The double-pole relay of (a) has been replaced by npn and pnp switching transistors. The transistors are used in the inverted connection to reduce the offset voltage.

In addition to the desired response at 500 cps, the filter has an attenuated response to the odd harmonics of the fundamental and to dc. The third, fifth and seventh harmonics are approximately 10, 14 and 17 db below the center frequency.

Additional rejection to the off frequencies can be obtained with broad-band RC filtering if desired. The magnitude of off frequency rejection is determined by the offset voltage developed by the switching transistors. The transistors used provided 40-db rejection with no selection of units.

Glen W. Ashley, Senior Research Engineer, Convair, Pomona, Calif.

If this idea is valuable to you, give it a vote by circling Reader-Service number 749.

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January 4 through June 21

All articles are indexed under one or more of the basic categories listed below:

The kind of article is identified by the following reference keys:

ART	Article (bylined by an authority)
DD	Design Decision
DIG	Digest
DYF	Designing Your Future
ED	Engineering Data
EDN	Electronic Design News
GA	German Abstract
IFD	Idea for Design
PF	Product Feature
RT	Russian Translation

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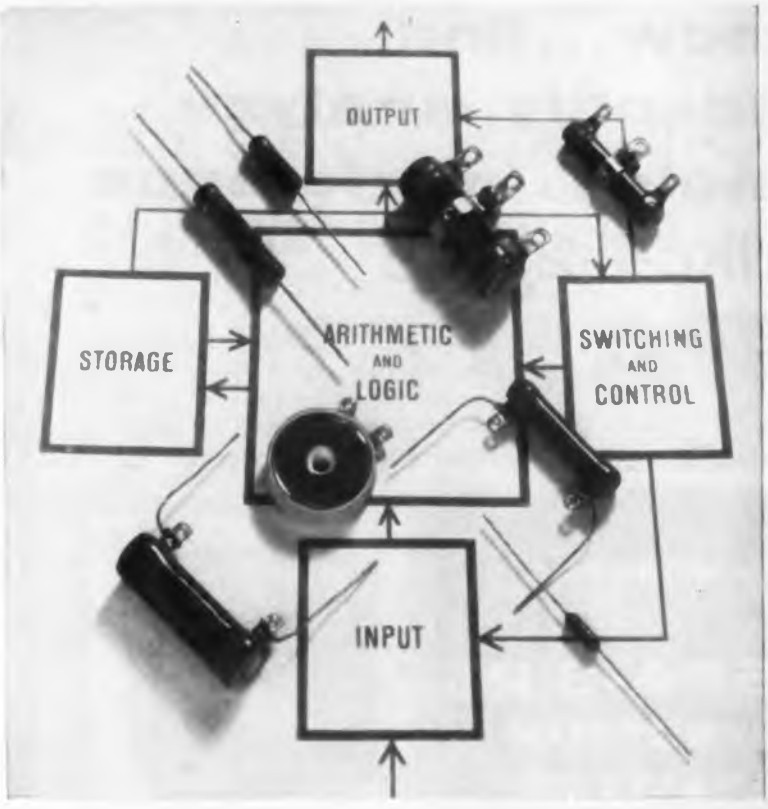

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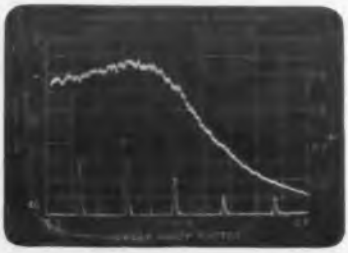
3. enables fast, reliable detection of comparatively low level discrete signals present in random spectra through use of adjustable narrow IF bandwidths and correlation techniques

4. allows identification and subsequent analysis of dynamic characteristics of modulated signals and noise.



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Center frequency: Variable, calibrated from 0 to 23.5mc
Markers: crystal controlled, 500kc and harmonics to 25mc
Resolution: Variable, 200 cps to 30 kc
Sweep rate: Variable, 1 cps to 60 cps
Amplitude Scales: 20 db linear, 40 db log, 10 db square law (power)
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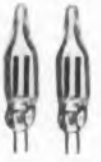
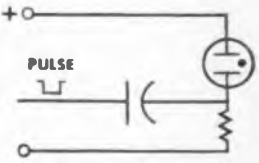
4 ways to use

General Electric Glow Lamps as Circuit Components

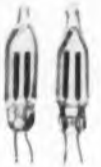


G-E NE-96 G-E NE-97

1. As a MEMORY DEVICE, because of the differential between starting and operating voltages. Both the General Electric NE-96 and NE-97 are well suited for switching circuits and counters where they can function as transfer elements and as indicators of state or sequence.

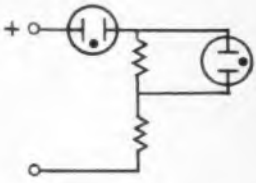


G-E Glow Lamp used in Memory Circuit



G-E NE-76 G-E NE-81

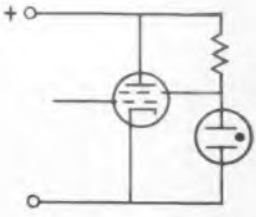
2. As a VOLTAGE INDICATOR, because of their critical starting voltage. The G-E NE-76 and the NE-81 are stabilized and selected for close tolerance on starting voltage. Both find use in gating circuits, logic matrices, switching circuits or as an indicator of input or output levels.



G-E Glow Lamps as Multiple Voltage Indicators

G-E NE-68 G-E NE-80

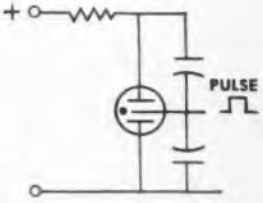
3. As a VOLTAGE REGULATOR, because of their constant operating voltage range. The General Electric NE-68 and its "first cousin", the G-E NE-80 (closer tolerance), function effectively wherever voltage regulation is required. (Glow Lamps for higher current applications are also available.)



G-E Glow Lamp used as a Voltage Regulator

G-E NE-77

4. As a TRIGGERED SWITCH. A low current signal applied to the trigger (third electrode) starts this lamp, permitting conductance of peak current surges up to 100 m.a. in the power circuit. It can be used in counting circuits or as a control device with photocells, thermostats or moisture sensors in trigger circuit.



G-E NE-77 in a Trigger Circuit

For more information, write for: Specification Sheet #3-092 "G-E Glow Lamps for Circuit Component Use". General Electric Co., Miniature Lamp Dept. M-126, Nela Park, Cleveland 12, Ohio.

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J. George Adashko

Nomograms for Calculating Mismatch Quantities

A RELATION widely used in transmission-line analysis and design is

$$b = \ln \left| \frac{Z + W}{Z - W} \right| \qquad (1)$$

If, for example, Z is the characteristic impedance of a line and W the load resistance, then b is the attenuation due to mismatch. Different definitions of Z and W yield other

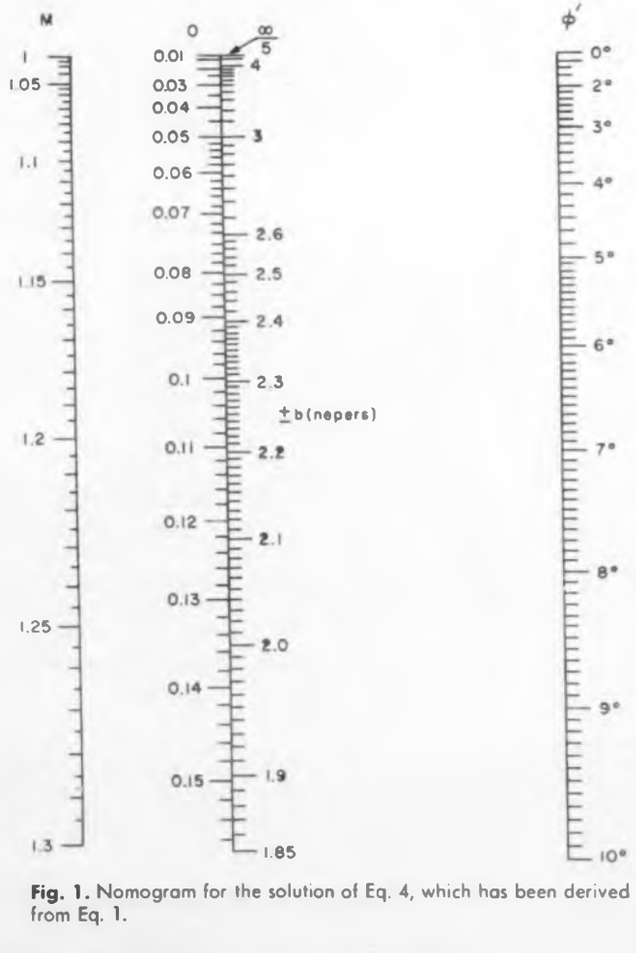

Fig. 1. Nomogram for the solution of Eq. 4, which has been derived from Eq. 1.

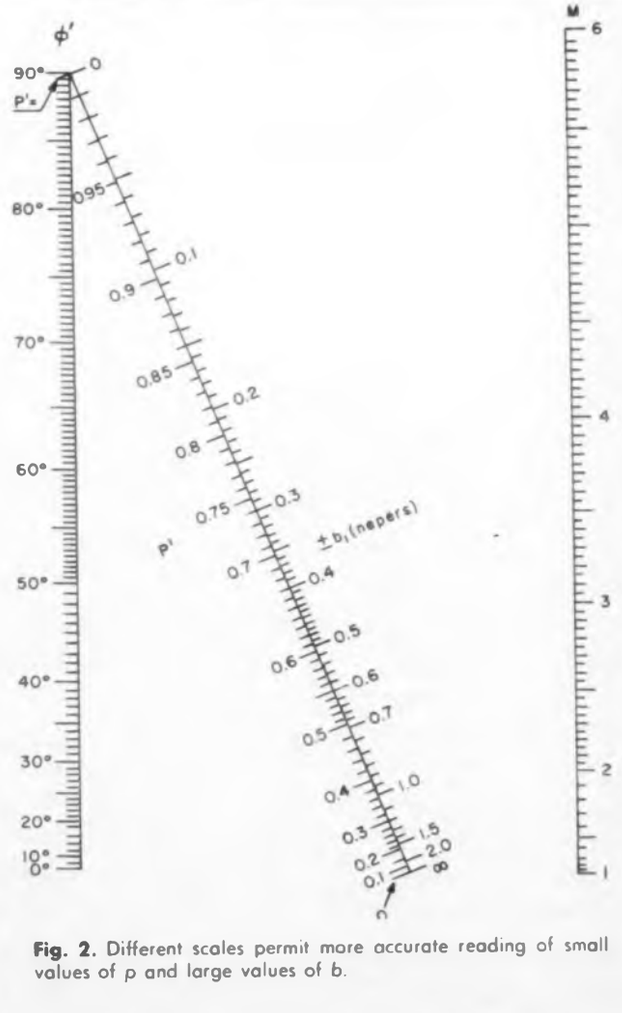

Fig. 2. Different scales permit more accurate reading of small values of p and large values of b.

meanings to the quantity b.

When Z and W are real, the use of Eq. 1 is straightforward and entails no difficulty. Manipulation of complex quantities, however, is cumbersome. Circle diagrams used for the purpose are neither too convenient nor very accurate.

The nomograms presented here are free of these shortcomings, and also offer the advantage that they yield the value of the reflection coefficient:

$$p = \left| \frac{Z - W}{Z + W} \right| \qquad (2)$$

The Nomograms

It is shown in the Appendix that Eq. 1 can be transformed into the equation:

$$\coth b = \frac{\cosh \ln M}{\cos \varphi} \qquad (3)$$

while Eq. 2 can be changed to:

$$\frac{1}{\cos 2 \arctan p} = \frac{\cosh \ln M}{\cos \varphi} \qquad (4)$$

where

$$M \angle \varphi = \frac{Z}{W} \qquad (5)$$

or

$$M \angle \varphi = \frac{W}{Z} \qquad (6)$$

depending upon the magnitude.

A nomogram for Eqs. 3 and 4 is easy to construct. And, since the right halves of these equations are identical, the nomogram for b can be combined with that for p to save space. Such nomograms are shown in Figs. 1 and 2. The difference between the two nomograms is that with one more accurate readings of small values of p and large values of b are possible.

Each nomogram consists of three scales. The M scale ranges from 1 to 6. This range determines which of the equations, 5 or 6, to use. Instead of using a scale for the angle φ, a scale is provided for an auxiliary quantity φ'. The quantities b and p are read from the same scale—the right side shows the values of the attenuation b, while the divisions on the left indicate an auxiliary quantity p'.

The significance of the auxiliary quantities is as follows:

(a) If

$$\varphi = \pm \varphi'$$

then

$$b > 0$$

and

$$p = p'$$

(b) If

$\varphi' = 180° - |\varphi|$, that is, if $|\varphi| > 90°$,

(continued on p 160)

RUSSIAN TRANSLATIONS

(continued from p 158)

then

$$b < 0$$

and

$$p = 1/p'$$

Example 1

Let us assume we have a line with a characteristic impedance $Z = 600 \angle -40°$, loaded by an impedance $W = 400 \angle 10°$. It is desired to determine the attenuation due to mismatch, b, and the reflection coefficient, p.

We first determine M and φ, using Eq. 5 in this case, to obtain a value of M greater than 1. From Eq. 5 we get:

$$M = 1.5 \text{ and } \varphi = -50°$$

A line joining 1.5 on the M scale with 50° on the φ' scale intersects the middle scale at:

$$b = \pm 0.69 \text{ neper}, \quad p' = 0.506$$

Since $p = p'$, we have:

$$b = +0.69 \text{ neper}, \quad p = p' = 0.506$$

Example 2

Determine the attenuation b and the reflection coefficient p if the line of the preceding example is loaded with an impedance:

$$W = 1{,}200 \angle 70°$$

In this case we use Eq. 6 to determine M and φ, and obtain $M = 2$ and $\varphi = 110°$. Since φ is greater than 90°, we use:

$$\varphi' = 180 - 110 = 70°$$

The line joining 2 on the M scale and 70° on the φ' scale intersects the middle scale at

$$b = 0.285 \text{ neper}, \quad p' = 0.755$$

and, since $|\varphi| > 90°$,

$$b = -0.285 \text{ neper}, \quad p = 1/p' = 1.325$$

Appendix

Consider the function

$$q = \left| \frac{Z + W}{Z - W} \right|$$

where

$$q = e^b \qquad \text{(a)}$$

in the case of Eq. 1, and

$$q = 1/p \qquad \text{(b)}$$

in the case of Eq. 2.

We denote

$$e^{\xi} = \frac{Z}{W} = M \angle \varphi \qquad \text{(c)}$$

Then

$$\xi = \ln \sqrt{Z/W} = \frac{1}{2} \ln M \angle \varphi = \frac{\ln M + j\varphi}{2}$$

and

$$q = \left|\frac{M\angle\varphi + 1}{M\angle\varphi - 1}\right| = \frac{e^{2\xi}+1}{e^{2\xi}-1} = \left|\coth\ \xi\right| = \tag{d}$$

$$\left|\coth\ \frac{\ln M + j\varphi}{2}\right|$$

But

$$\coth\ \frac{x + jy}{2} = \frac{\cosh x + \cos y}{\sinh x + j \sin y}$$

Therefore

$$q = \left|\frac{\cosh \ln M + \cos\varphi}{\sinh \ln M + j \sin\varphi}\right| = \frac{\cosh \ln M + \cos\varphi}{\sqrt{\sinh^2 \ln M + \sin^2\varphi}}$$

and since

$$\cosh^2 x - \sinh^2 x = 1$$
$$\cos^2 x + \sin^2 x = 1$$

we get

$$q^2 = \frac{\cosh \ln M + \cos\varphi}{\cosh \ln M - \cos\varphi}$$

or

$$\frac{q^2 + 1}{q^2 - 1} = \frac{\cosh \ln M}{\cos\varphi} \tag{d}$$

Substituting into this expression the value of q from Eq. a we get

$$\coth b = \frac{\cosh \ln M}{\cos\varphi} \tag{e}$$

Putting

$$\tan\alpha = p,$$

substituting this value of p into Eq. d, instead of $1/q$, and using Eq. 6, we obtain

$$\frac{1}{\cos 2 \arctan p} = \frac{\cosh \ln M}{\cos\varphi} \tag{f}$$

It is easy to verify that the same results, e and f, are obtained if we use instead of a

$$\frac{W}{Z} = M\angle\varphi \tag{g}$$

Thus, to determine M and φ we can use either e or g. We can therefore restrict ourselves in the nomogram to values of M either greater than or less than unity, thus improving the accuracy of the readings.

It is obvious that the numerator of the right half of e is positive for any positive value of M, and the denominator is positive for $|\varphi| < 90°$ and negative for $|\varphi| > 90°$. Consequently b is positive when $|\varphi| < 90°$ and negative when $|\varphi| > 90°$.

It is seen analogously that, for any value of M, $p > 1$ for positive b and $p < 1$ for negative b.

Translated from Kh. I. Cherne, Nomograms For The Calculation Of Mismatch Quantities, Elektrosvyaz' (Electric Communication) *No. 11, 1960, pp 71-74.*

GERMAN ABSTRACTS

E. Brenner

Drift In Direct-Coupled Amplifiers

THE amplification of signals whose dc level is to be preserved, (or the amplification of low-frequency signals) can be achieved either with direct-coupled amplifiers or with frequency translation. Using direct-coupled amplifiers with vacuum tubes, drift, as well as flicker noise problems arise.

Supply voltage variations can be compensated for by various schemes in which pairs of tubes are used to nominally cancel the errors.

Cathode drift occurs only with signals having a dc component. This drift, probably caused by cathode surface impurities, consists of a gradual decrease with time in cathode current. Referred to the plate, the order of magnitude of the drift effect corresponds to a change in plate voltage of about 1 μv/sec. In multistage amplifiers this effect may become large enough to require compensation.

One method for compensating cathode drift is indicated in Fig. 1. Zero-signal output variations are corrected for by periodically charging the capacitor to the output voltage with the input removed. The use of push-pull circuits, however, not only reduces drift more effectively, but also allows the circuit to be available continuously.

In the push-pull circuit, Fig. 2, drift corresponds to an "in-phase" current change in both cathodes. The heavy feedback minimizes the effect at the output. To be effective, the cathode resistor must be large, so that negative supplies are generally required.

The effect of drift can, in principle, be completely eliminated by modifying the circuit as indicated in Fig. 3. Here, the two poten-

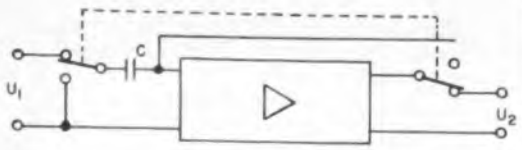

Fig. 1. Switching method of drift compensation.

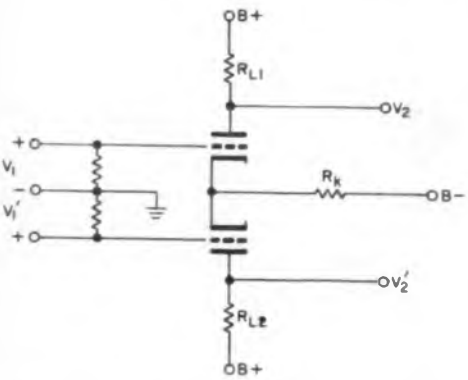

Fig. 2. In push-pull circuit drift corresponds to an "in-phase" change in both cathodes.

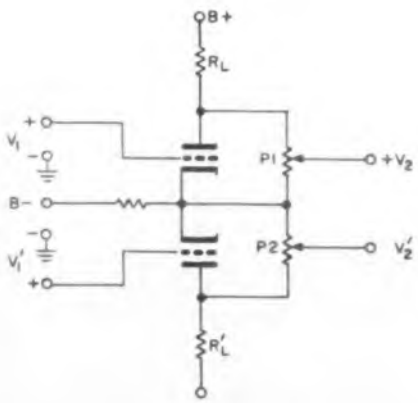

Fig. 3. Compensated push-pull circuit for eliminating drift. The potentiometers *P1* and *P2* can be adjusted so that the output voltage is independent of drift.

tiometers, *P1* and *P2*, are adjusted to eliminate the drift. In practice the two tubes should have similar drift characteristics, as well as proportionality between fluctuations in cathode and plate currents. For this reason triodes are preferred to pentodes.

The original paper also cites a variety of push-pull circuits. A resume' of other problems connected with dc amplifiers is presented and experimental results dealing with stable amplifiers are given.

Abstracted from an article by H. L. Koening, Archiv der Elektrischen Uebertragung, *Vol. 14, No. 12, Dec. 1960, pp 543-553.*

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REPORT BRIEFS

Cascode Distributed Amplifier

The use of triodes in cascode permits extremely wide band amplification. A cascode amplifier using 2C39A triodes as the active elements, was constructed and tested. A general procedure for synthesizing constant resistance grid lines for distributed amplifiers employing cascode or pentode active elements is presented. *Cascode Distributed Amplifier, Clement A. Skalski, Army Signal Research and Development Laboratory, Fort Monmouth, N. J., May, 1959, 34 pp, Microfilm $3.00, Photocopy $6.30. Order PB 150704 from Library of Congress, Washington 25, D. C.*

Delay Techniques

A review is given of important parameters of delay devices, presently used techniques, future requirements of ground electronic systems, and potential new mechanisms for achieving delay, primarily in the frequency range above 1 mc. Carrier frequency techniques employing propagation of both electromagnetic and acoustic waves in solid and gaseous media are reviewed. Circulator and other techniques are discussed as well as periodic delay and amplification structures. *A State-Of-The-Art Survey Of Delay Techniques, Joseph B. Brauer and Kenneth C. Striefvater, Rome Air Development Center, Griffiss AFB, N. Y. Sept. 1960, 47 pp, $1.25. Order PB 171420 from OTS, Washington 25, D. C.*

Phase-Lock Receivers

The characteristics required of a phase-lock tracking receiver under adverse reception conditions are analyzed. It is shown that for constant sensitivity of the phase-lock circuits, the use of a cross-correlation-type avc circuit is essential. It is also shown that either the use of extensive degeneration in the if circuits or the use of common channels is essential for minimizing phase errors. The transfer characteristic required for optimum tracking characteristics is derived, and a possible method for obtaining them described. *The Dynamic Characteristics of Phase-Lock Receivers, Keats A. Pullen, Jr., Ballistic Research Laboratories, Aberdeen Proving Ground, Md., Jan., 1960, 74 pp, Microfilm $4.50, Photocopy $12.30. Order PB 150066 from Library of Congress, Washington 25, D. C.*

Autocorrelation of Binary Codes

To get good range resolution from a long-pulse radar, it is necessary to increase the bandwidth of the pulse in some manner. One technique, first proposed by Siebert, is to subdivide the pulse into interval 0 or π according to some coding scheme. This report gives the results of an experimental search for phase codes with good autocorrelation functions. Thus the ambiguity function only along the zero Doppler axis ($\omega = 0$) is examined. *Experimental Autocorrelation of Binary Codes, D. F. DeLong, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass., Oct., 1960, 12 pp, Microfilm $2.40, Photocopy $3.30. Order PB 152974 from Library of Congress, Washington 25, D. C.*

Microwave Modulator

Experiments have been conducted in which a rod of germanium is inserted in a waveguide parallel to the direction of the electric field. Upon exposure to light or the injection of minority current carriers by means of a pn junction, the conductivity of the semiconductor is changed. The changes in conductivity, in turn, cause variations in the absorption of microwave energy. This effect has been designed into a device that offers the possibility of microwave amplitude modulation. *A New Semiconductor Microwave Modulator, H. Jacobs, F. A. Brand and others, Army Signal Research and Development Laboratory, Fort Monmouth, N. J., May 16, 1960, 28 pp, Microfilm $2.70, Photocopy $4.80. Order PB 153001 from Library of Congress, Washington 25, D. C.*

FM Receivers

Specifies a method for testing frequency-modulation communication receivers for their susceptibility to jamming. The method consists of five standard tests, the results of which permit a good appraisal of the performance of a receiver under jamming conditions. To facilitate rapid evaluation of the test results, a method of assigning numerical scores to the various test results has been developed and is included. *Specification For Methods of Evaluating The Susceptibility of FM Communications Receivers, D. Beaubien, E. Browne and others, General Electronic Laboratories, Inc., Cambridge, Mass., Sept., 1959, 29 pp, Microfilm $2.70, Photocopy $4.80. Order PB 153241 from Library of Congress, Washington 25, D. C.*

LETTERS

More on Bionics and Artron

Dear Sir:

Your article in the Sept. 14 issue "Electronics Learns from Biology" is a highly interesting and informative survey on bionics, in terms of activity at WADD and other research laboratories. I applaud both the article and the editorial. Also, I would like to join van Bergeijk (p 43 of the article) in adoption of the suffix -mime as a generic term for analogues of biological systems.

I was certainly pleased with the review of my Artron model as it appeared in the article. In the interest of rounding out a more complete picture of the model, as well as to help clarify the concept, I would like to comment on the article, and to make some additional observations.

The Artron is a neuron-analogue, a portion of which is breadboarded, but the entire working system is not yet built. It is primarily a logical and mathematical model. Using van Bergeijk's terminology, the Artron may be classed as a neuromime; Artron remains a particular designation of the nerve-like unit, however . . .

All 16 logic states and the delay values of the Artron (p 44 of the article) are initially variable. Then, as a result of learning, a particular combination of logic and delay (from the *a* and *b* inputs to the *c* output) will be developed in each Artron. Incidentally, the twelfth state, listed to the right of the illustration of the Artron model, should have been *a or not b* instead of *a and not b*, and the legend "Network Outlets" should have been "Network Outputs." The reward and punish signals come in parallel from the "Goal Circuit" to the reward and punish input channels of all Artrons. Connections from the "Sensors" or from the Artron *c* channels to the Artron *a* or *b* channels or to the "Network Outputs" can be random or systematic.

According to the article (p 43), the reward and punish inputs of the Artron "correspond to the excitatory and inhibitory inputs of the Bell Labs and other neuron simulations." As a matter of fact, the comparison is rather strained, but a closer correspondence would perhaps exist if the comparison had reference to the *a* and *b* inputs of the Artron rather than to its reward and punish inputs. The *a* and *b* inputs can produce or inhibit an output signal at *c* depending on which of the 16 states and

delay values are in effect, whereas the reward and punish inputs control the probability that associated states and delay values will remain and recur.

Concerning unspecialized goals of the Artron model, the phrase "as goals are specified during the course of learning" occurs in the article (p 44). Actually, goals can be entirely specified *before* the model is put on its own in a learning situation. These can establish criteria for adaptation to a wide range of environments and to unforeseen factors in the environments, with the goals themselves remaining fixed rather than being specified during learning. Examples of this (pattern recognition and maze solving), given in the article (p 45), both utilize the unspecialized fixed goal of keeping a battery charged. In solving a problem requiring generalized learning ability, the machine with fixed goals can be completely independent of any human operator.

In addition to having unspecialized fixed goals, it is possible for more advanced versions of the Artron system to develop specialized goals autonomously. These goals would be specified *by the machine itself* during learning, not requiring any human participation to specify them. For autonomous goal development, however, the "Goal Circuit" shown in the illustration (p 44) should contain adaptive elements, or should be affected by output channels from the Artron network as well as by the "Trial and Error Feedback".

The uppermost arrow in the illustration should go from the "Signaling, Display, or Control Equipment" block to the "Environment" block, rather than from the latter to the former. The Artron model can interact with the environment, rather than just monitoring it.

Among the objectives of developing the Artron and the various other neuromime models are (1) pattern recognition or perception by machine, (2) versatile automata that can solve problems without being told how, and (3) understanding the significance of individual neuron functions. Altogether, the neuromimes and biological sensory analogues described or mentioned in the article are contributory to a growing field.

The article states that I am affiliated with Melpar, Inc. Although this was the case at the time the article was written, I am now with Adaptronics, Inc.

Robert J. Lee
Vice President Research
Adaptronics, Inc.
Springfield, Va.

YOUR CAREER

NEWS AND NOTES

New graduate awards have been announced by the General Electric Co. for electrical engineers at the University of Arizona. Two candidates, to be selected by GE's Computer Dept. in Phoenix, will each receive $2,500 plus tuition and fees for MS work related to computer engineering. This program is in addition to a $2,500 GE Honor Program, established at the University of Arizona in 1957. The Honor Program awards $2,000 yearly for a PhD candidate in electronic digital computers and $500 for purchase of the candidates' project research equipment by the university.

* * *

Hyman barriers to research are being lowered at the University of Pennsylvania's new Materials Research Laboratory. The laboratory, which is expected to contribute to the understanding of the properties of semiconductors, will be populated by 20 professors and 90 graduate students. It will, says the University's President, Dr. Gaylord P. Harnwell, bring together chemists, physicists, electronic engineers and others who can contribute to the basic exploration of the structure of matter and will house them so that they cannot help but mingle.

* * *

Been doing your finger exercises? The following aptitude requirements were listed as necessary for electronic engineers in a New York State Dept. of Labor report on manpower requirements in the New York metropolitan area:

"An electrical engineer [there was no category for electronics] needs above-average intelligence. He must be good at figures and able to express his ideas verbally. He should enjoy abstract and creative work, be able to generalize and make decisions, and have good judgment. He should be able to visualize forms in two and three dimensions and perceive correct detail in objects or drawings.

"Good vision is required to see fine drawings and small parts, and deft use of hands is necessary for making notations and drawings and for manipulating a slide rule."

Other information in the report: There are now 4,900 engineers in the metropolitan New York electronics industry. By 1964, it is predicted, there will be a 45 per cent increase to 7,100.

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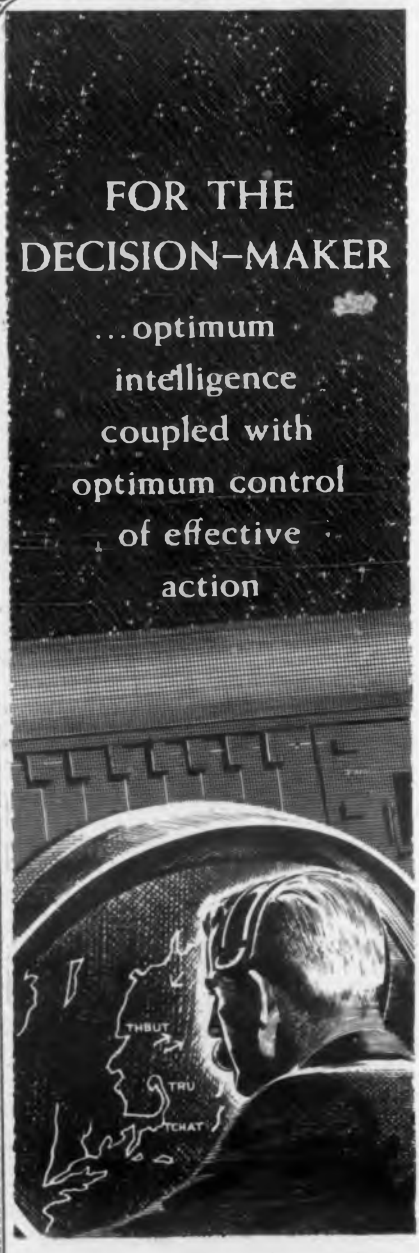

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301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	581	591
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	572	582	592
303	313	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
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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

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 AUGUST 2nd, 1961

Name _____ Title _____

Company _____

Company Address _____ City _____ Zone _____ State _____

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290
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
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