ELECTRONIC DESIGN

MARCH 1, 1961

Bridge calibrates ultrahigh resistances . . . p 86

1961 IRE show march 20-23

Counter features display storage . . . p 78

Pencil tube with integral cavity . . . p 80

Standard accurate to 1 sec in 750 years . . . p 76

	2N756-2N760 TO-18 PACKAGE	
Min BV_{CEO}	45v	not guaranteed
Min BV_{EVO}	6v	1v
Min. $F_{\alpha b}$	30mc	1mc
Max I_{CBO}	0.2μa	2.0μa
Max C_{ob}	8μμf	30μμf
h_{fe} vs Temp	Excellent	Poor
h_{fe} vs I_C	Excellent	Fair

2N756 SERIES SILICON MESA TRANSISTORS

Designed for general purpose applications where compactness, performance and reliability are musts, National Semiconductor's 2N756 series in the smaller TO-18 package simplifies circuit design while out-performing the obsoleted grown junction type.

For detailed information and technical data, write:

National Semiconductor CORPORATION

P.O. Box 443, Danbury, Conn. • Pioneer 3-7624 • TWX DANB 452-U

See Us at IRE Booth 1929

CIRCLE 1 ON READER-SERVICE CARD

COVER: A portend of this month's big event for engineers: the shuffle and scuffle of restless feet, winding between row upon row of new products at the IRE Show.

Selected Topics In This Issue

ELECTRONIC DESIGN · ONE DAY SERVICE

USE BEFORE APRIL 12th, 1961

A

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
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ELECTRONIC DESIGN · ONE DAY SERVICE

USE BEFORE APRIL 12th, 1961

B

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hp at IRE

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in science, the defense effort, and industry is dependent on precise measurements, made swiftly, surely, repeatedly. hp seeks to engineer into every instrument and system a genuine contribution to the art of measurement, plus the quality and dependability that has made hp instruments, for over 20 years, the exceptional value in electronic measuring equipment.

Lift this flap for **34** *time-saving, convenient, new instruments. Many are solid-state devices*

RACK 'EM UP—STACK 'EM UP

New, and only from hp

UNIVERSAL MODULAR INSTRUMENTS

Lightweight, portable bench instruments, or neat, clean, compact rack equipment—it's all one in the universal packaging concept developed for new hp instruments. Instruments mount in module multiples of one, two or three per rack-width; fit 24" two-sided racks back-to-back, or stack and nest neatly, firmly, one above the other, on your bench. Zip-off covers for unmatched service accessibility. See, at I.R.E., how much space and time you'll save!

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

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LIFT PAGE

6956C

Circle 3 on Reader-Service Card ▶

Achievement for your measuring progress —

New Frequency/Time Standard Systems Allow Precise Comparison With HF, VLF Standard Broadcasts

■ New ϟ 104AR Quartz Oscillator. Electronics' most ultra-modern precision oscillator, $1/10^{10}$ typical short term stability, high spectral purity, $3,250.00.

■ New ϟ 114BR Time Comparator. Allows time comparison without changing clock setting, $1,200.00.

■ New ϟ 724BR, 725AR Standby Power Supplies. Automatically assume load and warn when ac power fails, continuous operation assured, ϟ 724BR, $850.00, ϟ 725AR, price on request.

■ Improved ϟ 113BR Frequency Divider and Clock, $2,750.00.

■ Auxiliary equipment for HF or VLF comparison: ϟ 523CR Electronic Counter, ϟ 103AR Frequency Standard, ϟ 560A Printer/Recorder, ϟ 120AR Oscilloscope.

Still more versatility for hp high speed counters with these new p

ϟ 525C Frequency Converter. Plug-in for ϟ 524C/D Counters, permits measurement to 500 MC with counter accuracy. ϟ 525C, $425.00.

ϟ 526D Phase Measuring Unit. Plug-in for ϟ 524C/D Counters, gives 0.1 μsec resolution 10 cps to 20 MC, reads 400 cycle phase shift directly in degrees. ϟ 526D, $750.00.

New Oscilloscopes, Power Supplies, Oscillators, Voltmeters, Pulsers and Current Measuring Instruments Speed Your Audio-Video Work

ϟ 185B Oscilloscope. 1,000 MC all-purpose, "ultimate" oscilloscope, now with extended low frequency response. Price on request.

ϟ 215A Pulse Generator (not shown) produces fast rise-time pulses for computer, tunnel diode analysis. 1 nanosecond rise time, 1 MC rep rate. Price on request.

ϟ 170A 30 MC Oscilloscope. Multi-purpose vertical and horizontal plug-in versatility designed to MIL specs for high dependability. Easiest to use and calibrate. $2,150.00

ϟ 160B 15 MC Oscilloscope. Militarized, rugged, has same multi-purpose vertical and horizontal plug-in versatility of 170A. Beam finder, sure triggering for easy operation. $1,850.00.

2 Vertical, 3 Horizontal Plug-Ins for ϟ 160B, 170A Oscilloscopes.

New ϟ 166B Time Mark Generator joins other horizontal plug-ins: ϟ 166C Display Scanner for making recordings and ϟ 166D Sweep Delay Generator. Vertical plug-ins include ϟ 162A Dual Trace Amplifier, and new ϟ 162F Fast Rise Amplifier.

ϟ 723A Power S
output, program
duces precise re
components test
inet. $225.00.

ϟ 726AR
grammab
put. Incl
circuit g
under te

ϟ 428B Clip-o
1 ma to 10 amp
probe clips arou
circuit. Meter rea
ac. Recorder sc
cps for hum, noi

ϟ 457A AC-to-
bles usefulness
or digital dc volt
± 0.001 v, 50 cps
modular design

ϟ 413A DC Null Indicator. Highly s
reading dc voltmeter developed from p
ohmmeter. $350.00.

ϟ 204B Portable Oscillator. Floating
below or isolated from ground. Transi
stable output from turn-on. 5 cps to 50

ϟ 405BR/CR Digital Voltmeters. Au
struments, jitter-free, in-line readout, floa
to 999 v dc. ϟ 405BR, $850.00. ϟ 405CR,
output. $925.00.

– 34 new instruments to speed, simplify your scientific work!

5512A, 300 KC
In-line readout, $1,175.00

5532A, 1.2 MC
In-line readout, $1,550.00

4 New Transistorized Counters Give Continuous Display; Wide Temperature Range, 3½" High

Continuous display holds while counter making count, only changes when count changes, no "blinking."

- Four-line binary code (1-2-2-4) output.
- Measure frequency, phase angle, drift.
- Solid state dependability.
- Wide ambient temperature tolerance, −20 to +65° C.
- New universal module cabinets: portable, easy-to-stack bench instruments or sleek, space-saving rack mounting.

5212A, 300 KC
Columnar readout, $975.00

5232A, 1.2 MC
Columnar readout, $1,300.00

w plug-ins

wer Supply. ½ ampere, 40 v
grammable remotely, pro-
se repeatable voltages for
testing. New module cab-

26AR Power Supply. Pro-
mmable 2 ampere, 45 v out-
Includes positive-action
uit guarding transistors
er test. Price on request.

ip-on DC Milliammeter.
amps full scale unique
around wire, doesn't load
er reads dc, is unaffected by
r scope output dc to 400
, noise analysis. $550.00.

C-to-DC Converter. Dou-
ness of your conventional
c voltmeter. Accuracy 0.3%,
0 cps to 50 KC. Compact.
esign. Price on request.

ly sensitive, center-scale
om popular 412A Volt-

ating output usable above,
ransistorized, no warmup,
o 500 KC. $275.00.

s. Automatic precision in-
t, floating input, range 0.001
5CR, with recorder, printer

10-nanosecond Resolution Time Measurement!

5275A Time Interval Counter. Measures with 10 nsec accuracy time between two electrical events. Range 10 nsec to 0.1 sec. Rugged, transistorized, universal module cabinet. Price on request. Used with new 101A 1 MC Oscillator (not shown), same precision time base as in 524C/D counters, 100E Frequency Standard. Stability $5/10^{8}$/week.

526A Transistorized Printer. Prints data from two sources, stores information being received while printing previous data; does not "hold off" data source, speeds data acquisition. Accepts BCD, 10-line input codes. Price on request.

New Microwave Power and Standing Wave Ratio Meters

431A Power Meter. Easiest to use, ends "zero chasing" due to time-temperature drift; no zero change when switching ranges. Compact, transistorized, new universal module cabinet, line power or rechargeable battery operation. Quickly, accurately measures 1 μw to 10 mw with new *478A Thermistor Mount* (coaxial) and new *X486A X-band Thermistor Mount* (waveguide), truly temperature-compensated mounts. 431A, $345.00. 478A, $145.00. X486A, $145.00.

415C Standing Wave Ratio Meter, transistorized, incorporates revolutionary *four-times expansion of readings at any point on any scale.* Special circuitry protects bolometers. Recorder output, bolometer checker, line or rechargeable battery operation. Price on request.

New 1 to 4 GC (KMC) Coaxial Microwave Instrumentation

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CONTENTS FOR MARCH 1, 1961 VOL. 9 NUMBER 5

ELECTRONIC DESIGN

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ELECTRONIC DESIGN

NEWS

Push Intensifying for Commercial Altitude Radar

FAA Hears New Proposals, Gets Congressional Inquiries As First Trials of 3-D System Begin at NAFEC

Robert Haavind
News Editor

STEPPED UP efforts to add the third dimension to the air-traffic controller's radar presentation have begun since the mid-air collision of two commercial airliners over Staten Island, N. Y. last Dec. 16.

Informal Congressional inquiries on present traffic control procedures have already been made, ELECTRONIC DESIGN learned. Several electronics companies have also increased efforts to interest the Federal Aviation Agency in tests of systems that might be capable of adding altitude data to air traffic control.

A major step in this direction will be taken this month with the initial tests of a multi-beam, 3-D height-finding radar system near the FAA's National Aviation Facilities Experimental Center, Atlantic City, N. J.

This passive ASHR-1 radar system, built by Maxson Electronics, New York, works in synchronism with a conventional ASR radar now used at airports for range and bearing data. Reflected pulses from the aircraft are split into 90 vertically-stacked beams by the large receiving antenna. Each beam is 120 deg in azimuth, but beam height ranges from 3 milliradians for the lowest to 1.2 deg for the highest beam. Since the lower beams pick up targets at greater ranges, this difference gives the system fairly good resolution to long ranges.

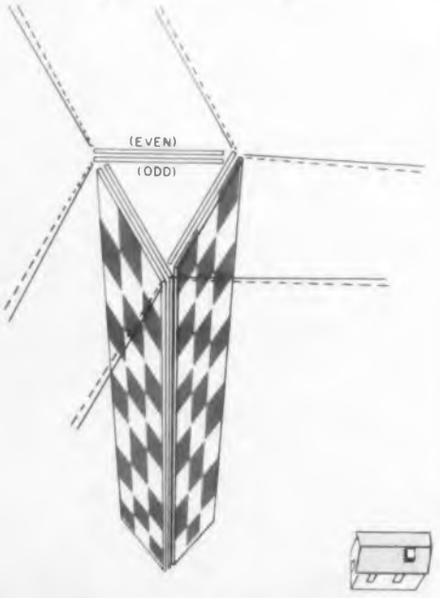
Resolution of the system is 1,000 ft in altitude, although because of a half-beam splitting technique accuracy for a single aircraft is 500 ft. Frequency is from 2700-2900 mc.

Received energy travels through a waveguide and is directed into the proper feed line to a receiver by a directional coupler.

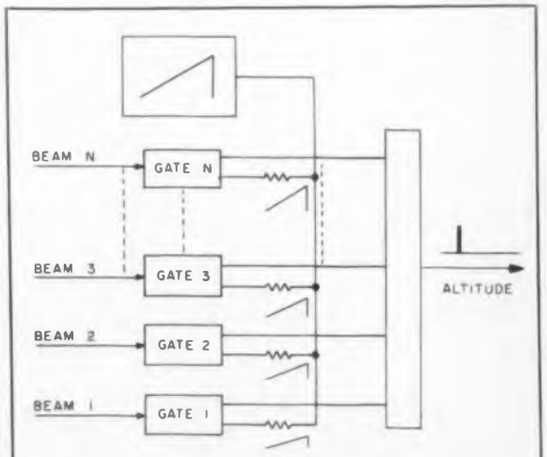
Considerable effort was directed toward solving sidelobe problems in the system design. If signals are received in two adjacent beams, the stronger one is attenuated significantly and compared with the weaker one. A logical decision is then made as to whether the weak signal is a sidelobe return or actually a second aircraft.

Tapered coupling was used in making the directional couplers for sidelobe suppression. Tests have shown that there is some mutual suppression of sidelobe returns, giving enough cancellation so that constant coupling could probably be used in future antennas of this type, according to a Maxson engineer. This would greatly simplify antenna construction.

High cost and complexity are two of the disadvantages of the Maxson system. The antenna structure itself cost about $500,000. Ninety receivers are required, although some savings are



Two panels on each of the three sides of the Maxson ASHR-1 antenna consist of waveguide stacks. All the odd-numbered beams in a vertical stack are formed by one of the panels on a side of the antenna, and all the even-numbered beams by the second panel. All beams have a beamwidth in azimuth of about 120 deg. Receivers are automatically switched from one side of the antenna to the other in synchronism with the rotation of the master antenna.



Sawtooth pulse is fed to each gate in a series of gates, each of which represents a particular beam in the vertical stack of beams. Since the range of the target affects the energy reflected by it, a point on the sawtooth proportional to the range of the target is automatically selected. The sawtooth is sent into each gate. However, the amplitude of the pulse is weighted according to the vertical beam represented by the pulse (higher beams have higher pulse amplitude). Since only one gate is energized, depending on which beam picks up the target, the output of the gates is a single short pulse with amplitude proportional to the altitude of the target. A slight correction is made for the curvature of the earth.

Possible altitude display system now being developed for the FAA uses the inner two-thirds of a ppi as a conventional range azimuth display. The outer third of the tube face is calibrated in altitude, so that an altitude pip for each aircraft appears on the same azimuth as the range-and-bearing pip. Aircraft at higher altitudes are shown toward the outside of the altitude sector.

possible because of the use of one local oscillator for all of them. Synchronization and signal processing also add to complexity.

Several other potential altitude systems, some simpler than Maxson's, have been proposed to the FAA.

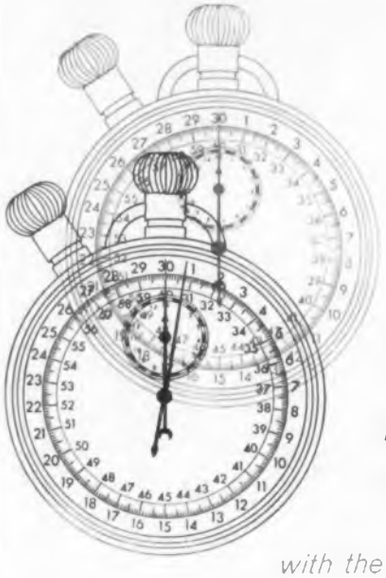
Among firms which have made additional proposals are Crosley Div. of Avco Corp.; Sanders Associates, Inc.; Marchetti Associates; Gilfillan Brothers, Inc.; Bendix Corp.; Hughes Aircraft Co.; and ITE Circuit Breaker Co.

Sanders has developed a small system which could be linked to conventional search radars without complex data-link equipment. Although it would be a phased-array approach, it would use fewer elements for the same number of beams than the Maxson approach.

Displays suitable for showing the altitude dimension along with range and bearing are also under development. The approach which seems to have greatest favor at present shows range and bearing on the inner two-thirds of a ppi, and altitude on the outer third.

Other novel display techniques are under development. One approach would show targets in simulated three-dimensional space. Another would use color-coding of targets to locate them in a particular altitude zone.

Eventually, however, the FAA hopes to integrate altitude into all other data handled by a master traffic control data processing system. This would remove the element of human error from the situation, and give early warning of any developing collision situation. ■ ■



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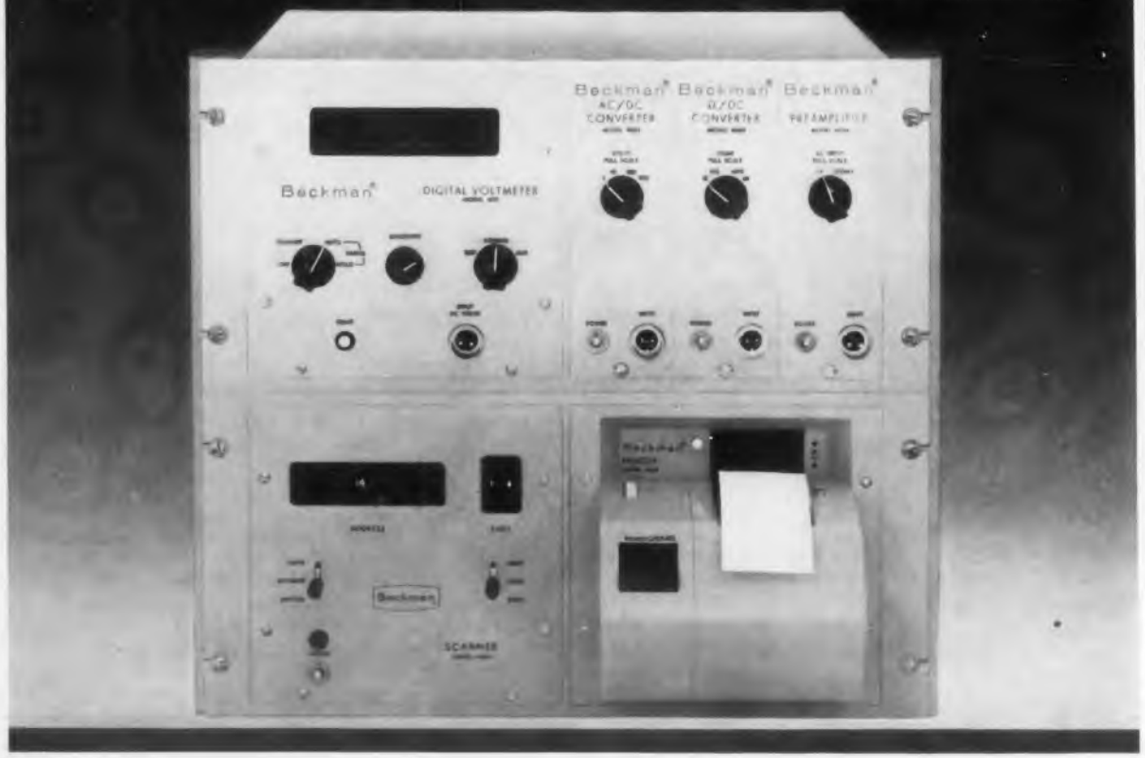

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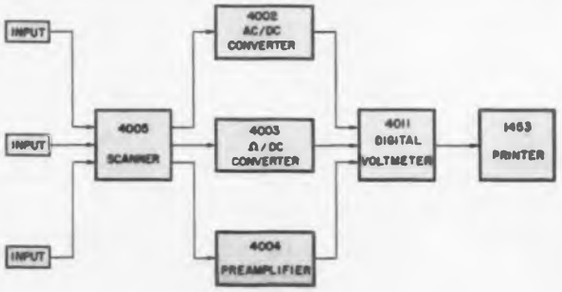

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CIRCLE 7 ON READER-SERVICE CARD

NEWS

Titanium Tunnel Diodes

Thin-Film Devices Being Developed With Titanium Oxide Dielectric Layer

Titanium thin-film tunnel diodes that operate at room temperature and have current peaks and valleys at somewhat higher voltages than those of gallium-arsenide tunnel diodes have been developed at Republic Aviation Corp., Farmingdale, N.Y.

The devices are made by precipitating a thin-film strip of titanium on a smooth glass substrate in a vacuum at about 1,800 C. A layer of oxide is formed on the titanium in minutes by a special anodic oxidation process. The oxide is formed at room temperature. A counter electrode of another metal, such as aluminum or silver, is vacuum-deposited in a strip across the titanium band to form a sandwich where the two strips cross.

The sandwich is about 1,000 A thick and about 5 to 10 sq mm in area. Tunneling through the titanium oxide dielectric occurs at room temperature and gives the device the characteristic negative resistance behavior of previously described tunnel diodes.

The only other thin-film tunnel diodes announced depend on superconductivity for their tunneling and must be maintained at cryogenic temperatures (*ED*, Dec. 7, 1960, p. 4).

Dr. Franz Huber, physicist, and Joseph Bloxsom developed Republic's new diode.

The titanium thin-film tunnel diodes resulted from research into the use of weld metals, including niobium, tantalum and others, as mate-

Thin-film titanium tunnel diodes deposited on glass substrate, held here by Dr. Franz Huber of Republic Aviation Corp., operate at room temperature.

Operate Without Cooling

rials for microminiature components. This research is part of a program to develop a complementary set of components that can be printed at the same time on a smooth substrate.

Republic hopes to produce microminiature circuits of titanium diodes, capacitors and resistors in one manufacturing operation that might include several deposition and oxidation steps. The company reports that it is near development of titanium thin-film capacitors.

Polarized-Plate Memory Promises Ultra-Fast Information Retrieval

In an information storage system developed at New York University, the phenomenon of persistent internal polarization is being used to achieve write-in and read-out speeds said to be comparable to those of the fastest existing computer memories.

Prof. Hartmut Kallman and Prof. Joseph Rennert have built a working laboratory system in which a plate coated with a thin photoconductive phosphor layer of zinc cadmium sulphide is used to store signals written by a beam of radiation.

Small spots on the plate are polarized by the beam, which can be of visible-light, infrared, ultraviolet or gamma-ray energy, depending on the composition of the phosphor. The beam is modulated by a mask.

Information can be recorded on the 1-in.-sq plate either by applying a voltage together with a light flash across the entire photoconductive layer and then selectively irradiating desired areas, or by irradiating the entire phosphor plate and selectively applying voltage and light.

To apply voltage selectively, however, would require that a grid of conductors be placed against the plate. This would prevent achieving extremely small devices and high information densities, Professor Rennert reports.

Writing consists of applying a voltage and a 2-μsec light flash to a plate simultaneously to polarize a single spot about 1 mm sq.

Reading is done by detecting either the presence or absence of a polarization voltage on the plate by exposing it to a light flash or scanning beam in the absence of an external voltage. Measuring the strength of the released signal tells whether information is or is not present.

Reading, however, removes energy and destroys the recorded information after several cycles have elapsed.

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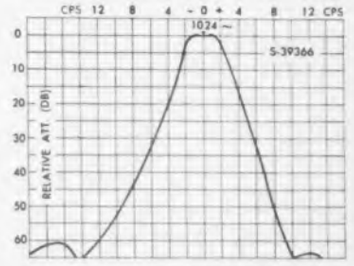

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NEWS

Designers Scrutinize Solid-State Circuits, Devices

Descriptions of Important New Developments Share Spotlight With Discussion and Evaluation at Solid-State Circuits Conference

DESIGNERS took a hard, evaluating look at many recent and brand new developments in solid-state technology at the 1961 International Solid-State Circuits Conference. Components like tunnel diodes, epitaxial transistors and microwave devices, and concepts like magnetics, logic systems, microminiaturization, and storage approaches were scrutinized and evaluated—not always favorably—at the lively Philadelphia conference. This stock-taking characterized the 1961 meeting, which may also prove notable for the many significant developments described there.

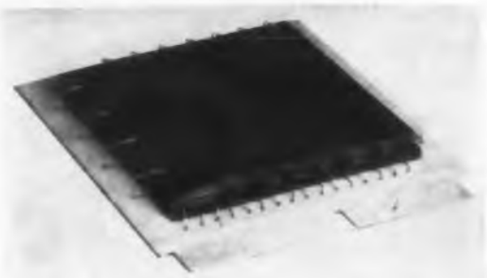
Among these were:

Novel logic concepts. Two optoelectronic approaches to logic, making use of electroluminescent-photoconductive elements in arrays, were described by researchers from General Electric and from International Business Machines. A neuron-like neuristor logical element invented at Stanford Research Institute was shown to be ready for implementation. Also described was a continuous-phase regenerative logic system for majority logic that uses a phase-script mode of operation. This GE development resembles the parametron in principle but is said to perform logic at a 100-mc rate, half that of its pump frequency.

New advances in magnetics. An all-magnetic arithmetic unit—an automatic decimal multiplier—was described as in operation at Stanford Research Institute. It consists of only ferrites and wire. Researchers from Bell Telephone Laboratories reported on progress with the Lab's ferrite-sheet memories. These are word-organized units that use guided flux for reading and writing. One developmental memory stores up to 8,000 4-bit words and has a 3-4-μsec read-write cycle.

Tunnel-diode applications. Several tunnel-diode switching devices were discussed. One, using voltage-mode selection, is being developed in England (see photograph). Another built at Texas Instruments to investigate GaAs tunnel diodes, uses transistors as emitter followers and is said to be capable of single-shot inputs faster than 100 mc and of binary action of about 200 mc. Another tunnel-diode switching circuit using transistors was described by IBM designers. This asynchronous circuit is said to have repetition rates of 100 mc.

Tunnel diodes were also discussed for non-switching applications. Bell Labs reports getting 0.5 mw from a gallium-arsenide-diode oscillator operating at 7.5 kmc. Japanese researchers reported a gain of 20 db at 8-mc bandwidth with a reflection-type parametric amplifier using tunnel diodes. Also described were a Bell Labs analog-to-digital converter with a speed of 5 mc, and a superregenerative tunnel-diode circuit developed by Philco.



Array of EL-PC elements described at conference recognizes combinations of three-bit patterns as they flow through data-processing system. Use of EL-PC elements permits construction of circuits suitable for a physical realization of a logical flow table. The device demonstrates both the power of flow-table logic and of EL-PC circuits. It consists of three superimposed 4 x 7 matrices of bistable elements and is said to be reliable and easy to fabricate.

Tunnel-diode module for developmental computer memory handles 64 bits in 3-in. diam. Complete read-write cycle was performed in 40 μsec with same circuit in different configuration—an 8 x 8 array on 9-in. circuit board. Module is for a word-organized memory designed at Plessey Co., Ltd., Hants, England, that uses voltage-mode selection. Circular arrangement was chosen to reduce delays caused by leads, which slowed read time in array format to 10 μsec.

Cryogenic developments. An experimental 100-bit coincident-current superconductive-memory with a 6-μsec read-write cycle was described by RCA researchers. Use of lead and tin thin films at cryogenic temperatures reduce drive current needs to 300 ma, it was reported. Two other developments discussed were IBM's 135-cryotron thin-film memory plane, and GE's thin-films that exhibit tunneling at cryogenic temperatures.

State of Solid-State Circuit Art Analyzed Informally in Discussions

Unusual frankness characterized the evening informal discussions at the conference, where as much attention was given previous developments as those announced at the meeting. In computer-oriented discussions, which, with microwave talks, dominated the conference, thin-films were downgraded as one of the techniques of the future. Twistor memories were said to be strictly limited in potential. Tunnel diodes were reported a long way from large-scale use in switching applications. Only one young engineer spoke up for superconductive devices. But surprisingly many commentators thought ferrites would be highly competitive in future computers.

Logic designers discussed approaches for three hours but could not agree on which techniques would dominate the next generation of data processing systems. Most agreed, however, that devices were being developed faster than logics to use them efficiently.

At the microminiaturization evening sessions, panelists said that departures from conventional circuitry are needed in order to achieve satisfactory operation with microwatt power input per stage. New logic is demanded to relax the tolerance level demanded in present circuits and active components must be tailored to micromin assembly techniques, stated the panel members.

In answer to such questions as ideal form factor for a module, maximum cost of a "throw away" module and best block-to-block connection scheme, the panel insisted that the customer or systems engineer would be responsible for the final decisions. The problem areas of micromin still appear to be tossed from device manufacturer to user, with both disclaiming full responsibility.

Circuits have developed faster than devices in low-frequency, low-level signal amplification, said both circuit designers and device manufacturers who attended an evening discussion on this subject. The basic circuits, particularly those based on differential input stages, have been around for many years; what is needed

are transistors that can make these circuits perform, they said.

Some specific improvements expected from device manufacturers are more precisely matched component pairs and more complete surface passivation, commented panel member J. S. MacDougall, Raytheon Co. Planar transistors may help provide the answer, added D. Hilbiber of Fairchild Semiconductor Corp. After the session Mr. Hilbiber told ELECTRONIC DESIGN that the long-sought field-effect transistor also might be available in the foreseeable future.

As for the transistors that have become available in the past year, J. Baworouski, Litton Industries, told the group that he has found none of them significantly better for signal amplification than the older 2N338—which he uses as a "workhorse for the front end."

Differential DC Amplifiers Favored Because of Need For Solid-State Chopper

Differential dc amplifier stages were favored by many of the designers because of the difficulty in perfecting a good solid-state chopper. To achieve the matching needed for the differential pairs, there was talk of not only putting the transistors in the same package, but also of immersing the mutual header in an oil bath. Most of those present indicated that they did not consider Peltier cooling at the junctions promising for temperature stability because of the inefficiency of thermoelectric devices.

A number of transistor choppers were discussed, as was a push-pull photoelectric type from Cambridge Electronics Corp., Boston. But, for transistorized choppers at least, the problems of voltage standoff and switching spikes appeared sufficiently discouraging to cause one of the panel members to predict that "a good mechanical chopper will be able to 'cop the market' for some time to come."

Discussion of the problems inherent in ferrite amplifiers was one of the top attractions of an evening session on microwaves.

As of now, according to E. Stern, General Electric Co.'s Electronics Laboratory, Syracuse, N.Y., there are three factors in which ferrite amplifiers lag behind existing microwave amplifiers. These are higher noise figures, higher pump power requirements, and lower gain-bandwidth products.

Work is continuing in this field, however, because ferrite amplifiers promise to provide improvements over existing receiver amplifiers in the millimeter-waves region.

What is needed are better materials with broad line width, for lower pump power, or a more efficient method of pumping, Mr. Stern told the group of microwave engineers. ■ ■

For a round-up on overseas developments disclosed at the conference see next page.

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	Min.	Typ.	Max.	
Static Characteristics				
Collector Cutoff Current, I_{CBO} (V_{CB} = −5v)		1	3	μa
✓ Collector Cutoff Current, I_{CBO} (V_{CB} = −5v, T = 56°C)			18	μa
✓ Collector Breakdown Voltage, BV_{CBO} (I_C = −25 μa)	20			volts
✓ Collector Breakdown Voltage, BV_{CES} (I_{CES} = −25 μa)	20			volts
DC Current Amplification Factor, h_{FE} (V_{CE} = −0.5v, I_C = −40 ma)	20	50		
✓ DC Current Amplification Factor, h_{FE} (V_{CE} = −0.3v, I_C = −10 ma)	30	70		
Base Input Voltage, V_{BE} (I_C = −10 ma, I_B = −1 ma)	0.25	0.32	0.40	volt
Collector Saturation Voltage, V_{CE} (SAT) (I_C = −10 ma, I_B = −1 ma)		0.12	0.20	volt
Collector Saturation Voltage, V_{CE} (SAT) (I_C = −10 ma, I_B = −0.5 ma)		0.15	0.25	volt
✓ Base Input Voltage, V_{BE} (I_C = −10 ma, I_B = −0.5 ma)			0.34	volt
Dynamic Characteristics				
Output Capacitance, C_{ob} (V_{CB} = −6v)		1.5	3	pf
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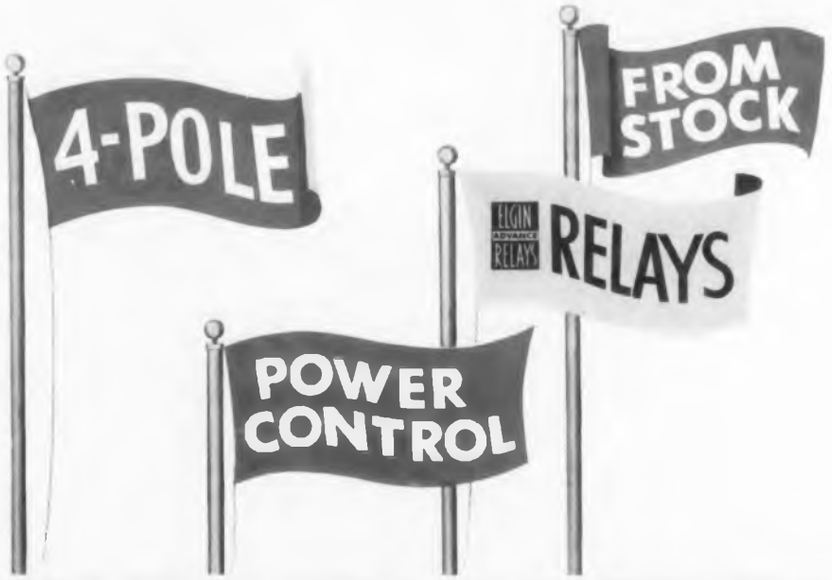

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NEWS

International Advances

Thin-Film Parametrons on Wire, Microrecording Method Described

THIN-FILM parametrons deposited on copper wires, advances extending the microrecording art into the submicron range, and promise for excellent results for dielectric diodes were among the significant foreign developments disclosed at the International Solid-State Circuits Conference in Philadelphia.

Prof. Eiichi Goto of Tokyo University outlined recent progress in solid-state research in Japan. He described two approaches used by his laboratory to construct permalloy thin-film parametrons by electrodeposition on copper wires.

In one configuration the pumping current is applied through the inner copper wire, and the easy direction of magnetization of the film is axial. A coil in a tuned circuit is wrapped around the permalloy-coated wire.

In the second configuration the coated wire is placed in a pumping magnetic field. An external capacitor is soldered to the permalloy film, and the copper wire is used as the inductance in a tuned circuit. Since the inductance is inversely proportional to the diameter of the wire, the wire must be very thin for this device. The oscil-

Traces produced by new German microrecording technique are shown as seen through an electron microscope, with 1-micron scale marks for size comparison. This technique produces writing small enough to write the entire contents of the Bible on 1/30th the area of a postage stamp, according to Dr. G. Moellenstedt.

In Solid-State Cited

lation current passes through inner copper wire.

The permalloy coatings used are only a few microns thick, and it is difficult to obtain the proper combination of nickel and iron in the films, according to Prof. Goto.

The 12,000-parametron PC-2 computer being built at Tokyo University should be completed in April, Prof. Goto told ELECTRONIC DESIGN after his report to the conference. He expects the machine to give a multiplication time of about 300 μsec. Ferrite parametrons will be used in this machine, which will have 2,000 words of magnetic core storage.

Advantages of the space-charge-limited dielectric diode over the conventional diffusion-limited semiconductor junction diode were cited by Dr. G. T. Wright, University of Birmingham, Birmingham, England.

Since large input capacitance is most easily achieved in the semiconductor junction diode, it is inherently more suitable for higher power applications, he commented. The dielectric devices are inherently more suitable for switching applications, however, because of the feasibility of faster transit times.

Space-charge-limited current has been achieved by Dr. Wright using insulating crystal plates of pure cadmium sulfide. Materials such as gallium arsenide or aluminum antimonide would be more suitable for device development, he added. Wider bandwidths and less temperature dependence were among other advantages of the dielectric diode presented by Dr. Wright.

Very High Density Storage Possible With Submicron Microrecording

Techniques developed for microrecording information in lines much less than 0.1 micron wide were described by Dr. G. Moellenstedt, University of Tubingen, Tubingen, West Germany.

Colloidion films 1,000 A thick are used for the recording process. A microprobe, controlled by an electron microscope, is used to do the writing. Where probe strikes, oxygen and hydrogen are driven out of colloidion film, leaving pure carbon.

In the experiments described the aperture is shifted over the objective lens to achieve writing, however later work has now been done using a magnetic field to deflect the beam, according to Dr. Moellenstedt.

The technique can be used for preparation of fine absorption gratings for super-orthicon tubes. It might also be extended to such applications as high-density data storage or printing miniature film circuits. ■ ■

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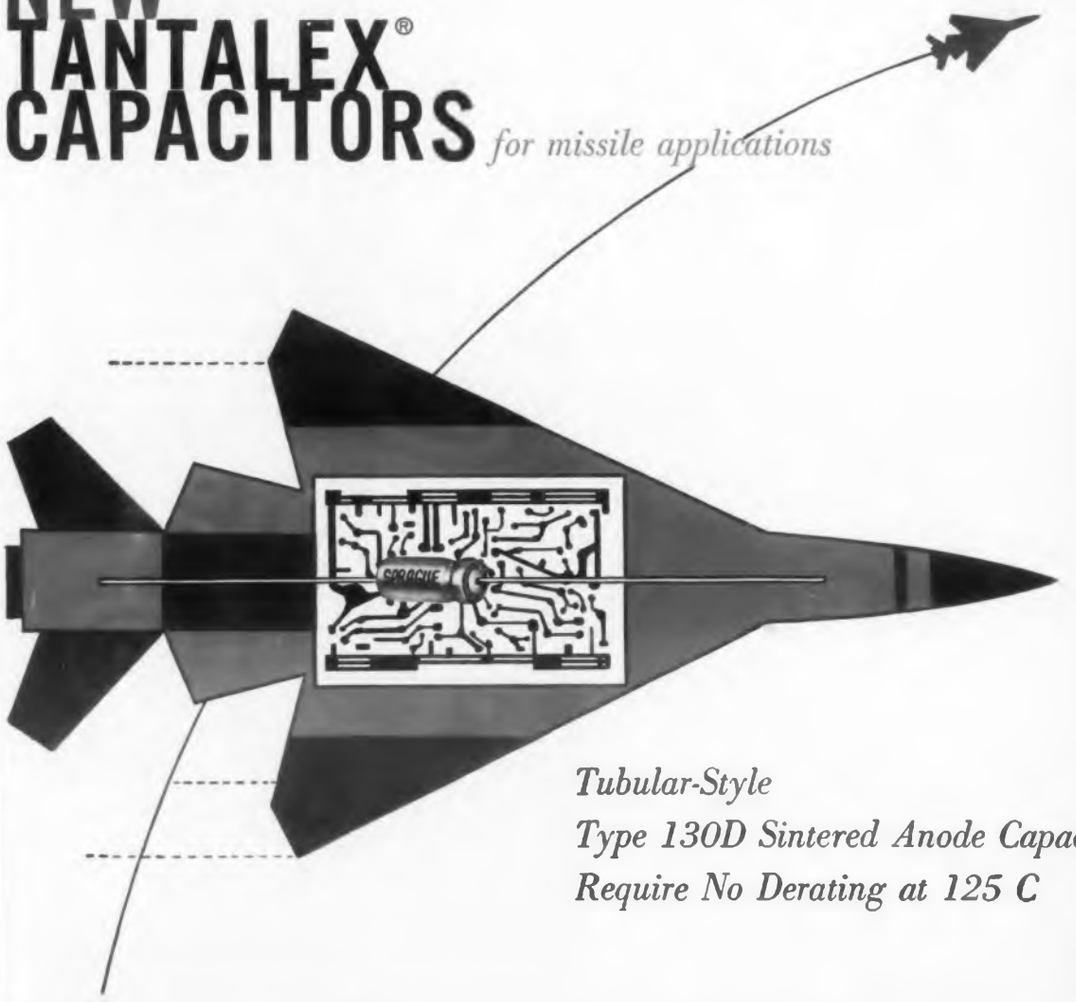

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CIRCLE 12 ON READER-SERVICE CARD

NEWS

Half-Tones Erased Onto New Storage Tube

Inverted Signals Applied to High-Energy Gun Grid Give Images of 100 to 120 Lines/in. Resolution

Simulated radar information is shown on the face of the new Multi-Mode Tonotron. Circle can be moved to any position on the screen without disturbing stored traces.

Thomas E. Mount
West Coast Editor

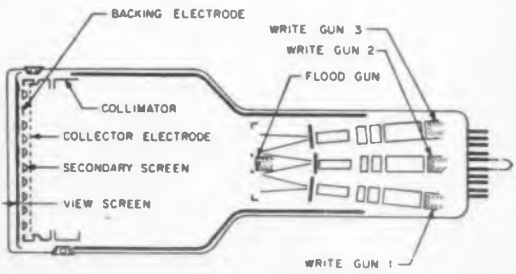
HALF-TONE images with 100-to-120-lines-per-in. resolution are produced in the storage mode by a high-energy erase gun with a new multimode, selective erasure storage tube designed by Hughes Aircraft Co.

The Multi-Mode Tonotron, developed by the company's research laboratory at Oceanside, Calif., might be used in air traffic control, or with special radar or sonar systems. The tube is also capable of continuously displaying slow-scan TV images resulting from the narrow-bandwidth transmission necessary for moon or planetary approach missions.

Can Erase Selected Images Without Disturbing Others

Conventional storage tubes erase the complete screen surface before writing a new image. The Hughes tube allows selected portions of the screen to be erased, so that new information—such as new targets or identification symbols—can be written onto a stored display.

In a demonstration at the Hughes laboratory, engineers showed a moving radar target on the screen of the multi-mode tube. A bright circle was moved to surround the target by pressing



Hughes Multi-Mode Tonotron is held by display systems engineer Gerald Slocum (left). Above is a schematic diagram of the tube. It uses three electron guns—low-energy write, high-energy erase, and write-through—in addition to the flood gun necessary to energize the secondary emission screen. Some tubes may lack one or more of the guns, substituting time-sharing circuitry to provide necessary functions. Information is stored on the view screen until erased by the high-energy erase gun's sweep. New information can be displayed by the low-energy write gun, following 1/8 in. behind the erasing beam. Resolution up to 120 lines per in. is achieved by using the erase gun to "write" a negative picture.

a button. Other images in the display were not disturbed. Thus an air-traffic pattern might be stored and real-time data written simultaneously.

Half-tone images of more than 100-lines-per-in. resolution are erased into a bright screen, rather than written onto a dark screen. First the screen is entirely covered with brightness with a low-energy write gun. Then a high-energy gun is used to erase an image onto the screen. Since this would normally be a "negative" image, the video signal can be inverted before it is applied to the grid of the erase gun.

High resolution is achieved in this arrangement because of the higher energy of the erase gun. Only about half the resolution would be possible with the lower energy write gun.

Slow-Scan Image Continuously Displayed Because of Selective Erase Feature

Slow-scan TV information transmitted over an experimental line with only 10-kc bandwidth was displayed on the new tube in another demonstration at the laboratory. With an ordinary storage tube, the entire display would have been erased after the completion of each raster. With the Multi-Mode Tonotron, however, only a 1/8-in. portion of each trace, just ahead of the moving beam, was erased. Thus the complete display was continuously visible to the operator. This mode of operation would be very useful with narrow-bandwidth satellite TV transmission systems, Hughes engineers pointed out.

The multimode storage tube's operation depends on a new dielectric film on the storage mesh (secondary screen in the diagram). When this dielectric film is bombarded by a beam of high-energy particles, it becomes conductive. In the Hughes tube 6,000 v or more are applied to the erase gun to form the high-energy beam.

The secondary-emission screen operates as a conventional Tonotron target when written upon by the low-energy writing gun. A charge pattern is established on the dielectric surface by this gun because of the secondary-emission ratio of the material.

When the high-energy erase gun bombards the secondary-emission screen with electrons, the surface potential of the dielectric film is conducted toward the backing electrode potential (negative) by currents induced in the dielectric. This conduction occurs only in the bombarded areas. The amount of erasure is controlled by varying the erase-gun beam current.

Thus if video signals are inverted and applied to the grid of this erase gun, half-tone images are formed on the tube's view screen.

The erasure speed is determined by two operating parameters, the beam energy and the backing electrode potential, according to Kenneth Hesse, Hughes tube engineer. Both have a

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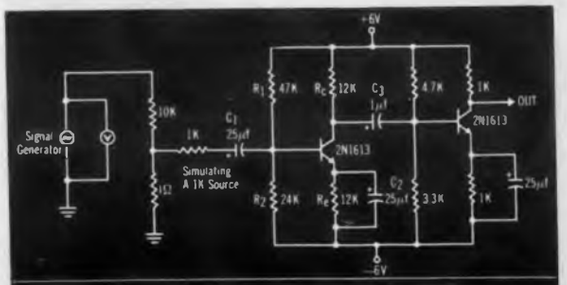

2N1613 SPECIFICATIONS – 25 C EXCEPT AS NOTED	MIN.	TYP.	MAX.	CONDITIONS
h_{FE} DC pulse current gain	40		120	I_C = 150mA V_C = 10V
h_{fe} Small-signal current gain	3.0	5		I_C = 50mA V_C = 10V f = 20mc
C_{ob} Collector capacitance		18$\mu\mu$f	25$\mu\mu$f	I_E = 0mA V_C = 10V
I_{CBO} Collector cutoff		0.8mμA	10mμA	V_C = 60 T = 25° C
		1.0μA	10μA	V_C = 60 T = 150° C

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threshold that must be reached before successful erasure can occur. Beam voltage must be at least 5,900 v, Mr. Hesse emphasized, to cause bombardment-induced conductivity. The negative backing electrode potential must also be at least equal to the target cut-off potential. Erase speed increases when the beam voltage increases or when the backing electrode is made more negative.

In practice at Hughes, erasure speeds of the order of 50,000 to 100,000 in. per sec have been achieved at beam voltages of 6,000 to 6,200 v. The backing electrode potential can be varied between about −5 and −12 v. The exact value is determined by the storage time desired, and it varies from tube to tube. The larger the negative voltage, the shorter the storage time.

Write-Through Mode Used To Present Nonstored Data

A write-through mode is used to write information not susceptible to erasure. These images are not erased because they are not stored on the tube face. By adjusting the energy of bombarding electrons, it is possible to make the addition and subtraction of charges equal. As much charge is deposited on the screen by secondary emission as is conducted to the backing electrode by bombardment-induced currents in this mode of operation. When this occurs, the beam is seen on the view screen in its unstored mode. No erasure of the information stored in that area takes place.

Write-through can be accomplished by using a separate write gun, as shown in the diagram, or by pulsing the back plate negatively and using the high-energy gun.

The view screen of the new tube, coated with a green-yellow P20 aluminized phosphor, is very bright and is highly visible even under poor lighting conditions. Physically the tube is about 4-1/2-in. shorter than conventional Tonotrons.

Inventor of the Multi-Mode Tonotron is Norman Lehrer, head of the special electron tube section of Hughes' Electronic Display Dept. ■ ■

Automatic Radio Locator Beacon Developed for Life Rafts

An automatic radio locator beacon, designed primarily for use in life rafts, has been developed by Hycon Manufacturing Co., Pasadena, Calif.

Called the Hy-Marker III, the self-contained unit is released automatically upon raft inflation. The spring-loaded antenna locks into place as water enters the battery compartment. The beacon begins transmitting on an emergency wavelength.

FAA Testing Binaural Recording Of Cockpit Talk in Airliners

The Federal Aviation Agency is looking into the feasibility of recording airliner cockpit conversations with binaural techniques as an aid to accident investigation. Tests are under way at the National Aviation Facilities Experimental Center near Atlantic City, N.J.

Tests that began last spring established that cockpit conversation could be recorded over noise for useful playback.

In its report on the first series of tests, the agency said: "The recording of crew conversation in transport aircraft is feasible and development of special circuits and equipment is recommended."

A meeting of FAA and industry representatives to review the findings and to consider equipment for such recordings is scheduled for March 7 and 8 at the Atlantic City test facility.

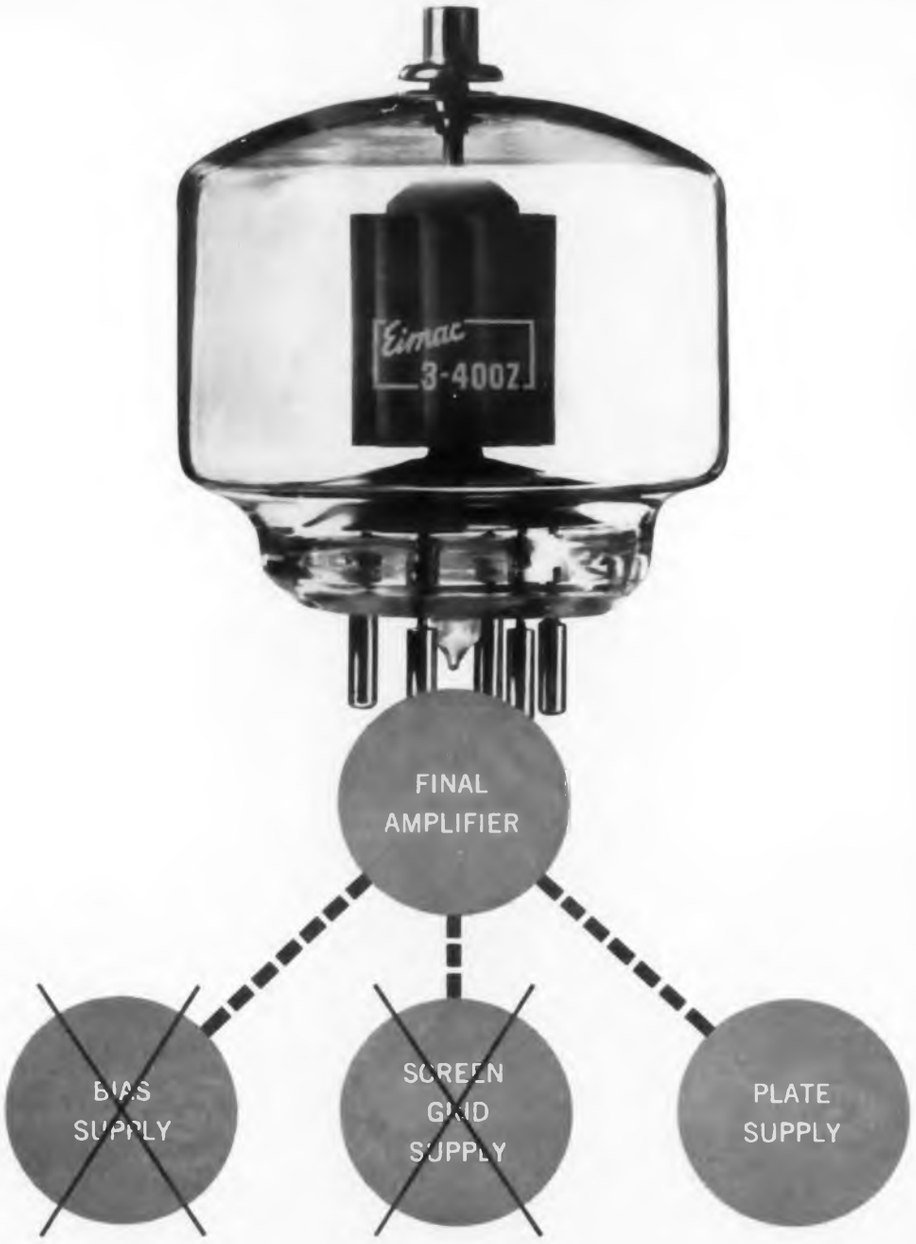
An area pickup microphone with a cardioid pattern was the only near-special device used for the first tests. "Sophisticated mounting techniques" were not considered necessary for the cockpit microphone.

In the new binaural tests, signals from two cardioid-pattern microphones placed about 8 in. apart are fed to a dual-track recorder.

Filters and filter combinations are being tested in another phase of the program. The agency has established that by suppressing the right combination of noise frequencies, the quality of the recordings is enhanced.

Cinerama Getting New Sound

Space-saving preamplifier (foreground), which replaces the cumbersome vacuum-tube unit behind it, is part of a new all-transistor sound system developed by the Grass Valley Group, Inc., of California. The system, said to be capable of 450-w total audio power with fidelity to 20 kc, will be used by Cinerama, Inc., in theaters around the world.



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Millimeter-Wave Devices—for Equipment Not Yet 'Born'

MIT's Lincoln Laboratory Emphasizing Hardware in Broad Research Into Signal Sources and Materials for Communications and Radar

DESIGN interest in millimeter waves, for the next generation of communications and radar equipment, is growing. As part of it a broad research and development program into potential signal sources, materials and devices is being conducted at the Lincoln Laboratory of Massachusetts Institute of Technology, Lexington, Mass.

The program's emphasis on hardware for the many aspects of a millimeter-wave system, including waveguides, isolators, circulators and measuring equipment, should prove valuable to microwave designers.

Until recently designers were reluctant to consider millimeter-wave systems because of atmospheric attenuation. Such "windows" as do exist are not very useful for ground communications. For systems that look straight up, or down, however, the millimeter-wave region warrants serious consideration. For example, a one-way trip through the atmosphere attenuates 2-mm waves only about 5 db.

Lincoln Laboratory is also actively developing radar and maser systems for the millimeter-wave region of the spectrum.

Illustrated here are devices and laboratory equipment employed in Lincoln's millimeter wave research program. ■ ■

Three-port, Y-type circulator developed for use at 4 mm. Small permanent magnet clamped to top supplies field for ferrite rod inside cavity.

Antiferromagnetic isolator is tested at 140 kmc with carcinotron signal source. Isolator, in liquid nitrogen Dewar between poles of the large electromagnet at bottom of photo, is adjusted by Dr. Gerald S. Heller, leader of the Resonance Physics Group at Lincoln Laboratory. At top, John J. Stickler monitors carcinotron output. The tube is said to average 20 mw of power within a 7 per cent tuning band.

Interferometer for measurements at 2 mm. Transmitting horn is at left, receiving horn at right. Dr. Peter E. Tannenwald, assistant leader of the Resonance Physics Group, conducts experiment.

1-mm harmonic generator is driven by 4-mm Amperex tube. Harmonic generator types under study include varactor diodes, paramagnetics and point-contact silicon whisker diodes. This method is inefficient at the low powers available from klystrons.

Millimeter wave sources in use at Lincoln Laboratory. From left to right: Raytheon QK396 klystron (4 mm), Compagnie Sans Fil COE-20R carcinotron (2 mm), and Amperex DX151 klystron (4 mm). Note the small, rectangular output waveguide for all three tubes.

(Advertisement)

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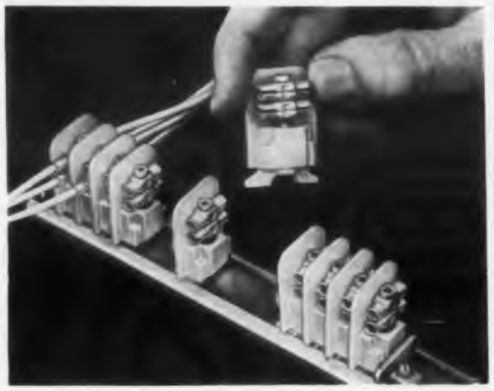

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How to use a 4-megacycle instrumentation tape recorder

Ampex's new AR-300 and FR-700 answer a whole new range of needs

For video-bandwidth phenomena

Radar, for instance, can now be tape recorded off receiver and played back repeatedly to scopes, analytical devices or radar guided equipment. Radar testing, reconnaissance and tracking are enormously aided by tape's live-playback capabilities. And for simulation and training, elusive transient phenomena now become repeatable at will.

For predetection recording and communications monitoring

The recorder's bandwidth catches everything at once – any 4-megacycle band of radio frequencies or the IF stage off a telemetering receiver. This simplifies on-site equipment. One kind of recording serves for all usual types of communications and telemetered data. Later you can play back through detector, discriminator and other equipment as many times as necessary to separate and process the desired channels of information.

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The Models: AR-300 Mobile or airborne record only; FR-700 single-rack laboratory record/playback. Response: 10 cps to 4 mc (±3 db). Tape speeds: 12½ and 25 ips. Playing time: 60 minutes. Tape: 1.0-mil Mylar, 2-inch width, 10½-inch reels. Data tracks: two wideband plus two auxiliary. Electronics: all solid state. Environmental (AR-300): 10g vibration; 50,000 ft. alt.; −54°C to +55°C. Tape interchangeability: yes, among all AR-300/FR-700 recorders.

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NEWS

Use of Computers

Specific Uses and Needs Cited at AIEE Meeting

THE increasing use of computers by design engineers was illustrated at the AIEE Winter General Meeting in reports on:

- An electrical analog approach to thermoelectric generator design.
- The problems of compiler programing.

Among other design highlights of the New York meeting were a report on a self-testing thyratron and a description of a hard-solder technique for silicon semiconductors to prevent high failure rate from heavy on-off cycling.

Computer solutions for thermoelectric generator design problems through use of the electrical analog approach were described by M. E. Talaat, Martin Co., Baltimore, in a paper entitled "Electric Analog of the Transport Phenomena in a Thermoelectric Generator."

An arm of a thermoelectric couple, he reported, can be represented by electrical analogs, using the equations derived. Electrical conductances are used for thermal conductances, and current sources are used to represent electrical power output and rates of input heat, Peltier heat, Joule heat and Thompson heat. The method was applied to derive an over-all thermal equivalent circuit for a typical isotope-fueled thermoelectric generator. The resulting electrical analog permits over-all efficiency and temperature distribution to be determined, Mr. Talaat said.

Language Problems Plague Compiler Writers

Two papers shed light on a subject sorely in need of illumination—compiler programs used to translate users' language into computer language. Publicity attending recent progress with problem-oriented computer languages, like Fortran, Flowmatic, Mathmatic, Algol and Cobol, has overshadowed the enormous problems that still face programers who write compilers.

CIRCLE 18 ON READER-SERVICE CARD

Noted in Design

In a very forthright presentation, V. A. Vyssotsky, Bell Telephone Laboratories, Murray Hill, N. J., explored compiler problems. He spoke on "Near Future Applicability of Problem Oriented Languages to Programing for Real Time Control Systems."

Compilers Also Problem For Switching Circuits

Less directly, almost in passing, S. H. Washburn of Bell at Whippany, N. J., pointed to the problems of writing compilers for the design of complex switching circuits.

"Conceptually," Mr. Washburn said, "the greatest need for advancement lies in the formulation and application of a requirement-oriented language which can be used naturally and effectiveiy by switching-system designers."

Detailing the problems more vigorously, Mr. Vyssotsky started by showing the basic problems facing the compiler writer: Should the compiler detect more kinds of mistakes at the cost of forcing the user to write more, risking more clerical errors? Should its language be more flexible, though harder to learn? Should the compiler use abbreviated notations, or should it be more readable?

Troublesome though these problems are, the major concern, according to Mr. Vyssotsky, is this: How is the user to know his programs are correct?

Checking out a compiler can be very costly, yet inconclusive. And it is hopeless to try to have the compiler detect all errors. Most errors in compiler programs lie deeply hidden; they emerge, one by one, as the compiler is used for more complex jobs.

Mr. Vyssotsky noted other problems plaguing compiler writers. These include automatic multiprograming (allowing a computer to handle several programs in proper sequence), optimization (allowing the program to operate as efficiently as possible with minimum use of

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INSTRUMENT DEPARTMENT

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memory), and machine independence (allowing a program to be used for any of several different computers).

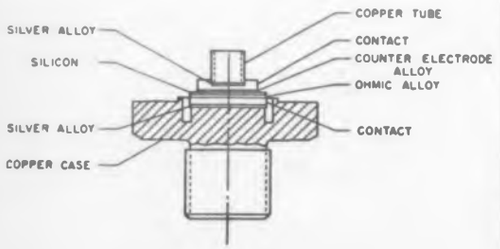
Self-Testing Thyratrons Use Xenon and Neon Gases

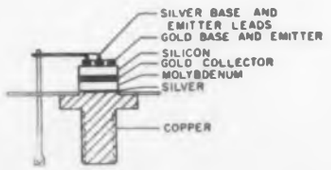
Self-testing thyratrons were described by W. A. Maijala and A. J. Humphrey, Reliance Electric & Engineering Co., Cleveland.

The self-testing feature is added to a conventional thyratron by the addition of a small amount of special gases, such as xenon or neon. These gases will not be ionized by the normal arc drop in the tube. As the arc drop increases, however, the second gas is ionized, giving a visible indication in the tube. This shows the user that the tube is nearing end-of-life failure and that it should be replaced within the next 300 operating hours.

Construction techniques, developed to overcome high failure rates of silicon devices under heavy on-off cycling, were described by W. B. Green, Westinghouse Electric Corp., Pittsburgh.

These failures are due to fatigue of the soft-solder joints previously used in construction of these devices, according to Mr. Green. A differ-





Hard-soldered silicon rectifier cell construction (top), used by Westinghouse, has already demonstrated lack of fatigue failures associated with previous soft-solder rectifier structures. This construction is used for rectifiers with 1/2- and 5/8-in. diam junctions with ratings of 150 and 225 amp respectively. The hard-solder silicon transistor structure shown below has been made possible through recent advances in control of the alloy fusion of large area devices. This construction is used in a 5-amp, 250-v device.

• *Reduced Saturation Voltage!* • *Reduced Storage Time!*

epitaxial • GERMANIUM

2N781 2N782

Refined by intensive research, proven by extensive testing—Sylvania Epitaxial Mesa Transistors offer extraordinary performance characteristics. They combine the high electrical and mechanical reliability, power dissipation capabilities, and fast switching speed of the mesa *with* the low saturation voltage, reduced collector capacitance, decreased storage time, and high gain at high current levels that are characteristic of the epitaxial process. Electrical uniformity, too, is superior because the epitaxial technique is ideally suited to the highly automated, modern production facilities of Sylvania. Result: remarkable high-speed switching and high-frequency amplifying devices that illustrate the dramatic advances being made in the solid state art at Sylvania.

SYLVANIA 2N781—WORLD'S FASTEST PNP GERMANIUM SWITCHING TRANSISTOR

. . . is designed specifically for circuits with high speed and low saturation voltage as prime performance features. Sylvania 2N782 offers similar electrical characteristics at lower unit cost.

ABSOLUTE MAX. RATINGS (AT 25°C)

	2N781	2N782	UNIT
Collector to Base Voltage	−15	−12	V
Collector to Emitter Voltage	−15	−12	V
Emitter to Base Voltage	−2.5	−1.0	V
Collector Current	100	100	mA
Power Dissipation (free air)	150	150	mW
Power Dissipation (case at 25°C)	300	300	mW
Storage Temperature	−65 to +100	−65 to +100	°C
Junction Temperature	+100	+100	°C

ELECTRICAL CHARACTERISTICS (AT 25°C)

		2N781		2N782		
Symbol	Conditions	Min.	Max.	Min.	Max.	UNIT
BV_{CBO}	$I_c = -100\ \mu A, I_E = 0$	−15	–	−12	–	V
BV_{EBO}	$I_E = -100\ \mu A, I_c = 0$	−2.5	–	−1.0	–	V
BV_{CES}	$I_c = -100\ \mu A, V_{BE} = 0$	−15	–	−12	–	V
h_{FE}	$I_c = -10$ mA, $V_{CE} = -0.22$ V	25	–	–	–	
h_{FE}	$I_c = -10$ mA, $V_{CE} = -0.25$ V	–	–	20	–	
V_{BE}	$I_c = -10$ mA, $I_B = 0.4$ mA	−0.34	−0.44	−0.34	−0.50	V
I_{CBO}	$V_{CB} = -5$ V, $I_E = 0$	–	−3.0	–	−3.0	μA
V_{CE} (Sat.)	$I_c = -10$ mA, $I_B = -1$ mA	–	−0.16	–	−0.20	V
	$I_c = -100$ mA, $I_B = -10$ mA	–	−0.25	–	−0.45	V
$t_d + t_r$	$V_{BE(0)} = 0.5$ V, $I_{B(1)} = -1$ mA	–	60	–	75	mμsec
t_s	$V_{CC} = -3.5$ V, $R_L = 300$ ohms	–	20	–	35	mμsec
t_f	$I_{B(2)} = 0.25$ mA	–	50	–	75	mμsec

See the SYLVANIA SEMICONDUCTOR display at the I.R.E. Show Booth # 2425

Explore the advantages offered your designs by performance-proved Sylvania Epitaxial Mesa Transistors. *Available from your* Sylvania Sales Engineer or Sylvania Franchised Semiconductor Distributor now! For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 183, 1100 Main Street, Buffalo 9, N. Y.

mesas

•SILICON
2N783 2N784

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TO–18 shown three times actual size

SYLVANIA 2N783 – WORLD'S FASTEST NPN SILICON SWITCHING TRANSISTOR

. . . is designed specifically for circuits with high speed as a prime performance feature. Sylvania 2N784 delivers low saturation voltage combined with exceptional high-speed capabilities.

ABSOLUTE MAX. RATINGS (AT 25°C)

	2N783	2N784	UNIT
Collector to Base Voltage	40	30	V
Collector to Emitter Voltage	20	15	V
Emitter to Base Voltage	5	5	V
Collector Current	50	50	mA
Power Dissipation (free air)	300	300	mW
Power Dissipation (case at 25°C)	1	1	W
Storage Temperature	−65 to +300	−65 to +300	°C
Junction Temperature	+175	+175	°C

ELECTRICAL CHARACTERISTICS (AT 25°C)

Symbol	Conditions	2N783 Min.	2N783 Max.	2N784 Min.	2N784 Max.	UNIT
BV_{CBO}	$I_C = 100\ \mu A, I_E = 0$	40	—	30	—	V
BV_{EBO}	$I_C = 100\ \mu A, I_C = 0$	5	—	5	—	V
BV_{CER}	$I_C = 1$ mA, $V_{BE} = 0, R_{BE} = 10$ ohms	20	—	15	—	V
I_{CBO}	$V_{CB} = 25$ V	—	250	—	250	mμA
	$V_{CB} = 25$ V, T = 150°C	—	30	—	30	μA
h_{FE}	$I_C = 10$ mA, $V_{CE} = 1$ V	20	60	25	—	
V_{BE}	$I_C = 10$ mA, $I_B = 1$ mA	0.7	0.9	0.7	0.9	V
V_{CES}	$I_C = 10$ mA, $I_B = 1$ mA	—	.25	—	.16	V
C_{ob}	$V_{CB} = 10$ V, $I_E = 0$, F = 1 MC	—	3.0	—	3.5	μμf
h_{fe}	$V_{CB} = 15$ V, $I_c = 10$ mA, F = '00 MC	2.0	—	2.0	—	
t_{on}	$I_{B(1)} = 3$ mA, $I_{B(2)} = 1$ mA, $V_{CC} = 3$ V, $R_L = 270\ \Omega$	—	16	—	20	mμsec
t_s	$I_{B(1)} = 10$ mA, $I_{B(2)} = 10$ mA, $V_{CC} = 10$ V, $I_C = 10$ mA, $R_L = 1000\ \Omega$	—	10	—	15	mμsec
t_{off}	$I_{B(1)} = 3$ mA, $I_{B(2)} = 1$ mA, $V_{CE} = 3$ V, $R_L = 270\ \Omega$	—	30	—	40	mμsec

SYLVANIA

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GENERAL SYSTEM

ence in the thermal expansion coefficient between the device and the heat sink used was responsible, Westinghouse tests showed, so that simple restructuring of the joints would not solve the problem adequately.

The hard-solder method was developed to overcome these difficulties. Using correct geometry to allow for some thermal expansion differences, refractory metal contacts were directly soldered to copper in such a way that the joint was free of plastic deformation. The technique has been adapted to high-power rectifying devices, transistor switches and silicon power transistors produced by Westinghouse. ■ ■

Electroplated Teflon Provided By New Metal-Plating Process

A new process for plating metals permits the use of the entire range of electroformable metals, both base and noble, on a variety of Teflon shapes.

The process, developed by Plasitron, Inc., New York, provides complete adhesion with no loss of Teflon's electrical properties. It also permits soft soldering without damage. With the bonding method employed, such a soldered joint becomes an hermetic seal at a wide range of temperatures, governed only by the size and geometry of the application, Plasitron says.

Successful applications of the process are reported in dielectric wave guides, feed-through insulators, and flush antennas for missile use that eliminate the need for radomes.

RCA Entering Tantalums Field

These miniature solid tantalum capacitors, left, to be available from Radio Corp. of America in April, are the first passive component to be marketed by the company. Size of the new flat, rectangular package is small enough to mount 24 capacitors in an area of a printed circuit board about the size of a postage stamp. Weight savings are illustrated here by balancing 26 of the RCA units against four conventional tantalum capacitors. RCA says that the new capacitors have twice the capacitance-voltage capability per unit volume of competitive units.

FIRST Tiros Weather Satellite Uses HERMES CRYSTAL FILTERS

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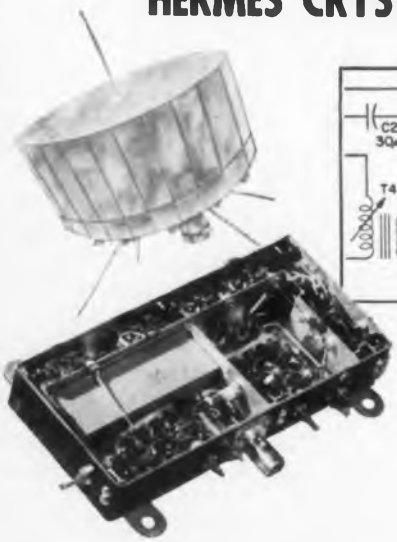
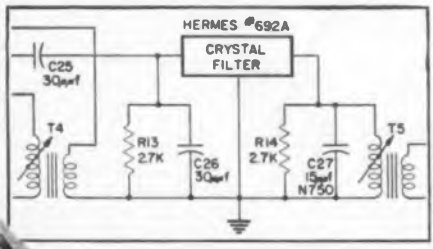


One of the two Command Receivers in TIROS



A portion of the schematic diagram for the Command Receiver in TIROS showing Hermes 20 Mc Crystal Filter at first mixer.

Hermes Crystal Filter, Model 692A, shown half size, occupies only 1.5 cu. ins.

The TIROS satellite, carrying the nation's most advanced space-borne television "eye" to study the world's weather, comprises perhaps the most elaborate electronics package yet sent into orbit.

The information-gathering element in a complex satellite-and-ground system developed for the National Aeronautics and Space Administration by RCA, TIROS contains miniature TV cameras, video tape recorders, transmitters, solar cell and re-chargeable battery power supplies, and an array of control and communications equipment. One Hermes Crystal Filter, Model 692A, is used in each of two Command Receivers which pick up coded signals transmitted from the ground to establish the time during orbit when cameras, tape recorders, and playback equipment will operate. Launched April 1, 1960, TIROS relayed meteorological data for 78 days.

Hermes Crystal Filters were selected because of their unusual ability to meet the severe environmental conditions encountered in space, while providing extremely high selectivity to receive command signals reliably. Characteristics of Hermes Crystal Filter, Model 692A, include: *Center Frequency:* 20 mc ± 1 kc; *6db Bandwidth:* 40 kc min; *Passband Response Variation:* ±½ db; *60 db Bandwidth:* 100 kc max; *Impedance:* 1K nominal; *Midband Insertion Loss:* 3 db max; *Size:* 1.5 cu. ins; *Environment: Shock:* 100 G's; *Vibration:* 20 G's −2000 cps; *Center Frequency Variation:* ±2 kc over the *Temperature Range:* −55° C. to + 85° C.

If you have a filtering problem, call on Itek Electro-Products engineering specialists to assist you in the design of your circuitry and in the selection of filter characteristics best suited to your needs. *Write for Crystal Filter Bulletin to Itek Electro-Products Co., Dept 10, 75 Cambridge Parkway, Cambridge 42, Mass.*

A limited number of opportunities are available to experienced circuit designers. Send Résumé to Dr. D. I. Kosowsky.

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CIRCLE 20 ON READER-SERVICE CARD

WASHINGTON REPORT

John J. Christie

RESUMPTION OF NUCLEAR TEST BAN TALKS later this month will give added significance to Project VELA, under which the Advanced Research Projects Agency is developing improved means of detecting atomic explosions. Hopes for a treaty hinge on Soviet acceptance of additional research, which the U.S. and Britain insist is necessary to resolve technical problems that stand in the way of effective policing of a test ban. Project VELA will continue to be the basis of the U.S. research efforts.

A worldwide system of 180 control posts was recommended by the 1958 Geneva Conference of Experts as providing, within certain limitations, a technically feasible means of detecting nuclear explosions underground and in the atmosphere. However, the results of a Nevada underground nuclear test later that year proved that the capabilities of the Geneva system were seriously deficient in respect to identifying underground disturbances. Soviet refusal to join the U.S. and Britain in further investigation led to suspension of the negotiations.

Meanwhile under Project VELA a prototype of the Geneva type of seismic detection station, with improvements recommended by a panel of U.S. experts, has been put into operation at Lawton, Okla. The Advanced Research Projects Agency is now studying proposed sites for a second prototype control post, which would incorporate still more advanced instrumentation and techniques.

U.S. experts also have suggested that the detection system could be greatly strengthened by supplementing the 180 control posts with a network of unmanned seismic stations This proposal has posed the difficult task of devising means of preventing signals from being foiled. Experts have concluded that existing decoupling techniques could reduce the seismic signal by a factor of 10 or more. Proper evaluation of this aspect of the problem will require an agreement to permit nuclear tests to be made for the purpose of further research.

The Geneva Conference of Experts acknowledged that provision for a satellite-detection system would be required at a later stage in the treaty-making procedure but deferred concrete recommendations. Project VELA encompasses this aspect of nuclear test ban enforcement also. It includes one R&D program concerned with ground-based detection tests in space and another with satellite-based detection. Both are still in the study stage.

THE STATE DEPARTMENT is not about to become another electronics procurement agency, but its expanding disarmament unit, acting under strong stimulus from the White House, will be required to make technical evaluations of a number of projects of the Defense Dept. and the National Aeronautics and Space Agency in terms of their potential use in enforcing whatever disarmament agreements might be achieved.

The unit's ultimate staff of 90 to 100 will include relatively few technical members. However, it will rely heavily on con-

sultants and task forces of scientists and engineers. Also it will initiate a variety of study programs, some to be carried out by the Defense Dept. and NASA and others under contract with academic and industrial research groups.

PROPOSED LEGISLATION that would grant the Federal Communications Commission authority to compel manufacturers to produce only all-channel TV receivers for sale to the public will be up for hearings at the current session of Congress. The controversial FCC proposal was submitted to Congress early last year.

Proponents of the legislation are likely to have the support of educators in the coming debate on the issue. This is because the commission has taken the position that all-channel legislation is a prerequisite to making provision for a nationwide educational TV system within the frequency space allocated to uhf-vhf television.

The idea of an educational TV network has gained considerable support among educators in the last year. In fact, a plan for such a network is due to be submitted to the commission shortly.

FCC members are not without misgivings as to the propriety of legally compelling manufacturers to modify their product. Moreover the belief has been expressed that TV receiver manufacturers would be willing to take the step without legal compulsion, if they could get an anti-trust exemption that would permit them to cooperate in planning the changeover. With the all-channel feature adding an estimated $15 to the price of a set, no manufacturer is going to make the first move on his own.

ENCOURAGEMENT OF AUTOMATION has figured prominently in two of the new Administration's economic messages to Congress. Pleas for increased productivity have been predicted primarily on the need to make U.S. prices more competitive in world markets and thus further increase exports to help overcome the present balance-of-payments problem.

Automation would be encouraged by two actions. One is a proposed tax incentive on new plant and equipment. The other is the administration's recent executive order setting up a labor-management advisory committee, which will be charged with encouraging productivity gains, advancing automation and promoting wage-price stability.

While trumpeting the blessings of automation, the new Administration is encountering mounting pressure to come to grips with technological unemployment. Some sort of federal program has been promised to help retrain workers whose jobs have been made obsolete.

The House Committee on Education and Labor will soon receive a special report on unemployment caused by automation. The report, prepared at the President's request by Rep. Elmer J. Holland (D, Pa.), is certain to dramatize the issue. As one example, Mr. Holland will report the loss of 50,000 jobs through automation in the radio-television industry.

INDUSTRIAL ELECTRONICS FIRMS comprise one of five growth industries, whose future location requirements will be studied in the hope of attracting new plants to depressed areas. The Commerce Department has contracted this study to Arthur D. Little, Inc. The Scientific Instrument Industry is another to be evaluated for the same purpose, with Stanford Research Institute making the study.

rectifier component news

Thermal Fatigue and G-E 6-to-70 Ampere Rectifiers

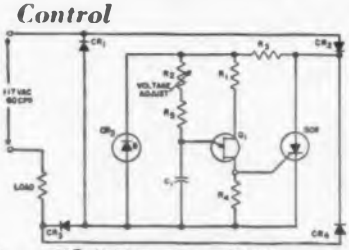
We've been advertising for some time now that G-E rectifier joints offer you freedom from thermal fatigue because only hard solder is used on the internal joints. Well, Bill Gutzwiller has an application note that covers the whole thermal fatigue story in detail, and gives you a better idea of *why* the use of hard solder is so important to you. For instance, he points out that thermal fatigue is a problem that is not limited to odd-ball applications. Junction temperature variations (or excursions) can occur any time the load changes. It takes time, of course, but repeated temperature cycling is sure to kill off soft solder joints. But G-E hard solder silicon rectifier cells are still going strong at 70,000 cycles . . . *without a single failure due to thermal resistance deterioration.*

Here's another interesting point Bill makes: just two 100°C thermal excursions from ambient to rated load each hour would ruin the best soft solder rectifier tested *in less than six months.* The worst one wouldn't last a week.

If you'd like a copy of Bill's application note, drop us a line and ask for "Thermal Fatigue and the G.E. 1N2154 Medium Current Silicon Rectifier." Write to Section 23CI.

The tremendous reception given Thyrector diodes in informal presentations recently has caused quite a stir. The Thyrector diode is by far the least expensive and most effective device today for protecting silicon rectifiers and silicon controlled rectifiers from high transient voltages.

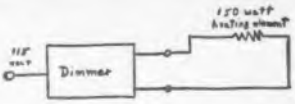
The SCR as an Inexpensive General Purpose Power Control



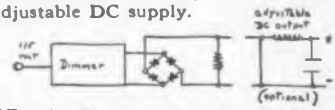
R_1	390Ω, ½ Watt	C_1	0.1 MFD
R_2	100K, Linear Pot	SCR	G.E. C11B
R_3	3.3K, 5 Watt	CR_1 thru CR_4	G.E. 1N1695
R_4	47 Ω, ½ Watt	CR_5	1N1527, 20 Volts 1 Watt Break-Down Diode
R_5	3.3K ½ Watt		
Q_1	G.E. 2N1671A		

G-E Vac-u-Sel selenium bridge rectifier regulator 6RSX762 combination is available to replace CR_1 through CR_4 and CR_5. It sells for approximately $4.00.

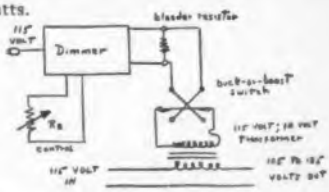
The circuit shown is a full wave phase controlled rectifier. The unit is not only a fine lamp dimmer, but it demonstrates the versatility afforded by General Electric SCRs. For example, it can be used as a general purpose control simply by substituting other types of loads for the lamp.



For a versatile general purpose DC supply the dimmer can feed into a suitable rectifier stack or filter, if needed for an adjustable DC supply.



OR—the dimmer can supply variable primary voltage to a buck-or-boost transformer used for partial adjustment of line voltages for much greater loads than 150 watts. If only a maximum of 10 volts adjustment is needed, a suitable step down transformer can be added up to 1500 watts.



One Thyrector diode can often save you 10, 20, or even 40 times its cost. And used in combination with General Electric transient PRV rectifier ratings you have virtually absolute protection.

G.E. Rectifier Characteristics and Selection Charts Now Available

. . . and they're yours for the asking. You use the characteristics chart to determine the parameters you need for your application, then go to the selection chart and pick out the right rectifier. From these two charts you can design any basic rectifier circuit . . . in seconds you pick out the optimum rectifier for your requirements. Write to Section 23CI.

Want to know more about the Thyrector diode? Call your General Electric Semiconductor District Sales Manager. He has the whole story.

Rectifier Components Department, Auburn, New York

GENERAL ELECTRIC

CIRCLE 21 ON READER-SERVICE CARD

NEWS

MADT Transistor Operates to 5 KMC With 14 db Gain, 8 db Noise at 1 KMC

A laboratory prototype MADT transistor has been operated to 5 kmc in tests at Philco Corp.'s Lansdale Div., Lansdale, Pa.

The experimental transistor exhibited gain of 14 db at 1 kmc with 8 db noise, and 21 db with 4 db noise at 420 mc, according to Dr. C. G. Thornton, director of research and development for the Lansdale Division.

The development brings closer the possible application of transistors in UHF space communications, particularly in the 1 to 4 kmc region, according to Philco.

Optimization of electrode geometry is the factor permitting the high oscillation frequency to be attained. The electrodes are about 1-1/2 mils in diameter, with a base width of 0.03 mils.

Army Vibration-Acoustic Analyzer Speeds Handling of Missile Data

A new vibration and acoustic analyzer, providing a significant increase in the amount of data that can be transmitted on the same telemetry channel, was used successfully in a recent Army missile test.

Developed by the telemetry branch of the Army Rocket and Guided Missile Agency in cooperation with Gulton Industries of Princeton, N.J., the missile-carrier analyzer handles five channels of vibration data. It puts the data into final usable form before transmitting them from the missile to the ground station.

With conventional systems, which transmit total vibration data, much time is required to process only a small amount of the desired information.

Vibration and acoustic analyzer, developed by Army in cooperation with Gulton Industries, operates at a frequency of 2,000 cps. Power requirement is approximately 75 ma.

SILICONE NEWS from Dow Corning

Build In Reliability

Seal Out Moisture and Humidity with Silastic RTV

Reliability of equipment starts with materials. Dow Corning Silicones have physical and electrical properties that mean extra reliability for electronic components, assemblies, systems.

For example: Silastic® RTV, the room temperature vulcanizing Dow Corning silicone rubber, is highly resistant to ozone, corona, weathering and oxidation. Heat-stable, Silastic RTV remains operable from —60 to 250 C; has good dielectric and physical properties.

Major uses for Silastic RTV include potting, filling, and encapsulation of electronic components and assemblies. Since it is a liquid, Silastic RTV pours easily to form a void free, rubbery mass around components. Available in several grades, Silastic RTV has set-up times ranging from several minutes to hours. Encapsulated parts can be handled in 24 hours, filled parts in even less time.

As a seal against humidity and salt water spray, Silastic RTV is used by Automatic Power, Inc., Houston, Texas to embed all tube sockets, connections, electronic components and wiring in the chassis of the control panel for their Dies-L-Air Automatic Warning Signal. This interchangeable control panel monitors operation of the entire warning signal system — including a diesel engine driving an integral air compressor, an air system, the control circuitry and air blast horns. Used to alert sea traffic to the presence of off-shore drilling equipment, reliability requirements for Dies-L-Air are continuous — and most critical during storms when the unit is being whipped by corrosive salt water spray and lashed by wind-driven rain. By sealing the control chassis with Silastic RTV, Automatic Power, Inc., has assured the reliabilty of electronic components.

CIRCLE 807 ON READER-SERVICE CARD

For "Silicones for the Electronic Engineer", Write Dept. 3315

first in silicones

Dow Corning

. . . Specify Silicones

Laminates Give Extra Strength

Silicone-glass laminates, made with Dow Corning resins, have dielectric properties at high temperatures that are superior to those of other laminate materials. They resist ozone, arcing, corona, fungus — even the combination of high humidity and high voltage. Mechanical strength is good — permitting thin, rigid coil bobbin walls; more winding space and better resistance to winding pressure. These are the reasons why Foster Transformer Company, Cincinnati, Ohio, specifies coil bobbins of silicone-glass laminates for transformers they manufacture for airborne guidance control systems. The one-piece coil bobbins, like those shown, are used in continuous operation at 250 C . . . tested for 1000 hours at 400 C.

CIRCLE 801 ON READER SERVICE CARD

Improve Transistor, Diode Performance

Used in mounting diodes to heat-sink or to chassis. Dow Corning Compound forms an excellent heat-sink seal . . . is easy to apply and never dries out. Its good thermal conductivity improves the heat transfer between diode-and-washer, washer-and-chassis.

Dow Corning silicone compounds don't melt, lose their grease-like consistency or dielectric properties from —70 to 200 C. Dow Corning silicone compounds have been found ideal for potting transistors. They cushion junctions against shock and vibration . . . improve heat dissipation because of their good thermal conductivity. Transistor junctions are not contaminated by Dow Corning's transistor potting compound . . . rejects from metal splatter are reduced when welding on transistor caps.

CIRCLE 802 ON READER SERVICE CARD

New Gel for "See Through" Protection

Poured as a liquid, transparent Dow Corning Dielectric Gel fills all voids, then sets up to form a heat-stable gel. Dielectric strength is excellent; stress on components almost nil. Potted components and circuitry remain clearly visible . . . can be checked by eye. Probes can be inserted for instrument checks . . . the gel re-seals itself when probes are removed. Individual components can be replaced. Dielectric Gel enabled CBS Laboratories to meet stringent reliability requirements on its Photoscan power supplies. Despite high temperatures, high voltages, and high vibration levels in this remarkably small unit, Dielectric Gel prevents arcing. Components are spaced less than ¼" apart, yet output voltages run from 1,000 to 25,000 volts!

CIRCLE 803 ON READER SERVICE CARD

VISIT BOOTH 4310-12 AT IRE SHOW

CORPORATION MIDLAND, MICHIGAN

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CIRCLE 801, 802, 803, 807 ON READER-SERVICE CARD

New Burroughs B5000 Computer Built For ALGOL, COBOL Use

The B5000 computer introduced by Burroughs Corp., Detroit, is designed especially for use with ALGOL and COBOL, the standard simplified computer programming languages.

The medium scale, solid-state computer will rent for $13,000 to $50,000 a month, depending on size. It will sell for prices ranging from $540,000 to $2 million. First deliveries are expected in 18 months.

Provisions for multiprocessing are also to be built into the new computer, so that several completely independent programs can be run simultaneously.

Addition time for the new computer is 3 μsec. The machine operates in fixed or floating point modes. It can also use either words or individual characters as the basic logic unit. Both business and scientific data can be handled by the machine with equal ease, according to Burroughs.

New Direction-Finder for Army

Pinpoint artillery firing accuracy and improved battlefield mobility are possible with ABLE (Autonetics Base Line Equipment), the Army's new portable, gyroscope direction finder. Basically a precision gyrocompass, ABLE determines true north to less than 30 sec of arc in less than 20 min operating time. Under old surveying methods, artillery base lines sometimes took hours or days to establish. ABLE is in production at Autonetics Div., North American Aviation, Inc.

E-H PRESENTS
4 PULSER THOROUGHBREDS

Which one of these advanced, quality-built instruments is right for your requirements?

NEW! MODEL 131
Low cost pulse generator with rise time of 10 nanoseconds!

$575 f.o.b. Oakland, California

If you've been looking for a high-quality pulser with excellent performance characteristics — but **without a high price tag** — the new E-H 131 was designed for you. The 131's fast rise time and high-power output pulses make it an ideal pulser for laboratory and research applications as well as production line testing of components and solid state devices. Check the 131's specifications. You'll agree it is the outstanding instrument in its price range.

SPECIFICATIONS

REPETITION RATE: 10 cps to 100 kc, internally controlled, zero to 100 kc externally driven.
RISE TIME: 10 nanoseconds.
PULSE DELAY: Zero to 100 microseconds with respect to the trigger.
TRIGGER (for sync. purposes): Positive 10 volt pulse.
EXTERNAL DRIVE: 5 volts RMS or equivalent positive pulse required.
ELECTRONIC GATE: Negative 20 volts required to block the pulse train.
PULSE OUTPUT: 50 volts into a 50 ohm load.
PULSE WIDTH: 100 nanoseconds to 100 microseconds, continuously variable.
POLARITY: Positive or Negative pulses available.
DUTY FACTOR: 10 percent. An automatic limiter prevents overload.
OUTPUT ATTENUATOR: 100:1 coarse selector, 10:1 vernier control.
DIMENSIONS: Standard 19" rack panel, 5¼" high.

E-H MODEL 130 This **double** pulser has repetition rates to 4 mc, rise and fall time of 10 nanoseconds, pulse widths and delay variable from 100 nsec to 50 milliseconds, and delivers 50 volts at 500 ma at 50% duty cycle. Either pulse polarity, output attenuator, and provisions for external drive and electronic gating. Especially suited for fast circuit applications in transistor testing, computer and missile fields. $1175 f.o.b., Factory.

E-H MODEL 121 A high-current pulser delivering a 50 volt pulse into 50 ohms. Rise and fall times 4 nanoseconds. Width variable from 20 nsec to 1 μsec. Repetition rate from 10 cps to 10 mc. Either positive or negative pulses may be selected on the front panel. Ideal for ferrite and magnetic switching studies, applications in high speed transistor and diode switching, and design of logic and memory circuits. $1675 f.o.b., Factory.

E-H MODEL 120B Rise time — 2 nanoseconds—is ahead of the field and offers new tool for fast, high-resolution work. Two outputs independently variable in amplitude (—8 volts into 93 ohms) and widths (2.5 to 25 nsec). Inverting and impedance matching transformer available. Repetition rate 10 cps to 10 mc. Advanced trigger pulse and a fast, flexible gate for complex pulse-time and pulse-amplitude selection. $1275 f.o.b., Factory.

WRITE, WIRE OR TELEPHONE TODAY FOR MORE INFORMATION — REPRESENTATIVES IN ALL MAJOR CITIES

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163 ADELINE STREET • TEMPLEBAR 4-3030 • OAKLAND 20, CALIFORNIA

CIRCLE 23 ON READER-SERVICE CARD

NEWS

1 Million-W Switching in 30 Nsec Reported in Diode Experiment

Semiconductor diodes were used to switch 1 million w in 30 nsec during recent experiments at the Shockley Transistor Unit of Clevite Transistor, Palo Alto, Calif.

The power was believed by Shockley to be the greatest ever switched by semiconductors in such a short rise time.

According to Dr. William Shockley, head of the unit, some 40 4J200 four-layer diodes were connected in series to switch 100 amp at 10 kv. The pulse duration was 4 μsec and the rate "one or two pulses a second," Dr. Shockley said.

"The network," he added, "could be operated at several thousand repetitions per second, such as would be required for radar."

Turn-Off Time Is Faster Than That for Gas Tubes

The 30-nsec rise time compares favorably with typical times possible with vacuum tubes—about 100 μsec—and with the 30-to-50-nsec rise times obtainable from hydrogen thyratrons. Turn-off time for the diode network, however, is from 2 to 8 μsec—better than gas tubes' 10 to 50 μsec.

The Shockley setup, experimental thus far, seems particularly well-suited to driving klystrons, traveling-wave tubes and high-power magnetrons. No heater power would be required in portable battlefield radar, thus increasing battery life from 8 to 24.

The sharp turn-off time is said to be valuable in radar where the pulses are closely spaced, such as in applications requiring a tracking radar to send pulse-coded information simultaneously with its tracking function.

Diodes Driven at 5 Times Their Rated 200-v Peak

Diodes used in the breadboard, which will be featured in Shockley's booth 2118 at the IRE show in New York, are metal-encased, top-hat diodes. Rated at 200-v peak, the 4J200's were actually driven at five times their rated voltage. Specifications call for a turn-on time of 0.1 μsec; the 30-nsec rise time was observed empirically in the breadboard. Rated reverse breakover voltage of the diodes is 60 per cent of the nominal switching voltage, while holding current is rated at 9 to 45 ma. Power rating is 300 mw.

Dr. Shockley said the switching diodes could be packaged in 6 or 7 cu in. and could be somewhat lighter than gas or vacuum tubes. No heater power would be required for the package.

CIRCLE 200 THRU 242 ON READER-SERVICE CARD ➤

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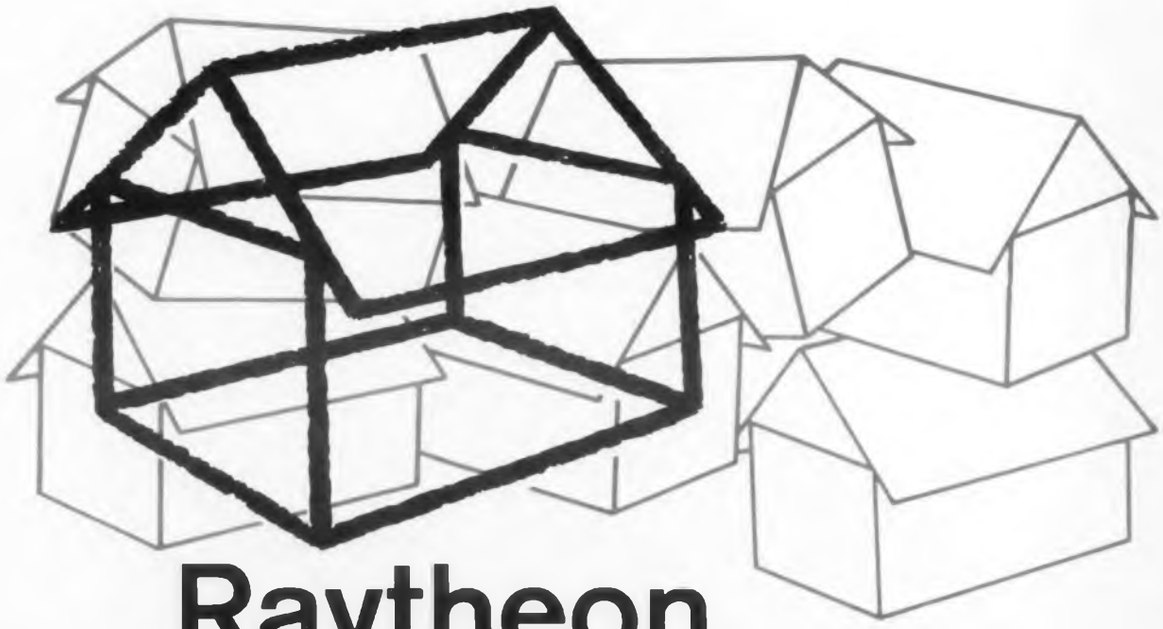

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SILICON AND GERMANIUM DIODES AND TRANSISTORS · SILICON RECTIFIERS · CIRCUIT-PAKS

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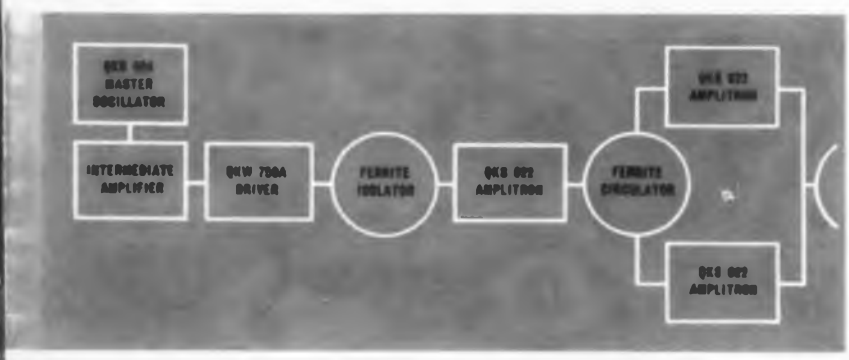
New microwave tubes for broadband, high-power S-band MOPA chains



QKW 750A TWT has 20 db nominal gain and 100 kw nominal peak power to drive Amplitrons in MOPA chains. Duty cycle is .015 for pulsed operation over the 2,900 to 3,100 Mc range. A similar tube, the QKW 782, covers the 2,700 to 2,900 Mc range. *Circle 201 on Reader Service Card.*

QKB 924 BWO is the master oscillator. This tube in conjunction with an external delay line feedback, provides an extremely stable frequency signal over the 2,700 to 3,200 Mc range. Tubes with similar characteristics are available through X-band. *Circle 202 on Reader Service Card.*

RAYTHEON COMPANY

MICROWAVE AND POWER TUBE DIVISION

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The new tubes described on this page make possible highly efficient master oscillator-power amplifier chains with bandwidths of 7%, peak powers of 6 megawatts and average powers of 30 kilowatts.

A new concept in master oscillators permits the precise determination and stabilization of frequency. Thus, the MOPA chain is ideally suited to high-duty-cycle, frequency diversity applications employing fully coherent MTI, pulse compression and pulse-to-pulse frequency shift.

Tubes with similar performance characteristics are also available for MOPA operation in other frequency bands. For complete technical details on this new microwave technique and comprehensive brochure, write to Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts.

Two QKS 622 pulsed type Amplitrons* in parallel operation produce 6 megawatts of power output over the 2,900 to 3,100 Mc range at efficiencies of 75% to 80% and duty cycles as high as .005. The QKS 783 is a similar Amplitron that covers the 2,700 to 2,900 Mc range. *Circle 203 on Reader Service Card.*

**Raytheon trademark*

RAYTHEON

High Power CW X-Band Circulators

Raytheon's Special Microwave Device Operations announces a new line of high-power ferrite X-band circulators which may also be used as isolators in conjunction with suitable auxiliary loads.

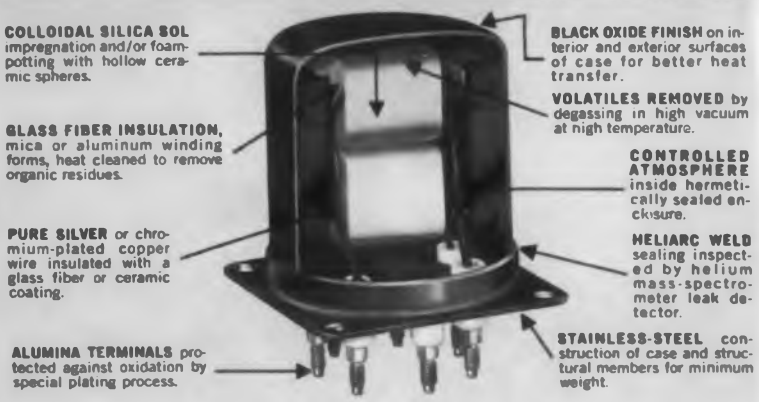
The typical unit illustrated is the model CXH2 covering 10.0 to 10.6 kMc with a continuous power rating of 10 kilowatts. Isolation is 20 db minimum, insertion loss is 0.25 db maximum and VSWR is 1.15.

Used as an isolator, the unit will handle continuous power levels up to 10 kilowatts with a front-to-back ratio of 60:1.

For complete details on this and other significant developments in microwave ferrite devices, please write to Special Microwave Device Operations, Raytheon Company, Waltham Industrial Park, Waltham 54, Massachusetts.

High power X-band circulator CXH2. *Circle 204 on Reader Service Card.*

RAYTHEON



Circle 205 on Reader Service Card.

New Raytheon transformer will resist nose cone temperatures to 1,100°F

Raytheon is now building transformers capable of withstanding temperatures such as those encountered in a re-entering missile's red-hot nose cone.

The unit pictured above resists temperatures up to 1,100 F which is 700 degrees higher than units presently in use. The goal for units now under construction at Raytheon is a minimum operation time of 2,000 hours with an internal temperature 200 degrees above the ambient of 900 degrees.

To accomplish this, Raytheon has developed new construction techniques and high-temperature resisting wire and insulating materials.

For further information on high-temperature transformers please write, stating your specific requirements, to Magnetics Operations, Raytheon Company, Microwave & Power Tube Division, Waltham 54, Massachusetts.

For nearest
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see last page of insert

Typical Specifications • MODEL CXH2

Frequency	10.0–10.6 kMc
Power	10kW (cw)
Isolation	20 db min.
Insertion loss	0.25 db max.
VSWR	1.15
Length	9 3/16 in.
Flanges	UG 39/U
Waveguide	RG 52/U
Weight	Less than 4 lbs.
Water cooled	

RAYTHEON COMPANY

MICROWAVE AND POWER TUBE DIVISION

UHF Planar Triodes for communications, radar, and missile application. Special types available include: quick warm up (12 sec. cathode heating) . . . 7.5 amp pulse current . . . grid pulsed power (2kW to 3000 megacycles). *Circle 206 on Reader Service Card.*

Hard Pulse Modulator Tubes for high power radar systems, precise pulse shaping, high repetition rate, coded signaling. From the industry's strongest line: shielded grid triodes (unipotential oxide cathode, output powers to 3.5Mw); high power triodes (pulse powers to 20 Mw; hold-off ratings to 100kV in production to 350kV in development). *Circle 208 on Reader Service Card.*

Electron tube specialist with major capabilities in these fields . . .

The Machlett Laboratories Inc., a pioneer in the art of high power electronics, offers significant advances in these specialized areas of electron tube design and manufacture . . .

Technical data and product line brochures on request.

High Vacuum Rectifier Tubes for hold-off diode application, high voltage power supplies. 110kV-10 amps, air insulated; 150kV-10 amps, oil insulated. *Circle 209 on Reader Service Card.*

High Power Triodes for communications, industrial heating, pulse modulation. Water and vapor cooled tubes to 400kW CW output. Ceramic, coaxial-terminal construction; lightweight F-A-C tubes, low, medium and high mu. *Circle 207 on Reader Service Card.*

TV Camera and Specialized CR Tubes — Vidicons: for ultraviolet sensitive response . . . low light level . . . near infrared. Scan conversion tube: S/N ratio of 100:1, rf separation not required. *Circle 210 on Reader Service Card.*

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Raytheon's complete line of components for industrial and military applications

Choose the most reliable electronic components available. Precision-produced by the Industrial Components Division, this broad line encompasses practically every electronic circuit requirement from electron tubes to the most advanced and sophisticated innovations in electronic components. Full technical data can be obtained by writing to: Industrial Components Division, Raytheon Company, 55 Chapel Street, Newton 58, Massachusetts.

Storage Tubes

The advanced design features of Raytheon recording storage tubes offer designers of radar systems many new application possibilities. A full line of single- and dual-gun types enable the design of unique circuits for scan conversion, retention, and signal integration. *Circle 211 on Reader Service Card.*

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Subminiature Tubes
Raytheon, leading manufacturer of subminiature tubes, maintains an unprecedented program of quality control. Outstanding features of Raytheon subminiature tubes include: reduced vibration output, superior characteristic uniformity, reduced microphonic output, controlled operation time, tightened characteristic limits, greater resistance to shock and fatigue. *Circle 213 on Reader Service Card.*

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Innovations in grid manufacturing techniques and advanced quality control methods result in higher performance and dependability in receiving tubes for radio, TV, high-fidelity, and mobile communications. *Circle 214 on Reader Service Card.*

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Wide band noise source modules are small, rugged, and require low power. They permit the successful design of extremely compact, portable test equipment and systems capable of reliable operation over wide extremes of shock, vibration, and temperature. *Circle 215 on Reader Service Card.*

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Printer, infrared stimulable, and high-altitude CRT's like the CK1354 and CK1355 illustrated, are representative of Raytheon's advanced development techniques in cathode ray display devices. Many types—oscillographs, radar indicators, video recorders, and flying spot scanners are available for industrial and military applications. *Circle 216 on Reader Service Card.*

Raysistors
Raysistor control devices are electro-optical components designed to operate efficiently as relays, potentiometers, choppers, commutators, and high voltage controls. No mechanical parts mean long trouble-free operation in many circuit applications. *Circle 212 on Reader Service Card.*

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Filters

For multiple narrow band filter channel applications, Raytheon magnetostriction rod filters are more rugged, weigh less, take less space and are more precise than other types available. Single filter and arrays are available in both stock and custom designs. *Circle 218 on Reader Service Card.*

Rayspan Spectrum Analyzers

Utilizing a unique magnetostriction filter application, Rayspan Spectrum Analyzers provide the outstanding features of high speed, high resolution, and high sensitivity. Operating over a wide frequency range they enable the analysis of pulses and transients and distinguish weak signals. *Circle 219 on Reader Service Card.*

Low Power Industrial and Transmitting Tubes

Popular rectifier, series regulator, and transmitting types featuring greater efficiency and reliability are available. Tubes are outstanding for their higher voltages, higher power, and higher temperature handling capabilities. *Circle 217 on Reader Service Card.*

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Raytheon Weld-Pak circuit modules contain more than 100 components and 300 welds in each cubic inch. A full line of standard computer logic modules, as well as complete custom-design service is available. Raytheon also provides a complete line of Weld-Pak neon, incandescent, and thyratron light indicator packages. *Circle 222 on Reader Service Card.*

Accelerometers
The EM900 piezoelectric accelerometer illustrated, is a general purpose type. It accurately measures shock up to 100,000 G's and vibration up to 10,000 cps with no measurable hysteresis and is operable in ambient temperatures ranging from 100° below zero F to 500° above zero F. *Circle 223 on Reader Service Card.*

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New portable fully transistorized d-c power supply. QR36-4AP regulates 0 to 36 vdc output voltage to ± (0.02% + 1mv) against combined line or load variations. Fully metered. Front panel terminals for remote sensing. *Circle 224 on Reader Service Card.*

New portable high-voltage supply Model 230-6P has unusually versatile controls, unusually complete protective features for a unit of its size. Rated: 0-30,000 vdc, at 0-6 ma. Reversible polarity. "Coarse" and "Fine" front-panel voltage adjustments. *Circle 225 on Reader Service Card.*

New wide-range three-phase frequency changer, Model FCR3P300, supplies up to 300 volt-amperes, three-phase, at any frequency in the range 45 to 2000 cps. Low distortion. Also rated at 200 VA two-phase or 300 VA single-phase. *Circle 226 on Reader Service Card.*

Three new models added to Sorensen line of off-the-shelf controlled power units

. . . just a sample of the more-than-400 Sorensen models . . . including regulated d-c power supplies, a-c voltage regulators, voltage regulating transformers, high-voltage d-c power supplies, high-voltage a-c and d-c testers, and miniature component-type inverters, converters, and d-c supplies. Request your copy of the new 1961 Sorensen "Power Supply Handbook and Catalog" from Sorensen & Company, Richards Avenue, South Norwalk, Conn.

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Sorensen

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SORENSEN & COMPANY, INC.

SOUTH NORWALK, CONNECTICUT

Analog-Digital converter handles 5 million information samples/second

Faster than any other available, Raytheon's new A-D converter provides up to 5 million independent 8-bit words per second.

The machine's twenty-five nanosecond aperture time allows digitizing of pulses less than one-half microsecond in width.

About the size of an office typewriter, the A-D converter offers industry and government a basic solid-state tool which significantly extends the state of the art.

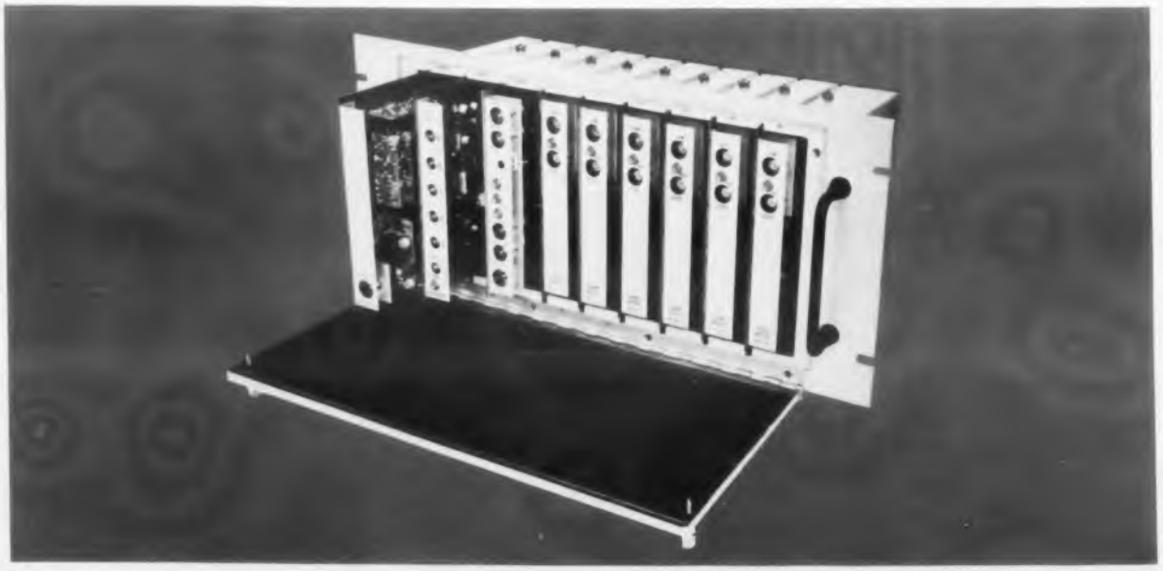
The machine lends itself readily to system integration because its flexible design allows acceptance of variable input as well as wide variations in output format and logic.

With multiplexed input, its applications encompass any product or process requiring continuous or intermittent digitizing of analog voltages in any form.

For complete specifications please write Communications and Data Processing Operations, Raytheon Company, 225 Crescent St., Waltham, Massachusetts.

For nearest Raytheon Sales Office see last page of insert.

Analog-Digital Converter, about the size of an office typewriter, is readily integrated in data handling systems. *Circle 227 on Reader Service Card.*



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Power, protection, regulation . . . all three in one transformer!

Series 2020 Voltage Regulating Transformers cost less than ordinary transformers plus associated regulating circuitry.

Is the transformer in your power supply merely supplying power or does it *regulate voltage* and *protect circuits*, too?

Raytheon's Series 2020 Voltage Regulating Transformers perform all *three* functions. They (1) provide the specified voltage and current from 10 VA to 10,000 VA, (2) stabilize voltage within ± 1% and (3) protect tubes and delicate semiconductor rectifiers against power surges as well as internal and external short circuits.

These versatile "magnetic regulators" are extremely compact and inexpensive, too—take less space and cost less than ordinary transformers plus associated regulating circuitry.

Send for convenient Raytheon Selection Guide and Power Supply Design Data that helps you match your requirements from 2,020 standard units. Commercial Apparatus & Systems Division, Raytheon Company, Keeler Avenue, South Norwalk, Conn.

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Series 2020 magnetic regulators are available in a wide range of models and styles. Convenient selection guide lets you choose from 2020 different units. *Circle 228 on Reader Service Card.*

New low-cost regulated dc power packages. These compact "RD" units are available in 132 different ready-to-operate models for standard 19-inch rack installation. 3 to 1,000 volts, 50 to 3,000 watts in 20 voltage steps and 7 power ratings. DC output is isolated and filtered with a ripple reduction to within 0.5 to 1.0% depending on model. *Circle 229 on Reader Service Card.*

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1961 WESCON Takes Shape As Officers Are Appointed

Principal board members for the 1961 WESCON have been named by the show's directors.

Chairman of the WESCON board this year is Albert J. Morris, president and general manager of Radiation at Stanford, and chairman of the executive committee is O. H. Brown, assistant for corporate relations, Eitel-McCullough, Inc., San Carlos, Calif.

Convention director is Dr. John V. N. Granger, president of Granger Associates, Palo Alto, and show director is Calvin K. Townsend, vice president of Jennings Radio Manufacturing Corp., San Jose, Calif.

Don Larson continues as manager of WESCON, which will be held this year in San Francisco, Aug. 22-25.

New Polaris Guidance Planned

A Mark II inertial guidance system for an advanced, 2,500-mile version of the Polaris missile is under development by a team of 300 engineers and technicians at Massachusetts Institute of Technology's Instrumentation Laboratory. Shown inspecting the Mark I system, used in the present 1,200-mile version and a 1,500-mile Polaris now in development, are Ralph Ragan, left, deputy associate director of the Laboratory, and David Hoag, right, assistant director. These two head the Mark II system team.

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Current:	10^{-11} to 10^{-5} amp. f.s.; to 3% of f.s. to 10^{-9} amp. 4% beyond.	10^{-11} to 10^{-4} amp. f.s.; to 3% of f.s. to 10^{-9} amp., 4% beyond.
Resistance:	10^5 to 10^{11} ohms f.s.; to 4% of f.s. to 10^9, 5% beyond.	10^5 to 10^{12} ohms f.s.; to 4% of f.s. to 10^9, 5% beyond.
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advances in pattern recognition

an ELECTRONIC DESIGN staff report

Advanced Concepts Studied for Pattern Recognition

Survey Indicates Many New Systems in Early Hardware Stages—Variety of Approaches Taken

Alan Corneretto
News Editor

DESIGNERS are widening their efforts to develop general-purpose pattern-recognition systems and are producing a stream of intermediate developments based on advanced concepts. The systems and devices under consideration represent many approaches to efficient, versatile pattern recognition.

Some conclusions can be drawn about the efforts to date. Any major appraisal would find:

- More organizations than generally supposed are conducting research in perceptron types of systems.
- This research is part of a growing investigation of neural-net devices and systems.
- Use of digital techniques and general-purpose computers is gaining favor.
- Many specialists consider the problem of pattern recognition to be one of learning and believe its solution is dependent on advances in adaptive-system and heuristic-programing techniques. Pattern recognition work is also linked to the growing activity in bionics.
- The first useful machines will be straightforwardly designed and nonadaptive. Some of these, the prepared-image readers, already exist.
- Achievement of general-purpose pattern recognition is considered many years away and will come gradually.

Many Organizations Conducting Research in Neural-Net Systems

Many groups conducting pattern-recognition research are building neural-net systems based on the concept of the original perceptron at Cornell Aeronautical Laboratory. This group includes Burroughs, Aeronutronic, the University of Illinois, Philco, and Stanford Research Institute. At the Cornell laboratory a Mark II perceptron is in early development.

Some of these organizations and others, including MIT in Cambridge, Mass., are exploring the problems of pattern recognition with perceptron-type computer simulations.

Other companies, notably Bell Telephone Laboratories, Lockheed, Radio Corporation of America, and General Electric, are using neural-net devices, similar to those basic to perceptron systems for research in pattern-recognition systems that do not use perceptron-type logic. Telefunken in Germany is reported to be building an entire general-purpose computer using neural nets.

Other hardware models using advanced concepts are being built. However, several groups, including International Telephone and Telegraph and the University of California, are developing novel systems based on correlation techniques. At Manchester University in England a system is being designed for a flying-spot-scanner input expected to code the patterns it scans. Such a scanner is in use at Bell Telephone Laboratories in this country.

Waveform and Speech-Recognition Research Also Being Pursued

At General Electric, Schenectady, N.Y., and at the University of London adaptive filters have been constructed that are able to recognize waveforms of varying types. The GE filter will converge automatically on any waveform in its range. The London University filter must be taught, but it can be made to recognize a sine wave in noise after about 50 teaching runs.

Speech has been recognized with specially built equipment at many organizations: International Business Machines, Bell, Stromberg-Carlson, ITT, Kyoto University, Japan, and the Air Force Cambridge Research Laboratories. Litton Industries is sponsoring a speech-recognition program that has reached the hardware stage.

Computer Programing Considered Powerful Approach to Recognition

All the systems mentioned above make use of specially designed hardware and all are, or are expected to be, relatively versatile—to be teachable to some degree. Adaptive behavior, however, may be achieved by programing computers—either general-purpose or special machines.

Some proponents of this technique expect that it will prove the most practical method. MIT, GE, IBM, and Lincoln Laboratories are working to develop versatile computer programs for general pattern-recognition problems.

Such programs, hopefully, would develop features for themselves that would help recognize patterns. A surprisingly large effort is being made to develop heuristic programs.

This type of program, in addition to containing much information about specific problem areas, has routines enabling it to deal adaptively with the unexpected. This contrasts with the traditional algorithms of most programs, which are written by designers able to anticipate every possible path needed to process a problem.

The combination of heuristic programing and list-processing languages, which provide easy access to data in complex list situations, is expected to be a powerful part of the next generation of pattern-recognition systems.

The conditional-probability computers, which are designed to operate somewhat like the brain,

Mark I perceptron, now moved to Cornell University, first full-scale learning machine used for pattern recognition, is prototype for smaller versions in many organizations. Mark II now in design at Cornell Aeronautical Laboratory will be special-purpose digital computer programed for threshold logic. Elements shown are transistor-driven relay circuit that operates as association units.

are another approach to recognition. Based on the original model developed at England's National Physics Laboratory, a simpler version is being built at the University of Saskatchewan, Canada.

The Canadian model is intended for pattern-recognition research related to industrial-process control. These computers are designed to overcome some of the limitations of analytical-type systems. Stromberg Carlson engineers are considering building a conditional probability computer for use in speech-recognition research.

A type of conditional probability program has been written for an IBM 709 at MIT's Lincoln Laboratories. It has successfully identified sloppily, hand-printed letters. The simulated system is adaptive, in that it learns from the input data, and it is parallel processing, reserving its decision until all comparisons are made. In effect, the system is size and position invariant. It does not require normalizing of patterns.

Nonadaptive Systems Developed For Character and Other Recognition

The hardware and programing systems described above include some degree of learning in their operation. Another large effort is dedicated

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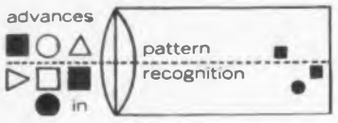

to producing pattern recognizers that are fixed in their behavior. These, which include the RCA, IBM, Farrington, Briggs, Solartron, Rabinow, Baird-Atomic, and National Data Processing optical readers, use fixed-logic, template-matching, or correlation schemes to achieve recognition.

Other systems, including a Bell Laboratories handwriting reader, a Maxson celestial-pattern recognizer, a Space Electronics Corp. optical correlation system for photo processing, and the ITT and Cambridge Research Laboratories speech recognizers, are fixed recognition systems that are finding useful applications in other than character reading.

Special Tools from Research Incorporate Novel Electronics

Another class of devices is resulting from the effort to automate pattern recognition. This consists of all the aids and special-purpose tools used to facilitate research and development. (See p 42) Philco, which is intensively investigating cathode-ray-tube system inputs and outputs in its recognition work, has developed electronic-gun circuitry and crts having tubes for resolutions equivalent to about 6,000 TV lines.

The company has also built an M-1 special-purpose computer with easily changed connections as an aid in the simulation of pattern-recognition systems.

Aeronutronic engineers have built a small perceptron, or learning network, and are constructing a medium-scale version to test a magnetic integrator element for Cornell Aeronautical Laboratory's perceptron program. These elements are intended to replace the W-units or

Pattern-Recognition Approaches Varied and Hard to Classify

The pattern-recognition systems being researched cannot be divided easily into categories. Techniques such as analog and digital operation, serial and parallel processing, predetermined and random organization, element matching and feature matching and computer-program and special-hardware implementations are used in many combinations in the systems being developed. In some designs the techniques are fundamental to the approach, in others they are not.

Three General Approaches, But Systems Blend Methods

If it were not for the mixing of techniques, systems could be divided into three groups:

1. Analytical methods, in which a pattern is analyzed into parts for processing and generally requires the storage of image characteristics.

2. Conditional-probability methods, in which features are analyzed and stored but are compared with new patterns on a probabilistic rather than absolute basis. This recently developed method is not yet receiving much attention.

3. Perceptron methods, in which patterns are either considered as a whole (or gestalt) or by some invariant properties they possess.

However, many systems, particularly those designed for general-purpose use, incorporate elements of more than one of these approaches.

Another way of considering, but not of classifying, systems is to distinguish between those that make an *a priori* analysis of patterns to be detected and those in which a given action and its result are determined *a posteriori*, so that operations continue on the basis of past experience.

In the *a priori* approach, common to many analytical or template-matching and correlation types of recognition systems, features are programed into the system so that characteristics that distinguish the input patterns from each other are used to narrow the task of recognition. A pattern tree or other scheme is then used to make the final decision.

In this approach, reports C. A. Rosen of the Stanford Research Institute, the main challenge is to provide positive recognition of a limited number of primitive characteristics in the presence of noise, distortions, and misregistrations.

In the *a posteriori* approach, followed in variable network designs, like perceptrons, individual bits of data are not considered definitive, and the processing techniques determine which are to control recognition. After many operations have been defined, they are applied to representative input material, for which the correct decisions have been independently obtained.

This permits assignment of weights relating every operation to every output. The importance of any operation therefore is determined *a posteriori* from typical rather than from ideal input data. Once the weights have been assigned, the data from new inputs are processed by the weights to produce a value for each possible output. The decision is based on which value is largest or whether one or more exceed predetermined thresholds.

This decision is generally not made until all processing is completed. This feature is a characteristic of parallel-processing systems. This type of processing, which is used in most perceptrons, lends itself well to the *a posteriori* approach.

The *a priori* types are generally serial and relatively simple systems. They use decision logic, stored features, or templates and correlation techniques, or combinations of these to process patterns. To operate, these systems generally depend on memory storage of explicit descriptions of target patterns.

This characteristic reduces system flexibility because of the difficulty of allowing for all distortions, translations, transformations and other variables in the character and presentation of an image to be processed.

Pattern Properties Studied For More Flexible Systems

To gain more flexibility than that afforded by prototype-derived pattern-recognition systems, other approaches have been developed. One of the most promising appears to be the manipulation of properties of a pattern. Many researchers are studying the fundamental characteristics of patterns hoping to abstract key features that would give more information than that already analyzed.

It appears that in nature much image processing occurs in periphery components of the main processing organ. This is believed accomplished by the manipulation of key pattern properties that are invariant under many transformations and other distortions. In electronic analogs of biological retinal systems, input stages that are, in effect, property filters bear a good part of the processing load.

The development of bionic hardware, such as

synaptic junction elements of the original perception.

Another tool designed for pattern recognition research is Bell Laboratories' generalized scanner. This is basically a flying-spot scanner that can be programed. It is used with a general-purpose computer that simulates recognition logic. The combined system reportedly permits any character-recognition method to be studied.

Many of the systems and devices mentioned above use novel concepts in pattern recognition and are described in the following pages.

simulated neurons or threshold switches, complements the concept of property filters and has made hardware models of neural-net systems practical at this time. Because of their threshold action and their suitability for digital and analog circuits and parallel processing schemes, neural-net systems are being used more and more in pattern-recognition research.

Some specialists believe that these systems, which are able to handle Boolean and other logics, will prove the most practical for pattern-recognition work.

Both neural-net systems and conventional digital computers are being programed to enable them to generate useful features, such as properties, processing procedures, and decision sequences. In such systems, the connections of the neural elements or digital logic circuits become signal paths that are either reinforced or made difficult so that experience is acquired, making possible a somewhat adaptive performance.

New Statistical Methods Hold Promise for Pattern Recognition

Pattern-recognition programing, especially of conventional digital computers, is being attempted with the latest statistical methods. Researchers at the Massachusetts Institute of Technology believe that sufficiently powerful statistical techniques might prove the best tools of all for pattern recognition.

Conditional-probability computing systems, in which patterns are compared with stored data by probability-theory techniques, appear to be a compromise that uses to advantage the merits of template-matching and analytic systems and computer-program systems.

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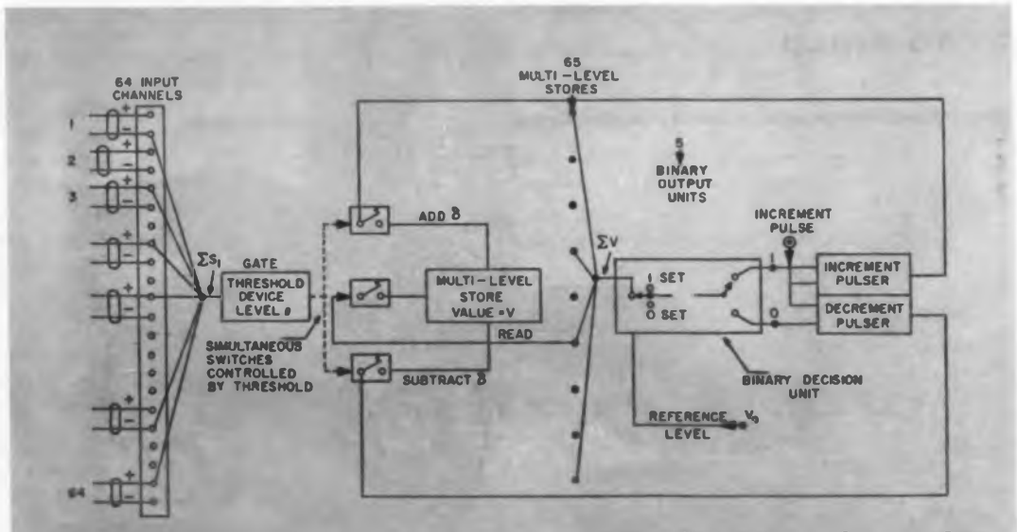
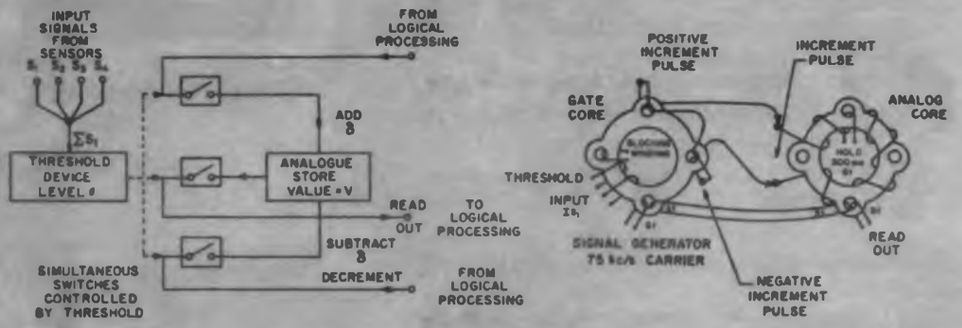


Small, parallel-connected learning machine for pattern recognition studies is undergoing first tests at Stanford Research Institute. System is designed to operate with multiaperture magnetic cores as threshold logic and analog storage elements. Connections are now random and logic is of perceptron type. However, nonrandom connections are planned as well as use of other types of logic. Unit is feasability model for larger version desired by Signal Corps for photointerpretation work. Research is part of larger SRI program looking toward eventual application of microcomponents built by electrom-beam etching techniques and SRI's photoprocessing technique for removing redundant information from photographs.



Basic element of SRI's experimental perceptron is the neural simulation consisting of two multiaperture ferrite cores with windings and a diode. The simulation shown is the equivalent of the block diagram of the basic perceptron circuit. In this circuit, inputs from the sensors are summed to generate an input signal that is compared with a threshold. If the input signal is greater than the threshold, the three normally open make-and-break contacts are closed and the unit is active. A signal level proportional to the stored weight is read out from the store and processed by subsequent threshold-logic elements. On the basis of the subsequent processing, the analog store may receive either an increment or a decrement to its store. The multiaperture devices lend themselves to this operation and meet the requirement that inactive units remain isolated from the active system and do not have their stored weights changed as long as they are inactive.

At Stanford Research Institute, Palo Alto, Calif., tests are just beginning on a perceptron-type pattern recognizer built for feasibility studies of various concepts and devices. The institute's program is being supported by the Signal Corps under an 18-month study contract in the hopes that a fairly large version of the machine capable of useful work like photo interpretation will result.

The SRI system is designed for parallel processing and for the use of a set of compatible magnetic components. Institute researchers have found a way to use multiaperture magnetic cores, designed originally for digital logic, for threshold logic and for analog storage. These elements form the basic components of the system, where they are used as multilevel storage, in gating functions, in controlling threshold level and for summation.

First stage of the system is an 8 x 8 array of photocells in which power level is about 5 ma at 0.4 v per element. Eventually some form of prescanning, either graphical or electronic will be included in the input system.

The multiaperture-core neural simulations operate in 65 gate circuits that simultaneously sample data from the photocell array and sum about 10 of the cells. Summed outputs to the gate circuit are compared with threshold levels so that the circuits for which the threshold has been exceeded will become active. One of 65 multilevel elements stores signals for each circuit that is activated.

Learning Controls Signal Amplitude; Decision Units Sum Signals

Amplitude of each signal depends on the information learned by the machine. Each of the stores has 20 useful levels. Output from them is sampled by five decision units, each of which sums its set of signals for comparison with a reference level. If the sum is greater, the decision unit shows a one, if less, a zero.

Learned information is introduced into the multilevel stores without difficulty. Initially all the stores are half full, and the reference signal against which the decision unit makes its comparison is set equal to the average summed input resulting from presentation of an image.

Inputs to the decision units are transferred from the output circuits of the multilevel stores

to a switch bank that provides signals corresponding to a selected, arbitrary output code. Pulse generators that are controlled by the decision units are tied back to the multilevel stores by increment and decrement circuits, and some of these have active gates selected by the input pattern.

The "1" and "0" pulse generators in each channel control reciprocal sets, so that when an increment button is pressed, the active units that are tied to a "1" channel—when a "1" has been set for that binary—receive an increment to their stores. Alternatively, the store receives a decrement.

This is the perceptron logic that has been wired into the feasibility model for its first tests. Connections are random and there are 32 binary output codes.

In the original perceptron, multilevel storage was done by motor-driven potentiometers; in the Mark II storage will be handled by magnetic integrators being designed by Aeronutronic. These units are versions of the company's biax cores.

The SRI neural simulations consist of only two standard ferrite cores, several copper windings and a diode. However, they provide compatible input-output connections and power gain. They are said to be an excellent coupling element for the multilayer logic systems that form part of neuron simulations.

Other Perception Systems Designed

The Mark II perceptron, just reaching the hardware stage at Cornell Aeronautical Laboratory, Buffalo, N.Y., will be faster and less complicated physically than its predecessor, which has been moved to Cornell University. The Mark II is designed as an all-digital system. It will be essentially a general-purpose computer programed for neural-net logic.

Input will be serial, but arithmetical processing will be parallel. Printed-circuit-board A-units will be interconnected, which was not a feature of the analog Mark I. Processing speed is expected to be as high as 10 kc, which could result in recognition time of 1 second per pattern. A drum with a 4-μsec read-write cycle and a 250-kc bit rate is planned as the memory.

A similar perceptron is under construction at Burroughs Corp., Paoli, Pa. Called Albert I, this system, like the Mark II perceptron, is a specially designed general-purpose computer programed with special instructions to process by neural-net logic. It is almost complete and is expected to be debugged and ready for its first tests sometime this summer. Its primary function is to aid re-

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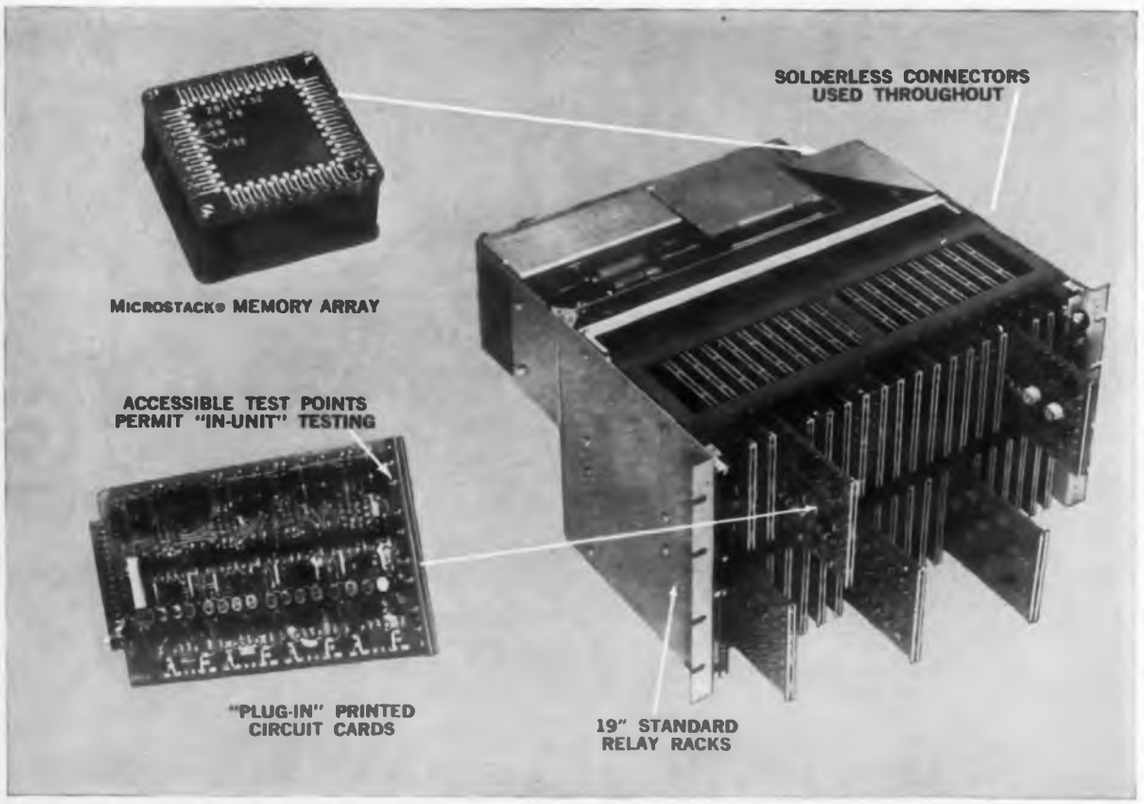

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advances in pattern recognition

search into the behavior of neural-net systems.

Patterns will be scanned by a flying-spot scanner operating at 40 lines with 40 elements per line. The raster will then be transferred line by line for subsequent processing to a standard 31-band drum memory. Add time for the system is 0.5 μsec per bit; logic-circuit speed is 2 mc.

The system was originally developed as a simulation of Cornell's perceptron but is now all digital and has cross-coupled A-units. Company engineers have developed a ferrite-core neural simulation for a later version. Albert I uses flip-flop circuit-board neural elements.

Another digital recognition system is nearing completion at Stromberg-Carlson, Inc., Rochester, N.Y. A distributed-state response model like the perceptron, but fundamentally different because of the use of a novel type of variable-network theory, this system incorporates variable nets that are represented symbolically in the digital logic of the system's organization. This organization is implemented by a magnetic storage drum.

Like other perceptron-class recognizers, the system will operate on a reward-punish basis, with stimuli building paths through association elements to favor taught responses.

The system is essentially a special-purpose digital computer. Input is provided by a flying-spot scanner with 1,024-bit resolution. Flip-flop circuit-board construction is used.

A simplified simulation of the system on an IBM 650 recognized hand-made drawings. Performance of the actual system is expected to be better than that of the Mark I perceptron.

Although some researchers are not optimistic about the future role of perceptrons in pattern recognition and are critical of their performance so far, improved performance of these systems seems assured. The development of magnetic integrators and multiaperture cores for use in threshold logic circuits, where they afford efficient driving without the need of transistors or other active devices, is expected to result in more powerful logics and more efficient systems. Aeronutronic, Stanford Research Institute and Burroughs are developing such elements.

Optical elements for neural nets may prove of great benefit to perceptron systems. General Electric is building an elaborately connected neural simulation that consists of electroluminescent cells and photoconductive layers. It will be used by Wright Air Development Div. in the

investigation of new neural-net systems.

RCA has constructed pattern-recognition devices that use similar optoelectronic cells in neural-net arrangements. These cells use photoconductivity and electroluminescence to achieve thresholding, inhibition, standard-pulsing and the other characteristics of neural simulations. The elements are optically coupled to each other in matrices.

At RCA an optoelectronic pattern recognizer has been built that duplicates the four types of property filtering believed to occur in the frog's eye.

At Armour Research Foundation, Chicago, researchers are investigating ways of combining optical fibers with photochromic globules in pattern-processing systems.

Italian Researcher Increasing Number Of Optimal Weighting Values in A-unit

New horizons for perceptrons are being explored by Prof. A. Gamba of the University of Genoa, Italy. Professor Gamba has constructed equipment to support his theory that perceptron A-units would contribute more to efficient system operation if they were able to store more than one optimal weighting value each. In most current perceptron designs each A-unit stores only one value—the best single function of the optimal value that aids in applying experience to new decision making through reinforcement.

Professor Gamba is also investigating the possibility of correcting the threshold of each A-unit. This would help in choosing the criterion that activates the A-unit usefully. Threshold correction would help avoid the inefficiency of having many A-units active for most pattern-recognition tasks.

A perceptron of novel design that incorporates these concepts has been described by Professor Gamba. In it the threshold of an A-unit triggers a beam of light to one or the other side of a film strip, according to whether or not it is active. Different classes of patterns correspond to different regions along the strip. If an equal number of patterns of each class is shown during the training period with equal exposure time for each pattern, the density of grains in each region could be made directly proportional to one of the factors determining the most useful criterion for a decision.

Series of A-units could be arranged in a rectangular plate, with each vertical strip being an A-unit and each horizontal row corresponding to a class of patterns. A pattern to be recognized would be compared with the total amount of plating in the activated regions of the horizontal rows. The A-units that are more uniformly plated would have their thresholds changed so that another training sequence could be made.

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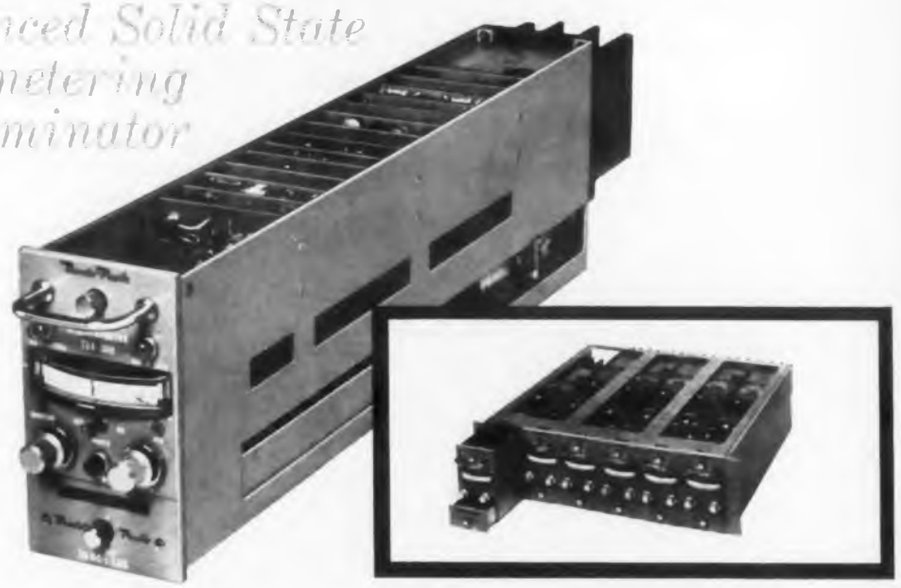

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POWER REQUIREMENT	Integral power supply operates from 105 to 125 volts rms at 40 to 420 cycles per second. Power consumption is less than 40 watts
SIZE	5¼ x 2 13/16 x 20 inches

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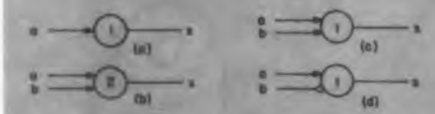
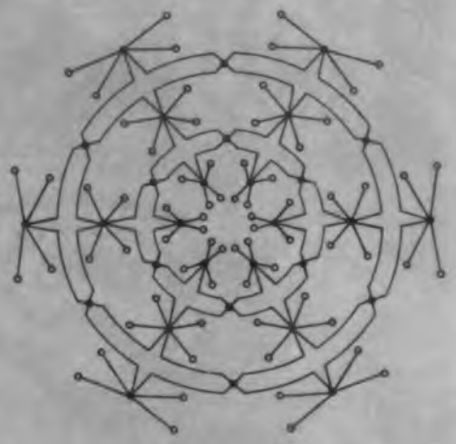
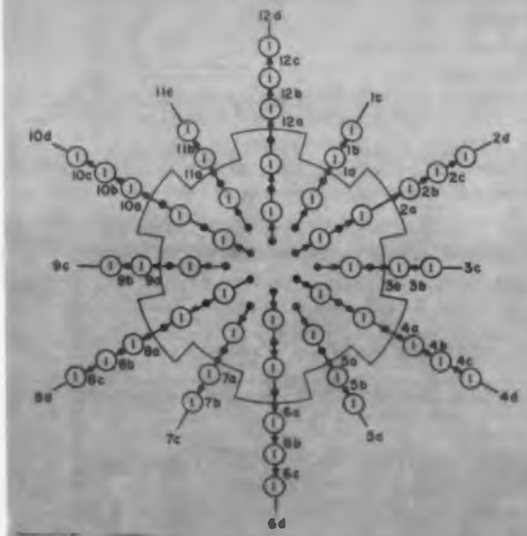
Visual Recognition System Reliability Designed to Operate Like Biological System



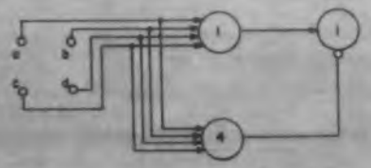
Neural-type elements of pattern-recognition system proposed by Prof. J. R. Singer, University of California, operates as (a) simple delay which provides a standard output pulse after a delay; (b) an "and" circuit that provides standard pulse after appropriate input lines have been stimulated within specified time; (c) an "or" circuit that acts like (b) but requires only one pulse to obtain an output pulse from the circular delay element; and (d) a bridge circuit, which provides a standard delayed pulse when one input line is stimulated and the other is not during an interval—the small circle on line b indicates an inhibitory input and the arrow on all lines a indicates a stimulating input. Numbers in circles denote pulses required to obtain an output pulse from circular delay element.



Input of system would be network of 72 photoreceptors differentiated four at a time and also in clusters of 16. Solid black circles represent 36 optic fibers to carry differentiated signal pulses. Entire system was designed to operate as closely as possible to a biological image processing organ. It would be used as input to computer in which stored patterns would be available for comparison.



Network of logic elements is designed to transform 36 optic fibers into delay space. Each unit of length for an image transforms into a specified unit of time. Dark disks represent optic fibers, and cogshaped borderline represents outer boundary of delay transformer. Delay space lies outside this line. Image of a circle would be recognized by a coincidence of all even or all odd radials.



Output from four photoreceptors can be combined with this circuit to obtain an output signal if one, two or three receptors are stimulated, but not if all four are stimulated. In a practical system this differentiator would emphasize image borders.

A parallel-processing, analog symbol and character system has been designed by Prof. J. R. Singer, University of California, Berkeley, as an input to a computer decision system. The system, for which logic arrangements are still being worked out, was designed to operate as closely as possible to the way a human recognition system is believed to function.

One of the principles basic to the electronic analog is that a group of transformations exist that will map a figure along manifolds of neurons in a way that leads to size-independent recognition response. Figure-size invariance, some tilt invariance, and majority decision have been designed into the system.

It would operate this way: an image would be projected on an array of photoreceptors, and would be differentiated and transformed by logic circuitry. The image would then appear in delay space, where the activation of specific lines analogous to nerve fibers would denote specific images.

In the delay space that Professor Singer describes, a symbol would be stretched in a very organized dilatation. This consists of projecting the symbol in an incrementally increasing size, while preserving shape, along a set of axes that are pulse carriers. Each pulse on a line carries one resolved element of the symbol and the pulse travels out on the line at a speed related to the propagation characteristics of the lines and delay elements. These would be primarily pulse-regeneration and synchronizing systems.

In recognizing a circle with the arrangement of receptors and delay-space logic elements shown in the drawings, the recognition circuit consists of a coincidence of all the even or all the odd radials.

Features of the system, which may coincide with biological features, are:

- All photoreceptors would be active for an interval, then would relax while the image is processed. This may be analogous to recovery time in neurons.
- Large images would be recognized more rapidly than small ones—they traverse fewer delay elements.
- Outline drawings may be more readily identified than silhouettes.
- It appears as though all symbol recognition would have to be designed to use previously stored recognition circuits to reduce the number of elements needed.

- Recognition of an image larger than the outermost ring of receptors would be difficult without resizing.
- There would be tradeoff among the number of recognizable symbols, the degree of allowed tilt and the distortion of each image.
- Stimulation time of photoreceptors would be generally much smaller than recognition time.

Optical Matcher Designed

A pattern-recognition system that works by optically matching images to be recognized with miniature stored images is under development at Space Electronics Corp., Glendale, Calif. Several engineering models of portions of this system have been built with the support of the Wright Air Development Div.

The system, called Simicore, for simultaneous multiple image correlation, works this way:

A received pattern passes through a bundle of fiber optics or through a mosaic of lenses and is multiplied many times so that it focuses on an array of images recorded on a plane. Each of the stored images is a pattern to be recognized. All may be the same image in different orientations or degrees of distortion.

A phototube pickup senses the light passing through the successfully matched pattern and indicates recognition.

Small neural-net, perceptron-type learning machine was built at University of Illinois and learned to recognize patterns. Modules are neural elements that have now been cannibalized to construct a larger, more versatile pattern-recognizer.

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AC103	AD103	AF103	AH103	AJ103	(10 kc)	ZJ103	ZH103	ZF103	ZD103	
AC153	AD153	AF153	AH153		(15 kc)	ZJ153	ZH153	ZF153	ZD153	ZC153
AC203	AD203	AF203	AH203		(20 kc)	ZJ203	ZH203	ZF203	ZD203	ZC203
AC403	AD403	AF403			(40 kc)		ZH403	ZF403	ZD403	ZC403
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AC104	AD104	AF104			(100 kc)			ZF104	ZD104	ZC104
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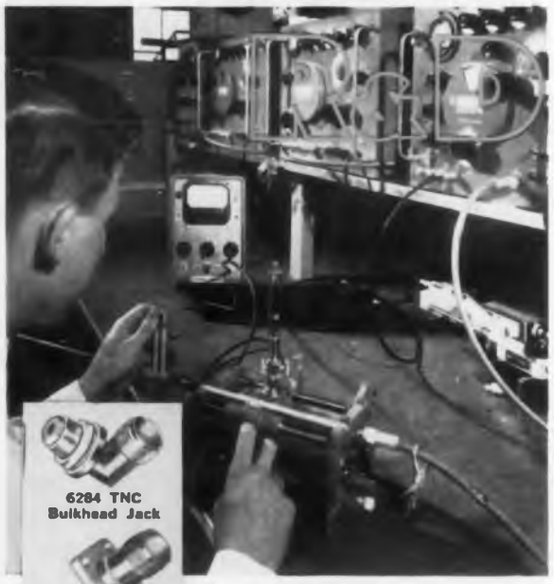

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advances in pattern recognition

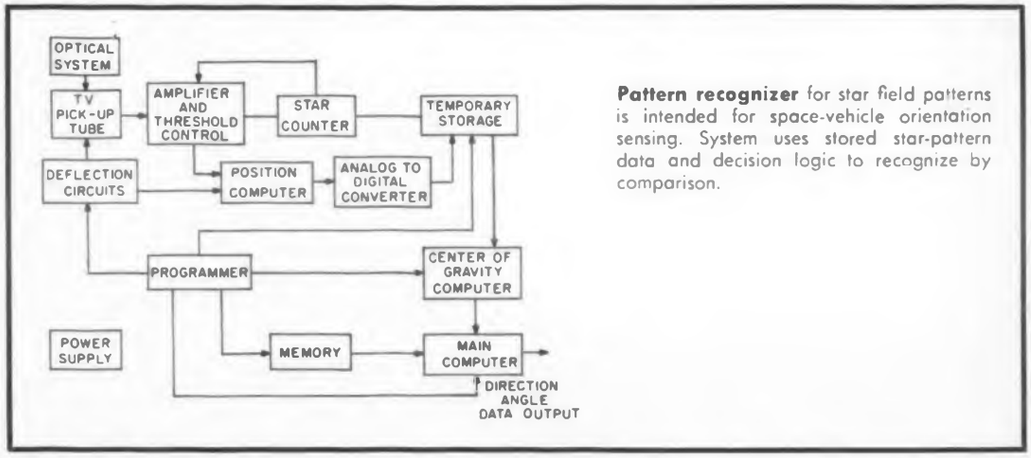
Celestial Pattern Recognizer Would Use Stored Star Fields

Engineers at W. L. Maxson Corp., New York City, have designed a pattern recognizer for sensing orientation of a vehicle in inertial space. The system would recognize patterns of stars by comparing them with patterns in its memory.

In operation, an optical system would focus a sector of the celestial sphere on a vidicon pickup. Deflection circuits would supply signals for scanning and would provide coordinate information for each star during scan. An amplifier would provide thresholding for selecting stars of appropriate brightness. A counter would use a shaped signal to establish the number of stars of the selected brightness.

Star count information and encoded position information would be obtained in blocks and stored in a programer-controlled buffer store. The programer would also sequence the processing of recognition and the computation of direction angle. This would be done by a center-of-gravity computer and a main computer, respectively. The programer would also control withdrawal of reference data on individual stars from the memory.

Maxson believes that the system could be designed to weigh less than 36 lb and use less than 200 w when on. With redesigned logic it could be expected to operate adaptively, reports Maxson.



Pattern recognizer for star field patterns is intended for space-vehicle orientation sensing. System uses stored star-pattern data and decision logic to recognize by comparison.

Many Approaches Pursued in Developing Pattern Recognizers for Speech

Among the companies that have developed equipment for speech recognition are Stromberg-Carlson, ITT, IBM, Tokyo University, Japan, and the Air Force Cambridge Research Laboratories. Each system uses different principles.

Among the most elaborate programs is that at Stromberg-Carlson's Rochester, N.Y., laboratories, which is based on processing of speech formants, the resonances in the vocal track. These have a slow rate of change and therefore carry a relatively large amount of information about what is being said. This work is part of an important program of bandwidth compression, which it is hoped will result in eliminating redundant information from transmitted speech.

The company has also developed a speech synthesizer with which speech sounds are mechanically generated. A sophisticated five-function control for this synthesizer has been designed.

At ITT Federal Laboratories, several different pattern-recognition programs are underway. In Palo Alto, Calif., a system of speech identification based on phonemic definitions has been used successfully. It identified about 90 per cent of 40 speakers, who in one test spoke the letter "E" and later repeated it. The system requires that the speech be recorded on tape, analyzed for phonemic definitions and be compared with the previous patterns to establish the definition. Dif-

ferences in the sounds made by different speakers are analyzed and only those providing sufficient differentiation are used as guides.

Palo Alto Laboratory is also working on a program of pattern-classification techniques with the long-term objective of developing a machine that will learn without having to be taught. Studies in the fields of adaptive techniques, statistical decision theory and pattern classification are now underway under partial sponsorship of government agencies. Included in this program is work on word recognition using optical correlation techniques, this work is underway at the company's San Fernando laboratories.

Basic speech characteristics are also the basis of one of several speech-recognition devices built at IBM, San Jose, Calif. Programed logic circuitry enables the system to discriminate between voiced, unvoiced and fricative sounds in two arbitrary forms, weak and strong. The digits 0 through 10 have been identified when spoken by many speakers.

Simple differences in energy level permit classification of strong and weak speech. But sophisticated modulation-envelope analysis is used to distinguish between voiced, unvoiced and fricative sounds. A phase-shifting network provides the envelopes.

Template matching is the basis of the speech and speaker recognition system built at the Air Force Cambridge Research Laboratories, Bedford, Mass. The templates are made from words spoken to the system. They are plottings of the energy in 18 frequency bands in samples taken from speech every 0.02 sec and formed into word lengths.

Samplings are taken by a vocoder spectral analyzer in analog form and converted to binary digits for storage in a medium-size drum-memory computer. The templates, once stored, can be used several ways. When the system is programed to recognize a speaker who has been prerecorded, the computer compares the stored templates with those constructed from the new speech.

AFCRL researchers are writing programs that will enable the system to adjust whatever masks it happens to have stored so that new ones do not have to be made for a speaker of unusual speech characteristics.

In addition to recognizing words and identifying speakers, the system has been programed to give answers to arithmetical problems asked in plain speech.

A phonetic typewriter built at Kyoto University types letters when monosyllables are spoken. Accuracy of the system, which uses 3,000 transistors and 6,000 diodes in its logic, is about 70 per cent.

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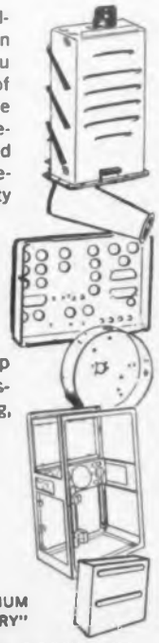

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advances in pattern recognition

Systems Built to Recognize Signal Waveform Patterns

Another form of pattern processing—waveform recognition—is being investigated. General Electric researchers at Schenectady, N.Y., have developed a filter that picks limited-bandwidth, fixed-waveform signals of high-level additive noise. The adaptive waveform recognizer is able to do this whether the waveform is known or not.

The device is being considered for classified defense applications, where it would be useful in analyzing returns from surveillance systems.

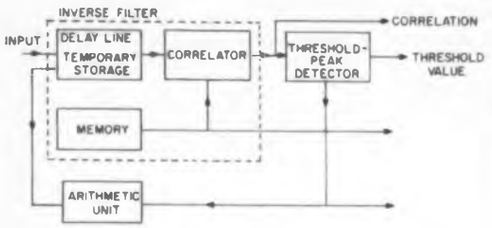
In essence, the system operates by converging to become a matched filter for whatever signal is passing through. Its basic feature is its ability to alter its memory.

Once the filter's memory contains an arriving waveform, a portion of the system converges to the matched filter. But conditions needed to initiate convergence are more severe than those required for detection of a known waveform by a predesigned filter.

The filter continuously correlates arriving waveforms with a waveform in its memory—the one for which it is a matched filter. When correlation is great enough, the system alters its memory so that the stored waveform is a weighted average of the previous contents of the memory and the input, and it increases the amount of correlation needed to alter the memory.

When no signal is present, the filter operates

Adaptive waveform recognition system is able to pick limited-bandwidth signals out of high-level additive noise. System consists of four racks in background and paper tape recorder for monitoring performance.



Adaptive system for recognizing waveform patterns is able to pick limited-bandwidth signals out of high-level additive noise. Temporary delay line memory and main capacitor memory can change their contents so that the filter becomes a matched filter for the waveform being processed. Delay line memory holds incoming signal while it is compared in segments with contents of main memory. Products of segments are multiplied and totalled in arithmetic unit and compared by threshold peak detector to determine how closely incoming signal is matching stored values.

Arithmetic unit continually triggers switching of input signal segments from delay line to main memory.

in equilibrium and the contents of its memory change randomly and continuously. If a fixed waveform arrives randomly and the filter's memory contains a large enough component of the signal, the filter preferentially accepts, in a statistical sense, samples containing that waveform, and convergence begins. Then the accuracy of the concept of the waveform in the filter's memory and the degree of correlation required for acceptance of an input simultaneously rise.

An elaborate, adaptive analog computer that functions as an adaptive filter is being tested at the University of London. Its designers call the system a universal nonlinear filter, predictor and simulator. It can be made to operate as an adaptive filter by training it on a record of a noisy process, together with a target record that contains only the signal.

It is taught as a predictor by taking as the target function a value of the stochastic process advanced by a certain time interval beyond the last value that goes into the input.

To simulate an unknown system, the simulator is trained by feeding it with the input of the system to be simulated at one end and presenting it at the other end with its output as the target function. The simulator will make itself into a model of the system and, in addition, will make it possible to read off the nonlinear transfer function of the system from the final setting of the coefficients displayed on the simulator.

The entire filter consists of many cabinets of components, among which are 80 novel piezomagnetic analog multipliers that can perform over 1,000 multiplications per second with no more than 0.5 per cent error. After debugging, the system will be put to useful engineering work in recognizing, predicting, and simulating.

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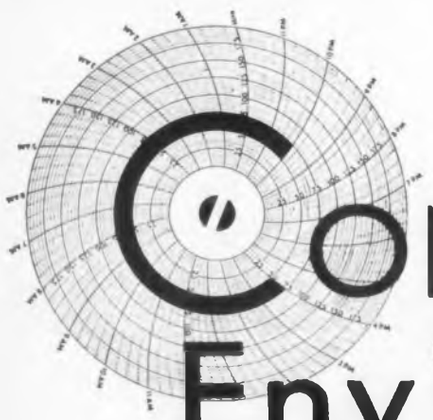

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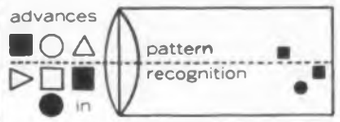
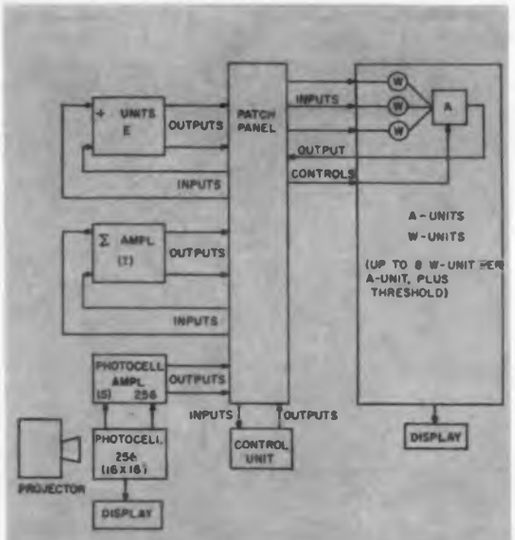


Special Tools Aid Pattern Recognition Research

Several systems and devices have been developed as by products of the effort to automate pattern recognition. Here are some that contain novel electronics and do unusual jobs.

Pattern illustrates extremely high resolution of 3-in. cathode ray tubes employed in input and output stages of pattern-recognition systems. Original pattern from which this enlarged view was made measured 3/16 in. wide by 1/4 in. high. Spacing between radials where they touch circle is 0.0008 in., equivalent to a resolution of about 6,000 TV lines. Settled-phosphor and catophoretic techniques are used to deposit the special phosphors used for the tubes. Philco is concentrating on developing crt inputs to pattern-recognition systems because they afford high resolution with little loss of geometric precision, they give rapid and random access, and can provide odd apertures. Time constants of the phosphors are reported to be 0.05 μsec, which permits fast changing of apertures.



This medium-scale learning network of the perceptron type is under construction at Aeronutronic Div., Ford Motor Co., to test design of the company's biax-type magnetic integrators, which are intended for Cornell Aero Labs' perceptron program.

System input is an automatic-advance slide projector that will display an image on a 16 x 16 photocell raster about 6 in. sq. Eventually about 500 magnetic integrators, which correspond to the W-units of the Cornell perceptron, will be included, although first tests will be made with fewer installed. Sixty A-unit neurons will be included eventually. Output is a bank of indicator lights. The unit's A-units can be interconnected in single-layer or complete cross-coupled arrangements. Also included are fixed linear-logic elements that may be interconnected to perform operations appropriate to particular environmental patterns.

The summing amplifiers (I-units) are fixed-weight, linear-logic elements analagous to the S-to-A interconnections in the CAL perceptron. They consist of a discriminator and two sets of summary resistors.

The E-units use linear logic to perform the exclusive-OR function for two variables. They are analagous to additional fixed-logic S-to-A interconnections in the perceptron.

The A-units are the decision and amplifying elements corresponding to either A or R-units in the perceptron.

The W-units consist of the magnetic integrator mentioned above and its transistor switch. They are designed to operate with a plus and minus logic level. The units are mounted on plug-in cards and will be parallel-connected to each A-unit in groups of up to eight.

The Aeronutronic system is an outgrowth of a smaller, one-neuron learning machine constructed previously (see p. 45). Both units were designed to solve Boolean-logic problems. The company hopes that the current model will be successful enough to allow design to proceed on a larger version that would do useful work.

DAPON RESIN STOPS ARCING DUE TO MOISTURE

DIALLYL PHTHALATE

ARK-trol connector can be disconnected while carrying full current loads—DAPON has high arc and tracking resistance even after moisture conditioning.

If you require outstanding electrical properties in a resin, tear a leaf from the design book of Crouse/Hinds Company, Syracuse, N. Y. At the heart of their new ARK-trol connector series, you'll find molded parts of DAPON resin. By using DAPON, they—

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DAPON molds easily around metal inserts without corrosion. With DAPON there's virtually no shrinkage or cracking after molding (connector pins remain tight!). The material has extremely low moisture absorption—it maintains high arc resistance even in moist atmospheres. DAPON diallyl phthalate resin withstands extremes of temperature, vibration and shock. The tolerances of DAPON parts are practically unaffected by long-term operation at temperatures up to 450°F.

Specify DAPON (diallyl phthalate) Resin when you need:

- Low dielectric loss
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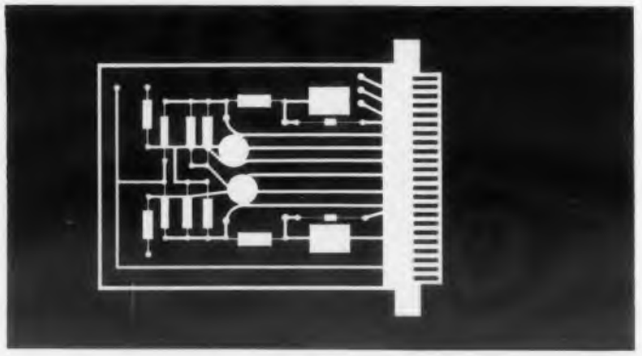

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From the *leader* in automatic circuit testing comes an entirely *new* concept in circuit analysis . . . AUTOMATIC LOGIC CIRCUIT TESTING. The first equipment of this type, the new DIT-MCO Model 720 automatically tests operating characteristics of logic circuit modules, memory boards, component cards and similar units—with speed, precision and dependability.

The Model 720 rapidly performs static and dynamic tests on active and passive modular circuits.

Tests that can be performed with the new Model 720 include:

- Logic circuit response to all logical combinations of DC input levels.
- Margin tests to evaluate logic modules under conditions of lowered or raised supply levels in combination with lowered or raised signal input levels.
- Complete tests of conversion matrices for proper logic, levels.

The DIT-MCO Model 720 will accurately test variables which are required to maintain ± 0.5% accuracy, and 3 digit tolerance values can be programmed. Provision is made for programming AC or DC sources and external signals through the tester.

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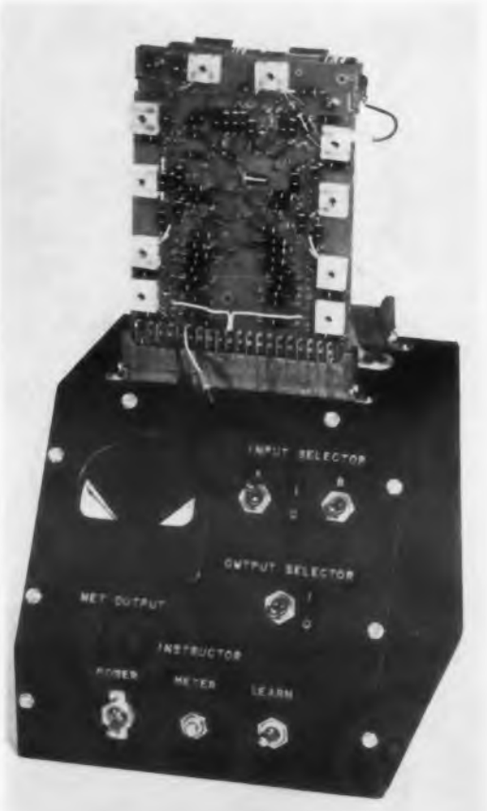
advances in pattern recognition



Device built by Philco to demonstrate and explore a concept of adaptive logic and to aid in pattern-recognition research consists of "student" circuit board and black-box "teacher," which instructs student to learn 14 Boolean-logic propositions. Battery-operated circuit is wired as a net of three digital adaptive gates. Each adaptive gate may assume three states; short-circuit, open-circuit, and inversion. Net organizes itself to recognize propositions, by relating two inputs and one output.

Toggle switch registers inputs of either 1 or 0. These correspond to A and to B of proposition in the form "F(A,B) = C." Ouput corresponding to desired response C is indicated by the meter. When meter switch is pushed, indicator needle points to either 0 or 1 to show whether net has organized itself to learn the proposition under consideration. If it has not learned, the "learn" switch is pushed again. To date, no more than 8 cycles have been necessary for device to learn any of 14 propositions. Theory has been extended to design of larger systems.

Learning machine of perceptron-type built at Aeronutronic solved problems in Boolean logic equivalent to pattern recognition problems. Machine was test vehicle for biax-type magnetic integrators wanted by Navy for perceptron program at Cornell Aeronautical Laboratory. Larger version of learner under construction at Aeronutronic will also use magnetic integrators. If performance is satisfactory, still larger version, capable of useful work, will probably be built.

M-1 pattern recognizer is a special-purpose computer built by Philco to conduct recognition research. Flying-spot scanner in cabinet at left has gun that gives resolution of about 2,000 TV lines. Data from scanner goes to video processor then to 264-bit shift register for quantizing. Array of lights on cabinet at right indicates position of data in shift register, permitting templates of resistors to be plugged in to test recognition schemes. Plugboards can form templates of any pattern of 264 bits in two polarities.

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Radar Window of G-E TEXTOLITE 11546 protects exposed feedhorns (A) while permitting transmission of radio frequency energy. Hot air continually blown through window cells prevents ice formation during sub-zero arctic weather.

Towering high over the Arctic wasteland, giant radar antennas like this one (each larger than a football field) form part of the surveillance radars for the U. S. Air Force's Ballistic Missile Early Warning System (BMEWS). Developed by G-E's Heavy Military Electronics Department for RCA, BMEWS prime contractor, these surveillance radars will be instrumental in providing approximately a fifteen minute warning in case of a missile attack across the northern polar region. The first of three BMEWS sites is nearing completion near Thule, Greenland.

So gigantic is this surveillance radar that feedhorns and other vital equipments are housed in separate scanner buildings. Protecting each feedhorn from the sub-zero arctic weather is a Deicer Panel Assembly or "radar window" fabricated from G-E TEXTOLITE 11546, a G-10, high IR, glass epoxy laminate.

Micarta Fabricators Inc., an independent Chicago fabricator, built the windows for the Andrew Corporation who had the overall responsibility for the feedhorn-window system. Andrew specified TEXTOLITE after conducting a development program to select the most suitable material consistent with low cost. Tests prove TEXTOLITE 11546 meets the rigorous electrical, mechanical and environmental (−70° to +50°F, temperature variations, winds up to 185 MPH) conditions inherent in the BMEWS project.

For information on 11546 or other G-E TEXTOLITE laminates for your particular application requirements write: Laminated Products Department, Section ED-31, General Electric Company, Coshocton, Ohio.

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Our answer could surprise and please you, as it did the designers of a space antenna when a conductor 20 feet long was etched to an accuracy of .015 inches over an area of 17.45 feet; or as it did the Bell Laboratories when they asked for thousands of apertures spaced to .00005 in 1 square inch of nickel.

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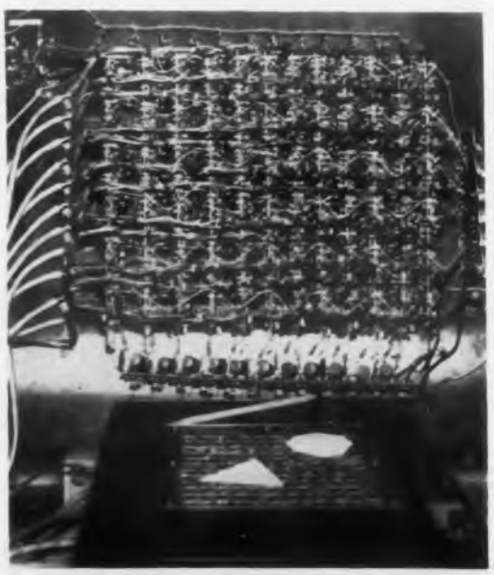
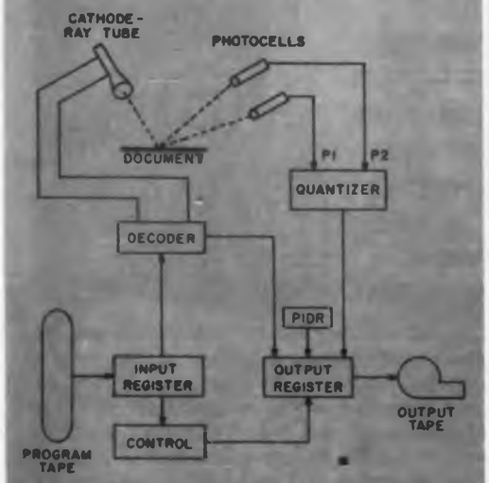
CIRCLE 41 ON READER-SERVICE CARD

advances in pattern recognition

Control unit for speech synthesizer at Stromberg-Carlson controls five functions useful in speech synthesis: three formants, intensity, and pitch. Carriage moves along pattern of tracks to control equipment that switches oscillators on and off.



Recognizer developed at University of Illinois was designed to exhibit property filtering. System is able to sense the "n-ness" of whatever is laid on photocell matrix.



Generalized scanner built at Bell Telephone Laboratories is used as an input to an IBM 704 in pattern-recognition studies. Capable of complex scans, the system can move its scanning spot to any of 10,000 points in a 100 x 100 array in a field variable from 1/8 x 1/8 to 3 x 3 in. The scanning spot moves in a constant time, 200 μsec, from any point to any other. Points are specified by a sequence of coordinates as a function of time. Two photocells and associated pickup circuitry give the scanner two-color capability. Basic equipment is a DuMont Dual Opaque flying spot scanner.

What Lies In the Future?

It is hard to predict the extent of use of pattern-recognition machines once they emerge from the laboratory.

Certainly one of the most important initial applications will be in computer input. Not only written data, but images and other special forms of data might also be entered into logic circuits by the use of pattern recognizers. Internally, computers could use pattern recognition to sort and collate information automatically.

Analysis of reconnaissance information is envisioned as an important military application of the concept. Many complex military systems might make use of various pattern-recognition schemes to automatically direct integrated control systems at lightning speeds.

But beyond some of these obvious uses, there lies an area where the imagination can only guess at the future. Pattern recognizers could well be a key element in the automated society that is already beginning to take shape.

Approximately actual size

This 3 lbs. of transistorized new AC amplifier gives you 20 or 40 db gain, increases scope or VTVM sensitivity 10 or 100!

This new hp 466A AC Amplifier is just 4" high, 6" wide and 6" deep. Yet it can become one of the most helpful instruments on your bench, or in the field. It is ac or battery powered; battery operation gives you hum-free performance and easy portability. Response is flat within approximately ½ db over the broad range of 10 cps to 1 MC, distortion is less than 1%, and gain is stabilized by substantial negative feedback to virtually eliminate effects of transistor characteristics and environment.

For a demonstration on your laboratory or field application, call your hp representative or write direct.

Specifications

Gain:	20 and 40 db, ±0.2 db at 1000 cps.	**Distortion:**	Less than 1%, 10 to 100,000 cps.
Frequency Response:	±0.5 db, 10 cps to 1 MC; ±3 db, 5 cps to 2 MC.	**Power:**	Ac line power normally supplied, but battery operation available. (12 radio type mercury cells, battery life about 160 hours.) Specify battery operation if desired.
Output Voltage:	1.5 v rms across 1500 ohms.		
Noise:	75 μv rms referred to input, 100,000 ohm source.	**Dimensions:**	6¼" wide, 4" high, 6¼" deep. Weight: approx. 3 lbs.
Input Impedance:	1 megohm shunted by 25 μμf.		
Output Impedance:	Approximately 50 ohms.	**Price:**	$150.00 f.o.b. factory. (Either ac or battery operation.)

Data subject to change without notice.

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NEWS

Automatic Checkout System Under Development for Saturn

An automatic checkout system for the Saturn satellite booster is under development at Packard Bell Electronics Corp., Los Angeles, under a $3,008,000 NASA contract.

The new system will replace to a large extent manual checkout procedures now in use.

Random-Access Memory Employs Multiaperture Ferrite Cores

A high-speed, random-access memory, capable of nondestructive readout and nonvolatile storage, employs multiaperture ferrite cores and fully transistorized circuitry.

Developed by the Westinghouse Electric Co. at Baltimore, Md., the 1,024-word prototype has operated at 0.6-μsec cycle time with an access time of 0.20 μsec. The model and its memory-core stack, drivers, switches, timing circuitry, and sense amplifiers have operated successfully at temperatures ranging from −25 to +100 C.

As an extension of the development, Westinghouse is building a 4,096-word, 50-bit electrically alterable, nondestructive and nonvolatile instruction memory with tape-loading equipment.

An important aspect of the present memory is that stored program information can be altered by electrically writing in new information. This permits new instruction or an entirely new program to be written into the memory under control of a tape reader or other input device. A coincident current writing technique is used.

Random-access memory unit developed by Westinghouse Electric Corp. operates at 0.6-μsec cycle time with an access time of 0.20 μsec.

ENGELHARD HYDROGEN DIFFUSION PURIFIER

This Hydrogen Purifier removes all impurities (including oxygen, nitrogen, argon, water vapor, hydrocarbons, etc.) from hydrogen gas streams. Produces hydrogen of highest purity obtainable from dissociated ammonia, steam reformed natural gas or propane, commercial hydrogen purchased in cylinders and other hydrogen containing gas streams. *No trace of impurities detectable in purified gas.* Ultra-pure product hydrogen obtained at lowest cost. • Available in standard sizes: 100 c.c. per hour, 20 SCFH, 75 SCFH, and 150 SCFH. Larger sizes custom built to requirements. Write for literature.

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Hermach-Engelhard multi-range transfer volt ammeters provide laboratory standard accuracy in reading voltages or current with an error not exceeding 0.05% through a frequency range from d-c to 50,000 cps. These readings are obtained without the use of correction factors directly from the instrument itself. Bureau of Standards certificates are provided on request. Write for complete technical data.

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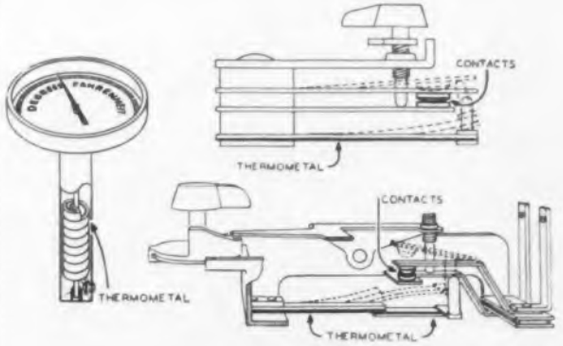

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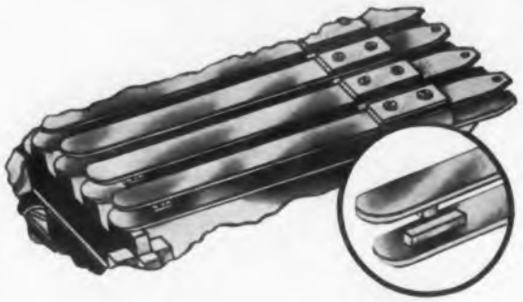

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Environment Testing Lab Nears Completion at Redstone

A new laboratory for environmental testing of missiles and their components is nearing completion at the Army Rocket and Guided Missile Agency installation at Huntsville, Ala.

Technicians will be able to expose test items, ranging from tiny missile components to complete missiles up to 36 ft long and 8 ft in diam., to a full spectrum of environmental conditions.

The test cells with walls at least a foot thick, are of concrete reinforced with steel.

Situated in an isolated area at the Restone Arsenal, the new facility will be available for testing missiles or components of Government services and agencies and industrial missile contractors.

Geodetic Position System To Be Tested in Satellite

An electronic system capable of determining geodetic positions anywhere on the earth is slated for use in this month's Transit III-B test firing.

The system, called SECOR (Sequential Collation of Range), was developed by the Cubic Corp. of San Diego.

SECOR consists of a miniature 7-lb transponder, to be carried aboard the 36-in Transit III-B sphere, and four ground stations. An orbit at 500-mile altitude, using a Thorable-Star vehicle for launching, is scheduled for the test.

Four SECOR ground stations, which can be transported by helicopter, will measure distance by sending and receiving signals through the satellite transponder. With three of the ground stations situated at surveyed points, the precise position of the fourth can be computed with resectioning techniques.

Each ground station determines its distance from the satellite by first transmitting a frequency-modulated, continuous-wave signal, which is received and rebroadcast by the transponder. During transmission the ground station measures and records the phase shift between its transmitted signals and those received from the transponder. To permit compensation for errors introduced by ionospheric refraction of the SECOR signals, the transponder replies on two different frequencies.

The four ground stations interrogate the transponder, in sequence, for 12-1/2 msec. Dynamic smoothing of the distance-information allows interpolation, to provide the equivalent of simultaneous sightings by all stations. Data-handling ground station equipment provides real-time recording of binary range data.

TANTALUM CAPACITORS...NEW HEIGHTS IN RELIABILITY
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When Pyramid tantalum capacitors with proven dependability are incorporated into essential electronic equipment you manufacture . . . greater reliability of your product is assured.

To design engineers searching for miniature electrolytic capacitors with unusual capacitance stability and a low dissipation factor over a wide temperature range, soundly constructed tantalum capacitors are gratifying discoveries.

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CIRCLE 45 ON READER-SERVICE CARD

NEWS

Chance-Vought Building

Flight and Environment Devices For Astronaut Training and R&D

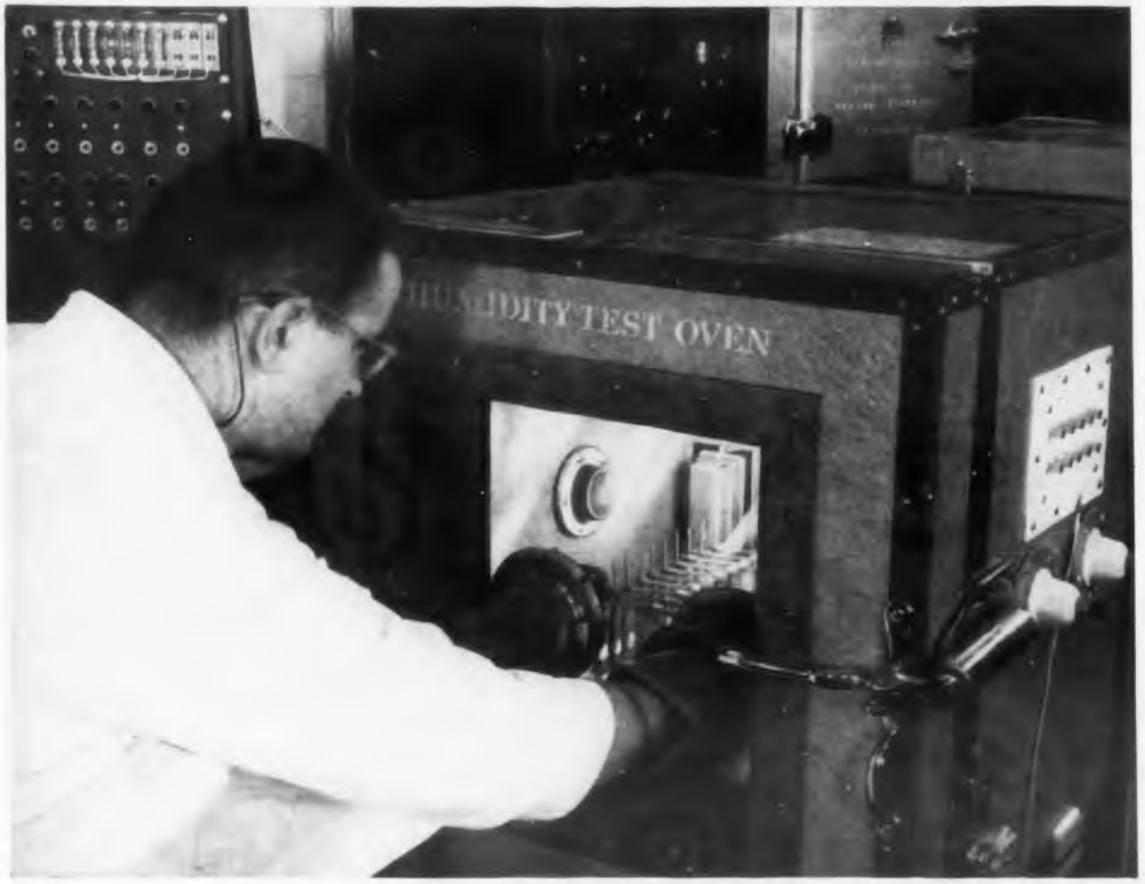
THREE SIMULATORS duplicating space-vehicle operation and expected environments are being built by the Astronautics Div. of Chance-Vought, Dallas. Completion is expected within a few months.

A flight simulator, to be used in research and development and for pilot training, will demonstrate earth orbiting and landing, moon and interplanetary flights, satellite rendezvous missions, lunar parking orbits, and lunar landings and launchings.

The pilot's compartment will move in three directions to duplicate maneuvers. The pilot will

Space environment simulator (CVPR-2997), as depicted in scale model, will test payloads nearly 8 ft in diam by spinning and rotating them to duplicate their positions relative to the sun.

Manned space flight simulator (CVPR-2996) will demonstrate earth orbiting and landing, moon and interplanetary flights, satellite rendezvous missions, lunar landings and launchings.



Insulation of "Mylar" gives capacitors longer-lasting stability under high humidities

Punishing, hot, humid atmospheres like those in the test chamber above have little effect on capacitors insulated with "Mylar"* polyester film. These capacitors have remarkable stability and longer life, because "Mylar" is much less sensitive to high temperatures, changing humidity and aging than other commonly used insulating materials.

Capacitors made with "Mylar" meet the highest standards of reliability, yet are frequently smaller and less costly than other units. Thinner insulation can be used, because of the exceptionally high dielectric strength of "Mylar". And "Mylar" reduces the need for costly encapsulation because of its remarkable resistance to moisture.

Whether you manufacture or buy electrical products, you can get improved performance with "Mylar". And, figured on a square-foot basis, "Mylar" will often cost you less than your present material. For full facts on "Mylar", write for free booklet. E. I. du Pont de Nemours & Co. (Inc.), Film Department, Rm. No. 14, Wilmington 98, Del.

Tough, thin "Mylar" has this unique combination of properties for superior insulating performance:

- Average 4,000 volts per mil dielectric strength (Per ASTM D-149). Average power factor of 0.002 at 60 cycles.
- Thermal stability from -60°C to Class B range.
- Chemical and moisture resistance.
- Resistance to aging, abrasion, tearing and rotting.

IN MOTORS — Insulation of "Mylar" cuts size and weight, improves moisture resistance . . . at no increase in cost.

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*"Mylar" is Du Pont's trademark for its brand of polyester film.

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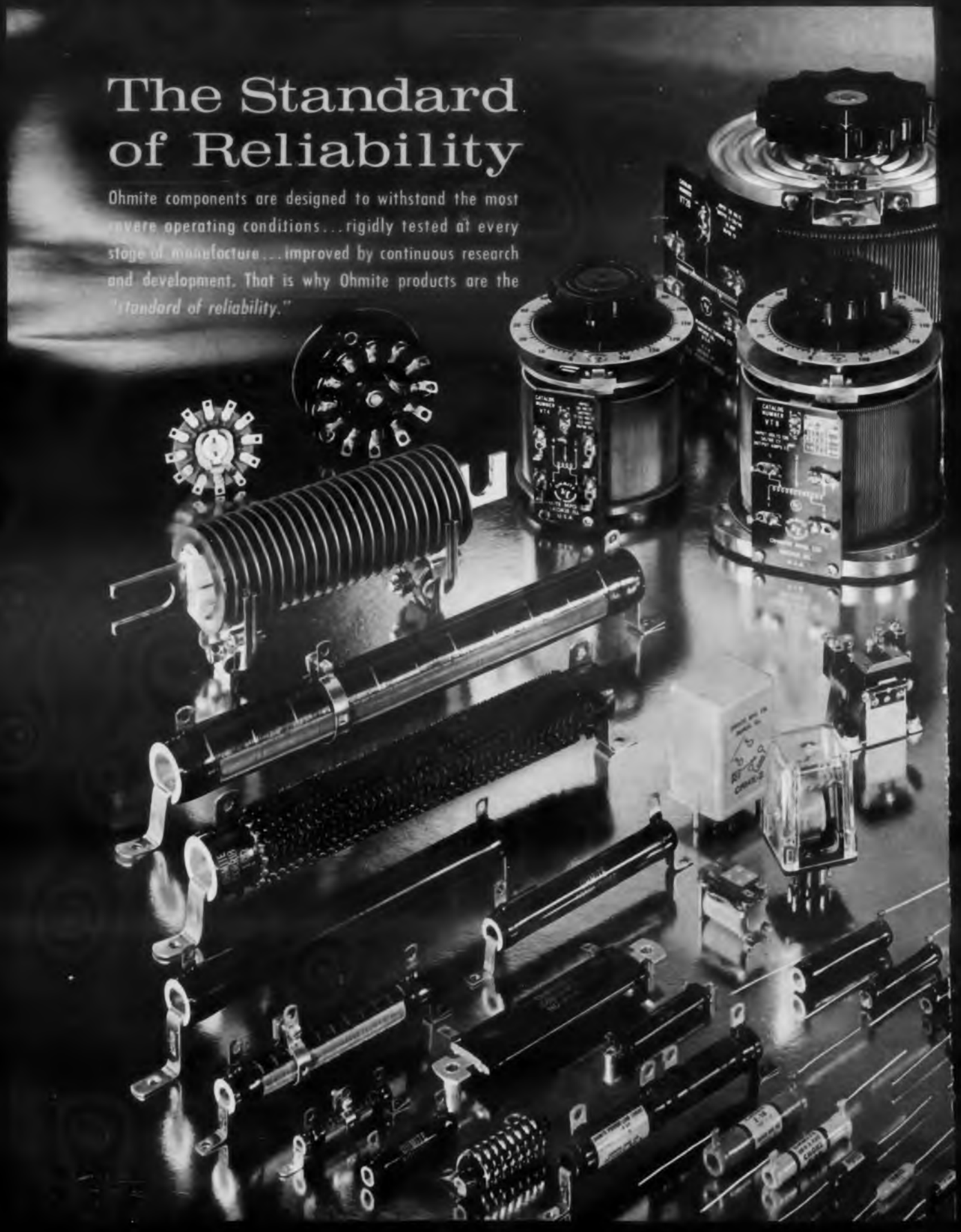
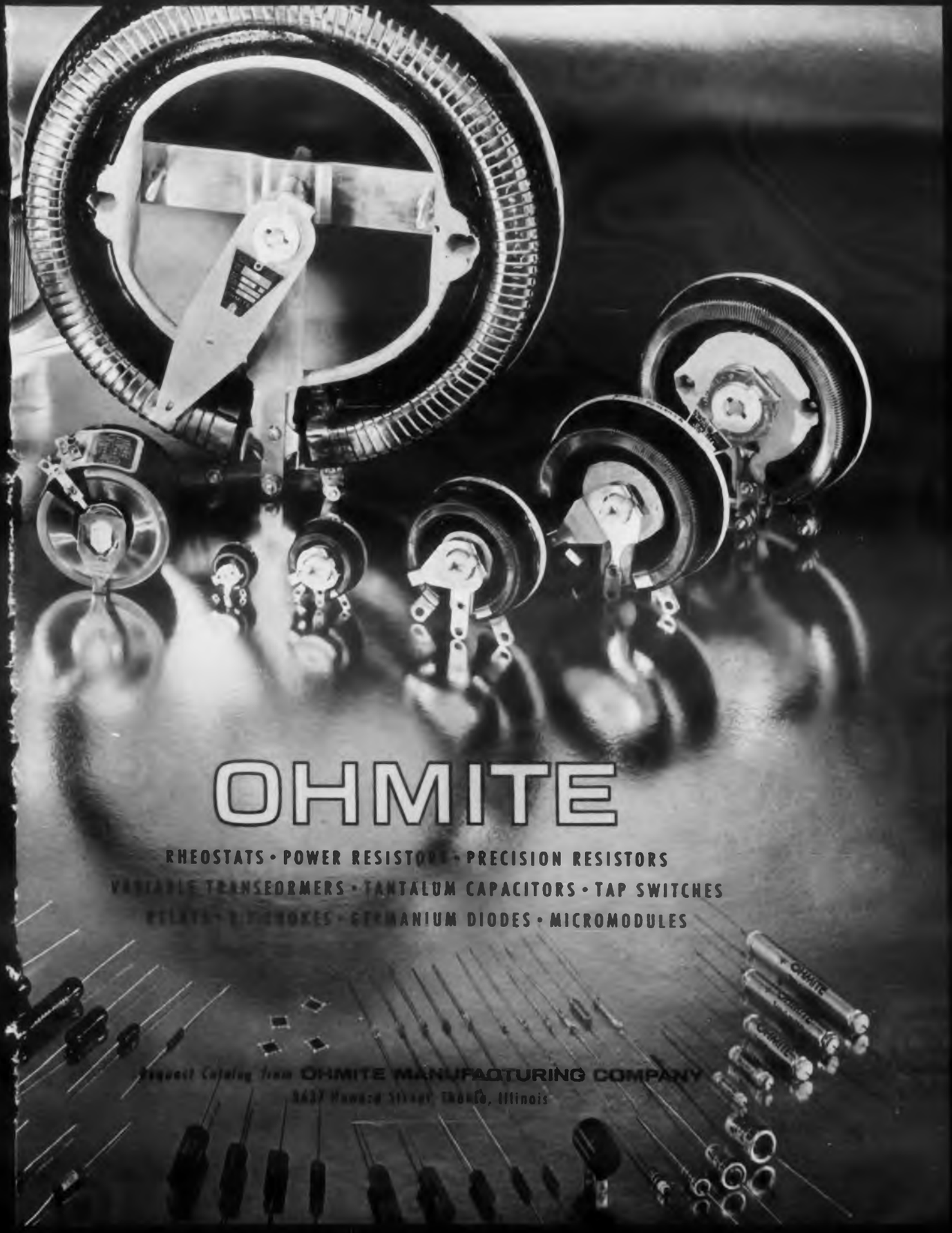

The Standard of Reliability
Ohmite components are designed to withstand the most severe operating conditions... rigidly tested at every stage of manufacture... improved by continuous research and development. That is why Ohmite products are the "standard of reliability."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Three Space Simulators

see earth and planetary horizons and star fields as they would appear in space. He will communicate with simulated stations and will experience the heat, noise and vibration of a space vehicle.

Environment Unit to Duplicate Sun's Radiation Spectrum

The environment simulator will demonstrate altitudes of more than 200 miles. It will plunge temperatures to −320 F and will duplicate the sun's radiation spectrum. Future additions will make it possible to subject test instruments to meteoroid-like particles and possibly nuclear particles.

The environment simulator will aid in the development and testing of vehicle designs, power systems, temperature controls, communications, instrumentation, guidance and control systems, space suits, small propulsion control systems and other equipment.

This simulator will be able to handle space payloads nearly 8 ft in diam. It will spin and rotate them to duplicate positions relative to the sun. Each test will run for weeks, if required.

Automatic Control Simulator Will Integrate Systems

The third simulator, called ACES, will be used for the development and testing of automatic control systems for both manned and unmanned space vehicles. Basically an R&D tool, ACES will help develop and integrate the systems for stabilizing or controlling satellites and vehicles in space. It will use reaction controls, inertia wheels and similar devices. ■ ■

Intense Bursts of Soft X-Rays Are Produced by EGG X-Ray Tube

A novel X-ray tube reported capable of producing extremely intense bursts of soft X-rays has been designed, developed and tested by Edgerton, Germehausen, and Grier, Inc., of Boston, Mass.

One of the features of the tube is a thin beryllium window (0.010 in.). A large fraction of the rays of interest can penetrate this window. Short bursts of X-rays lasting approximately 0.0000001 of a second are produced, reports the company. During this time, doses of over 100 roentgens have been delivered corresponding to a dose rate exceeding 1 billion roentgens per sec. The

NEW FASTER WAY TO ANALYZE TRACES

The all-new Hughes High Frequency Memo-scope® Oscilloscope saves you time and money in transient analysis. With its 10 mc bandpass and one million inches per second writing speed, it can store fleeting phenomena for an indefinite period of time. It displays these non-recurring transients for thorough study until intentionally erased. In this way, you can eliminate expensive "hit or miss" methods of transient analysis.

This is the *only* measuring instrument that can give you stored response at these fast writing speeds!

An added benefit: you can also use this unique new instrument as a precision laboratory oscilloscope. Thus, you get two precision instruments for the price of one.

SPECIFICATIONS:

CONVENTIONAL MODE:
- DC to 10 mc Band Pass
- Sweep Range: 0.1 μ secs/division; 5X Magnifier for speeds to .02 μ secs/division; Multiplier for sweeps long as 10 secs/division
- Rise Time: 35 nanoseconds
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STORAGE MODE:
(All features of Conventional Mode, PLUS:)
- One million inches per sec Writing Speed
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Learn more about the new High Frequency Memo-scope Oscilloscope—its applications, operating characteristics, and principle of operation.

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DeJUR Announces unique...new DIGITAL TRANSDUCERS and SUBMINIATURE PRESSURE INSTRUMENTS

DeJur Digital Transducers are self-contained solid state miniaturized packages designed to measure various parameters (pressure, temperature, flow, acceleration) and supply a digital signal output without the use of auxiliary equipment. The result can be a pulse duration type (PDM) digital signal whose pulse width in time is directly proportional to the amplitude of the input parameter being measured. PPM and PFM outputs also can be made available.

Constructed to meet rigorous conditions of application and exposure, DeJur Digital Transducers produce signals compatible with digital computers and electronic counters found in all military and industrial installations.

A new dimension in pressure instrumentation is created by the introduction of a complete line of subminiature pressure instruments. It includes potentiometric pressure transducers, pressure switches and pressure indicating meters with static, dynamic and environmental performance characteristics superior to larger units.

FEATURES

- Small size . . . light weight
- Completely self-contained—no auxiliary conversion equipment needed
- Accuracy equal to much larger units
- Improved environmental and dynamic performance—ideal for military applications
- Multiple outputs obtainable
- Superior reliability and versatility

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CIRCLE 48 ON READER-SERVICE CARD

NEWS

Illinois Jailbreaks May Be Foiled By New Electronic Stool Pigeon

An electronic fence invented by Airtronics International Corp. of Fort Lauderdale, Fla., has been declared a success by Illinois prison officals after a recent test.

A team of Airtronics engineers—under the command of Cornelius Vanderbilt Jr., vice president and director of the electronics manufacturing firm—staged a simulated jailbreak at Statesville Prison, Joliet, Ill.

The newly invented electronic system uses three very fine wires. It is designed for use at defense installations, missile bases, industrial plants, and prisons.

In a demonstration test, Vanderbilt walked toward the almost invisible wires. Soon a screeching buzz-saw sound jarred the watching crowd. The perimeter alarm detects and renders an alarm upon intrusion of a person into an unauthorized area.

It Brooks No Interference

Digikey, a device that sends messages in digital form, is being used in the Hughes-built long-range communication system, Hacon, now operational with the B-58 Hustler supersonic bomber. Developed by Hughes Aircraft Co., Culver City, Calif., Digikey operates through heavy electrical interference by breaking up a message into a series of coded electrical pulses. These are transmitted over several frequencies. The unit operates at 150 words per minute.

Telemetering Standards Group Starts Four-Pronged Task

A Telemetering Standards Coordination Committee has begun work under the direction of the executive body of the National Telemetering Conference, held recently in Chicago.

The committee chairman, A. E. Bentz of the Sandia Corp., outlined the task as follows:

- To determine the standards in existence.
- To determine the technical adequacy of planned and existing standards.
- To determine the need for additional telemetering standards.
- To promulgate any new standards.

The committee consists of fourteen members—seven from industry and seven from government—and in addition has a representative from each professional engineering society of the conference. The professional engineering societies represented are ISA, IAS, IRE, ARS, and AIEE.

GE 'Neutron Telescope' Measures Atomic Reactor Steam Output

A neutron telescope has been developed to permit nuclear engineers to measure steam output of a portion of an atomic reactor through thick walls.

The device, developed by Samuel Untermyer II, consultant at the Vallecitors Atomic Laboratory, Pleasanton, Calif., a component of General Electric's Atomic Power Equipment Dept., is mounted above the core of the reactor.

Mr. Untermyer described the neutron telescope as basically a fast neutron counter, in a special tube, which can measure small differences in the steam output of selected fuel channels in the reactor. It can be aimed accurately at a fuel channel from a distance of 20 ft or more, and will count fast neutrons coming up out of that section of the reactor through 6 ft of water and several inches of steel.

From the number of fast neutrons coming out of the reactor, the engineers can tell how much steam that part of the reactor is making.

Since water acts as a block to the passage of fast neutrons, if the reactor is not producing a lot of steam bubbles, the number of neutrons counted by the neutron telescope will be small. If the reactor is producing a lot of steam, fast neutrons can pass through easily.

According to Mr. Untermyer, the device provides reactor operators some of the same information as present instrumentation, and is very sensitive to changes in local exit steam conditions in the reactor caused by movement of the control rods.

and ALL NEW

Completely covers the frequency range from 4.0 to 40.0 KMC/S with only one probe carriage.

The new PRD 230 Universal Probe Carriage represents a major achievement in accurate standing wave and impedance measurements. Here is a precision instrument which features bold, rugged styling with laboratory accuracy. The position of the probe holder can be quickly determined to 0.01 mm.

A complete series of Waveguide and Coaxial Slotted Lines are available for snap-in convenience and low VSWR performance. Unusual features include a scale calibrated directly in dial revolutions and self-contained slope adjustment of the U, K, and A band Slotted Lines.

PROBE CARRIAGE: Accepts both PRD 250-A Broadband probe for 4.0 to 12.4 KMC/S and PRD 253 Fixed Tuned Probe for 12.4 to 40 KMC/S.

VSWR: PRD 231 Waveguide Slotted Lines have a maximum residual VSWR of 1.01.

VERNIER RESOLUTION: 0.01 mm.

PROBE TRAVEL: 6 cm.

PRD 231* SERIES SLOTTED LINES

PRD Type	Frequency Range (kmc/s)	Transmission Line Size (Inches)	Length (Inches)	Coupling Type
N231	4.0-10.0	[illegible]" Coaxial	9-¼	**
X231	8.20-12.4	1 x ½	9	UG-39/U
U231	12.4-18.0	.702 x .391	9	UG-419/U
K231	18.0-26.5	.500 x .250	9	UG-425/U
K231-F1	18.0-26.5	.500 x .250	9	UG-595/U
A231	26.5-40.0	.360 x .220	9	UG-381/U
A231 F1	26.5-40.0	.360 x .220	9	UG-599/U

*Available in WR waveguide sizes on special order.

**Normally supplied with Type "N" male and female adapters (PRD 367 and 368).
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EAI Series 5000 features include –

- ☐ **Full-time input impedance to 1000 megohms**
- ☐ **Relative accuracy 0.01% full scale**
- ☐ **200 readings per second average**
- ☐ **Input noise filter**
- ☐ **Fully transistorized**
- ☐ **Outstanding long term stability**
- ☐ **Quiet, reliable, trouble-free operation**

Versatile as well as economical, these voltmeters provide decimal and binary-coded decimal electrical outputs for driving a full range of accessory equipment. Brilliant, easy-to-read projection displays eliminate "glow-through" ambiguity while providing wide angle reading – even under adverse ambient lighting conditions.

Write for complete details on the new Electronic Associates, Inc. Series 5000 Voltmeters, or call your nearest EAI Engineering Representative.

EAI ELECTRONIC ASSOCIATES, INC. *Long Branch, New Jersey*

See us at Booth Nos. 3712, -14, -16, -18 at the IRE Show, March 20-23

CIRCLE 50 ON READER-SERVICE CARD

NEWS

Tiny New Cryostat Cools

Novel Tunnel-Diode Power Supply Also Described at Winter PGMIL

A NEW cryostat system designed for military applications, and described as the smallest ever announced for its capacity, measures less than 1 cu ft and weighs 30 lb, including a 25-lb compressor.

The cryostat proper weighs 2 lb, according to its inventor, K. W. Cowans, Hughes Aircraft Co., Los Angeles. It uses a two-stage Claude-type thermodynamic cycle followed by Joule-Kelvin cooling.

The system's small size is mainly a result of the special tubing used, into which extremely fine helical fins are cut. A pitch of 0.006 in. for a fin 0.0008 in. thick is said to be possible with the production techniques used.

Eliminating the usual bulky valve train also contributes to the unit's small size. This is done by using "a unique mechanical cycle in which the valves are actuated within the engine solely by engine motion."

The sealing problem is said to be solved with a device that affords essentially perfect sealing with very low friction and long life. The seal is reportedly good for operation at 10 K.

"For an essentially no-mass load like an array of infrared detectors," reports Mr. Cowans, "cool-down is effected within 30 minutes after 1.5 kw of power is applied to the system."

An external power supply is required with the cryostat. Design net capacity is 0.5 w at 4.2 K, which is the temperature of liquid helium.

The new cryostat was one of several developments reported at the Second Winter Convention on Military Electronics, in Los Angeles. Also described at the conference was a tunnel-diode power supply in which a linear and a switching regulator are combined by tunnel diodes.

Another highlight of the meeting was the reports on results achieved by the AGREE (Advisory Group on Reliability of Electronic Equipment) reliability program, which confirmed indications of success apparent at the recently held symposium on reliability and quality control (*ED* Feb. 1, 1961, p. 12).

Cooler Comprises Two Units, Crystostat Proper and Compressor

The cryostat described by Mr. Cowans, who developed the device in Hughes' infrared laboratory, consists of two units, the 2-lb cryostat proper and a compressor with motor, filter,

to 4.2 K, Fits in 1 Cu Ft

chamber volume and all interlocks. In it, high-pressure gas enters a counter-current heat exchanger and is cooled by an oppositely flowing stream, which flows through an adiabatic expansion engine and does work. The work done in the engine is transferred outside the cryostat, leaving the gas with less enthalpy and making it colder.

The expended gas is injected into the exhaust side of the exchanger to cool the incoming gas after cooling the load.

Because a gas at a temperature close to its critical point will cool to a lower temperature when it is allowed to expand from a higher temperature to a lower one through a throttling valve, one of these is used in the next stage to replace the engine. After several exchanges the gas is at 18 K and is cold enough for Joule-Kelvin cooling.

Last section of the system is a Joule-Kelvin cryostat with its cold end at 4.2 K.

Operating life of the first generation of production units is said to be 3,000 hr. with servicing required every 200 hr. Further development is expected to give the system essentially unlimited life, with servicing required no oftener than 1,000-hr intervals.

Linear and Switching Regulator Combined in Tunnel-Diode Supply

An unconventional regulator was also described at the conference. In this device, a linear and a switching regulator are combined by tunnel diodes to overcome the disadvantages of either type used separately.

Hughes engineer R. P. Farnsworth reported that the device can supply 350 w of "quality power" at better than 90 per cent efficiency. At no load, the dissipation of the supply is said to be less than 300 mw.

The unit reportedly combines the good transient response and zero dc output resistance of nonlinear switching regulators with the low ripple and good load transient response of linear regulation.

A tunnel-diode voltage is used in the regulator to control a transistor switch directly. Normally a bias voltage would be used for this purpose.

Testimonials on the success of AGREE procedures in significantly boosting reliability figures were delivered during the meeting by both Radio Corp. of America, Camden, N. J., and Hoffman Electronics Corp., Los Angeles. ■ ■

INLAND d-c torque motors save critical weight in guidance systems

PLATFORM SHOWN ½ SIZE

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

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

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

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

COMPARE THESE TYPICAL INLAND TORQUER RATINGS

	T-1321-A	T-2136-A	T-2108-B
Peak torque, oz. in.	20.0	35.0	60.0
Volts at peak torque, stalled at 250°C	48.0	26.0	25.6
Amps at peak torque	1.21	1.6	1.24
Total friction, oz. in.	0.5	0.8	1.5
Rotor Inertia, oz. in sec²	.001	.007	.011
Weight, oz.	5.0	9.0	14.0
Dimensions (inches):—O.D.	1.937	2.81	2.81
I.D.	.625	1.00	1.00
Thickness	.50	.63	1.00

For complete catalog with engineering data, outline drawings and specifications on these and other Inland d-c pancake torquers, write Inland Motor Corporation of Virginia, Northampton, Massachusetts. Dept. 3-3.

INLAND MOTOR CORPORATION OF VIRGINIA
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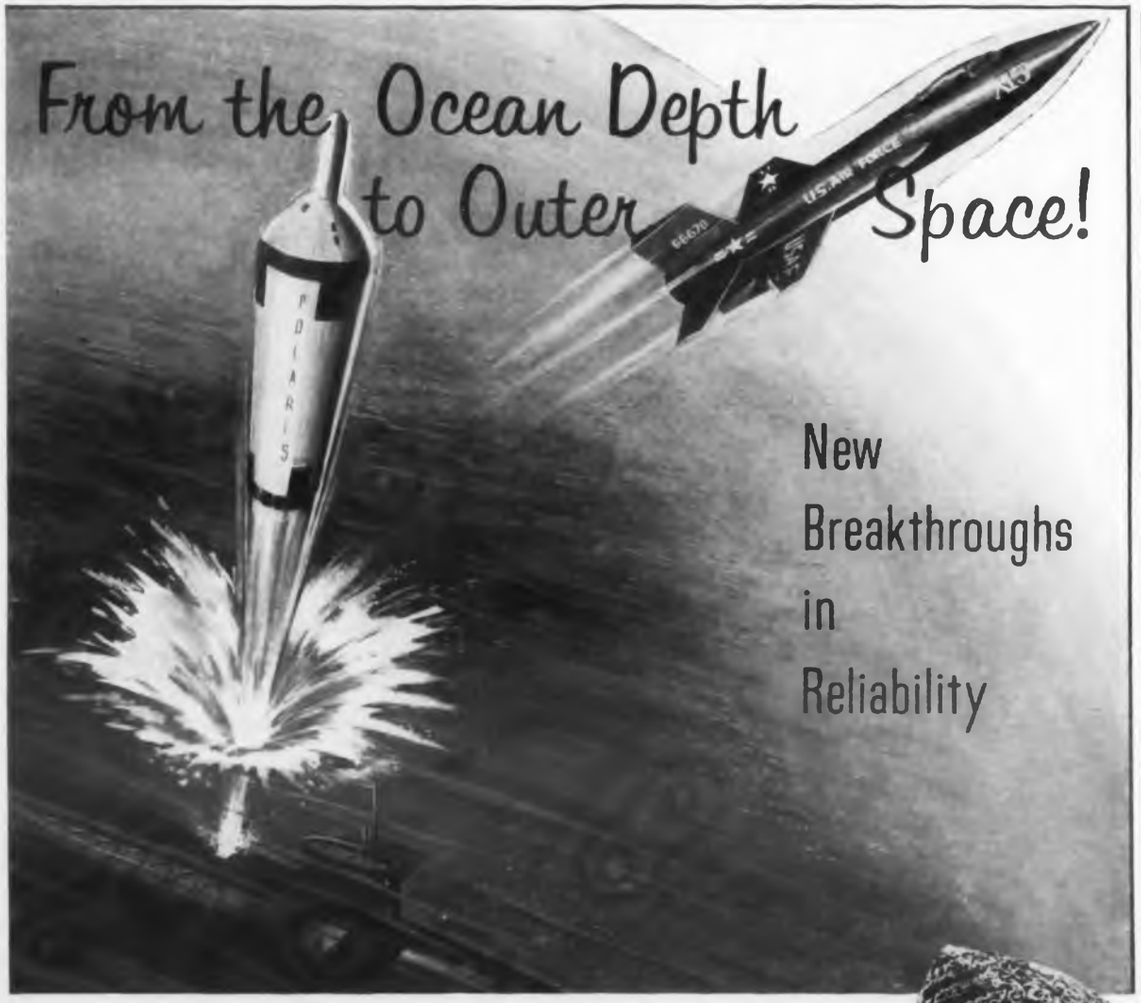

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Aboard the latest nuclear powered Polaris Submarines, Robinson MET-L-FLEX mounting systems safeguard performance and long-term reliability of inertial guidance and single sideband communications equipment—plus critical components in the Polaris missiles themselves. Robinson ***low-frequency*** shipboard mounting systems combine ***both*** vibration and shock protection—a new design breakthrough now available for the underwater and surface fleets of the U. S. Navy.

Nearly every aircraft and missile delivered to the Air Force since 1950 carries MET-L-FLEX mounting systems designed and produced by Robinson. In the X-15 aero-space research vehicle, for example, MET-L-FLEX mounts protect 24 vital electronic and electro-mechanical equipment units. Robinson has also pioneered in the development of high performance, high temperature resistant all-metal mounting systems for jet and rocket engine installations.

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DESIGNERS AND MANUFACTURERS OF VIBRATION CONTROL SYSTEMS

CIRCLE 52 ON READER-SERVICE CARD

NEWS

1,200-F Hermetic Seals Claimed for Mica Composition

A high-temperature hermetic sealing material has resulted from a new manufacturing process for synthetic mica-glass ceramoplastics.

According to the maker, Mycalex Corp. of America, Clifton, N.J., Supramica 620-BB will act as a sealing agent for metal joints at temperatures up to 1,200 F. The new material has electrical and precision-molding characteristics similar to the company's previous glass-bonded mica compositions.

In the new process the glass portion, the weak link from the temperature standpoint, has been improved. Synthetic mica is "in effect" grown inside the glass during melt solidification.

The sealing action comes from two separate characteristics of the material. Its thermal expansion is similar to most metals.

Helium leakage rates as low as 2×10^{-10} cc/sec were claimed by Mycalex.

Unfortunately the sealing operation must be performed at too high a temperature to be used directly with semiconductors. However Mycalex says it has made diode seals for the B-58 program by forming the 620-BB seal before the semiconductor is in place and then finishing the encapsulation with a fast spot weld.

GE Fuel Cell Passes Space Test

Back from space after performing successfully in an RVX-2A re-entry vehicle is this experimental fuel cell. The experiment was conducted recently over the Atlantic Missile Range to determine whether or not the cell would operate normally in zero gravity. Telemetered information (transcribed on the paper roll above) indicated that the fuel cell had operated for the full 30 min of flight time with no fluctuation in voltage and current. Developed by General Electric Co., Philadelphia, the oxygen-hydrogen cell uses platinum electrodes, solid electrolyte and an ion-exchange membrane.

New Radio System Conquers 'Noise Barrier' on Carriers

A new radio communication system for aircraft carriers overcomes a traditional "noise barrier" in communications between the flight-control center and flight-deck crews.

Developed by the Plessey Co. of Ilford, Essex, England, the system circumvents both aircraft noise and the ear protectors worn by crew members. It enables the controller to transmit orders over a broadcast channel at audio frequencies.

The signals are fed into a magnetic coupling loop encircling the flight deck. Individual crew members carry a receiver that picks up the audio signals, amplifies them and feeds them to an earphone built in the ear protector.

Key members of the flight-deck crews are able to talk back to the control center through a vhf radio transmitter clipped to the receiver.

Fully transistorized, the miniature equipment is battery operated and protected by a nylon cover.

Crystal control is used to provide a preset frequency for the vhf transmitter. The audio output of the receiver is kept constant by automatic gain control, thus dispensing with operating controls on the portable equipment.

External radiation from both the vhf and audio channels is kept to a minimum to reduce interference with other electronic equipment.

Advanced Vibration System

Vibration system at Wyle Laboratories, El Segundo, Calif., meets high-force test requirements of increasingly powerful missiles. Shown testing Titan II electrical umbilical disconnect, the system includes Ling model PP-40/60 40-kw amplifier, Ling A246 vibration exciter rated at 7,500-lb force, and Ling model ESD-20/ASD-20 spectral density equalizer/analyzer which permits continuous and parallel observation and control of spectrum in random vibration test programs. Tape recorder is used for permanent record of applied vibration for subsequent analysis.

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• higher junction temperature	100°C	95°C
• twice the power dissipation	150 W	70 W

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2N1358 (SIG.C)

80 VOLT / 15 AMP POWER TRANSISTOR

Motorola's new 2N1358 (SIG. C.) power transistor has less than half the maximum thermal resistance called for in mil-specs . . . 0.5°C/W . . . with a *typical* rating of 0.35°C/W. This means it runs cooler . . . thereby increasing reliability. The Motorola 2N1358 (SIG. C.) is rated for 100°C continuous junction operation compared to the 95°C required by military specifications. It offers 150 watts power dissipation . . . over twice the 70 watts per MIL-T-19500/122.

The 2N1358 (SIG. C.) is typical of the high performance-quality combination you receive from Motorola power transistors. There's a standard Motorola power transistor for nearly all of your design requirements . . . over 100 different devices are available in both the TO-3 "diamond" and TO-36 "doorknob" packages. You'll find a wide variety of mil-type units . . . and all Motorola industrial power transistors are 100% lot life-tested to assure maximum reliability.

MOTOROLA MIL-TYPE POWER TRANSISTORS

TYPE	MAXIMUM RATINGS P_T watts	T_J °C	BV_{CEO} volts	BV_{CES} volts	I_C amps	ELECTRICAL CHARACTERISTICS h_{FE}@I_C min	max	amps	CASE
JAN 2N174	150	100	80*	70	15	25	50	5	TO-36**
2N297A (Sig C)	90	100	80	50	3	40	100	0.5	TO-3
2N1011 (Sig C)	90	100	80	80	5	30	75	3	TO-3
2N1120 (Sig C)	90	100	80	70	15	18	50	18	TO-3†
2N1358 (Sig C)	150	100	80*	70	15	25	50	5	TO-36†

*BV_{CB} **with flexible leads †with lugs

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CIRCLE 55 ON READER-SERVICE CARD

EDITORIAL

Cash for Creativity

How to make engineers more creative has been the subject of a number of articles appearing not only in this publication, but others as well. Theories of creative process have been described and blocks to creativity—emotional, cultural, mental, etc.—have been analyzed. The hope has always been the same—if the way to create is clear, we can all be creative.

Of late, a little-discussed factor has been proposed that may do more to trigger creativeness than all our theories, all our attempts to build creative climate. Cash may be the answer.

Several large companies have announced substantial cash awards to engineers who are granted patents on inventions. Last year NASA awarded $3,000 to Dr. Frank T. McClure for his invention of a satellite Doppler navigation system.

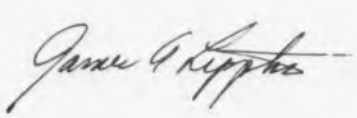
One might hastily conclude the originator of a patentable idea was being justly rewarded for the money-making potential of his idea. The more significant reason, to us, is the incentive of cash to spark innovation. This view disregards the worth of the idea in terms of future earning to the company holding the patent. Actually, because of rapid obsolescence today, patents are of dubious value to the holder. While they may be more than just a "license to sue," no clear case can be made out to prove the company that holds many patents is more successful the one that doesn't.

The cash bonus for a patent, then, is reward for the creative process at work. If a company elects to use the patent office as the judge of who warrants a reward, that is one way.

We would like to suggest another. Let engineers themselves pick the person or persons deserving recognition.

This is exactly what ELECTRONIC DESIGN will do in 1961. On p 186 we announce a $1,000 cash annual award and a $50 award each issue for the outstanding ideas published in our Ideas for Design section. In 1960 the editors picked a deserving contributor. In 1961 engineer-readers will select the engineer deserving recognition.

Engineers acknowledge that man does not work for bread alone, but they also recognize that material rewards make it possible to enjoy other pursuits. For this reason, we say, cash for creativity is good. At the same time we acknowledge that the satisfaction gained from doing inventive work is high. If we can get paid to enjoy ourselves, this is living!



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CIRCLE 56 ON READER-SERVICE CARD

Detector Circuits for Sequential Checkout Systems

In any missile system there are many discrete functions that must be monitored to ensure proper missile operation. These checks are generally performed just prior to missile firing and must be done in a rapid sequence. The circuits presented here, or their related types, can perform almost all the necessary checks in a missile ground-checkout system. These circuits would send a "go-no-go" sense command to a sequential operator or malfunction bus.

Chalmers G. Riley
Staff Engineer
Astro-Space Labs., Inc.
Huntsville, Ala.

SENSING a function level and determining whether it is within its active range of operation is one of the primary functions of a checkout detector. After this determination is made a signal must be sent to the command bus for sequential operation. This would be in the form of a go-no-go command.

Some of the more commonly used sensing circuits are null detectors, level detectors, phase discriminators, and verification amplifiers. These circuits will perform almost all the required functional checks in any missile ground-checkout system. Of course, whether the missile and ground components are digital, analog, or as is generally the case, a combination of both, will determine the class of detector circuit used. However, they can be designed to perform any of the following operations:

1. Determine the rotation of a missile in an azimuth alignment system with respect to its vertical axis, and determine when missile rotation is complete.
2. Send and receive guidance information to perform sequential operations.
3. Determine if the guidance integration scheme is functioning properly.
4. Verify servo voltages and stability.
5. Check the guidance engine cut-off system.
6. Remove components during active tests.
7. Send ready-complete commands.

Phase Detector Uses Servo Reference Voltage

By monitoring a servo-motor voltage, the phase detector can be used to determine missile rotation and direction, and whether missile rotation is complete. Typically, the missile function will be driven by an analog-to-digital converter servo loop. The motor control voltage of a remotely located repeater loop will have a one-bit error signal of, say, 10 v ac. This voltage is fed to the

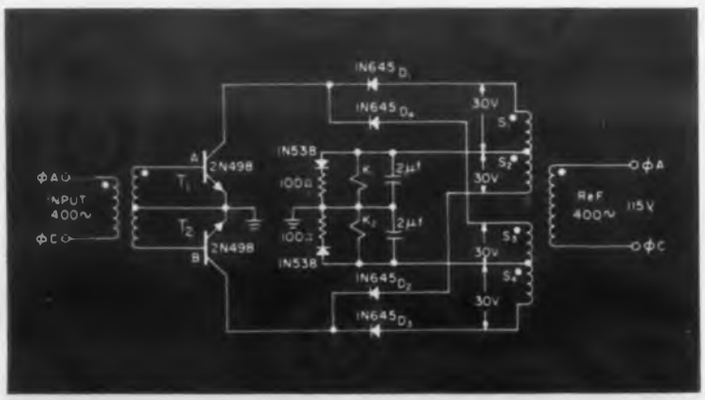

Fig. 1. Phase detector matches phase relationship between reference voltage and monitored function.

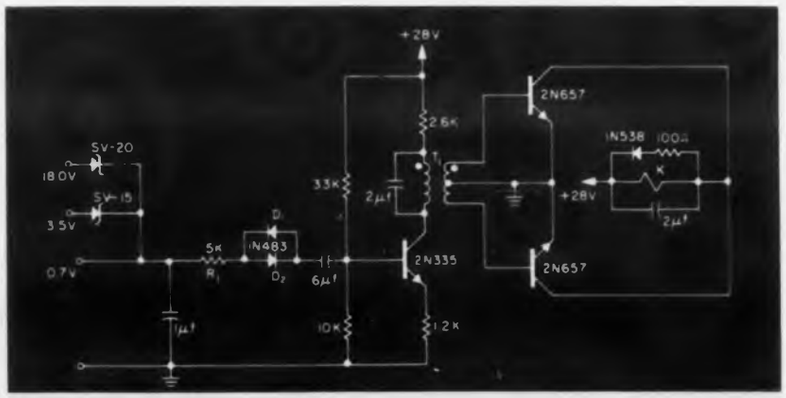

Fig. 2. Null detector is basically a transistor amplifier with full-wave rectification for relay operation.

phase detector, Fig. 1, and its phase relation to the reference voltage is detected.

Briefly, the circuit works in this manner: When the base of transistor T_1 and S_1 both become positive, T_1 conducts through diode D_1 and relay K_1. During this half-cycle, transistor T_2 is cut-off because of the negative signal at its base. On the second half-cycle T_1 and S_1 become negative cutting off T_1 while T_2 and S_2 become positive. T_2 then conducts through D_2 and relay K_2. If a phase reversal should take place transistor T_1 and S_3 would become positive simultaneously, and conduction would take place through T_1, D_4, and relay K_2 for one half-cycle. On the second half-cycle T_1 and S_3 become negative while T_2 and S_4 become positive, and T_2 would conduct through D_3 and K_2. When the input signal is zero neither relay is conducting.*

The relay contacts of this circuit can furnish the go-no-go command for the next sequence.

This is a simple circuit that requires only one external supply voltage. The detector is limited only by the current capabilities of the transistors. The input transformer can be designed to operate the circuit at any voltage level. However, if a zero null is required, the transistors must be biased. If biasing is not used, the secondary voltage of the input transformer must be approximately 1 v for the transistors to conduct and the relays to operate. Phase balance depends on transistor matching. This can be improved by connecting a diode from the center-tap of the input transformer to the emitter legs. In turn, the input signal level must be increased to compensate for the voltage drop across the diode. Diode matching is not as important, since this would change the relay coil voltage very little. The secondary voltage of the reference transformer is determined by the transistor rating and the relay coil pick-up voltage.

Null Detector Senses Set Input Levels

Null detectors are probably the most common sensing devices in sequential systems. Their range of operation is limited only by the input circuitry. The null detector shown in Fig. 2 was designed to operate at levels of 0.70, 3.5, and 18.0 v ac. This circuit is a basic transistor amplifier with full-wave rectification for relay operation. The diodes, D_1 and D_2, are used so that the amplifier will not conduct until at least 1/2 v is present at the input. This will also sharpen the zero null point.

The voltage detection level is less than the breakdown level of the Zener diodes. This is due

* De Sautels, Albert N., "Transistorized Phase Discriminators," American Institute of Electrical Engineers, Communication and Electronics, No. 29, pp. 20-21, March 1957.

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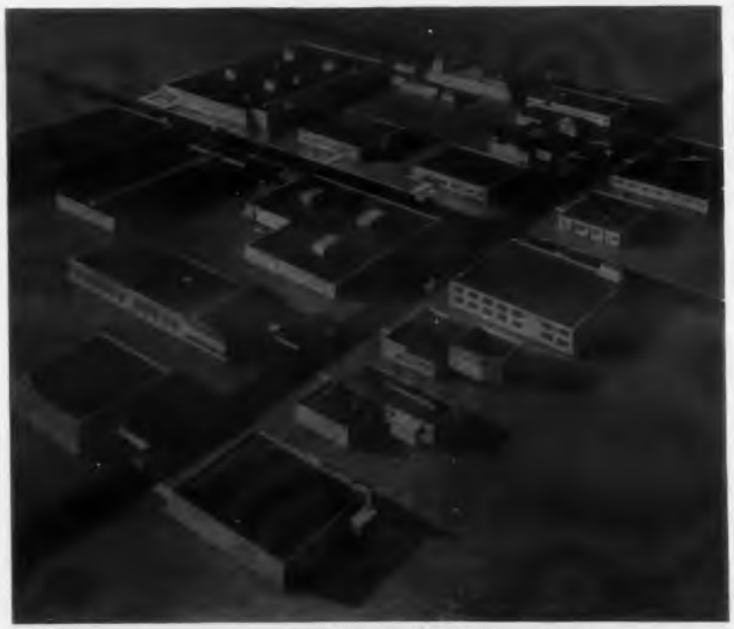

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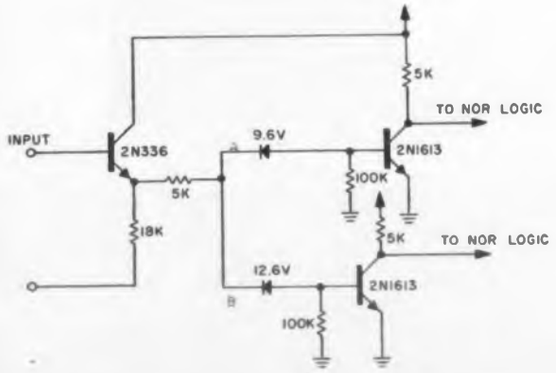


Fig. 4. Detector of Fig. 3 can be temperature-compensated by inserting voltage regulators after emitter-follower input stage.

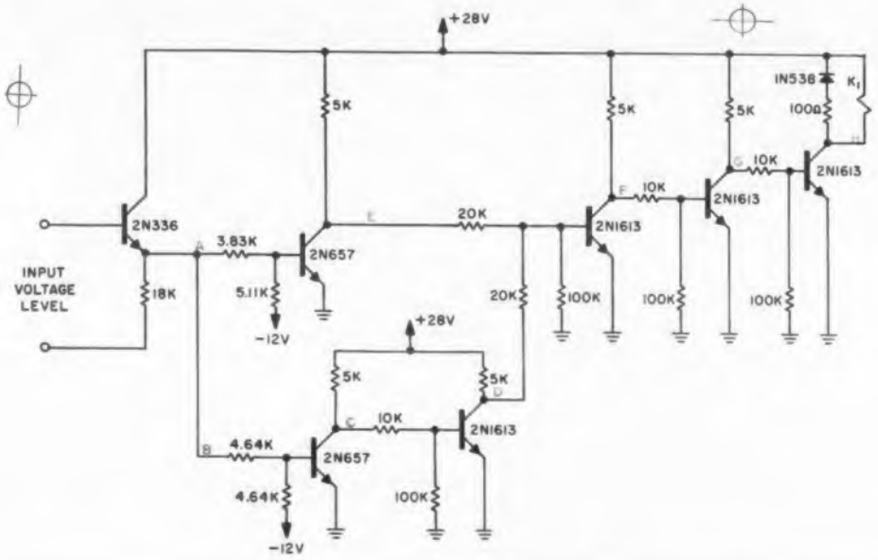
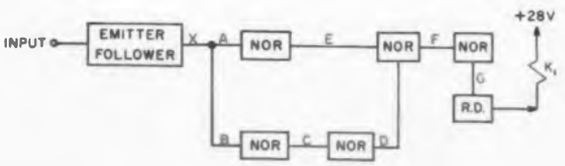


Fig. 3. Sample level detector provides no-go command if voltage level is below 11 v or above 14 v.



(a)

A = 1 WHEN x ≥ 11 VOLTS
B = 1 WHEN x ≥ 14 VOLTS

A	B	C	D	E	F	G	H
0	0	1	0	1	0	1	1
1	0	1	0	0	1	0	0
1	1	0	1	0	0	1	1

(b)

Fig. 5. (a) Block diagram presents logic circuit elements of level detector of Fig. 3. (b) Truth table for level detector.

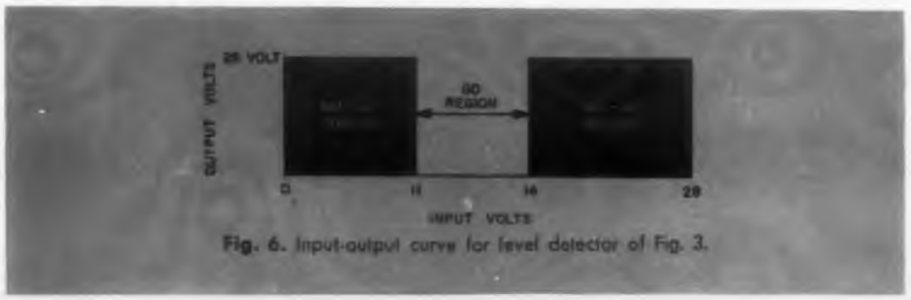


Fig. 6. Input-output curve for level detector of Fig. 3.

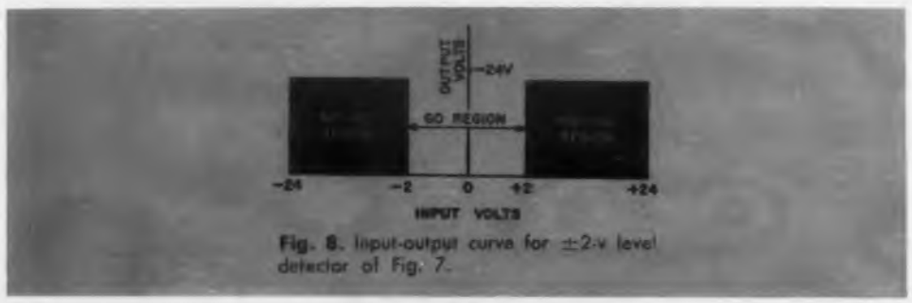


Fig. 8. Input-output curve for ±2-v level detector of Fig. 7.

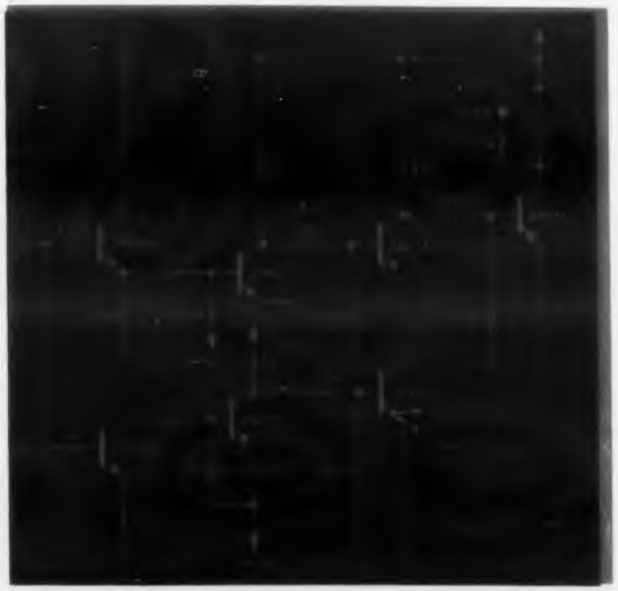


Fig. 7. Level detector monitors plus and minus voltage levels. Circuit shown is for ±2 v.

to the voltage drop across the input resistor and the fact that the diode regulators do not have a sharp breaking point. If the Zener voltages were decreased and the resistance of R_1 increased, the circuit would not operate as sharply. Transformers could be used at the inputs to detect almost any voltage level.

When the proper testing point is switched into the circuit, the relay will be energized if the point is above the specified input level. There will be a certain tolerance due to variations of the transistor with temperature and relay pick-up voltage deviations. However, for the more exact checks, compensation can be used.

Level Detector Monitors Within Set Limits

Various sub-systems must be checked to see that they are within their range of operation. These checks could be used, for example, to indicate integration accuracy, integrator zero drift, or pre-setting accuracies. If the integrator is electro-mechanical, the sensing voltage would be, in most cases, a dc level from a control potentiometer. This can be detected by simple NOR logic.

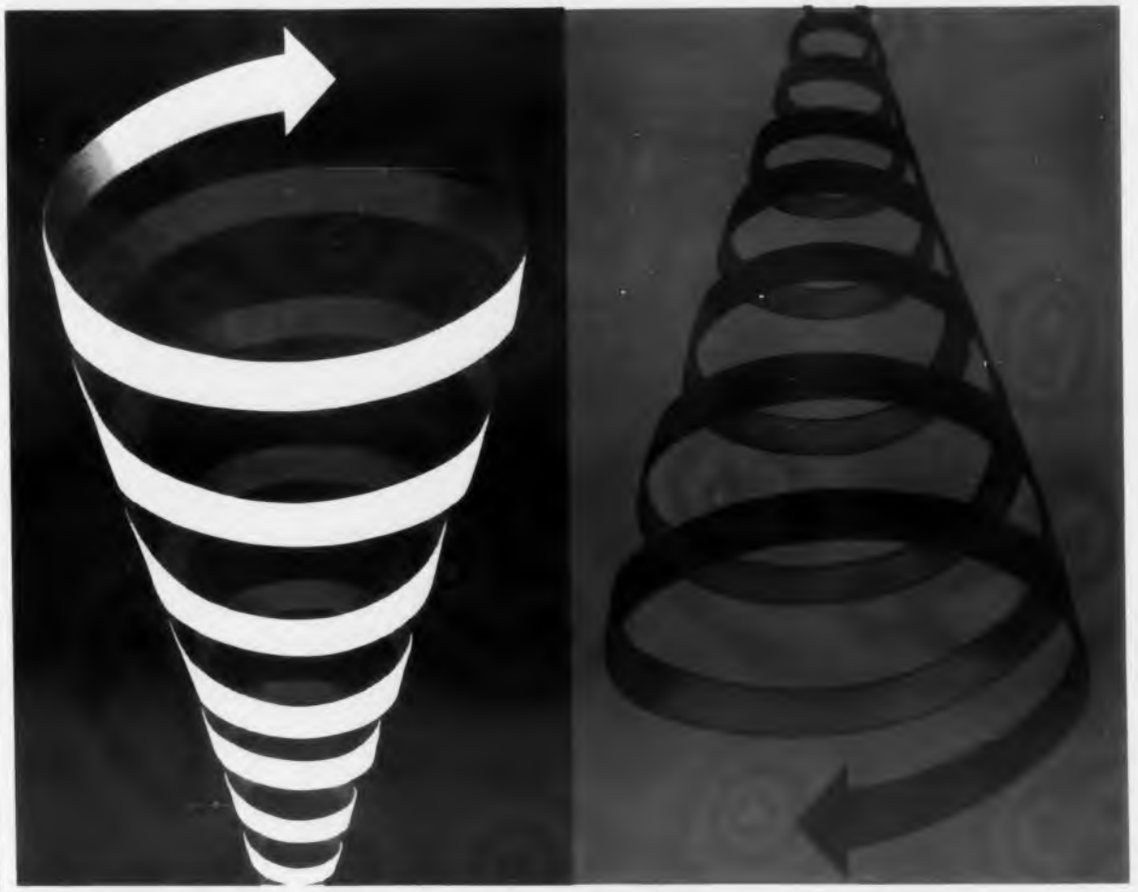
For example, suppose it is necessary to detect a voltage range from 11 to 14 v and provide a sequential command. If the voltage level is below 11 v or above 14 v, a no-go command is sent to the malfunction bus. This can be done by the circuit shown in Fig. 2. This type of circuit is very temperature sensitive. However, the sensitivity can be reduced by using voltage regulators of 9.6 v and 12.6 v as shown in Fig. 4. The circuit block diagram and truth table are shown in Fig. 5, with the input-output curve presented in Fig. 6.

In some instances it is necessary to detect a plus and a minus voltage level, such as -2 v and $+2$ v. This can be done by the circuit of Fig. 7. The logical structure of this circuit is similar to that shown in Fig. 5. The input-output curve is shown in Fig. 8.

This circuit will be somewhat temperature sensitive but this can be compensated for by using sensistors or diodes.

Each circuit has an emitter follower input circuit for high input impedance. If diodes are used in the next stage as shown in Fig. 4, the input impedance will be decreased. However, this will not occur until after circuit operation has begun. A series resistor could be used and the voltage would remain almost the same since it is at a low current level.

The circuit tolerance could be made to operate within ± 2 per cent over a wide temperature range if switching transistors with a very low saturation resistance, such as a Fairchild 2N1613, and temperature compensation were used. ■ ■



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CIRCLE 58 ON READER-SERVICE CARD

Practical Measurement Frontiers

Even more impressive than our fine array of test equipment is the array of test equipment and measurement techniques we don't have. In this article, Herbert Cahn of ASRDL's Instrumentation Branch discusses some of the major instrumentation shortcomings and trends. These are being explored extensively by Armour Research Foundation under contract to ASRDL.*

Herbert Cahn
U. S. Army Signal Research and
Development Laboratory
Fort Monmouth, N. J.

THE INCREASING use of more and more complex electronic equipment in military communications, weapons, and support systems has resulted in increased pressure on instrumentation people, not only to keep pace with these advances, but to stay ahead of them. Devices for testing, aligning, and calibrating such equipment must have accuracies and stabilities at least an order of magnitude better than the gear on which they are used.

They must deliver or receive appropriate modulations, gates, synchronizations, and other required signals, and should be versatile in terms of application to a wide variety of equipment and situations. Wide frequency range and large dynamic-range equipment is needed. Trouble-free instrumentation circuitry is highly desirable as is operational simplicity.

A few references to major instrumentation trends are worthwhile. One of these trends centers around low-noise system development. Considerable activity exists today both directly and indirectly concerned with circuit design using parametric amplifier principles, tunnel diodes, masers, and similar devices.

Some of the techniques apply to room-temperature operation; others have low-temperature requirements. All have the advantage over more conventional circuitry in that the noise figure of systems in which they are used is significantly better. Such techniques are worth considering, both from their potential application in advanced instrumentation, and from the requirements they will place on the equipment that must measure their performance.

An important trend relates to complex operational and advanced communication and guidance systems. These systems are extending over wider frequency ranges, as in the case of fire-direction radars; higher powers in the case of communication links, radar, and scatter systems; and to higher-precision circuitry; in the case of satellite and missile electronics.

Requirements for nanosecond pulse generation and performance exist. More rigid frequency, phase, and gain stability are necessary. High-performance reliability with, in some cases, zero allowable down time, must be achieved. The need to pre-test such equipment and future generations of such equipment accurately and swiftly is obvious.

Serious 'Know-How' Gaps Mark Test-Equipment Needs

Frequency Selection. One of the most serious gaps in the art of rapidly programed automatic testing of electronic equipment is the inability to select, by a practical means, the one required signal from among the infinitely large range of possible frequencies, levels, and waveforms.

This signal, for checking one point in the range of a radio receiver, for example, is but one of the multitude of check points which must be within the capability of a general-purpose, automatic tester. The connection of the signal generator to the equipment under test through the programer is impractical using present techniques.

Noise Content. Another signal-source limitation, noise content in low-level alternating signals, is a continuing problem that has come to be taken more or less for granted. The uncertainty of the extraneous frequencies, or noise, which engineers must always deal with in the microvolt region, results in rather crude measurement devices so far as accuracy is concerned.

Frequency Instability. A further weakness of signal generators is their frequency instability. It is desirable that signal-source oscillators be at least 10 times better than the radio receivers for which they provide test signals. At the present time, they are of the same order of magnitude, making them of questionable value, at best, for such tests as frequency drift and selectivity.

Modulation Gap. Modulation poses a severe problem in signal generators covering the frequency range from 400 to 600 mc. Below 400 mc, lumped-constant techniques are suitable. Above 600 mc, distributed-constant techniques are used effectively. But between 400 and 600 mc, there are no practical modulation techniques for military generators.

Signal Generator Calibration. With regard to calibration of signal generators, a severe shortcoming has been recognized for years, but no practical field solution is yet in sight. This problem is the detection and accurate measurement of very small rf and microwave signals at levels which represent the smallest detectable signals of standard military radio receivers.

A substantial effort has been made in recent years to solve this problem, but engineers are only now arriving at the completion of the first laboratory model of a super-cooled bolometer used in a sensitive bridge circuit which will enable them to measure small fractions of a microvolt with reasonable accuracy, that is, within about 3 per cent up to 1 Gc.

Progress in microcircuitry has been rapid. Less than two years ago, Texas Instruments announced the first Solid Circuits and created quite a stir at the IRE convention. Designers are now forced to think in terms of testing and maintaining complete circuits as the smallest testable and replaceable elements in future equipments.

* More detailed information on the projects covered in this article and on other investigations being conducted at Armour Research Foundation is given in "Instrumentation and Measurement Techniques Study, DA 36-039 SC-78269," which is available from the Armed Services Technical Information Agency.

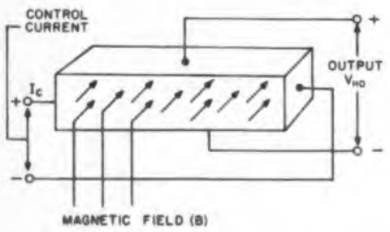

Fig. 1. Typical Hall generator develops a voltage which is a product of a magnetic field and a perpendicular current flow in a semiconductor.

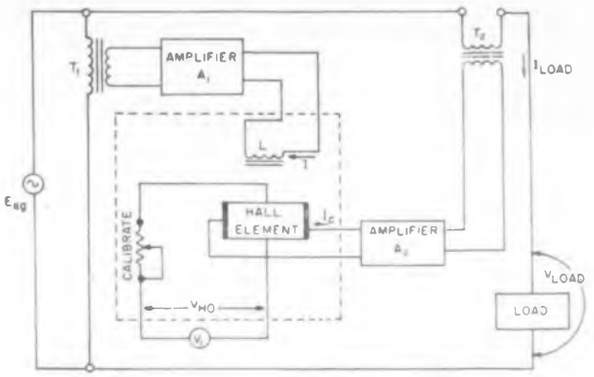

Fig. 2. Experimental audio wattmeter uses a Hall device as a current-voltage multiplier.

RF Quality of Tubes and Semiconductors. The radio-frequency quality of electron tubes and solid-state devices is critical in many applications. General-purpose tube and transistor test sets deal only with static and low-frequency performance, frequently indicating as an acceptable component one which is, in fact, a poor or even inoperative component for an rf circuit. While there is considerable improvement in both tube and transistor test-set design, the important measurement of rf quality is still a problem.

Programing automatic and semiautomatic testers to control rf signals has seen little progress in recent years though dc and audio signals are easily programed. Perhaps an entirely new approach to rf-signal generation could be used, for example, recorded rf signals.

The best magnetic video tape is inadequate for this purpose, but the new thermoplastic recording may soon extend the range well up into the spectrum. Fifty mc have already been shown theoretically possible with this new method.

Other problems demanding attention include:

- Calibration of delay lines.
- Measurement of rf power without absorption of power.
- Correlation of intermodulation distortion with harmonic distortion.
- Measurement of amplitude modulation, especially below 10 per cent.
- Measurement of amplitude distortion on an rf carrier.
- Measurement of transmitter splatter or spurious low-amplitude signals very close to the output frequency.
- Simplification of both test equipment and test methods.

New Components and Methods May Boost Equipment Performance

Much work has been concerned with galvanomagnetic effects (namely Hall effect and magnetoresistance) and various applications of the back-biased junction diode.

Since these devices and techniques may be used in new test instruments, it is well worth describing six of the areas showing considerable progress.

*1. **Magnetoresistance.*** This effect represents a change in the resistance of a material when a magnetic field is applied across the material. It is most significant in the intermetallic semiconductors, such as germanium or indium antimonide. The effect may have application in amplification, oscillation, and variable attenuation.

*2. **Voltage-Variable Capacitors.*** Back-biased silicon diodes provide a change in capacitance with applied voltage. Such devices have previously been considered in oscillator-tuning applications. Their capabilities have been investigated in more sophisticated phase-modulation and single-sideband modulation systems.

*3. **Parametric Amplifiers.*** These amplifiers are low-noise devices employing voltage-variable capacitors. Emphasis is being placed on broadbanding techniques.

*4. **Gas-Discharge Phenomena.*** Many effects have been noted by interacting an electron gas (plasma) with microwave energy. In particular, the gaseous medium can serve as an attenuator, a modulator, or a phase shifter. Other applications are possible.

*5. **Digital Frequency Control.*** To improve signal source compatibility with automatic system-test facilities, it is desirable to be able to control frequency by digital means. Methods are currently under consideration.

*6. **Hall-Effect Devices.*** These devices develop a voltage which is a function of current flowing through them and a magnetic field in which they are placed. The voltage is developed in a plane at right angles to both the applied current and the field as shown in Fig. 1. Extensive work is now under way to find practical circuit applications for the Hall effect which has been known since 1879.

Optimistic Emphasis Centers on Hall Devices

Since the development of intermetallic semiconductors, in which Hall voltages are of sufficient levels to be considered usable, Hall devices have become very important. Magnetic-field sensors, rf mixers, squarers, and analog multipliers are but a few of the Hall devices which have been considered.

Most devices employing the Hall effect have approximately the same semiconductor material requirements. Basically, the ideal material should have a high electron mobility and a large energy gap, and both of these parameters should remain constant. For a specific material to possess a high mobility and a large energy gap simultaneously is incompatible from a practical viewpoint. Intermetallic semiconductors offer the best compromise for at least a partial solution to this problem. Two of the more common commercially manufactured materials used as Hall generators are indium antimonide and indium arsenide.

The Hall effect has been found to be a true product device; it multiplies the control current by the perpendicular component of magnetic field without introducing measurable distortion components. This feature lends itself to a variety of useful applications. A few of the major devices which are either under investigation or have been investigated are as follows:

Wattmeters. Two separate investigations are being conducted on Hall-effect wattmeters—one type for use in the audio-frequency range, and the other for measurement of microwave power. Both types feature simplified circuitry of the envelope type (as opposed to average) and use a minimum of moving parts.

The audio wattmeter is potentially compact, lightweight, and reliable. A transmission-type af wattmeter may be developed by using the Hall effect as a true multiplier. The basic block diagram of such an instrument is shown in Fig. 2. Transformers T_1 and T_2 monitor the load voltage and current, respectively. The Hall voltage is proportional to power, and hence proportional to the product of the current output of amplifiers A_1 and A_2 and the cosine of the angle between the load voltage and current. Hence the millivoltmeter V_1 can be calibrated in terms of power.

A microwave power meter uses the Hall effect to make the measurement we now make with calorimeters, bolometers, and water-cooled devices. Though much previous work has been accomplished on this type of wattmeter, present effort has to do with increasing the measurable power range of this device. Fig. 3 shows the construction of the essential element of this

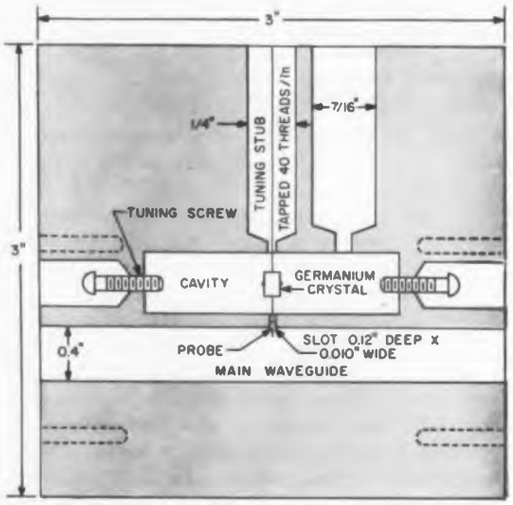

Fig. 3. Front views of a microwave power meter using the Hall effect. The unit is less than 1-in. deep.

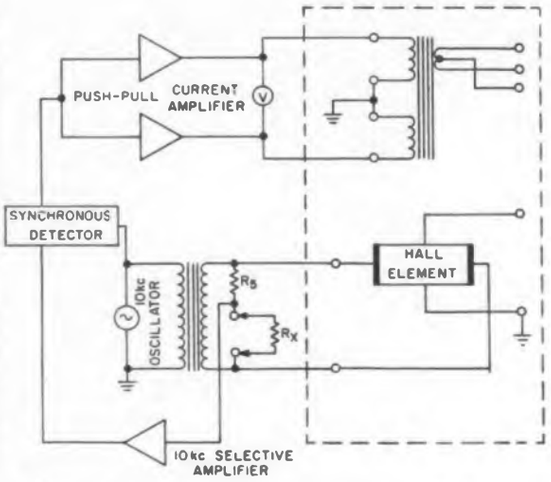

Fig. 4. Self-balancing resistance bridge uses a Hall device as a continuously variable ratio-arm bridge.

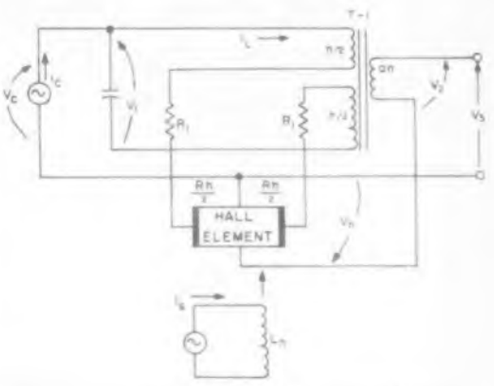

Fig. 6. Phase modulator provides reasonably linear phase deviation over a 100-deg range with a 100-gc carrier.

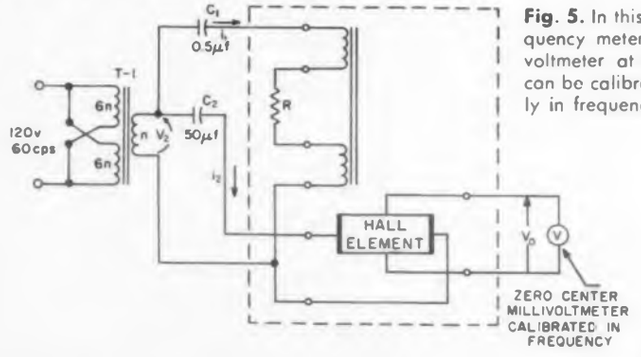

Fig. 5. In this 60-cps frequency meter, the millivoltmeter at the output can be calibrated linearly in frequency.

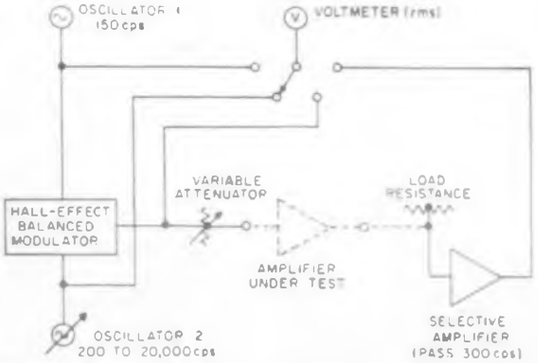

Fig. 7. Intermodulation tester uses a voltmeter and a selective amplifier as a tuned voltmeter to give a direct indication of per cent intermodulation distortion.

particular type of microwave power meter.

Self-Balance Bridge. Another application of the Hall effect is in a self-balancing bridge. This bridge, which is nearly independent of signal voltage and gain changes, has sufficient output power to drive a recording voltmeter. The unusual features are complete absence of contacts and, of course, freedom from vibration, shock, and acceleration effects.

This self-balancing resistance bridge has been developed using a Hall device as a continuously variable ratio-arm bridge. A simplified block diagram of the complete system is given in Fig. 4.

A 10-kc sine-wave oscillator furnishes a signal to the resistance bridge and provides a reference signal for a synchronous detector. A selective amplifier raises the level of the bridge error signal before the signal is applied to the synchronous detector.

The amplified output of the synchronous detector develops the magnetic field for the Hall device. The polarity of the feedback loop is chosen to make the error signal tend to reduce the bridge unbalance. The voltage developed across the field coil of the Hall device provides an indication of resistance change.

The bridge has been shown to be virtually insensitive to oscillator-level variations. An increase in oscillator output voltage of 100 per cent gives a change in output signal of only 2 per cent.

Frequency Meter. A rather simple and reliable method of measuring frequency in the neighborhood of 60 cps is shown in Fig. 5. In this circuit diagram, capacitor C_1 is series resonant with the excitation coil at 60 cps; C_2 delivers about 400 ma through the Hall element at the nominal line voltage of the system.

It can be shown that the component of the Hall output V_0 will take on the shape of a discriminator characteristic with the zero output at 60 cps. The output voltage will be, to a good approximation, a linear function of frequency deviation. Hence the millivoltmeter may be calibrated linearly in line frequency.

After suitable amplification the dc output signal can be used to control the fuel flow to an engine driving a generator to effect direct frequency control. Such a frequency control would be more reliable than the more conventional Wien-Bridge frequency controlling meter used in large generating stations, as control would be obtained with no electromechanical device in the system except the fuel valve.

Direct Frequency Modulator. Using a Hall element in the feedback loop, a transistor-oscillator system provides a reasonably linear frequency deviation in response to variations in a dc control current. In this direct, fm system, an oscillator feeds a constant carrier frequency to a Hall device whose output drives a constant-current source. The current source feeds back to the oscillator through another Hall device.

Frequency deviations above and below the carrier frequency are achieved as both the magnitude and polarity of the Hall dc control current are varied. Essentially, the Hall effect, in conjunction with the constant-current source, acts as a variable reactance, shifting the signal polarity from either plus or minus 90 deg. The modulator gives a reasonably linear transfer characteristic over a deviation range of about 5

per cent of the center frequency.

Phase Modulator. A second modulation technique is a rather simple, two-stage-cascade, phase modulator. Shown as Fig. 6 is the circuit configuration capable of providing reasonable linearity over a phase deviation of plus and minus 50 deg when using a carrier frequency of 100 kc. Theoretical considerations indicate that satisfactory results can be achieved up to 1 mc with such a circuit.

If a carrier current is applied to the Hall element and a signal current is applied to the excitation coil, the Hall device will function as a balanced modulator. A separate, parallel-resonant circuit may be used to increase the carrier current through the Hall element. A small secondary, wound on the same core as the coil of the parallel-resonant circuit, can furnish the required quadrature carrier component, and a series connection of the Hall-output terminals and the secondary will provide the phase-modulated output voltage.

Intermodulation Distortion Measurement. A novel intermodulation distortion measuring method has been made feasible by the Hall principle. This device, shown in Fig. 1, performs as an essentially distortionless, balanced modulator throughout the audio-frequency spectrum.

If a fixed, low-frequency, sine-wave current of, for example, 150 cps is applied to the excitation coil of the Hall device, and an arbitrary, single-frequency, sine-wave signal, adjustable throughout a frequency range of 200 to 20,000 cps, is applied to the Hall element, the output signal developed by the Hall device will have two sidebands. The difference between the frequencies of the two sideband components is constant at 300 cps; twice the value of the 150-cps modulating frequency.

If the output voltage of the Hall device is used as the signal source for an amplifier under test, a selective voltmeter, tuned to respond to signals of twice the modulating frequency, can be calibrated directly in per cent intermodulation distortion. This system permits the rapid measurement of intermodulation distortion on a point-by-point basis throughout the audio spectrum. If desired, it can be adapted to give a continuous recording of intermodulation distortion as a function of frequency.

These few examples are intended to give a quick picture of the effort being performed under a particular contract program, but, more than that, they are intended to indicate a direction which farsighted instrumentation people must take. It is only by way of such advanced thinking that the developments in fields of physics, materials, chemistry and other areas can be most expediently applied to the over-all measurement program. ■ ■

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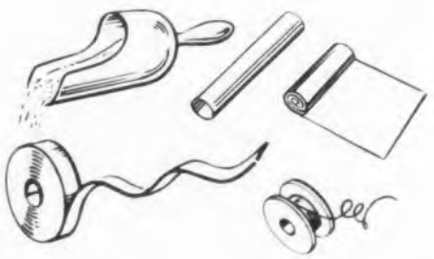

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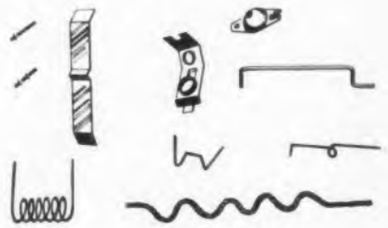

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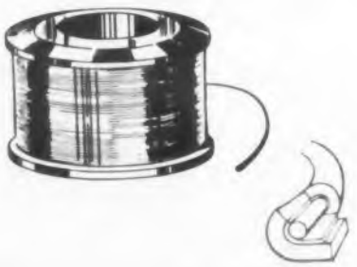

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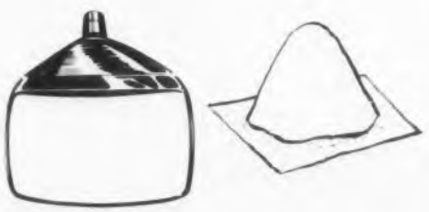

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All-Pass Networks—Part 4
Reduce Ripple and Rise Time

The all-pass network shows another face in this article, as a corrective network to reduce ripple and improve rise time. Here, in the fourth article in Mr. Lubkin's series on all-pass networks, he shows how to predict ripple level and how to design corrective all-pass networks. The concluding article in this series will deal with guidelines and pitfalls in using all-pass networks.

Yale Jay Lubkin
Loral Electronics Corp.
The Bronx, N.Y.

IT IS useful to know, in advance, what level of ripple is to be expected from a given network and how the network can be designed to reduce ripple. Ripple and overshoot are important parameters of a network's response.

Ripple is seldom desirable, because many circuits will not work properly if the ripple is excessive. Nearly all digital circuits require that the ripple not exceed a certain level if reliable operation is to be maintained. All-pass networks can be invaluable for corrective filters in this application, since they can be used to reduce ripple and rise time simultaneously.

Fig. 1 shows typical pulses having ripple and overshoot. The percentage ripple is defined as the percentage ratio A_r/A_s in the figure; the percentage overshoot is defined as A_2/A_1.

Low-Pass Network Considerations Can Be Extended to Bandpass Nets

We will consider low-pass systems in this article, as in the previous ones in this series, but the results can be extended to bandpass systems as well. If the network amplitude characteristic, A, and phase, ϕ, are expanded in a power series, the resulting expressions will be of the form

$$A = e^{-(a\omega)^m} + \ldots\ldots$$
$$\phi = \omega + (b\omega)^n + \ldots \qquad (1)$$

In Eq. 1, the amplitude characteristic is m th order maximally flat, and the phase is n th order maximally flat. (In the previous article, for the same equation, we would have said that the delay was (n-2) the order maximally flat. Here, as in many other places, people working in slightly different fields use the same terms for somewhat different concepts.)

If the system bandwidth is restricted, so that Eq. 1 describes the network, then ripple will be minimized when phase distortion is zero. The ripple increases monotonically with phase distortion, i.e., as phase distortion increases, the ripple never decreases. A network having zero ripple must have zero phase distortion and a gain which falls off as the square of frequency.

This implies an attenuation of 12 db/octave beyond cutoff, and corresponds to a second-order Butterworth characteristic. If the attenuation is increased so as to fall off as the fourth power of frequency (24 db/octave), corresponding to a fourth-order Butterworth filter, the minimum ripple is slightly more than 5 per cent.

When the network has no attenuation, as in all-pass systems, there will always be overshoot and ripple. For n=3, the overshoot is 27 per cent; for n=5, it is 21 per cent; and for n=7, it is 14 per cent.

These values are for a single section and get progressively worse in cascade, so that some form of attenuation is essential. Overshoot percentages greater than about 10 per cent are considered very high, and networks are not normally expected to operate with signals having so much overshoot.

The relative importance of phase and amplitude distortion in ripple control is illustrated in Fig. 2. It shows the impulse response of a network with perfect phase (n is infinite) but with severe amplitude distortion (m is infinite), and one with perfect amplitude (m is zero) but with severe phase distortion (n = 3).

The latter network is all-pass. The fact that the perfect phase response is much better than the perfect amplitude response points up the necessity of good phase response, and illustrates one of the dangers in careless design with all-pass filters.

Table 1. Ripple as a Function of Δ

m	n	Limits on Δ	% Ripple
2	3	0.3<Δ<15	12+10 log Δ
4	3	0.6<Δ<7	17.5+10 log Δ
2	5	0.15<Δ<25	12+5 log Δ
4	5	0.2<Δ<10	18+5 log Δ

Table 2. Overshoot as a Function of Δ

m	n	Limits on Δ	% Overshoot
2	3	0.2<Δ<5	30+35 log Δ
4	3	0.3<Δ<7	36+35 log Δ
2	5	0.04<Δ<7	29+20 log Δ
4	5	0.2<Δ<5	33+23 log Δ

Phase Distortion at Amplitude Cutoff Determines Per Cent Ripple

The most important parameter determining the ripple response of a network is the phase distortion at amplitude cutoff, Δ.

For a network described by Eq. 1, Di Toro[1] has shown that

$$\Delta = \left[\frac{\Gamma\left(1+\frac{1}{m}\right)}{n/b}\right]^n \qquad (3)$$

where Γ is the gamma function. Other methods are readily available for determining Δ.

$$\Gamma(n) = \int_0^\infty x^{n-1}\, e^{-x}\, dx$$

is tabulated in many references.

Tables 1 and 2 show the dependence of the ripple and overshoot percentages on Δ for various network types, and the limits over which the tables hold. The overshoot is calculated for the response to an impulse; the ripple is calculated for the response to a step.

There is no simple formula for extending the table, since in general, there is no solution in mathematically closed form. Solutions must be calculated for each specific case and the calculations are quite lengthy.

The tables show that the ripple at Δ = 1 is substantially independent of n, i.e., if the phase distortion at amplitude cutoff is one radian, then, as far as ripple is concerned, it does not make much

difference what the distortion is at other frequencies. (The network must, however, be described by Eq. 1 if the statement is to be valid.) If the amplitude response drops rapidly after cutoff, as it should to obtain good rise time, the ripple obtained should not prove excessive for many uses.

If Δ is much greater than one radian at amplitude cutoff, both ripple and rise time will suffer, and the network will have rather poor characteristics. If better ripple control is desired, the gain must drop slowly and yet must be small at moderate values of phase distortion. (Amplitude cutoff must occur when the phase distortion is much less than one radian.)

This implies greater rise time, so the designer must strike a balance between rise time and ripple for his particular application. Note that only the amplitude response is affected. The gain must drop slowly for low ripple and must drop rapidly for low rise time. Low phase distortion minimizes both ripple and rise time.

Cascading Sections Gives Ripple-Rise-Time Compromise

One can obtain a better compromise between ripple and rise time by cascading sections. Part 3 of this series (*ED*, Feb. 15, 1961, pp 44-47) showed that the delay-to-rise-time ratio of a delay line can be improved by cascading if the individual sections are good enough. The same is true for the ripple. If Δ is the phase distortion at amplitude cutoff for one section, and Δ_q that for a cascade of q identical sections, then

$$\frac{\Delta q}{\Delta} = q^{\left(\frac{m-n}{m}\right)} \qquad (4)$$

If too much attention has been paid to getting good amplitude response, and $m>n$, then the ripple will increase as the number of sections increases. If, on the other hand, attention has been paid to the phase response, and $n>m$, the ripple will decrease. (Note that m is even and n is odd, so the two can never be equal.)

As an illustration of the importance of good phase, if $m=4$ and $n=3$, then cascading 10 sections will increase the ripple by 2.5 per cent of the amplitude of the step response. Adding an all-pass network to increase n to 5, but still keeping Δ the same, will decrease the ripple by the same 2.5 per cent. The all-pass network can be used to reduce Δ and hence reduce the ripple and rise time even more.

Complete Ripple Control Offers Disadvantages Too

Another example of the conflict between good rise time and low ripple is shown in Figs. 3 and 4. Fig. 3 shows three possible responses to a step,

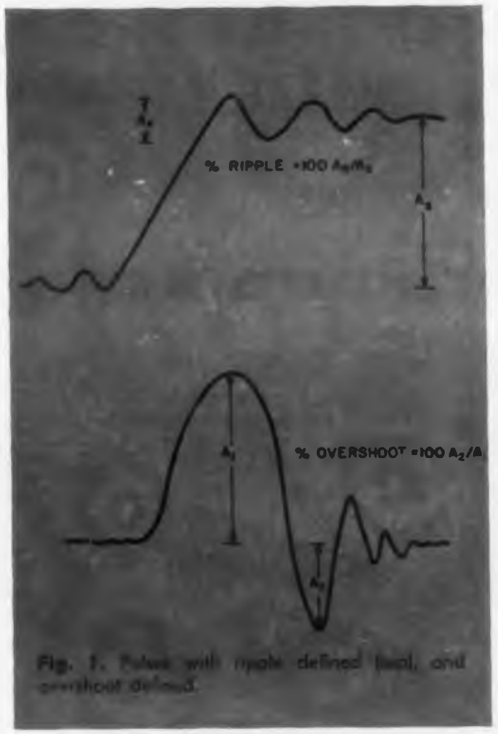

Fig. 1. Pulse with ripple defined (top), and overshoot defined.

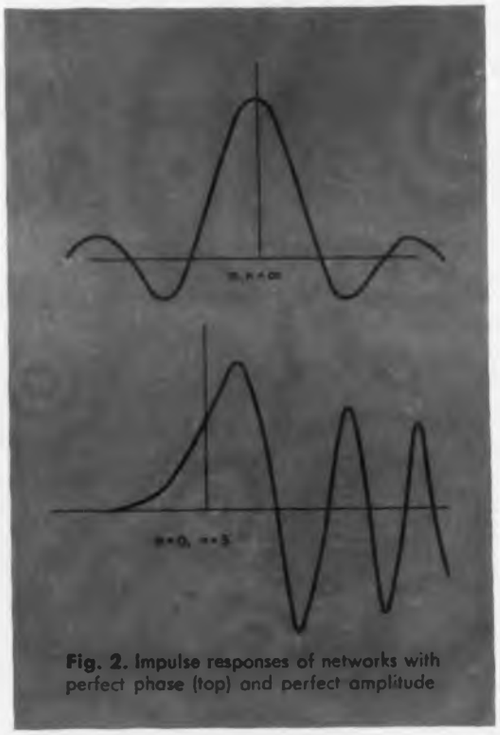

Fig. 2. Impulse responses of networks with perfect phase (top) and perfect amplitude

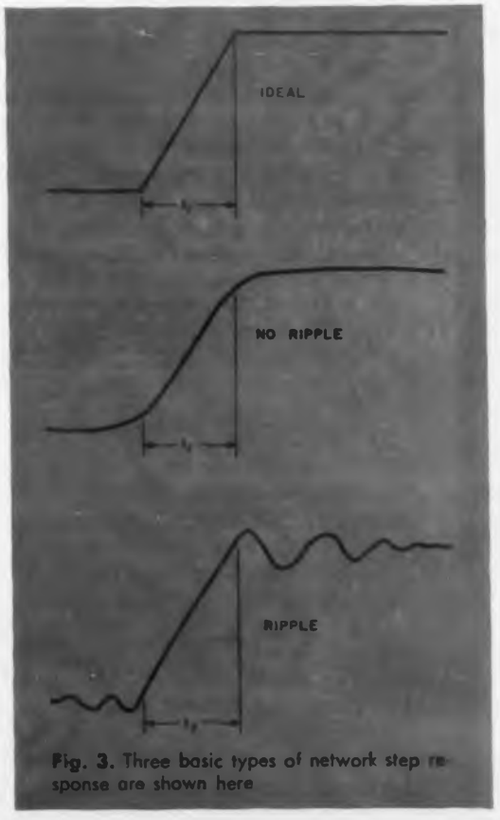

Fig. 3. Three basic types of network step response are shown here

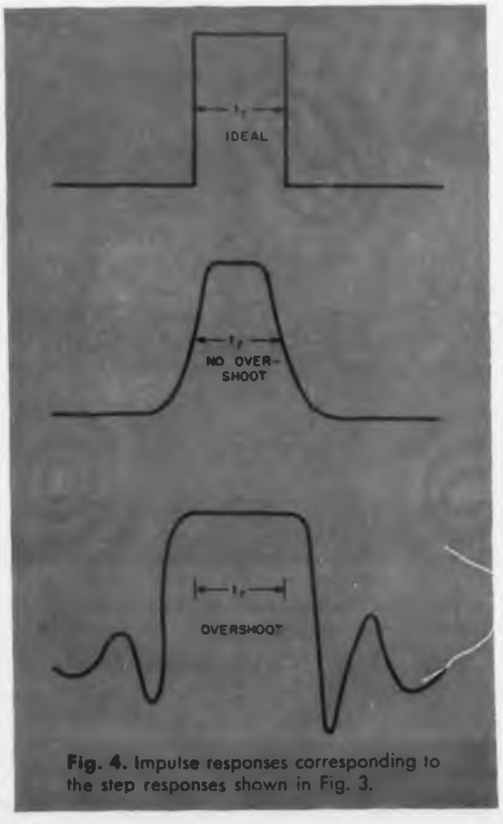

Fig. 4. Impulse responses corresponding to the step responses shown in Fig. 3.

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all having the same rise time: an idealized response, a response with no ripple, and a response with a good deal of ripple. Fig. 4 shows the impulse responses corresponding to the step responses in Fig. 3.

The ripple-free response requires a very good and very narrow impulse response. This, in turn, requires a wide bandwidth with either real poles or a great many properly spaced complex poles. (An *RC*, *RL*, or Unipole network has real poles.) The impulse response containing overshoot is broad and contains oscillations, indicating that a narrow bandwidth and complex poles are satisfactory.

We can obtain quantitative data which show how much is lost by trying to eliminate all ripple. The filter producing the idealized impulse response shown has a transfer function

$$F = \frac{\sin \frac{1}{2}\omega t_r}{\frac{1}{2}\omega t_r} e^{-j\omega t_d} \qquad (5)$$

where t_r is the width of the impulse response and t_d is the delay between input and output. This network has linear phase to the first zero at $\omega t_r = 2\pi$. The amplitude cut-off frequency of this filter is

$$\omega_c = 3.78/t_r$$

If the network had unity gain to ω_c and zero gain at higher frequencies, with the same phase shift, the network would have a rise time equal to $t_r/2$ with a ripple of 5 per cent. In this case, half of the bandwidth has been used to eliminate a 5-per-cent ripple.

Ripple-Free Networks Make Inefficient Lines

If the step response of a section has no ripple, the impulse response is always positive (i.e., it has no overshoot) and can be treated mathematically as a probability density function. Then, by the central-limit theorem, the impulse response of a large number of identical sections in cascade tends towards a normal distribution curve. This curve is the familiar Gaussian bell-shaped curve.

The mean-time value of the over-all response is the sum of the mean-time values of the individual responses. This says that the system delay is the sum of the delays of each section. This should come as no great surprise. The variance of the sum is the sum of the individual variances, so the standard deviation of the sum is the square root of the sum of the squares of the individual standard deviations. (Remember that we are treating the impulse response as if it were a probability density function.)

Since we have a large number of identical sec-

tions, the output wave shape is independent of the network, and the standard deviation is proportional to the rise time of the step response. But from the above, for identical sections, the standard deviation, and hence the rise time, is proportional to the square root of the number of sections.

This is a very important result. It shows that if we wish, for instance, to design a delay line without ripple, then the delay-to-rise-time ratio increases as the 0.5 power of the number of sections. This means that the design is very inefficient, and that a great many more sections are needed to make a delay line of a given quality than if we were to optimize the line for minimum rise time and accept a few per cent ripple.

Transmission Lines Make Poor Delay Lines

The behavior just described can be observed in transmission lines. A transmission line behaves like an infinite cascade of infinitesimal low-pass filters. The impulse response is Gaussian and the rise time increases as the square root of the line length. The delay is, of course, proportional to the line length.

As can be expected, transmission lines perform very poorly as delay lines, and delay-to-rise-time ratios exceeding 10 are very rare. Transmission lines (distributed-parameter delay lines) are widely used as low-quality delay lines because they are much cheaper than low-quality lumped-parameter lines.

All-Pass Networks Make Effective Ripple Reducers

One of the most effective ways of reducing the ripple of a network is to add an all-pass network to linearize the phase shift. This has no effect on the amplitude characteristic so it can be invaluable where the amplitude characteristic must be preserved, as in i-f strips. Ripple can be reduced to about 10 per cent in the manner. Further reductions will require modification of the amplitude response.

The ripple amplitude can be reduced below 10 per cent by improving the phase response and then cascading sections. This is a preferred method if very sharp cutoffs are required.

If extremely small values of ripple are required, then bandwidth and rise time must be sacrificed. In some cases it may be necessary to increase the system bandwidth by more than 100 per cent to obtain low values of ripple. ■ ■

Reference

1. Di Toro, J. J., Phase and Amplitude Distortion in Linear Networks, *Proc. IRE*, Jan. 1948.

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Engineer's Guide to Dust Hoods and Dry Boxes

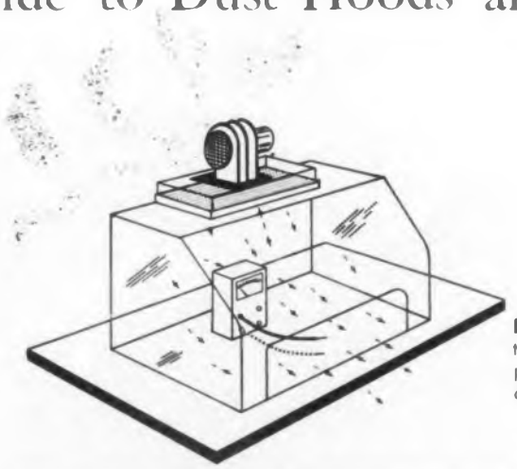

Fig. 1. Air is drawn into the hood through a filter which removes dust particles down to 0.5 microns in diameter.

Harry K. Bond,
Chief Engineer
Air Control, Inc.*
Narberth, Pa.

Table-top enclosures which keep dust and moisture out of precision electronic assemblies are simple design projects, if you know a few basic parameters.

MICROSCOPIC dust particles and minute quantities of moisture can seriously affect the operating characteristics of subminiature components. To protect components against contamination by dust and moisture, they must be assembled under an environmental hood. For the engineer who wishes to design his own environmental hood, this article will point out the design criterion used by commercial dust hood and dry box manufacturers. For the engineer who wishes to purchase a manufactured environmental hood, this article will provide the knowledge necessary to specify equipment which will adequately meet his needs.

A dust hood, see Fig. 1, filters room air and provides a working environment for the assembly of components which are sensitive to dust. A blower at the top of the hood forces room air through a filter and into the cabinet. The flow of filtered air out the front of the cabinet prevents contaminated room air from entering. Tests have shown that a worker walking in front of a dust hood can create 50 ft per min backwash of air. Output of filtered air, therefore, should be a minimum of 50 feet per minute.

The front opening of a dust hood must be wide enough to permit easy access to all parts of the hood and high enough to accommodate a worker's arms comfortably. Standard dimensions for the opening are 30 in. wide and 6 in. high. If the opening is increased, the volume flow must also be increased to maintain the same degree of protection. When a larger opening is essential, a larger blower must be used.

Considerations In Determining Filtered Air Requirements

Several factors have to be considered in determining minimum flow of filtered air. Will there be movement in and out of the dust hood? Are the components themselves dust generators? Is air in the work area still, or is there a lot of air movement? Laboratory areas where gasses are burned off and areas with air conditioning often require velocities as high as 80-100 ft per min to prevent contaminated air from entering.

When cleanliness requirements can be reduced, it is an easy matter to increase air flow with a less dense filter. If cleanliness requirements cannot be reduced, a higher speed motor and blower combination are necessary to combat air currents in the room.

Standard dust hood filters made of glass wool will take out dust particles down to half a micron. A filter developed during the war for the Atomic Energy Commission, called an "absolute" filter, will remove 99.97 per cent of the particles down to 0.3 of a micron. Engineers have a tendency to specify an "absolute" filter simply because it is the best available and not necessarily because they always require this high degree of filtration.

Since filter costs vary considerably, selecting a better filter than necessary is an expensive luxury. Fiberglass filters which remove particles down to 0.5 microns are about $16 per dozen. In contrast, an "absolute" filter removes particles down to 0.3 microns and costs about $60-$80 per filter. The life of a filter depends solely on the contamination of the air it is filtering. As an approximation, a fiberglass filter might last three or four weeks and an "absolute" filter about six months.

It is interesting to note that, up to a point, the dirtier a filter becomes, the more efficient it is at removing particles from the air. Of course, the drawback is that a dirty filter reduces air flow to a point where air coming out the front of the hood does not have sufficient force to prevent room air from entering.

The most common methods for determining when to change the filter are visual inspection, thermo-anemometer testing and a pressure gage. As a fiberglass filter becomes clogged, it changes in color from a normal pink to grey,

* Formerly Industrial Division, Air-Shields, Inc.

Fig. 2. Dry box provides a dehumidified atmosphere for components which are moisture sensitive.

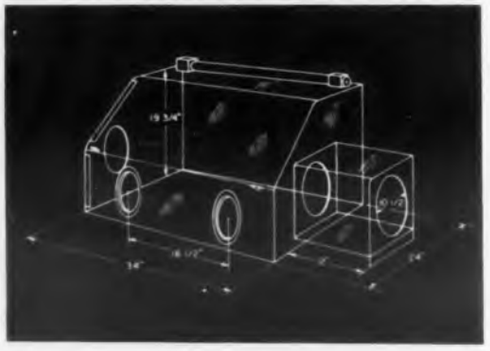

Fig. 3. Dimensions of a dust hood or dry box are based on a compromise length for a human arm. An average person can just barely reach all parts of the box. Room must be left for test equipment.

DUST HOOD AND DRY BOX APPLICATION CHART

Requirement	Equipment	Possible Applications	Comment
Moisture Control	Dry Box	Micromin components and semi-conductors	Source of dry air being purged into the box should be drier than required in the box to compensate for moisture contamination through the rubber gloves. If a dew point of —70 F is required inside the box, the dry air supply should have a dew point of —100 F.
Dust Control	Dust Hood or Dry Box (if source of dry air is precleaned)	Precision components	A good dry box will not have openings to the outside. Any dust inside the box therefore cannot be blown out. The box and the purging air must be clean initially when a dry box is used for dust control.
Inert Gas Control	Dry (Glove) Box	Oxygen sensitive materials	When inert gas is used, tightness and the rate of purging to compensate for leaks are critical.
Temperature Control	Dust Hood or Dry Box with thermo-static con-trol on heat source (Fig. 7)	Gyros	If a dust hood is used, the front opening should be sealed and iris entry ports used to reduce the amount of hear required. Temperature range is 140 F to 160 F, ±2 F. Above 160 F a metal hood must be used.
UV Control	Dust Hood or Dry Box made of amber plexiglass	Photolitho-graphic etching of semiconductors	Amber plexiglass filters all light transmitted in the ultraviolet region below 5,000 A. Natural UV radiation in daylight does not enter the box and a UV source inside the box will not hurt the operator's eyes.
Chip Control	Dust Hood	Balancing gyros	Gyros are balanced by grinding away excess metal. Performing the grinding operation under a dust hood with the blower reversed prevents the metal chips from contaminating the clean room.
Fume Control	Dust Hood with or without a filter	Venting noxious fumes during semiconductor manufacture	Blower is reversed and room air sucked into the hood and exhausted through a window or the plant's fume system.

indicating a new filter is required. A thermo-anemometer measures air velocity. When air velocity drops to a predetermined level, for instance 50 cu ft per min, a new filter pad must be installed.

A third method for determining when to change the filter is to place a low-range pressure gage in the plenum chamber above the filter. The pressure above a new filter is approximately 7/10 of an inch of water. As the filter becomes clogged, the pressure increases and can be used as an indication of when to replace the filter.

Dust-producing operations performed under a hood require an increase in filtered air flow to sweep the dust out quickly and efficiently.

A dry box is a chamber for performing operations which must be moisture-free. Fig. 2 shows a typical dry box with an air lock on the right, a drying train on top of the hood and a recirculating pump to the left. Since most of the chemicals used to desiccate air are dusty materials, it is important that the recirculating pump be equipped with a good filter to prevent the dust from entering the hood. To prevent oil or other lubrication vapor from entering the hood, a pump with a diaphragm compressor which does not require lubrication should be used. Oil vapor is just as detrimental to most micromin components as water vapor.

Operator Must Be Able To Reach All Parts of Box

The dimensions for both dry boxes and dust hoods are based on a compromise length for a human arm. As shown in Fig 3, the depth is 24 in., the height is 19-3/4 in., and the length 34 in. These dimensions permit an average person to just barely reach all parts of the box. Standard dry box gloves are 27 in. long. When the cuff is folded over the arm port, the glove is approximately 24 in. long and will just reach to the rear of the cabinet.

A natural tendency is to design dust hoods and dry boxes too small. It is usually desirable to store frequently used tools and test equipment inside the hood so that they will be as dry and as dust-free as the components they are being used on. A careful analysis of the operation which is going to be performed and the auxiliary equipment necessary inside the box should be made before specifying a size smaller than the box shown in Fig. 3.

In designing a dry box, careful attention must be given to the positioning of doors, latches and controls. If door latches cannot be comfortably reached through the arm ports, there will be a tendency to leave the air lock doors open. Sixteen inches between centers of the arm ports is a comfortable distance for most people.

Height of the ports must also be correct. The

Convert Your Counter to a 0.1% Digital Voltmeter...

Vidar 240 cabinet model shown in use with standard electronic frequency counter. Rack mounting also available.

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Vidar transistorized voltage-to-frequency converters develop output pulses at a rate precisely proportional to dc input voltages. Because these instruments combine solid-state reliability with good linearity and high stability, they offer the ideal method of converting any electronic frequency counter into an 0.1% digital voltmeter.

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Output pulses generated over any given period of time are directly proportional to the time integral of the input signal. By combining a Vidar 240 with a counter, analog input signals can be accurately integrated. This capability is particularly valuable where a steady or slowly changing signal is contaminated by noise or hum. The average value can be accurately recovered from the noise with ease.

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- Choice of 0-10 kc or 0-100 kc frequency outputs
- Automatic polarity indication
- Long term drift less than ±0.1% per week
- Full scale sensitivities from 0.1 v to 1000 v
- Priced at $700; no extra charge for rack, cabinet or modular version.

Also Available – Vidar offers the Series 2500 analog to frequency converters for conversion of ac-dc voltages and resistance to frequency.

More Information – *For complete technical information, a demonstration, or other data on the Vidar 240 or 2500, call your nearest Vidar engineering representative whose name and phone are listed below, or write directly to the factory.*

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CIRCLE 62 ON READER-SERVICE CARD

Fig. 4. Vacuum oven inside the air lock contains components which have been baked dry. The components are taken from the air lock into the dry box where they are hermetically sealed. Bubbles in the glass bottle indicate the air lock is being constantly purged with clean dry air.

most comfortable position is when the arms hang naturally from the shoulder and are bent at a 90 deg angle at the elbow. If the ports are too high or too low, the user's arms are under a constant strain and will quickly become fatigued. The height of the ports, of course, depends on the height of the bench or chair and not on the construction of the hood.

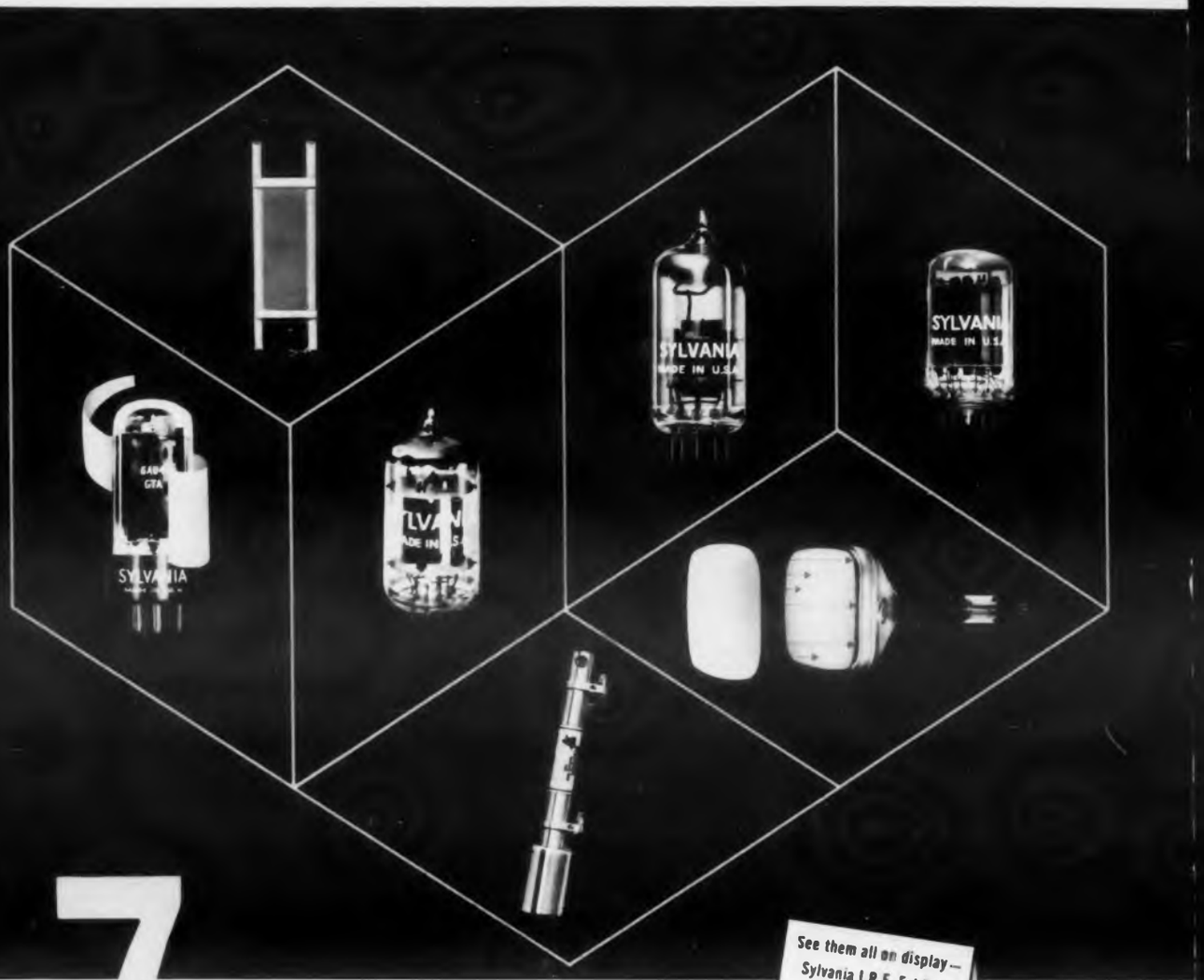
When the operation in a dry box requires a lot of lateral arm motions, elliptical ports are better. Inside dimensions of elliptical ports are approximately 10 in. by 6-1/2 in.

Each dry box should be equipped with gas-tight doors for admitting new parts and materials. One of the doors should be equipped with an air lock, as shown in Fig 4, which can be flushed with dry gas before the door to the dry box is opened. If a vacuum oven is used in conjunction with a dry box, it can also serve as the air lock provided it has a door on both ends.

Magnetic catches are easier to operate than positive acting latches on the doors but do not provide as tight a seal. It is also better to hinge the door at the side so that it does not have to be held open while parts are being removed. The number of openings should be kept to a minimum, however, since each time a gasket is inserted between an opening and a door there is a potential source of leakage.

A standard dry box with an air lock is essentially a piece of R&D environmental equipment. It can be designed, however, so that the various elements—the center section of the hood, the end panels and the air lock—are each built and assembled separately. A system consisting of any number of dry boxes with dust hoods and air locks interspersed can be easily assembled when the sections are designed

ELECTRON TUBE NEWS
...from SYLVANIA



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7 *significant developments create*

NEW DIMENSIONS FOR DESIGNERS!

- Sarong Cathode
- Strap Frame Grid
- 9-T9 Outline
- 10-Pin Tubes
- 12-Pin Tubes
- "Bonded Shield" CRT's
- Compact TWT's

Among the notable accomplishments in recent tube technology are important Sylvania refinements in the state of the art. Impressive advances are being made in tube *reliability*, tube *versatility* at Sylvania. Performance parameters are undergoing marked improvement while electrical uniformity is rigidly maintained. Some results of this vigorous new approach to the tube art can be seen in the following Sylvania tube developments.

SYLVANIA...*new dimensions for designers*

SYLVANIA STRAP FRAME GRID

Delivers high Gm, low noise

Sylvania *Strap Frame Grid* improves tube reliability, provides high Gm per mA of Ib, enables uniform grid-cathode spacing and resultant narrow dispersion of characteristics. It affords much improved control of cutoff characteristics. *Strap Frame* design significantly improves stability, resistance to vibration and shock. Extensive Sylvania development brings *Strap Frame* advantages to: 6ER5, *semi-remote cutoff triode;* 6DJ8, *sharp cutoff double triode;* 6FQ5A and 6GK5, *semi-remote cutoff triodes;* 6EH7, *semi-remote cutoff pentode;* 6EJ7, *sharp cutoff pentode.* Another example, Sylvania-6ES8, *semi-remote cutoff double triode*, combines *Strap Frame Grids* and *Sarong Cathodes* for greater accuracy in grid-cathode spacing for improved cutoff characteristics, high stability, exceptional uniformity.

SYLVANIA-DEVELOPED SARONG CATHODE

Improves tube stability, uniformity

The extraordinary *Sarong Cathode* is a major tube refinement designed to stabilize cathode performance, add life to tube service. The Sarong Cathode uses a thin film of cathode material precisely controlled for uniform density and surface smoothness, and *wrapped* on an ultrasonically cleaned cathode sleeve. As a result, possibility of plate-to-cathode arcing or cathode "hot spots" is drastically reduced.

SYLVANIA TYPES UTILIZING SARONG CATHODE			
5V4GA	6BC8	6DE4	6W4GT
6AL5	6BQ7/A	6ES8	7F7
6AU4	6BY5GA	6FQ5A	12AU7/A
6AU6	6BZ7	6K6GT	12AX7/A
6AX4	6CY5	6U8	35Z5
6BA6	6DA4	6V6GT	

SYLVANIA 9-T9 TUBE OUTLINE

Brings new efficiency to chassis layout

Utilizing the straight-sided bantam envelope and a miniature 9-pin circle, Sylvania-developed 9-T9 increases volumetric efficiency by eliminating the T9 octal base. 9-T9 enables the use of large tube assemblies in those stages where higher power dissipation capabilities are a design requirement. First new 9-T9 types are – *6/10EW7* . . . double-triodes intended for service as a vertical deflection oscillator and amplifier • *6/17HC8* . . . triode-pentodes designed for use as vertical deflection oscillator and amplifier in 110° deflection circuits of TV receivers *7695* . . . beam power pentode features unusually high power sensitivity as an AF amplifier. In Class A1 operation, self-biased, it delivers 4.5W power output with a B+ voltage of only 140 volts • *7754* . . . 6-volt version of 7695 • *6GM5* . . . beam pentode features improved sensitivity and output characteristics for AF power amplifier use • *6GC5* . . . beam power pentode features high power sensitivity as an audio power amplifier.

NEW SYLVANIA 10-PIN TUBES!

Double tetrodes in T-6½ bulb!

Sylvania adds a new dimension to circuit design with the addition of a 10th pin to the center of the 9-pin miniature circle. Sylvania 10-Pin design provides improved tube performance, makes possible new multiunit combinations . . . offers unusual design advantages with a minimum of chassis redesign. Case in point: *Sylvania-6C9* and *-17C9*, sharp cutoff double tetrodes, offer two high-performance units in the compact T-6½ envelope . . . providing potential savings in circuitry, reducing space requirements. With the addition of the 10th pin, heat dissipation capabilities are increased, cathodes have separate connections, shielding is introduced to effectively reduce undesirable oscillator signal radiation. Sylvania-6C9 and -17C9 are designed for VHF service as RF amplifiers and autodyne mixers.

SYLVANIA "BONDED SHIELD" CRT's

Measurably improve image display

Sylvania pioneered the dramatic improvements made in image viewing by *"Bonded Shield"* design. First to demonstrate the feasibility of quantity-producing *"Bonded Shield"* TV picture tubes, Sylvania applied its knowledge to the specialized requirements of industrial-military CRT's for virtually any application.

"Bonded Shield" eliminates the need for conventional safety glass, reduces the number of reflecting surfaces by 50%. Here's what it does for the viewer: apparent light transmission and contrast are increased; mirror-like reflections are eliminated. Image display is brought "out front" for wide-angle viewing, mounting and styling are simplified, tube face is made accessible for easy cleaning. Other unique advantages: *"Bonded Shield"* caps are available with special anti-reflection treatment that can diffuse up to 70% of reflected light; several *"Bonded Shield"* CRT's are available with calibrated reference scales permanently etched on the safety cap, thereby reducing viewing errors caused by parallax.

NEW 12-PIN MULTIFUNCTION TUBES

Sylvania 12-T9, 12-T12 types!

Presently under development at Sylvania are five new 12-pin tube types for TV receiver applications. A natural advance in the evolution of small-size, multifunction tubes, Sylvania 12-pin tubes utilize dome-shaped bulbs evacuated from the bottom providing reduced seated height. First types to be announced soon will be commercial versions of these prototypes: two 12-T9 types using the T-9 bulb—SR-3202, damper tube; SR-3203, double diode-double triode, horizontal phase comparator and oscillator; and three 12-T12 types in the T-12 bulb—SR-3201, double-diode, low voltage rectifier; SR-3204, double-pentode, sound discriminator, sound output; SR-3205, beam power pentode, horizontal deflection tube.

Contact your nearest Sylvania Sales Engineering Office for further information on these and other exciting tube developments under way at Sylvania. For data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. C, 1100 Main Street, Buffalo 9, N. Y.

MICROWAVE DEVICE NEWS from SYLVANIA

50% Smaller!
80% Lighter!

LOW-PRICED PPM-FOCUSED TWT's

for test equipment applications

TYPES	FREQUENCY RANGE (kMc)	POWER OUTPUT	GAIN-db (Min.)
TW-4267	1-2	10 mW	35**
TW-4268	1-2	1 W	30*
TW-4261	2-4	10 mW	35**
TW-4260	2-4	1 W	30*
TW-4281	4-8	10 mW	35**
TW-4278	4-8	1 W	30*
TW-4282	8-12	5 mW	35**
TW-4273	8-12	1 W	30*

**Small signal gain *At saturation

Sample quantities of L- and S-band TWT's immediately available.

Sylvania introduces important advantages to microwave amplifier applications where economy, compact size, light weight are vital design considerations.

Less than 4 lbs. in weight and 2¼" in maximum diameter, Sylvania TWT's for test equipment present unusual opportunities for design of compact equipment when compared with bulky 15-35 lb. package of the solenoid types. However, electrical performance advantages over solenoid types are still maintained. Investigate the wide range of TWT's by Sylvania. Contact your nearest Sylvania Sales Engineering Office, or write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. MDO-C, 1100 Main Street, Buffalo 9, N. Y.

SYLVANIA

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GENERAL SYSTEM

around a common shape. If a modular unit is used by the R&D department, it can be easily incorporated into a production line when the component enters production.

The most frequent problems encountered by engineers who design their own dry box and have it built by the model shop are: poor seals on the doors, placing the air lock in a position which cannot be conveniently reached from inside the hood, and placing controls inside the box which cannot be adjusted without coming out of the rubber gloves.

Desiccants Lower Dew Point To Desired Level

Commercial dry boxes are available with a desiccant system which can dry room air down to a dew point of about —40 F. For lower dew points, either a dry gas or larger external air drying equipment is necessary. Moisture content of air with a dew point of —40 F is 188 parts per million. At —100 F the moisture content is 3 parts per million.

The transistor industry generally specifies air from a dryer with a dew point of —100 F. This insures that a dew point of —70 F is maintained inside the box. Instruments are available which measure dew points of —100 F but their adjustment is very critical and it is difficult to check their accuracy. As inaccurate as it may seem, many manufacturers depend on the reject rate to tell them if the desired dew point is reached.

Because of the very small size of the components assembled in a dust-free environment, it is often desirable to perform some of the operations under a microscope. A rubber scope port can be placed in the front of the hood so that the stage of the microscope is inside the hood and the eyepiece outside. The eyepiece fits through a small hole in the rubber sheet stretched across the port. The rubber has enough flexibility to allow a focusing travel of about two inches and fits tightly around the microscope to prevent dust or moisture from entering.

Plexiglass Is Generally Best Material

Plexiglass is the most common construction material for dust hoods and dry boxes because of its transparency. However, if it is necessary to use cleaning solvents, fluids, or chemicals which are not compatible with plexiglass, the hood should be made of metal.

Amber-colored transparent plexiglass should be used when photolithographic etching is performed under the hood with ultraviolet light. The amber-colored plexiglass protects the worker's eyes from sunburned corneas and also protects UV sensitive components under the hood from ambient UV light. ■ ■

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SUB-MINIATURE SERIES SM-20

Available in 5, 7, 11, 14, 20, 26, 29, 34, 42, 50, 75, and 104 contacts, with guide pins and sockets, polarizing screwlocks*, aluminum hoods, protective shells and hermetic plugs.

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A larger size than MM22 and SM20, available in 4, 5, 7, 8, 9, 11, 14, 18, 20, 21, 26, 34, 41, 42, 50, 75 and 104 contacts. Hexagonal plug and socket models, and hermetic seal plugs are also available.

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Receptacle types for 1/32", 3/64", 1/16", 3/32" and 1/8" printed circuit boards. Available in single and double row construction, in sizes up to 210 terminals. Wiring styles include eyelet lug, wire-wrap and taper tab.

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For heavy duty applications requiring high current, di-electric strength, and voltage carrying capacities. Various contact sizes, aluminum hoods and polarizing screwlocks* available.

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Available in 152, 104, 78 and 34 contacts. Feature double lead thread action center screwlock, closed entry contacts for increased reliability and reinforcing stainless steel channels.

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Plug and socket types with right angle pins for dip soldering to printed circuit board or tape cable are available. Variety of contact sizes, moldings, terminations, and polarizing screwlocks* can be specified.

*Pat. No. 2,746,022

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★ **Inductance and Storage Factor**

★ **Capacitance and Dissipation Factor**

The Model ZB-1 provides for measurement of AC and DC resistance, inductance and storage factor, capacitance and dissipation factor. It is a laboratory instrument in accuracy, range and versatility in addition to being compact, portable and ruggedly constructed. It meets all the requirements of the Military Impedance Bridge Model AN/URM-90.

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RANGE:

RESISTANCE	0.001 ohm to 11 megohms A-C or D-C (8 ranges)
CAPACITANCE	1 uuf to 1100 uf (7 ranges)
INDUCTANCE	1 uh to 1100 h (7 ranges)
D	0.001 to 1.0 at 1 KC) Provision for external
Q	0.02 to 1000 at 1 KC) extension

ACCURACY

RESISTANCE	0.1 ohm range	±0.35%
	100 K ohm range	±0.2%
	All other	±0.15%
CAPACITANCE	100 uuf and below	±2 uuf
	100 uuf range (above 100 uuf)	±2%
	All other	±0.5%
INDUCTANCE	100 uh and below	±2 uh
	10 h and above	±10%
	All other	±1%
D FACTOR		±(5% + 0.0025)
Q FACTOR	to 10 hy	±(5% + 0.0025)
	at 100 hy	±(5% + 0.015)
	at 1000 hy	±(5% + 0.055)

INTERNAL OSCILLATOR FREQUENCY	1 KC ±1%
INTERNAL D-C SUPPLY	10 V at 250 ma. (D-C Low) 200 V at 10 ma. (D-C High)
INTERNAL DETECTOR	Response flat or selective at 1 KC; sensitivity control provided.
POWER LINE	115 volts, 50-1000 cycles, 18 watts.
DIMENSIONS	10¼" x 11¼" x 11¼" overall with cover.
WEIGHT	21 lbs.
ACCESSORIES SUPPLIED	Set of red and black test leads (19" long) with 2 alligator clips.

For complete technical specifications write . . .

Industrial Instruments
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CIRCLE 65 ON READER-SERVICE CARD

Portable Rubidium Frequency Standard Has Stability of 2 Parts In 10 Billion

A READILY portable, independent atomic frequency standard with a stability of 2 parts in 10 billion is now available for use as a time base or frequency standard. The Rubidium Frequency Standard offered by Space Technology Laboratories, Inc., a subsidiary of Thompson Ramo Wooldridge, Inc., weighs 20 lb, displaces 1.6 cu ft and is unaffected by terrestrial or space environmental conditions expected to be encountered in normal use.

For Navigational And Industrial Use

For navigational systems that are dependent upon radio signals for triangulation and Doppler effects, this unit satisfies the essential requirement of an extremely accurate time base. For industrial purposes, it provides a portable, independent frequency standard as a tool for the calibration of instruments for advanced technology. With a stability of 2 parts in 10 billion, it maintains its accuracy with less than one second of error in 750 years. Output power is 10 mw into a 50-ohm load.

A configuration of the STL, Rubidium Frequency Standard, designed for space use has been flown in ballistic missiles and in spacecraft as part of the instrument package.

Light Source Is Rubidium 85

Atomic resonance, recognized as the most stable frequency base, is the fundamental principle of the device. The basic frequency reference is an optically pumped rubidium cell.

Optical pumping, the process of redistributing the atoms among the energy states of rubidium is effected in the fre-

quency standard by irradiating a rubidium 87 cell with light of a properly tuned, very narrow frequency band. The light source is a rubidium 85 vapor discharge lamp excited to luminescence by a helical coil wound around the lamp and carrying rf current supplied by a transistorized oscillator.

Redistribution Replaces Energy

When the cell is illuminated by microwave energy of a proper frequency a further redistribution of the atoms occurs and tends to replenish some of the energy levels depleted by the optical pumping. The pumping process must now continue indefinitely at an increased rate. When the microwave energy is at exactly the proper frequency, the pumping light transmitted through the cell is at a minimum.

In the STL standard, the microwave energy is derived from a crystal oscillator at 6,834 mc, the resonant frequency of rubidium 87, and supplied to a resonant frequency cavity containing the gas cell. The frequency of the crystal oscillator is electronically controlled by a signal from a photo detector sensing the transmitted light to maintain it at a frequency which keeps the light transmission of the cell at a minimum.

Solar Cell Detects Signal

The optical signal emitted from the rubidium 87 cell is detected by a solar cell which possesses a favorable signal-to-noise ratio at light of that wavelength. The stabilized signal from the crystal oscillator is fed to a transistorized frequency synthesizer circuit, containing five tunnel diodes, where it is divided into three convenient output frequencies: 5 mc; 1 mc; and 100 kc.

The Rubidium Frequency Standard will be available early in April at a cost of $22,500. For further information on this portable, independent, atomic frequency standard, turn to the Reader-Service Card and circle **251.**

See at Show Booth 1435-37.

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Check the specs on just 2 of the 34 available.

Model	DC Voltage	Current	Ripple	Price	Size
H-60	0 to 50,000	5 MA	2% RMS	$1300.	Control: 22" x 22" x 18" *Tank: 27" x 22" x 22"
H-80	0 to 120,000	5 MA	2% RMS	$1850.	Control: 22" x 22" x 18" *Tank: 27" x 22" x 22"

*Oil not included

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After trying several other time delay devices in their automatic control equipment for carbon arc lamps, design engineers at Macarr Inc. turned to G-V Red/Line Timing Relays. By holding in a current limiting resistor in the circuit until the arc had struck, the Red/Line Relay provides complete continuity of operation and lengthens the life of the DC power supply feeding the carbon arc. As an added advantage, it also facilitates smooth, soft starting of the carbon arc. **So, at Macarr, the high quality of G-V Red/Line Timing Relays is "paying off".**

More and more companies are finding the reliable performance of G-V Red/Line Timing Relays makes them best for their products. G-V Red/Line Relays will "pay off" in your product, too. Your customers appreciate the importance of high quality, reliable components. G-V Red/Line Timing Relays are specially designed for industrial applications. They have the precision, reliability and long life needed to "pay off" in industrial use.

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G-V

G-V CONTROLS INC.
Livingston, New Jersey

Transistorized Counter Provides Constant Display

CONTINUOUS DISPLAY of the most recent measurement allows the user of this electronic counter to read data at any time. A display storage feature maintains the readout until a differing count is registered. The display then shifts directly to the new count.

Manufactured by Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif., the five-digit counter uses a storage transfer stage and a set of storage binaries to provide the continuous display. Input signals are gated to count binaries in the usual manner. Their outputs are fed through the storage transfer to the second set of binaries, which controls the display through a decoding matrix.

During storage, a multivibrator prevents any change in the storage binaries even though the state of the count binaries is changing. On completion of a new count, the storage transfer multivibrator enables immediate transfer of the new data from the count binaries to the storage binaries and thence to display.

Maximum counting rates of 300 kc and 1.2 mc are available in two basic counters, with column or in-line readout. Input sensitivity is 0.1 v rms, at 1-meg impedance, for all counter functions. The instrument makes multiple period average measurements up to 10^5 periods, providing period-measurement accuracy improvement equal to the multiplication factor used. Ratio measurements may also be made, with the quotient of two applied frequencies displayed as a product of the multiplication factor.

Designed for bench use or rack mounting, cabinets of the compact instruments

◀ CIRCLE 67 ON READER-SERVICE CARD

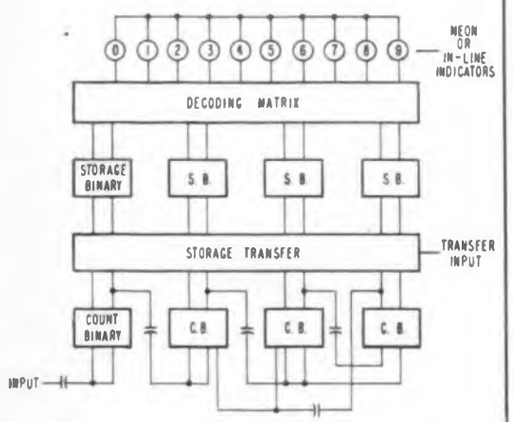


Diagram shows count-binary, storage-transfer, and storage-binary arrangement.

are arranged for easy maintenance access. Front panel height is 3-1/2 in. Plug-in module construction increases instrument versatility and simplifies maintenance. The counter has low-power consumption, and can operate with full accuracy over a wide temperature range.

Self-check provisions, operated from the front panel, are incorporated for each position of the function selector switch. Decade dividers are used in the gate-generating circuits for stable calibration and operation. The counters may be operated with four-line binary-coded decimal output, with assigned weights of 1-2-2-4, suitable for systems use.

Model designation for the 300-kc counter is 5212A and 5512A, column and in-line readout respectively, and 5232A and 5532A for the 1.2-mc counter with the same readout option. Accuracy of the 300-kc models is 0.01%, absolute; time-base stability of the 1.2-mc models is ±2 ppm per week.

Price of the 300-kc counter is $975 to $1,175; the 1.2-mc counter costs from $1,300 to $1,550. Delivery schedules will be published for the IRE Show.

For further information on the constant-display counter, turn to the Reader-Service Card and circle 252.

See at Show Booth 3205-15.

SEE CANNON AT BOOTH 2727-31, IRE SHOW

CANNON HERMETICALLY SEALED PLUGS

INCLUDING THE FIRST SERIES APPROVED TO MIL-C-25955! Cannon Hermetic Seals meet low leakage rate requirements under the most extreme pressures and environments. The Cannon KH Series includes the first receptacle approved to MIL-C-25955, which requires leakage rates of less than .001 micron cubic foot per hour (1.5×10^{-8} cc/sec). Our Phoenix Plant is staffed with hermetic seal specialists—combines in one location every phase of engineering, manufacturing, and testing to produce hermetically sealed plugs with the highest standard of performance in the industry. Hermetically sealed receptacles are available for most popular plug lines... with some series designed to withstand intense thermal shocks—temperatures from −100°F to 1000°F—pressures above 2000 psi! Our standard receptacles are available from Authorized Cannon Distributors. For complete information on the standards or custom designs write to:

CANNON PLUGS

CANNON ELECTRIC COMPANY, 3208 Humboldt Street, Los Angeles 31, Calif.

CIRCLE 68 ON READER-SERVICE CARD

GERTSCH NULL INDICATOR

—a phase-sensitive, fully transistorized unit. Combined with any Gertsch RatioTran,® it forms an AC ratio bridge. These features are standard:

10 μv sensitivity—excellent resolution for bridge circuit operation. Sensitivity ranges: 10 μv, 100 μv, 1000 μv.

Quadrature rejection—provided by phase-sensitive detector.

Zero-center meter gives a "sense" as to above or below null. Frequency range: 50-10,000 cps. Unit can be used as an amplifier.

Available in two models: NI-2, battery operated, portable carrying case—NI-3, a 3½" high rack mounted version, with built in AC power supply. Request Bulletin NI.

companion instrument:

GERTSCH RATIOBRIDGE

—offers high accuracy and high input impedance at 10 kc and up

Combined in the one instrument is a precision ratio transformer and an electrostatically shielded bridge transformer. Either can be used independently. This instrument when teamed with the NI-2 or NI-3, forms a complete AC ratio bridge.

Accuracy of the RatioBridge is as good as .0025%. Input impedance is 300K ohms at 10 kc. Ratios up to 1.1111. Unit provides switching transient suppression, plus in-line switching and readout. *Bulletin RB-105.*

Gertsch

GERTSCH PRODUCTS, Inc.

3211 S. La Cienega Blvd., Los Angeles 16, Calif. • UPton 0-2761 • VErmont 9-2201

See us at the IRE Show—Booths #3715-3717

CIRCLE 69 ON READER-SERVICE CARD

Pencil Tube-and-Cavity For Compact Airborne Equipment

A NEW low-cost oscillator may be the answer to the Federal Aviation Agency dream of providing all aircraft with transponding equipment for air-traffic control. The 1,090-mc cavity oscillator is an integral pencil tube-and-cavity similar in design to the cavity oscillator now in use in radiosonde systems. It weighs less than 1.5 oz and, excluding leads, tuning screws and rf connector, measures approximately 3-1/2 in. in length and 7/8-in. in diam. Power drain for both heater and plate is less than 5 w in typical applications.

Is Capable Of 0.01 Duty Factor

The A-15132V1 is a fixed-tuned, ultra-high-frequency oscillator cavity intended for pulsed transmitter service in compact airborne equipment. It provides a minimum peak power output of 100 w and is capable of operation at 0.01 duty factor. It may be mounted in any position and has an ambient temperature range of −55 to +75 C.

Accurate frequency settings can be made over the 30-mc tuning range of the oscillator. This is accomplished through the use of two tuning screws. With both screws at maximum frequency, setting the desired frequency may be tuned approximately with either screw. The exact frequency may then be tuned with the second screw which acts as a vernier adjustment.

Electrical specifications for the unit are: heater voltage, 6 v ±5%; heater

current, nominal, 0.280 amp; frequency tuning range, 1,090 mc ±15 mc; rf coaxial output terminal characteristic impedance, 50 ohms.

Maximum ratings for Class C service are: peak positive-pulse plate-supply voltage, 1,250 v max; peak negative grid-bias voltage, 100 v max; plate dissipation, 7.0 w max; pulse duration, 1.5 μsec max; duty factor, 0.01 max.

Extensive test results, Mr. Gipslis of the Electron Tube Div. of the Radio Corp. of America, stated, have demonstrated that this lightweight oscillator meets, with considerable safety margin, all transponder application requirements.

Inductive Feedback Is Employed

The plate power efficiency that can be expected from this pencil tube at L- and lower S-band frequencies in pulsed plate service is an efficiency of approximately 40 per cent at 1,100 mc in an optimized adjustable test cavity. The maximum peak-power output at this frequency is approximately 1.35 kw.

In the design of the L-band oscillator, an inductive feedback is employed similar to that successfully used for radiosonde pencil tube-and-cavity units. The grid disk of the pencil tube is supported within the cavity by means of a special grid disk clip. The open spaces around this clip form an inductive feedback path. In addition, probes are used for fine feedback control. This design permits the feedback circuit to be properly optimized for each particular frequency in the L-band.

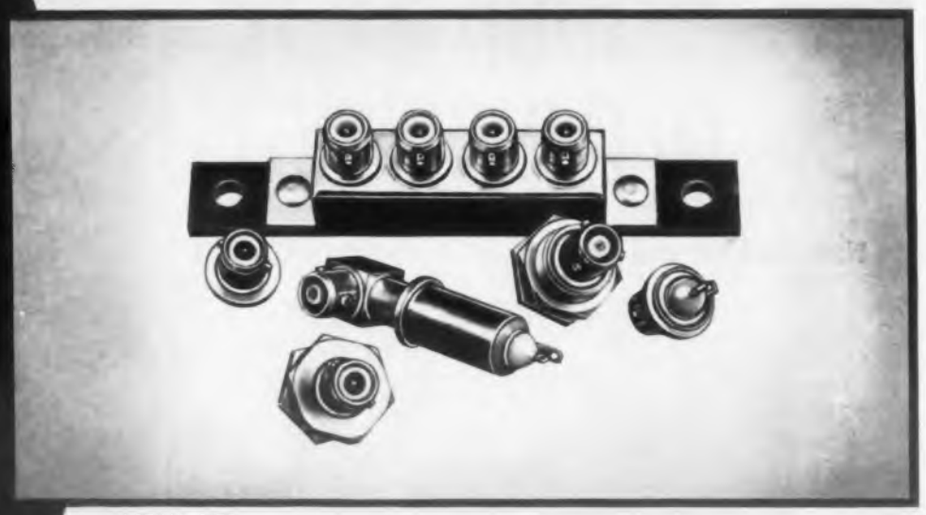
Additional features of the oscillator assembly include a temperature sensitive frequency compensator, adjustable power probe for varying the output coupling a frequency-adjustment screw, and all-mica insulation for high-voltage breakdown resistance and best dielectric properties.

The entire unit is compact in size but does not require special cooling in operation because of the low-power drain and low dissipations of the pencil tube.

For further information on this pencil tube-and-cavity oscillator turn to the Reader-Service Card and circle 253.

MAKE YOUR CONNECTIONS WITH DAGE

another FIRST!



ACTUAL SIZE

Isolated Ground DMs

a complete series of coaxial cable connectors

The new ***Isolated Ground*** DM Series gives absolute protection from circulating currents and ground loops that cause oscillation and faulty readings of current and voltage.

A unique, concentric three-element, glass-to-metal seal provides a hermetically sealed isolated ground without shoulder washers and other insulating or mounting devices.

The Dage ***Isolated Ground*** Series mates with the industry standard Dage DM Series for easy modification of existing systems.

Complete specifications are available in a four-page folder. *Write or phone . . .*

DAGE ELECTRIC CO., INC.

Beech Grove, Indiana · STate 7-5305

CIRCLE 70 ON READER-SERVICE CARD

SWEEP AUDIO FREQUENCY and HIGH Q FILTER CIRCUITS

with the Ease and Precision of RF Sweep Techniques

NEW KAY *Sona-Sweep*® MODEL M

F E A T U R E S

- Built-In Audio Detector
- Sharp, Pulse-Type Markers
- Logarithmic and Linear Frequency Sweep
- Both Swept and Manual Frequency (and scope display) Control
- Variable Center Frequency
- Variable Sweep Width Built-In Attenuators
- Zero Reference Line
- All-Electronic

Visit KAY at the IRE Show Booths 3512 — 3518

FREQUENCY RANGE: 20 cps to 200 kc, variable
SWEEP WIDTH: 20 cps to 20 kc, variable
REPETITION RATE: 0.2 to 25 cps, variable

Write for Complete Catalog Information

KAY ELECTRIC COMPANY
DEPT. ED-3 MAPLE AVE., PINE BROOK, NEW JERSEY • CAPITAL 6-4000

CIRCLE 71 ON READER-SERVICE CARD

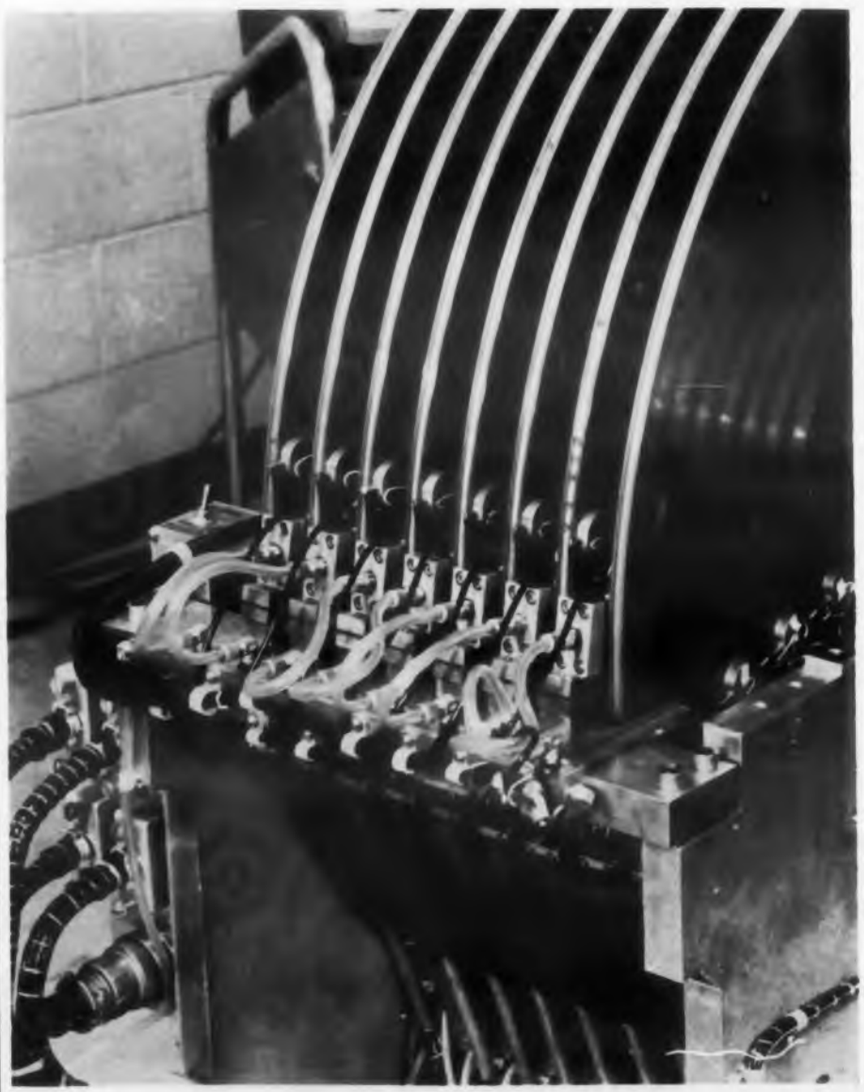
Large, Parallel-Access, High-Speed

WITH AN access time of no more than 167 msec (including 100 msec for positioning), a new magnetic disk file can store from more than 30 to almost 620 million bits. The file can include from one to 20 storage disks, each 39 in. in diameter.

Manufactured by Bryant Computer Products, a division of Ex-Cell-O Corp., 850 Ladd Road, Walled Lake, Mich., the series 4000 disk file offers high-speed random access, very large storage, and low cost. Cost per bit ranges from 1/10 cent for the smallest file (with a single disk) down to 1/40 cent for the largest (with 20 disks).

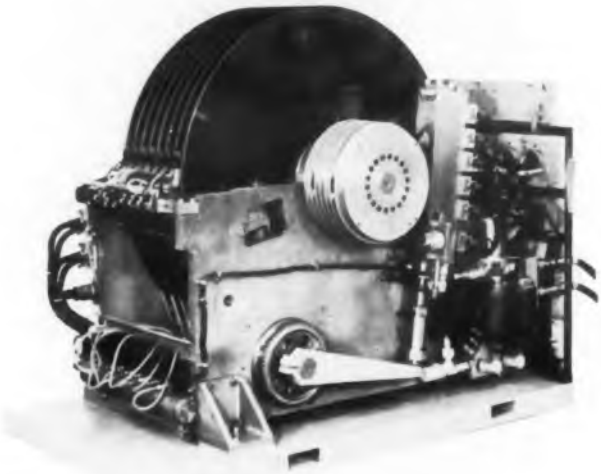
The maximum-capacity, 20-disk file allows one to read or write 40 bits simultaneously. Bryant guarantees zero dropouts and a minimum signal-to-noise ratio of 32 db.

Each disk side offers a useful record-



Hydraulically driven read/write heads track disk-filed data quickly and accurately.

Disk File Cuts Storage Costs



Eight-disk file can store more than 30 million bits.

ing surface between radii of 6.75 and 18.75 in. Each recording area is divided into six 2-in. wide frequency zones with 128 tracks per zone. Bit densities vary downward in each zone from a maximum of 273 bits per inch. Recording frequency ranges from 174 kc in the innermost zone to 431 kc in the outermost.

Aerodynamic read/write heads, 240 of them, serve the 240 frequency zones on the 40 disk surfaces. Each head floats within 1 2 mil of the microfinished surface of a rotating disk. Forty headmounting bars, each holding six heads, are driven in unison by a single hydraulic positioner mounted on a base plate. The individual heads are selected electronically.

The head positioner is a hydraulic system of a digital, open-loop type. It is addressed by a 7-bit binary signal from a customer's control unit. The positioner can repeat each of the 128 discrete data-track positions in each frequency zone to within 1 mil without adjustment for long intervals.

A 7-bit digital transducer generates information on the actual head position at any time. This information can be compared with the address information to generate a position-verification signal.

Additional positioners can be incorporated in the disk file to reduce access time and increase flexibility. Or, the number of heads per disk surface can be changed.

Individual heads require write-current pulses of about 125 ma with durations of about 1.0 μsec. The read voltage from a head is at least 10 mv at the innermost track for disk rotation at the recommended 900 rpm.

The file is available with disks rotating at 900 rpm or 1,200 rpm. The unit can operate in temperatures from +35 to +100 F. It requires no external cooling.

With its associated positioner and power supply, the file occupies a single cabinet about 50-in. long, 40-in. wide, and 60-in. high. The complete assembly weighs about 1,700 lb.

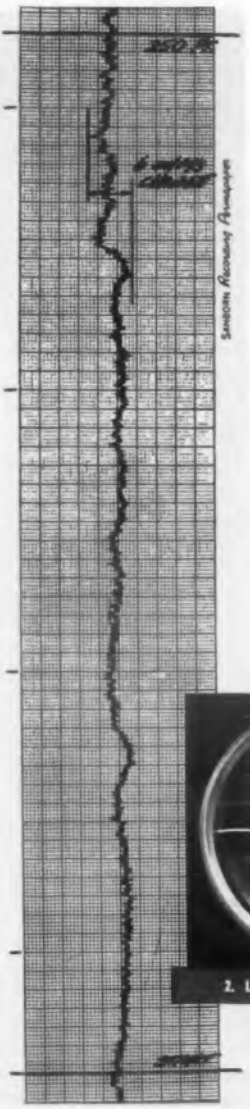
Delivery on the series 4000 disk files is about six to nine months. Prices depend on quantity and configuration. For example, the model 4010 (with a single disk), costs $41,000 for one and $32,000 in quantities of 10 or more. The model 4200 (with 20 disks), costs $140,000 as a single unit and $110,000 in quantities of 10 or more. Basic price for the electronics—either serial mode or four-bit parallel—is about $15,000.

For more information on this high-speed, random-access file, turn to the Reader-Service Card and circle **254**.

How to produce better

POTENTIOMETERS

without increasing costs



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a new custom-quality nickel-chromium alloy especially developed, processed and controlled to assure you of:

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2 Lower electrical noise level, unconditionally guaranteed to be less than 40 ohms of E.N.R. when received at your plant.

3 Greater efficiency in winding mandrels—with more uniform spacing between turns—due to its superior wire roundness.

2. Lower Electrical Noise Level 3. More Uniform Mandrel Winding

If you make POTENTIOMETERS this wire is right for you!

It's premium in quality but not in price. And sample spools plus complete technical data are available now to potentiometer manufacturers for immediate testing and evaluation. Your request on company letterhead will receive our prompt attention.

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Producers of Custom-Quality Resistance, Resistor and Thermo-electric Alloy Since 1908

You Are Invited to Visit ELECTRONIC DESIGN's Booth

ELECTRONIC DESIGN's editors will be waiting to talk to you about design problems you've recently solved, new products you'll be introducing, articles you'd like to write . . . anything that will help engineers to do their jobs better. So visit us. You are always welcome at Booth 4403-05.

New and Improved Products Await Your Inspection at the IRE Show

In January ELECTRONIC DESIGN queried manufacturers who planned to exhibit at this year's IRE Show. We asked them to highlight the special features of the new products they would display. The answers are summarized here. More details and technical data are contained in the New Products Department, p 86.

Arthur W. Solda
Technical Editor

THE IRE Show will exhibit many New Products along with improved versions of products previously available. An ELECTRONIC DESIGN questionnaire, distributed in January, requested manufacturers to highlight the special features of the products they will show. The response indicates that design engineers will be presented with products that are more reliable, more compact, and have more special features and usage. We have summarized the answers we received and the following paragraphs contain brief descriptions of some of the products; more detailed information is available in the New Products Department, p 86.

Instruments

Measurement. In this category are many new and improved units. An entire family of transistorized counters only 3-1/2 in. high and enclosed in modular cabinets for bench or rack-mounting use are offered by Hewlitt-Packard. These instruments are designed to provide the utmost in reliability and operating convenience.

Better measurement accuracies, less power consumption and small space requirements are the outstanding features of the transistorized vlf phase comparator made by Specific Products.

A semiautomatic calibration feature incorporated in the Keithley Instruments megohm bridge speeds the standardization and calibration of resistors in the range of 10^5 to 10^{15} ohms.

Recorders. An instrument recorder and reproducer manufactured by the Mincom Div. of Minnesota Mining & Manufacturing Co. has a bandwidth of 200 cps to 300 kc at 60-in.-per-sec speed, using analog modules. Built-in calibration allows the recorder to be preadjusted to the incoming signal amplitude.

A computer format recorder, shown by Epsco, Inc., is all-transistorized and features compatible gapped recording of continuous analog data. The basic mechanism is simpler and has a three-times faster memory than units previously offered.

Combined use of their X-Y recorder and line-follower by the F. L. Moseley Co. made possible the transport delay simulator being shown at the Show. It will reproduce any time delay encountered in a process control or experimental laboratory situation.

New concepts in speed control, tape-handling and compactness are incorporated in the magnetic tape recorder and reproducer being displayed by the Sangamo Electric Co. It can be changed from reel to loop operation without rehandling the tape or making any changes in the transport.

Subassemblies

Amplifiers. The dc operational amplifier displayed by Micro Gee has better drift and linearity characteristics and is more convenient to use than models previously offered by the firm.

High continuous rated power output of 75 w and a gain of 1,000 v per v are the features of the Diehl Manufacturing Co.'s vacuum tube servo amplifier. Their transistor servo amplifier measures 1-7/8 in. long and 2-in. in diameter. It has no measurable phase shift in 20-cps pass band for a 60-cps carrier.

Components

Resistors. Miniature size, rugged construction and reliability are the outstanding features of the series of resistors announced by the Pyrofilm Resistor Co. Long-term stability of 2% per year is ensured by new sealing and coating techniques developed by Pyrofilm.

Unique panel mounting designs have been designed into the ultraminiature series of trimmers by Spectrol Electronics Corp. All case styles are sealed to meet MIL specifications.

Capacitors. Higher operating temperatures and more capacitance in smaller packages are the goals of the industry. Erie Resistor Corp. has developed an enamel-coated capacitor 0.320 in. long and 0.125 in. in diameter which has a capacitance of 2 to 56 pf with operating temperatures to +125 C. A variable temperature coefficient capacitor is available in fixed capacitance values of 2.0 to 12.0 pf from JFD Electronics Corp. These units can be tuned to provide any temperature coefficient between −500 and +500 ppm per C.

Designed for use in high-reliability systems such as missiles and nuclear equipment, the fusion-sealed series of moisture resistant glass capacitors offered by the Corning Glass Works has had the range of capacitance quadrupled. They are guaranteed to exceed MIL-STD-202A moisture requirements by a factor of four.

Transducers. For direct use with digital computers, DeJur-Amsco has developed a complete line of transducers with true digital output. These devices reduce over-all size and increase the reliability of instrumentation systems. They produce results which can be directly stored and used in digital computers.

Crystals. The vacuum-sealed, hard-glass micromodule crystal unit shown by McCoy Electronics Co. is claimed to be the smallest ever produced and vacuum-sealed in hard glass. Long-term frequency stability is 5 times better than that of conventional metal types.

Transistors. Motorola is introducing a complete TO-3 package power transistor line. A new "low-silhouette" type container will make possible valuable space savings in printed-circuit-board sandwich-type equipment.

Tubes. Designed by the Amperex Electronic Corp. for frequencies up to 200 mc, a new forced-air-cooled triode being shown has a specially processed platinum grid. This development has resulted in low-drive power requirements.

Relays. Long term reliability was the goal of the Automatic Electric Co. when they designed their new mercury-wetted contact relay. Over a billion reliable operations with complete freedom from contact bounce and maintenance are claimed.

Switches. Control Switch Div. of the Control Co. of America will announce the development of a T switch in a hermetically sealed steel case. It is 0.787 in. in length and weighs only 7 g.

Rectifiers. So compact that it can be placed at the point of use, the medium-power-range silicon

bridge rectifier developed by the Semiconductor Div. of Syntron Co. eliminates the need for long dc power runs from the rectifier to the equipment it supplies.

Materials

Wire. Temperature requirements have played a big role in the development of wire products to be shown at the Show. Phelps Dodge has a "Polyester" type magnet wire which has been modified to avoid the heat shock of earlier wires of this type. There is no heat or solvent shock at Class F operating temperatures. A magnet wire rated for Class H temperature service is offered by the Tensolite Insulated Wire Co. Tests of this wire have shown a life in excess of 10,000 hr at 240 C. Cut-through resistance is in excess of 400 C.

Greater long-term stability, coupled with a negligible temperature coefficient change after winding and processing are the results of improvements made to Karma resistance wire by the Driver-Harris Co.

Resins. Many resins with new or improved characteristics are being introduced by several companies this year. Minnesota Mining and Manufacturing Co. will announce a one-part, fully flexible, Class F epoxy resin which exerts little, if any, pressure on imbedded parts.

Visual inspection of circuits and components within embedded or encapsulated assemblies is permitted by the use of Dow Corning's transparent, flexible silicone resin encapsulent.

The flexible, thermal shock resistant epoxy resins prepared from a dimer acid offered by Union Carbide Chemicals Corp. exhibit good combinations of tensile strength and elongation. Self-extinguishing epoxy casting resin, suited for potting components and systems requiring fire-retardant capabilities will be among the resins shown by Emerson and Cuming, Inc.

Printed Circuit. In this category, flame-retardant plastic laminates are offered for printed-circuit applications by the Synthane Corp. The outstanding feature here is the combination of unusual arc-resistance, room-temperature punching and flame-retardance.

The American Lava Corp. has developed a thin, flat, strong ceramic for substrate and microceramic applications. They can furnish this material with dimensionally accurate holes, slots, serrations or other designs.

Electralab Printed Electronics Corp. will show for the first time its Dielox printed circuitry. This represents a new concept in the use of substrate materials and circuit deposition techniques, utilizing dielectric oxides on prefabricated metal bases. Continuous operation at temperatures in excess of 900 F is claimed for this printed wiring. ■ ■

Instruments that Stay Accurate

After More Than 600 Separate Inspections – One Panel Instrument

Sounds like a lot of inspecting, but it's one of the things that makes possible Simpson's fine panel instruments.

Take pivots, for example, which support the rotating armature of a meter movement. Because Simpson quality standards are so high, Simpson makes its own pivots which require more than 60 separate inspections during manufacture. Among these are 100% inspection under a 100X microscope and sampling inspection under a 400X microscope to check radius, cone angle, finish and other characteristics. One result is pivot points with a radius tolerance maintained to within .000010". Moreover, Simpson inspects each and every group of pivots for correct hardness so they won't deform under rough use.

Through such meticulous care as this, Simpson is able to offer you panel instruments with accuracy limits that are 100% guaranteed . . . instruments with conservative ratings on which you can rely . . . instruments that *stay* accurate . . . instruments you can specify with confidence.

Write for Catalog 2059A.

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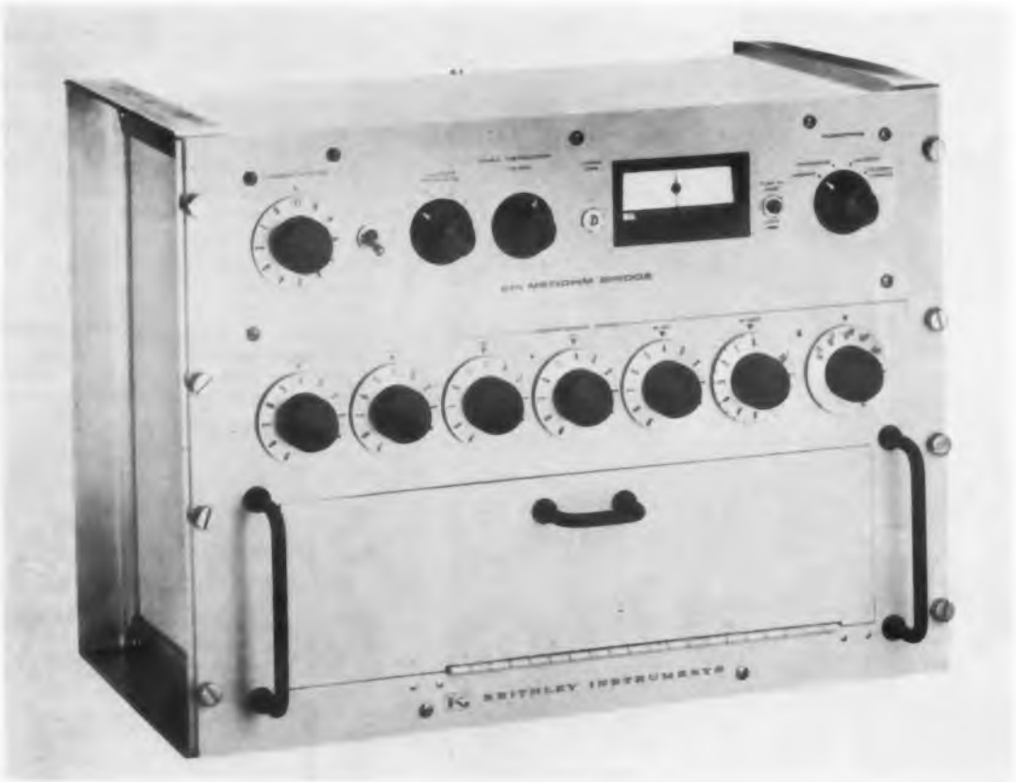
CIRCLE 73 ON READER-SERVICE CARD

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.



Megohm Bridge
Calibrates High Resistances **281**

The 515 megohm bridge is designed for the calibration and standardization of resistors in the range of 10^5 to 10^{15} ohms. It is also suitable for measurement of resistor voltage coefficients, leakage, and insulation resistances. Accuracy is 0.05% to 1.0%. A semiautomatic calibration feature and direct reading speed operation. The measuring compartment, shielded against stray pickup, will hold resistors up to 8 in. long and 2 in. in diameter. A stable electrometer null detector is used. Bridge potentials up to 10 v are supplied by an internal power source.

Keithley Instruments, Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

Price & Availability: $1,500, 120-day delivery.

See at Show Booth 3920.

Featuring products to be displayed at the IRE Show.

Multi-Trace Cathode-Ray Tube Provides Triple Display **280**

A multi-trace cathode-ray tube, type SC-3061 has three independently controlled electron guns capable of producing three simultaneous displays. The 10-in. tube is available in a variety of phosphors, is electrostatically focused and deflected, and has an astigmatism-control electrode. Deflection factors, at 5-kv anode potential, are about 130 v per in. horizontal and 70 v per in. vertical. Scan width is about 8-1/2 in.; traces are 1-3/8 in. apart on a common vertical line.

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

***Availability:** Engineering samples.*

See at Show Booth 2322-32, 2415-25.

Vacuum Coaxial Relays Handle 15 kw at 600 mc 283

Vacuum transfer relays enable these coaxial devices to handle up to 15-kw peak power at 600 mc. Some models weigh only 11 oz. and range in size from 3-1/4 to 4-1/16 in. high. Vacuum guarantees permanently low contact resistance that does not change even if the relay is accidentally switched under load. The vswr is 1.05:1 max. stable in any environment; isolation is 30 db min at 400 mc. Type RC43 LCA1 has a power rating of 1 kw average, 15 kw peak at 600 mc. Relay actuation is available with 24- or 115-v dc solenoids; four models accommodate a variety of standard coaxial connectors.

Jennings Radio Manufacturing Corp., Dept. ED, P. O. Box 1278, San Jose 8, Calif.

Price & Availability: *$200 to $230; 30 to 45 days.*

See at Show Booth 1802-04.

Trigistor in TO-18 Package Simplifies Binary Circuits 282

Types 2N892 through 2N901 provide complete on-off control at a single base input, enabling binary functions with one active element per stage. The number of auxiliary components is reduced; practical logic levels down to 1 ma are possible. The pnpn devices are housed in a TO-18 package. The series combines ratings to 200 v with inputs on the μa level. All units are subjected to 100% acceptance testing, and MIL-S-19500 capability is assured.

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

Price & Availability: *$10.50 ea.; stock.*

See at Show Booth 1920.

SM GROUP

Optional 0.1% or 0.01% regulation:

3½" PANEL HEIGHT

0.1% REGULATION MODELS	DC OUTPUT RANGE VOLTS	AMPS	0.01% REGULATION MODELS
SM 14-7M	0-14	0-7	SM 14-7MX
SM 36-5M	0-36	0-5	SM 36-15MX
SM 75-2M	0-75	0-2	SM 75-2MX
SM 160-1M	0-160	0-1	SM 160-1MX
SM 325-0.5M	0-325	0-0.5	SM 325-0.5MX

5¼" PANEL HEIGHT

SM 14-15M	0-14	0-15	SM 14-15MX
SM 36-10M	0-36	0-10	SM 36-10MX
SM 75-5M	0-75	0-5	SM 75-5MX
SM 160-2M	0-160	0-2	SM 160-2MX
SM 325-1M	0-325	0-1	SM 325-1MX

8¾" PANEL HEIGHT

SM 14-30M	0-14	0-30	SM 14-30MX
SM 36-15M	0-36	0-15	SM 36-5MX
SM 75-8M	0-75	0-8	SM 75-8MX
SM 160-4M	0-160	0-4	SM 160-4MX
SM 325-2M	0-325	0-2	SM 325-2MX

HB GROUP

Optional 0.1% or 0.01% regulation:

3½" PANEL HEIGHT

0.1% REGULATION MODELS	DC OUTPUT RANGE VOLTS	MA	0.01% REGULATION MODELS
HB 2M	0-325	0-200	HB 20M
HB 4M	0-325	0-400	HB 40M
HB 6M	0-325	0-600	HB 60M
HB 8M	0-325	0-800	HB 80M

PR GROUP

7" PANEL HEIGHT

MODEL	DC OUTPUT RANGE VOLTS	AMPS
PR 15-30M	0-15	0-30
PR 38-15M	0-38	0-15
PR 80-8M	0-80	0-8
PR 155-4M	0-155	0-4
PR 310-2M	0-310	0-2

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Precise, reliable performance in a wide choice of output ranges.

Three rack sizes: 8¾" H, 5¼" H, and 3½" H. Impervious to operational damage: circuit protection is an inherent function of input transformer and regulator characteristics.

HB GROUP

Exceptional performance: delivers 0-325 v dc at 200, 400, 600 or 800 ma from one standard 3½" H rack-mounting package.

Incorporates many "special" features as standard: **constant current mode, remote programming, remote dc on-off control.**

PR GROUP

A flexible new general-purpose line of semi-conductor power supplies. Adjustable wide-range outputs.

± 1% line regulation; semi-regulated for load. Many standard modifications available.

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makes power supply news for '61

FOR DETAILED SPECIFICATIONS ON MORE THAN 150 STANDARD MODEL POWER SUPPLIES, SEND FOR KEPCO CATALOG B-611

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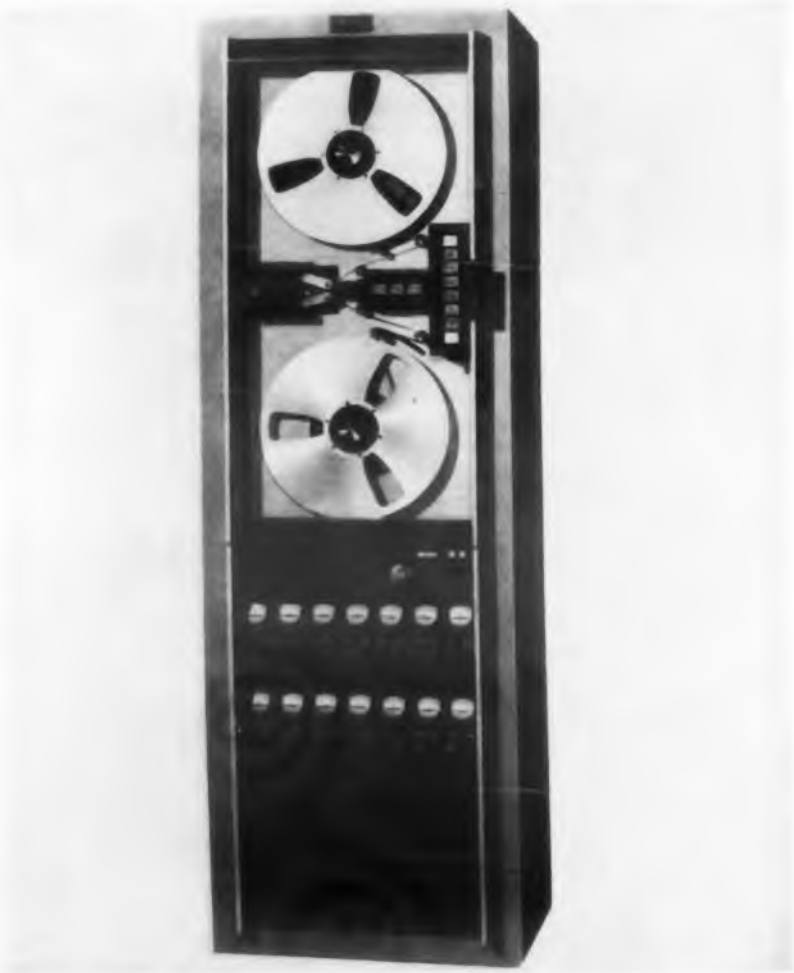
CIRCLE 74 ON READER-SERVICE CARD



Instrumentation Recorder Has 300-kc Bandwidth **278**

An instrumentation recorder and reproducer, the G-100 has a bandwidth of 200 cps to 300 kc at 60 in. per sec, using analog modules. With all-transistor electronics, the one-rack unit accommodates up to 14 tracks of information plus a voice track. Bandwidth is dc to 20 kc using fm modules. Design of both module types provides shielding against radiation and external interference. A built-in signal monitoring switcher and built-in calibration enable preadjustment to incoming signal amplitude. Bias module and fail-safe power supply are offered as optional equipment.

Mincom Div., Minnesota Mining and Manufacturing Co., Dept. ED, 2049 S. Barrington Ave., Los Angeles 25, Calif.

Price & Availability: *On request; 60-day delivery.*

See at Show Booth 3243.

Crystal Frequency Standard Stable to 5 Parts in 10 Billion

279

The model 105A ultra-stable oscillator is a 5-mc frequency standard with a guaranteed stability of five parts in 10^{10} per day. A single-stage oven houses the crystal and all components of the oscillator and temperature control circuits. Output is sine wave, 0.25 v rms; output impedance is 50 ohms. Power requirement is 100 ma at 100 to 140 v ac, 45 to 70 cps. The unit contains power supply, standby batteries, and provision for four plug-in dividers with outputs of 1 mc, 100 kc, 10 kc, and 1 kc.

Hermes Electronics Co., Dept. ED, 75 Cambridge Parkway, Cambridge 42, Mass.

Price & Availability: *$4,150; 90 days.*

See at Show Booth 3038-39.

Integrating Digital Voltmeter Is Fully Programable

276

The average values of steady or varying dc signals up to 1 kv are measured by the model 2401 over preselected, crystal-determined sample periods. Reading resolution of 1 part in 10,000 for a 100-msec samplin,; period is provided, with an accuracy of ±0.05% min. Floating input, guarded against common-mode pickup, can be operated up to 500 v above chassis ground. The meter may be used in high-speed data acquisition from multiple sources, integration of analog inputs, and frequency measurement to 300 kc. Binary-coded decimal output is provided.

Dymec Div., Hewlett-Packard Co., Dept. ED, 395 Page Mill Road, Palo Alto, Calif.

Price & Availability: *$3,750; 12 weeks.*

See at Show Booth 3205-15.

Ceramic-Metal Spark Gap Handles 10,000 Amp 275

Designed as a replacement for hydrogen thyratrons in crowbar applications, the ceramic-metal GP-12 triggered spark gap has a hold-off capability of 25 kv, and will handle peak currents in excess of 10,000 amp. The hermetically sealed device has low triggered energy requirements, and a fast follow-through time after application of the trigger pulse. Diameter is 3-1/2 in., height 2-1/2 in.

Edgerton, Germeshausen & Grier, Inc., Dept ED, 160A Brookline Ave., Boston 15, Mass.
Price & Availability: On request.
See at Show Booth 3244.

Miniaturized Delay Line Has 40:1 Time Ratio 277

Delay line model 37-74 has a delay time to rise time ratio of better than 40:1, in a case size of less than 3-1/2 cu in. Delay time of the miniaturized unit is 2.5 μsec ±5%; rise time is 0.07 μsec max. Attenuation is 2 db max, and impedance is 500 ohms. Temperature coefficient is less than 50 ppm per deg C, over a range of −55 to 125 C. The line is tapped as required. Case measures 2 x 2-5/8 x 5/8 in.

ESC Electronics Corp., Dept. ED, 534 Bergen Blvd., Palisades Park, N.J.
Availability: 4 to 5 weeks.
See at Show Booth 2915.

THE *Lavoie* LA-80 ELECTRONIC COUNTER HAS

GREATEST OVER-ALL STABILITY

TRUE DECADE SYSTEM ELIMINATES BINARY CONVERSION

The Lavoie LA-80 is the most versatile electronic counter on the market. Time base stability of ±one part in 10^8 per day, count down time base dividers, and self-contained provisions for additional plug-in heads give the LA-80 broad capabilities for sophisticated applications.
The LA-80 features the only directly coupled in-line readout available in 10 megacycle counters. Beam switching tubes completely eliminate germanium diodes, keeping maintenance and down time to an absolute minimum.

Frequency range is 10 cycles to 10 megacycles. Plug-in units for extended ranges are available. Time interval range is one microsecond to 10 million seconds. Nine standard frequency outputs in decade ranges are provided for oscilloscope calibration and precision timing.

- Automatic Reset
- Silicon Rectifiers
- In-line 8-place Readout
- Automatic Decimal Point
- Count Down Time Base
- Digital Voltmeter Converter
- 0.1 Microsecond Resolution
- 115-230V AC; 50-440 cycles
- Rugged Militarized Construction
- Human Engineered for ease of operation

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and see us at
IRE BOOTH 3815-17

LA-80 is shown with LA-901B time interval plug-in unit

Lavoie Laboratories, Inc.
MORGANVILLE, NEW JERSEY

Unparalleled reliability, with minimum maintenance, makes the LA-80 an invaluable tool for laboratory, production, military depot, and field operations.

CIRCLE 75 ON READER-SERVICE CARD

ELECTROMECHANICAL COMPONENTS

PRECISION MADE FOR MAXIMUM RELIABILITY

TEST JACKS per MS-16108

Heat-treated Berylco contacts, silver-plated. Color-coded nylon insulators. Available with turret, spade, taper pin, slotted or feed-thru terminals... standard, back-mounting or limited-space mounting shells.

FOR FULL ENGINEERING DETAILS, CIRCLE INQUIRY CARD NO. 247

LOW COST printed circuit TEST JACKS

Gold-over-silver-plated Berylco contacts per MIL-F-14072, M-310. Nylon bodies in 11 standard code colors. Simplified construction affords economical use in all quantities. Immediate delivery from stock.

FOR FULL ENGINEERING DETAILS, CIRCLE INQUIRY CARD NO. 248

TORSION CONTACT printed circuit CONNECTORS

Rolled contact points (see separate illustrations at right) ensure high pressure, clean connection without scoring... allows .020" variation in card thickness without setting contacts. Polarizing keys available.

FOR FULL ENGINEERING DETAILS, CIRCLE INQUIRY CARD NO. 249

BOOTHS 2535-2536 I.R.E. SHOW

DOT **The UCINITE COMPANY**

Division of United-Carr Fastener Corp.
Newtonville 60, Mass.

CIRCLE 247, 248, 249 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Converter 533

Accuracy is ±0.3% ±2 mv

Model 457A ac to dc converter has a conversion accuracy of ±0.3% ±2 mv from 50 cps to 50 kc. When used with the firm's model 405 BR CR digital voltmeters it provides ac voltage measurements with three-digit resolution and an over-all accuracy of 0.5% ±1 count, ±0.002 v. Attenuation ratios are 1 to 1, 10 to 1, 100 to 1, and 1,000 to 1 with highest rated input of 300 v rms.

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

See at Show Booth 3205-15.

Color Coder 624

Wire may be color-coded in stripes or whole colors with this color-coding device. User needs to stock only a single wire color, adding the stripe or color as the wire is stripped with automatic equipment.

Artos Engineering Co., Dept. ED, 2757 S. 28th St., Milwaukee 46, Wis.

See at Show Booth 4108.

Mass Spectrometer 583

Responds in 0.1 sec

A mass spectrometer amplifier, model 51A will discriminate currents as low as 10^{-16} amp quickly and reliably. Response time is 100 msec to 5 sec. A vibrating capacitor modulator reduces warm-up time. Voltage sensitivity is controlled over four decades with 10 steps per decade. Zero drift is ±100 μv over a 12-hr period.

Electronic Instruments Ltd., Herman H. Sticht Co., Inc., Dept. ED, 27 Park Place, New York, N.Y.

Price & Availability: *$2,480; 90-day delivery.*

See at Show Booth 3236.

Ceramic Capacitors 369

Subminiature

The "Wee Con" series of dipped phenolic-coated, plate ceramic capacitors have rectangular shape and are subminiature in size. They are available in six sizes from 0.150 x 0.150 x 0.100 to 0.600 x 0.500 x 0.150 in. Capacitances range from 10 pf to 0.036 μf, working voltage is 200 v dc.

Erie Resistor Corp., Dept. ED, 644 W. 12th St., Erie, Pa.

Availability: *In sample quantities.*

See at Show Booth 3210-12.

Flexible Epoxy Resins 644

Flexible, thermal-shock-resistant resins for Class B insulations at 155 to 175 C can be prepared from UNOX epoxide 201, a dimer acid and stannous octoate catalyst. UNOX 201 is claimed to be a compound of moderate general toxicity.

Union Carbide Chemicals Co., Dept. ED, 270 Park Ave., New York 17, N.Y.

Price: *$0.67 lb in tank car quantities.*

See at Show Booth 2401-05.

Random Noise Generator 356

Range is 5 to 2,000 mc

Known as the Auto Node this random noise generator and measuring device has automatic measurement over the range of 5 to 2,000 mc. Accuracy is ±0.2 db at 0 to 6 db and ±1.0 db at 13 to 15 db with measurement accuracy to ±0.2 db over-all. Maximum vswr is 1.1 with a maximum change of 0.002 during operation.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N.J.

Availability: *56 to 70 days.*

See at Show Booth 3512-18.

Diode Multiplier 531

Accuracy is 0.025%

This quarter-square law multiplier can operate in four quadrants, and employs silicon junction diodes in the squaring networks. The multiplier has a static accuracy of 0.025% and extremely high dynamic response. Amplitude error is 0.5%; phase shift is 0.1 deg at 100 cps. Computing networks are mounted on printed-circuit, plug-in cards. All calibrations are made at the factory; no field adjustment is required.

Reeves Instrument Corp., Dept. ED, East Gate Blvd., Roosevelt Field, Garden City, N.Y.

See at Show Booth 1305-07.

Printed-Circuit Film 635

Used in the production of printed-circuit layouts. Stabilene film is dimensionally stable and actinically opaque. The material has a visually transparent, peelable surface.

Keuffel & Esser Co., Dept. ED, Hoboken, N. J.

See at Show Booth 4506.

Transport Delay Simulator 354

Range is 4 sec to 32 min

Any time delay encountered in a process control or experimental situation may be reproduced by the model 2D-5 transport delay simulator. It consists of a controller, a standard X-Y recorder, and an optical line follower. Delay time may be varied in steps from 2 to 32 min, or continuously from 4 sec to 7 min. Slopes up to 80 deg can be tracked to within 0.05 in. at speeds through 15 in. per min. An alarm circuit detects errors up to 0.1 in.

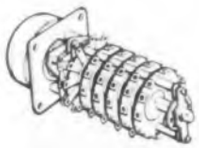
F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

Price & Availability: *$4,300; 90 days.*

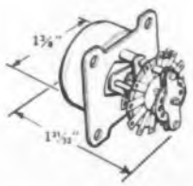
See at Show Booth 3310-12.

Ledex Rotary Selector Switch

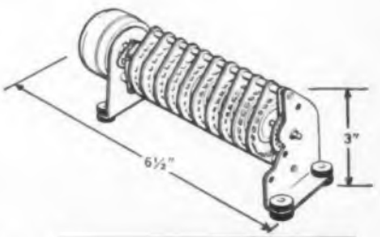
BASIC INFORMATION



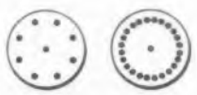
Functions as a power operated remote control circuit selector or stepping switch.



Smallest switch is size 2E with 1 to 4 switch wafers.



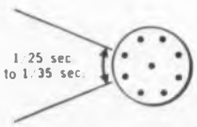
Largest standard switch is size 5S with 1 to 10 switch wafers, foot, flange or panel mounting.



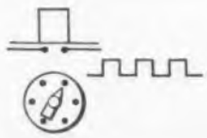
Switch wafers available with 8, 10, 12, 18, 20 or 24 positions.

Circuitry of wafers is flexible. For example 12 position wafer can be one circuit with 12 positions or 3 circuits with 4 positions each.

Will self-step to any pre-selected position.



Self-stepping speed is 25 to 35 steps per second depending on number of positions.



Pushbutton, manual rotary switch, or pulse controlled.

Hermetically sealed switches meet extreme environmental conditions.

The Ledex Rotary Selector Switch is a compact, highly efficient power-operated circuit selector or stepping switch, designed for remote control. Nearly unlimited design combinations permit great variety of applications for stepping, counting, adding, subtracting, programming and sequencing. Many stock models on hand for immediate shipment. Hermetically sealed models also available.

Power source is the Ledex Rotary Solenoid. This unit gives highest-torque-to-size rotary motion. Applications for Rotary Solenoids include actuation of valves, vanes, shafts, and other mechanical loads.

Also Ledex Syncramental Stepping Motors for accurate, reliable shaft indexing.

Write for literature, mentioning application, to Ledex, Inc., Dayton 2, Ohio; Marsland Engineering, Ltd., Kitchener, Ont.; NSF Ltd., 31 Alfred Place, London, Eng.; NSF GmbH, Nurnberg, Germany.

CIRCLE 77 ON READER-SERVICE CARD

do you tremble at the sign of a sine?

Does a sine-cosine pot in your pet project mean special prices and annoying delay? No need to pay more . . . no need to wait. Ace has a *full* line of sine-cosine function pots — in sizes, conformities and driving resistances to meet all your requirements — and delivery is prompt. Our *standard* line — which meets 95% of your needs — we can ship promptly . . . AND a special one goes off to you with minimum delay! Ace offers, as standards, conformities in a ⅞″ or 1-1/16″ size that you'd pay for as a *special* in a 2″ size elsewhere! Consider the space, weight and money you save!

Ace's standard sine-cosine line includes sizes from ¾″ to 3″, driving resistances from 1K to 1 megohm, in comparable conformities from 0.5%, peak to peak. So if you think you have a special requirement — talk to us! Chances are it's an Ace *standard* sine-cosine pot!

This ¾″ sine-cosine ACEPOT® features conformity of 1.0%, peak to peak, in a resistance range of 1K to 30K. Other driving resistance ranges and conformities available.

See us at IRE Booth 1912-1914

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CIRCLE 78 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Semiconductor Tester 532

For reliability programs

Developed for reliability programs, this semiconductor test system provides repetitive data from lots of transistors or diodes. Fifty or more units may be tested for leakage currents, breakdown voltages, saturation voltages, dc gain, reach-through and small signal "h" parameters. Data is recorded on a matrix chart and punched cards. Test accuracy is ±1%; repeatability is 0.2%. Power capability is 0 to 1 kv, 0 to 3 amp. The system is self-testing.

Optimized Devices, Inc., Dept. ED, 864 Franklin Ave., Thornwood, N.Y.

P & A: *From $14,000 to $18,000; 4 months.*

See at Show Booth 3060.

Alarm Unit 357

For low-level inputs

The Magne-Alarm is a solid-state alarm unit for monitoring over-limit conditions from low-level inputs such as thermocouples and strain gages. A simple, reliable bi-stable magnetic amplifier is used. Lamp indication is given of normal and alarm conditions. Critical deviations from set limits are immediately indicated visually and audibly, on local or remote indicators. The device has isolated input windings, high common mode rejection, and is insensitive to random noise.

San Diego Scientific Corp., Dept. ED, 3434 Midway Drive, San Diego 10, Calif.

Price: *From $125 to $200 per channel.*

See at Show Booth 3021.

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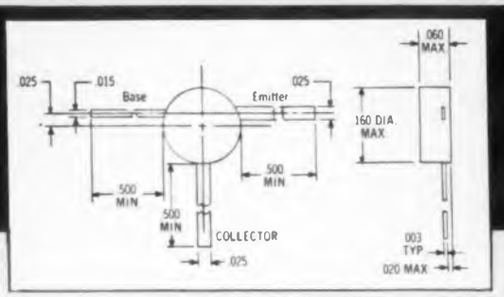

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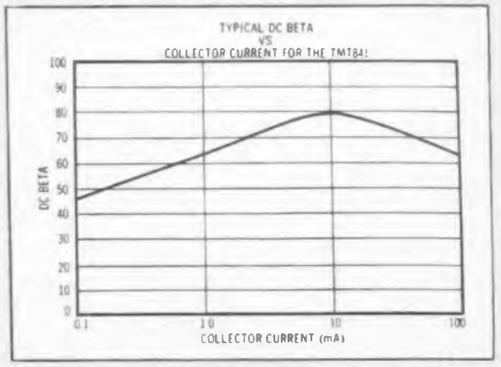

AMPLIFIER TYPES					
Type	Maximum Collector Voltage (Volts)	Minimum AC Beta (h_{fe})	Typical Gain-Bandwidth Product (Mc)	Maximum Collector Leakage Current at 25°C (μA)	Maximum Power Dissipation at 25°C Ambient (mW)
TMT 839	45	20	45	1	150
TMT 840	45	40	45	1	150
TMT 841	45	80	65	1	150

SWITCHING TYPES					
Type	Maximum Collector Voltage (Volts)	Minimum DC Beta (h_{FE})	Typical Gain-Bandwidth Product (Mc)	Maximum Saturation Resistance (Ohms)	Maximum Power Dissipation at 25°C Ambient (mW)
TMT 842	45	20	45	120	150
TMT 843	45	45	65	120	150

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Development of the **MICRO-T** — first silicon diffused mesa micro-transistor in an hermetically sealed all-glass package — represents a major step forward in microminiaturization. As compared with conventional "metal can" configurations, the **MICRO-T's** hard glass packaging embodies a significant improvement in the hermetic seal between leads and package. Reliability is substantially increased; possibility of leakage is sharply reduced.

This new series of 45-volt micro-transistors is the first designed for small-signal low-level applications, with current operating range from 50 microamps to 20 milliamps. Other electrical characteristics include an Rcs of 100 to 200 ohms; minimum Betas from 20 to 80; cut-off frequencies of over 50 megacycles. Perfectly compatible with present circuitry, **MICRO-T's** will facilitate microminiaturizing in such critical areas as airborne, space vehicle and missile application. They are 1/20th the size of the TO-5, and 1/5th that of the TO-18.

The first five types of **MICRO-T's** are available now. For full information, write for Bulletins No. PB-78, (Amplifier types) and PB-79, (Switching types).

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BOOTH NOS. 1220-1224

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wakefield, melrose, boston, mass.

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price $3850

CIRCLE 82 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Marking Machines 355

For cylindrical units

Model RG is a conveyor type machine for printing cylindrical pieces such as capacitors, tubes, etc., at a printing rate of 3,600 units per hr. Model B3-2F is a hand-operated machine for printing serial numbers in a minimum of space.

International Eastern Co., Dept. ED, 801 Sixth Ave., New York 1, N.Y.

See at Show Booth 4024.

Printed Circuitry 626

Operates to 900 F

Using dielectric oxides on prefabricated metal bases, Dielox printed wiring is designed for long term, continuous operation at temperatures to 900 F. There is no limitation on size, and the boards are not subject to breakage or warp. Finishes are available in copper, silver, and gold; rhodium over nickel may be furnished flushed for commutators and switches.

Electralab Printed Electronics Corp., Dept. ED, Industrial Center, Needham Heights 94, Mass.

See at Show Booth 2130.

Time Interval Counter 497

Range is 10 nsec to 0.1 sec

Model 5275A time interval counter provides digital measurements of time intervals over a range of 10 nsec to 0.1 sec. Counted frequency is 100 mc and resolution is 10 nsec. The unit has remote reset and four-line BCD electrical output.

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

See at Show Booth 3205-15.

Resonant Reed Relay 648

Range is from 67 to 160 cps

Resonator J500 resonant reed relay control is a stable electromechanical device used to generate and decode specific ac signals. It is available in frequencies from 67 to 160 cps and coil resistances of from 1 to 1,500 ohms.

Security Devices Laboratory, Dept. ED, Rochester 21, N.Y.

Availability: *30 days.*

See at Show Booth 1508.

Power Module 631

Used with strain gages

Model 801C is an all-semiconductor dc power supply designed for use with strain gages. Isolation is greater than 10,000 meg from output to ground or ac. Output is 0 to 25 v at 0 to 0.2 amp. Load regulation is less than 2 mv, no load to full load; line regulation is less than 2 mv from 105 to 125 v. Ripple and noise are less than 100 μv rms. The module is 5 x 14-7/8 x 1-5/8 in. Nine modules will mount in a standard relay rack, with a panel height of 5-1/2 in.

Harrison Laboratories, Inc., Dept. ED, 45 Industrial Road, Berkeley Heights, N. J.

Price & Availability: *$110; 10 to 30 days.*

See at Show Booth 1825.

Transistorized Encoders 647

For four-letter code groups

The main function of these 12-tone, 4-pulse transistorized encoders is to enable the operator to select up to 11,000 possible four-letter code groups.

Security Devices Laboratory, Dept. ED, Rochester 21, N.Y.

P&A: *$412 per unit; thirty days.*

See at Show Booth 1508.

Plug-in Counter 530

Has 75% less parts

This plug-in counter uses 75% less parts than the firm's previous models. The numerical-indicating tube is a long-life Nixie. A single counting tube replaces the usual four-tube ring counter for increased reliability.

Franklin Electronics, Inc., Dept. ED, Bridgeport, Pa.

See at Show Booth 3838.

Computer Format Recorder 628

For high-speed systems

The model S-2010 computer format recorder is designed for use in high-speed systems. The all-transistorized unit provides compatible gapped recording of continuous analog data. A complete family of optional auxiliaries is available.

Epsco Inc., Systems Div., Dept. ED, 275 Massachusetts Ave., Cambridge, Mass.

P&A: $47,500; 120-day delivery.

See at Show Booth 1216, 3915.

Inductance Bridge 655

For mutual and self-inductance

Bridge model 1854 measures mutual and self-inductance from 0.001 μh to 30 mh directly, with 1% accuracy. Resistances from 0.001 ohm to 3 K are also measured. Terminal connections are used. A fully transistorized, built-in oscillator and phase-sensitive detector operate the bridge. Measuring frequency is set at 1,592 cps (10,000 radians per sec) for simple Q calculation.

Marconi Instruments, Dept. ED, 111 Cedar Lane, Englewood, N. J.

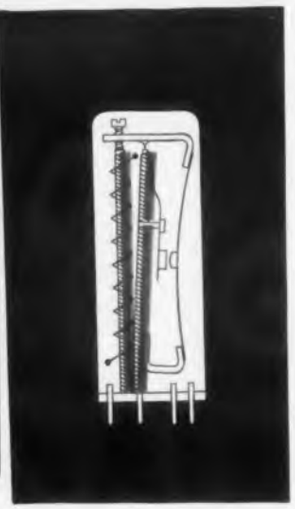
***Price & Availability:** $700; March delivery.*

See at Show Booth 3702-6.

7000 and 9000 Series

- Lowest Cost
- Rugged Construction
- Reliable Performance
- Interchangeable
- Wide Selection of Time Delays
- Wide Range of Operating Voltages

6000 and 8000 Series



THOMAS A.

EDISON

MINIATURE TIME DELAY RELAYS FOR MISSILES AND JET AIRCRAFT

Here's an opportunity to lower costs and at the same time improve the performance of your electronic products or equipment by using Edison Model 250 Miniature Time Delay Relays. An exceptionally rigid internal construction permits this relay to withstand vibration to 1500 cps for jet aircraft and missile applications while providing highly reliable performance. Since the operating structure of the relay is *independent* of the outer shell, damage or deformation of the latter does not affect the timing. The fast rate of contact closure insures positive contact operation under the most severe environmental conditions. ■ These permanently calibrated and hermetically sealed relays are available in a wide range of time delays and operating voltages to meet your particular application requirements. ■ Whether you need time delay relays for tube protection, gyro-erection or for other purposes, you will get better performance at lowest cost with Edison relays. Write for Bulletin 3046 showing timing ranges and operating performance or send your special requirements to:

Thomas A. Edison Industries
INSTRUMENT DIVISION
55 LAKESIDE AVENUE, WEST ORANGE, N. J.
CIRCLE 83 ON READER-SERVICE CARD

OBJECTIVE:

TANTALYTIC* CAPACITORS 99.999% PERFECT

L. W. Foster, Manager of General Electric's Tantalytic Capacitor High Reliability Program, discusses a new unique data-system approach to achieve .001% failure rate per 1000 hours

December of this year will mark the successful completion of General Electric's continuing program to achieve a Tantalytic capacitor failure rate of .001% per 1000 hours under specified test conditions. This achievement will stand out in contrast to numerous reliability claims because of the unique approach used to attain it, and the immense test sample used to prove it.

G.E.'s unique program recognizes limitations of "reliability testing" —emphasizes instead that reliability must be *built-in!* To build it in is to uncover all critical variables. G.E.'s Integrated Reliability Data System does this with its complex of minds and computers that weigh every factor from incoming material test to field performance.

Once all variables are isolated, corrective action eliminates weaknesses. Action is often drastic, and costly: a new chemical process . . . designing a new sealing machine . . . or adding a new QC check at a key stage. This is the *price* of reliability.

AC and DC Matrix Test Programs then call for testing hundreds of thousands of capacitors under various temperature and voltage combinations—some for as long as three years.

And the cycle repeats: more corrective action, more feedback, more testing and a lower failure rate, with correspondingly higher confidence levels—the *payoff* of capacitor reliability for critical circuits. For data and specific proposals on our foil and solid Tantalytic capacitor programs, contact your G-E Sales Engineer. Or, write High Reliability Program Manager, General Electric Co., Irmo, S. C. 430-01

Progress Is Our Most Important Product

GENERAL ELECTRIC

* Registered Trade-mark of General Electric Company.

NEW PRODUCTS
AT THE IRE SHOW

Subminiature Relay 534

Weight is 2.6 oz

This 6p2t subminiature relay weighs 2.6 oz. It is actuated by a rotary motor which develops high torque-to-size ratio. The motor is self-contained and does not depend on the housing to complete the magnetic circuit. Contact rating of this 1-in. diam relay is 2 amp at 26 v dc or 115 v ac. It is designed and manufactured in accord with MIL-R-5757D.

E. V. Naybor Laboratories, Inc., Dept. ED, 26 Manorhaven Blvd., Port Washington, N.Y.

P&A: *$32 in sample quantities; 6 to 8 weeks.*

See at Show Booth 1230-32.

Marking Machine 528

Handles up to 7,000 units per hr

Model 150AB is a semiautomatic marking machine for color-banding and imprinting axial-lead components. It can simultaneously color-band up to six colors, print variable data, or both color-band and print at rates up to 7,000 units per hour. Axial-lead components up to 1/2-in. in diameter and 2-in. long can be handled.

Markem Machine Co., Dept. ED, 168 Congress St., Keene, N.H.

P&A: *$8,000 to $12,000; 90 to 120 days.*

See at Show Booth 4210.

◀ CIRCLE 84 ON READER-SERVICE CARD

Latch Relay 375

Microminiature Size

Series 2LB microminiature dc magnetic latch relay has rotary balanced construction and measures 0.4 x 0.8 x 0.875 in. Sensitivity at pull-in at 25 C is 150 mw spdt or 300 mw dpdt. Contact rating is dry circuit to 2 amp resistive at 32 v dc. Dielectric strength is 1,000 v rms, insulation resistance is 1,000 meg min.

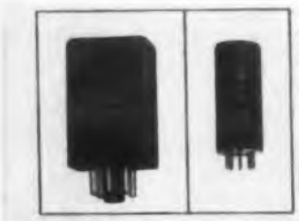
Hi-G, Inc., Dept. ED, Bradley Field, Windsor Locks, Conn.

Price & Availability: *$15 ea, 1 to 10; 4 weeks.*

See at Show Booth 2812.

Tuning-Fork System 388

For remote control



These miniature, plug-in tuning fork components are designed for selective calling or remote control systems. The resonant relay, installed at the receiving end, performs independent of mounting. Control tone is supplied by the oscillator stabilizer at the transmitting end. Frequencies range from 150 to 1,000 cps. Oscillators are made in tolerances of ±5% and ±1/2 cycle. The system permits control of many functions through a single radio channel or cable pair.

Stevens-Arnold, Inc., Dept. ED, 7 Elkins St., South Boston 27, Mass.

See at Show Booth 2934.

CIRCLE 85 ON READER-SERVICE CARD ➤

Because military reliability isn't always the best answer, CBS Electronics brings you "instrument quality" tubes

CBS Instrument Tubes feature gold-plated base pins for high conductivity

Your advanced industrial electronic equipment calls for tubes designed for *industrial* service . . . not tubes engineered specifically for military, airline, and mobile applications. With this in mind, CBS Electronics has designed, manufactured and tested a line of "instrument quality" tubes offering unusual advantages of stability and long life.

Although these CBS Instrument Tubes are engineered for industrial service at minimum cost, they are not just reliable military tubes less shock and vibration controls not required. They incorporate characteristics controls proved important to instrumentation, industrial control, broadcast, medical electronics, nuclear electronics, and commercial sound applications.

Upon request, CBS Instrument Tubes can also be supplied with special characteristics controls for particular applications.

Note the features of CBS Instrument Tubes. Check the types now available from stock. Order them now from your local sales office and test them in your designs.

UNIQUE FEATURES:

- 10,000-hour warranty • stable characteristics
- tighter test limits • extensive life tests* • coil heaters
- maximum value and performance per dollar for critical sockets

*Include unique 100-hour life assurance tests, comprehensive 1000-hour life tests, 5000-hour informational life tests.

SELECT FROM THESE INSTRUMENT TUBES BY CBS ELECTRONICS

CBS 7728 Stable medium-mu twin triode replacing 12AT7.

CBS 7729 Stable high-mu twin triode replacing 12AX7.

CBS 7730 Stable medium-mu twin triode replacing 12AU7.

CBS 7731 Stable vhf triode-pentode replacing 6U8.

CBS 7732 Stable high-gain r-f pentode replacing 6CB6.

CBS 7733 Stable high-perveance video pentode replacing 12BY7A.

Watch for more "instrument quality" tubes by CBS Electronics.

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NEW!

TRUE RMS Voltmeter with 1/4% ACCURACY

measures wide range of **Waveforms**

BALLANTINE model 350

features:

- High accuracy achieved on waveforms in which peak voltage may be as much as twice the RMS. **Not limited to sinusoidal signals.**
- Left-to-right DIGITAL READ-OUT. Fast, simple nulling operation consists of selection of decade range by push-button, and adjustment of four knobs for minimum meter indication. These operations attenuate the input signal to a predetermined value, causing a bridge circuit to be balanced by changing the current through a barretter.
- Temperature-controlled oven contains the barretter and and ambient temperature compensating resistor. Effect of ambient temperature changes is less than 0.005%/° C from 20° C.
- Proper NIXIE digit is lighted automatically while bridge is being balanced. No jitter.
- Rugged, accurate. Doesn't require the extreme care of many laboratory standard instruments. No meter scales to read. Useful for laboratory, production line, and in the field.

specifications:

$720

VOLTAGE RANGE: 0.1 to 1199.9 v

FREQUENCY RANGE: 50 cps to 20 kc

ACCURACY: ¼% 0.1 to 300 v, 100 cps to 10 kc;
½% 0.1 v to 1199.9 v, 50 cps to 20 kc

INPUT IMPEDANCE: 2 megohms in parallel with 15 pF to 45 pF

POWER: 60 watts, 115/230 v, 50 to 400 cps

WEIGHT: 19 lbs. for portable or rack model

Available in Cabinet or Rack Models

Write for brochure giving many more details

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BALLANTINE LABORATORIES INC.

Boonton, New Jersey

CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS, REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC DC AND DC/AC INVERTERS, CALIBRATORS, CALIBRATED WIDE BAND AF AMPLIFIER, DIRECT-READING CAPACITANCE METER, OTHER ACCESSORIES. ASK ABOUT OUR LABORATORY VOLTAGE STANDARDS TO 1,000 MC.

CIRCLE 86 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Wide-Field Radiometer 606

For target tracking

Designed for manual acquisition and tracking of small, remote, fast-moving targets, the wide-field radiometer model R-4K1 can make contrast or absolute measurements of target radiation. A reticle-chopper package rejects uniform background signals by a ratio of 10,000:1 for daylight tracking; a total-chopping package permits absolute measurements. Detectors and preamplifiers are packaged as interchangeable plug-in units.

Barnes Engineering Co., Dept. ED, 30 Commerce Road, Stamford, Conn.

Price & Availability: *$13,500; 90-day delivery.*

See at Show Booth 3036.

Magnet Wire 663

Poly-Thermaleze, a polyester magnet wire, shows no heat or solvent shock at Class F (155 C) operating temperatures. A balanced combination of chemical, physical and electrical properties makes it a multi-purpose wire.

Phelps Dodge Copper Products Corp., Dept. ED, Fort Wayne, Ind.

P&A: *Same as Formvar; delivery from stock.*

See at Show Booth 4028-29.

Semiconductor Mounts 654

Made of new alloys

The cold-formed bases of these semiconductor mounts are oxygen-free copper or a zirconium-copper alloy. The former material has higher thermal conductivity than the conventional tellurium-copper alloy. The zirconium copper retains its strength at brazing and welding temperatures. The base doubles as heat sink and electrically conducting mount.

Standard Pressed Steel Co., Dept. ED, Jenkintown, Pa.

See at Show Booth 4528-30.

SOLD

BY BRANSON

THE FIRST

4 POLE CRYSTAL

CAN RELAY

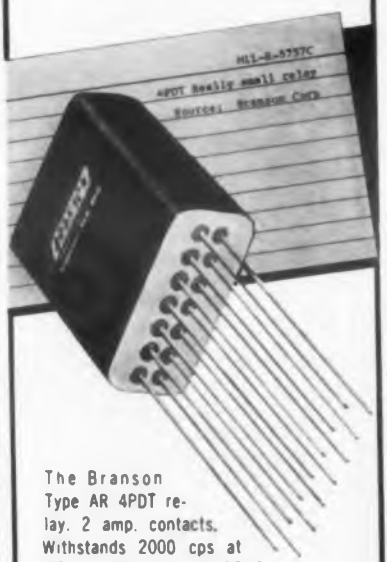
PROVEN

IN

CRITICAL

MILITARY

SYSTEMS



The Branson Type AR 4PDT relay. 2 amp. contacts. Withstands 2000 cps at 20G. −65°C to +125°C. Hermetically sealed and dry nitrogen filled for high altitudes. Wt. 15-20 gms. Dim. .384 x .784 x .882. Hook, plug-in or wire leads available. Std. 0.1 in. grid spacing. Suitable for dry circuit conditions. Meets specs: MIL-R-25018, MIL-R-5757C, MIL-E-5272C.

Delivery from stock, special orders in 4 weeks.

See us at Booth 2434 at the IRE Show

BRANSON Corp.

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CIRCLE 87 ON READER-SERVICE CARD

CIRCLE 88 ON READER-SERVICE CARD ➤

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Complete Engineering and Production Service including:

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All Shapes and Sizes, Long or Short Production Runs
Light, Medium and Heavy Gauges to Close Tolerances
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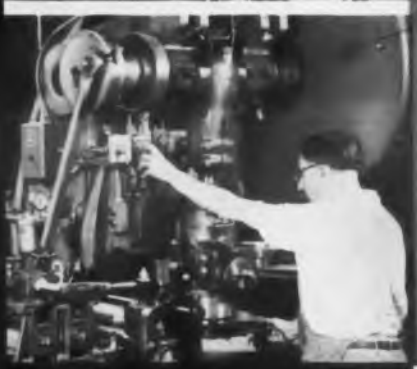
- MAGNESIUM
- TITANIUM
- SILVER
- HAYNES STELLITE
- STAINLESS STEEL

KAUPP ...Metal Craftsmen Since 1924



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FOR ELECTRONICS, NUCLEONICS
AND GENERAL INDUSTRY

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- DEEP DRAWING
- SPINNING
- PROTOTYPES
- LONG OR SHORT PRODUCTION RUNS

Precision metal-working machines of all types assure high-accuracy metal forming to exact specification. All operations are performed by trained mechanics under the close supervision of experts.

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1 Monarch—16x54
1 Le Blond—17x54
1 South Bend—14x36
2 South Bend—10x36
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MILLING MACHINES
1 Milwaukee Universal
1 Milwaukee Vertical
1 Hardinge
2 Bridgeport ½ HP
2 Cincinnati Tool-masters
1 Bridgeport 1 HP
1 Simmons Horizontal Production
1 14" Gould Eberhardt Universal

GRINDERS
1 Cincinnati Universal —10x36 Internal External Hydraulic
1 Brown & Sharpe—6x12x18 Surface
1 Heven Bench Grinder Complete with Diamond Wheel
1 Thompson—6x12x18 Surface Hydraulic
1 Reid—6x12x18 Surface
1 Arter Surface Grinder No 18
1 Monoset Tool & Cutter Grinder

PRESSES
1 Bliss No. 4A Single Crank Double Action
1 Bliss No. S-100—100 Ton 10" Stroke Pneumatic Cushion 15 Ton
1 [illegible] No. 3[illegible]—90 Ton 10" Stroke Pneumatic Cushion 15 Ton
1 Niagara No. 3½A—54 Ton
2 Niagara No. H2½—25 Ton
1 Bliss No. 20B—32 Ton
2 Bliss No. 18 Horn
2 Bliss No. 18 Inclinable
3 Bliss No. 18C Inclinable
1 Consolidated No. 72 Pneumatic Cushion —5 Ton
1 Loshbough & Jordan No. 2 Special
1 Loshbough & Jordan No. 3 Special
1 Zeh & Hanneman No. 4
1 Zeh & Hanneman No. 2 Inclinable
1 8" Hydroform
1 12" Hydroform
1 19" Hydroform

METAL SPINNING LATHES
1 Grabo Gap Lathe 24" to 60"
1 Grabo 26"
3 Grabo 22" Motor Driven
1 Grabo 18"
1 Grabo 16"
1 Prybil 26"
1 Frum 22"

SAWS
1 Grob Band Filing Fab No. 18
1 Grob Band Die Cutting
1 Marvel Power 6x8
1 Marvel Power 10"

SHEARS
1 Niagara Squaring Shear 6'
1 Niagara Squaring Shear 4'
1 Foot Shear 3'
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1 Niagara Power Ring & Circular Shear
1 Hand Circular Shear

SPOT WELDERS
1 [illegible] 15KVA & Timer
1 Eisler 10KVA & Timer
1 Taylor Winfield 50KVA

JIG BORER
1 Pratt & Whitney 1½B

MISCELLANEOUS
1 Walmat High Speed Sensitive Drill Press
1 Leland Gifford 26" Single Spindle Press
1 Buffalo 16" Drill Press
4 Walker Turner 14"
1 Compressor Westinghouse 5 HP
1 Compressor Ingersoll Rand 3 HP
1 Drop Hammer 200 lb.
2 Atlas Lathes Prod. Work Trim
3 Utility Bit Grinders
1 Walker Turner 10" Tilting Arbor Table Saw
1 Zip Lift No. A
1 30"x80" Surface [illegible]
Computer
1 Moore 10" Dia. Rotary Table
1 [illegible] 6 ft.

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Kaupp engineers have solved many unusual metal forming problems relating to both military and commercial type metal components. In many instances slight design changes, suggested by our engineers, have resulted in substantial savings in both time and money. Kaupp's wide experience ranges from parts for electrical appliances to guided missile components.

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Multiplier-Divider 579

For process control

Type 33-5947 analog multiplier-divider is applicable to any type of analog process control in military or industrial instrumentation. It accepts 3 dc analog input voltages and forms a proportional output. The unit may also be connected to square, find geometric means, extract square roots and solve quadratic equations. The solid-state device has a frequency response of 50 cps. Accuracies are ±0.5% as a multiplier and ±1% as a divider.

Airpax Electronics Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

See at Show Booth 2306-08.

Tape Recorder 549

With precise speed control

The model 461-RB handles tape up to 2-in. wide at speeds to 60 in. per sec. Transport can be provided with the Hare tape-synchronized speed control, a fast-acting, completely damped system. Record speed deviations of up to ±15% are corrected without loss of synchronism. Maximum speed is reached in less than 1 sec. Speed deviation is ±0.01% standard; wow and flutter, 0.2% max. Frequency response is 100 to 100,000 cps ±3 db. Signal-to-noise ratio is 34 db min, and harmonic distortion is 1% total.

Sangamo Electric Co., Dept. ED, Springfield, Ill.

See at Show Booth 2205-07.

this is the actual size of the

NEW, COMPACT, PROGRAMMABLE, HALF-RACK, ®REGATRAN POWER SUPPLIES...

with continuously variable current limiter...

These new Regatrans are sparing only of space . . . delivering super-regulated, virtually ripple-free d-c power with the instant start-up and very high reliability of solid-state circuitry . . . and offering a group of features hitherto unprecedented in d-c power supplies of this size.

REGULATION, LINE OR LOAD, 0.1% OR 0.01 V

MODEL NUMBER	DC OUTPUT		MAX. RMS RIPPLE
	VOLTS	AMPS	
TR212A	0-100	0-100 MA	250 μv
TR018-1	0-18	0-1 AMP	150 μv
TR036-0.2	0-36	0-200 MA	150 μv

For a closer look, ask your local Electronic Measurements representative for a copy of Specification Sheet 5000 . . . or write direct.

SEE IT AT IRE BOOTHS 2227-2229

ELECTRONIC MEASUREMENTS
COMPANY OF RED BANK
RED BANK · NEW JERSEY

®Reg. U.S. Pat. Off. Patents Issued and Pending.

CIRCLE 89 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Casting Resin 562

Has low viscosity

Stycast 2651-40 is a low-viscosity, general-purpose epoxy casting resin. It offers excellent physical and electrical properties. Normally supplied in black, it is available in any color to specification. The resin can be cured at room temperature with catalyst 9, or at an elevated temperature with catalyst 11, which has a longer pot life. It is stable over a temperature range of —100 to 350 F.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

Price & Availability: *$1.35 per lb; stock.*

See at Show Booth 3823.

Humidity Chamber 573

For military testing

Designed and guaranteed to perform MIL-202B, Method 160A, Steps 1 to 6 and Method 103A, procedure 2, this counter-flow controlled humidity chamber is constructed of arc-welded, polished 18-8 stainless steel. Cycle is automatic between 25 and 65 C. Two saturable reactor controls are used with single reactor to modulate power to wet and dry bulb.

Blue M Electric Co., Dept. ED, 138th & Chatham Sts., Blue Island, Ill.

Price & Availability: *$1,595; 30-day delivery.*

See at Show Booth 3008.

Have you sent us your subscription renewal form?

measure the volume of a pulse beat . . . the weight of a breath . . . the vacuum of outer space
measure gyro rotor unbalance . . . liquid level in a remote tank . . . the thickness of a continuous sheet of hot metal

Convert any variable into a change in capacitance and there's a Delta unit available to measure, record, or control that variable more accurately and more economically than was ever before possible.

You just plug the Delta unit into a 115 Vac supply and hook up the probes to your simply constructed capacitance sensor. Capacitance changes as slight as 1% generate output voltages as large as 0.2 Vdc, indicating direction as well as magnitude.

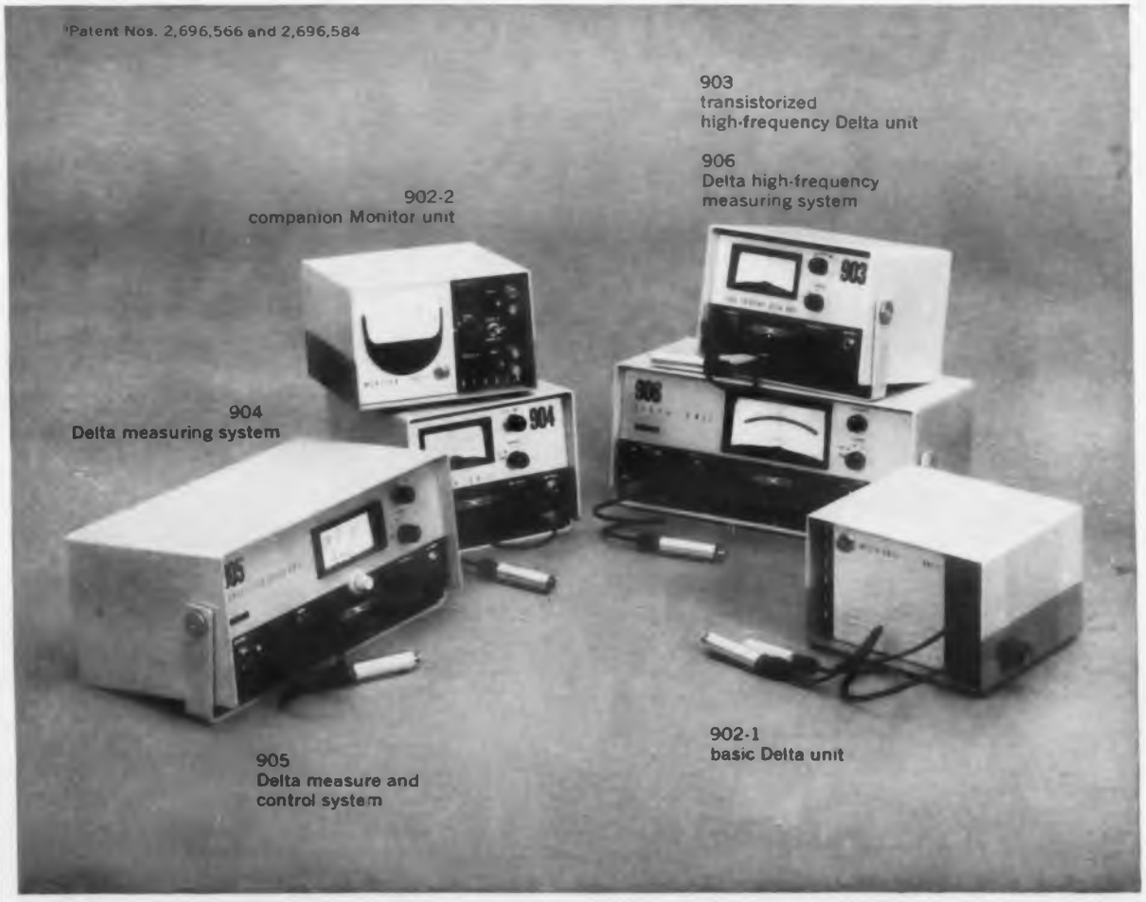
Everything you need for measurement in the laboratory, on the bench, or in the field is built right into one or another instrument in the Delta family. All incorporate the proved principle of the Decker T-42 Ionization Transducer*, the most important advance in measurement in decades. All models but 902-1 have internal meters. Or, you can easily bypass the meter and feed results directly into external display, recording, or control equipment.

Write for complete details, specifications, and application suggestions in Series 900 Instrument Data Sheets, available without obligation. Or, just let us have your measurement problem, and we'll gladly recommend a practical solution.

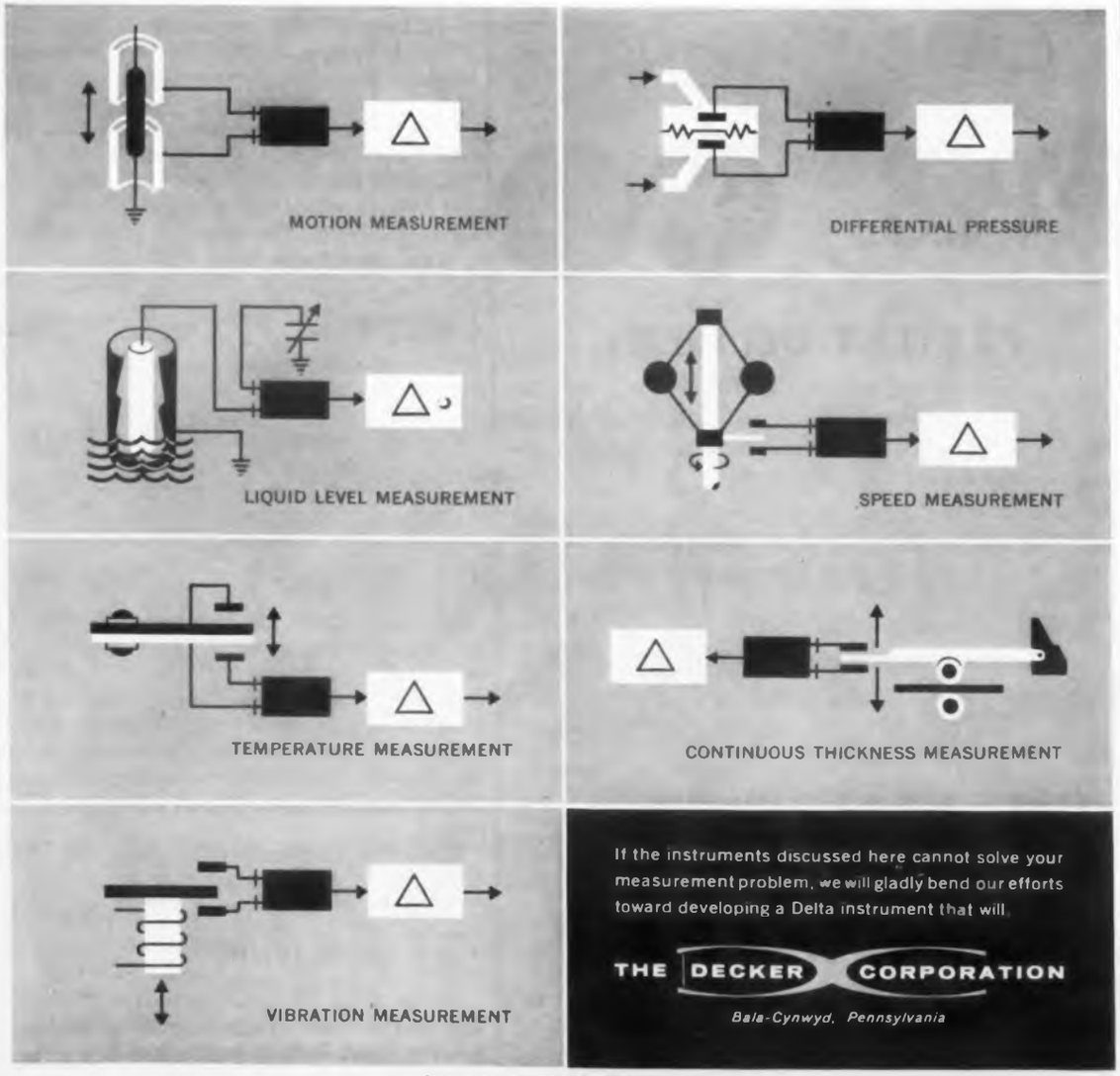
THE DECKER CORPORATION *Bala-Cynwyd, Pennsylvania*

MEASURE ANYTHING!

*Patent Nos. 2,696,566 and 2,696,584



DECKER'S DELTA UNIT makes non-contact capacitance gauging practical and economical for the first time. Compared with conventional capacitance measuring systems, the Delta unit has no complex circuitry, provides excellent long-term stability. The basic Delta unit is little more than a stable RF oscillator which excites the T-42 Ionization Transducer. The transducer output itself is a phase sensitive differential d.c. voltage analogous to any change in capacitance across the probe terminals. Here are just a few of the uses to which Decker Delta units are daily put in research laboratories, manufacturing plants, defense installations, and hospitals.



CIRCLE 91 ON READER-SERVICE CARD

Tape Deck 581

Stereo, four-track

Model RP100 tape deck records stereo or mono on four tracks. Transistor circuitry is used throughout. At tape speed of 7-1/2 in. per sec, wow and flutter variation is 0.2% rms; frequency response is ±2 db, 30 to 15,000 cps. Signal-to-noise ratio is 55 db. Provision is made for sound-on-sound recording and 1/2-track playback. Three stacked heads are used.

Electronic Instrument Co., Inc., Dept. ED, 33-00 Northern Blvd., Long Island City 1, N.Y.
Price: $289.95 *kit*, $395 *wired*.
See at Show Booth 3509.

Plug Insulator 597

The sealing ends of the MS/RX and the KPT/KSP two-shore plug insulators have 40-shore hardness which enables the endbell to compress the rubber into a solid mass around the conductors. The mating end is 80-shore hardness which retains the contacts firmly in place yet allows them to be removed repeatedly.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.
See at Show Booth 2727-31.

Multistage Blowers 580

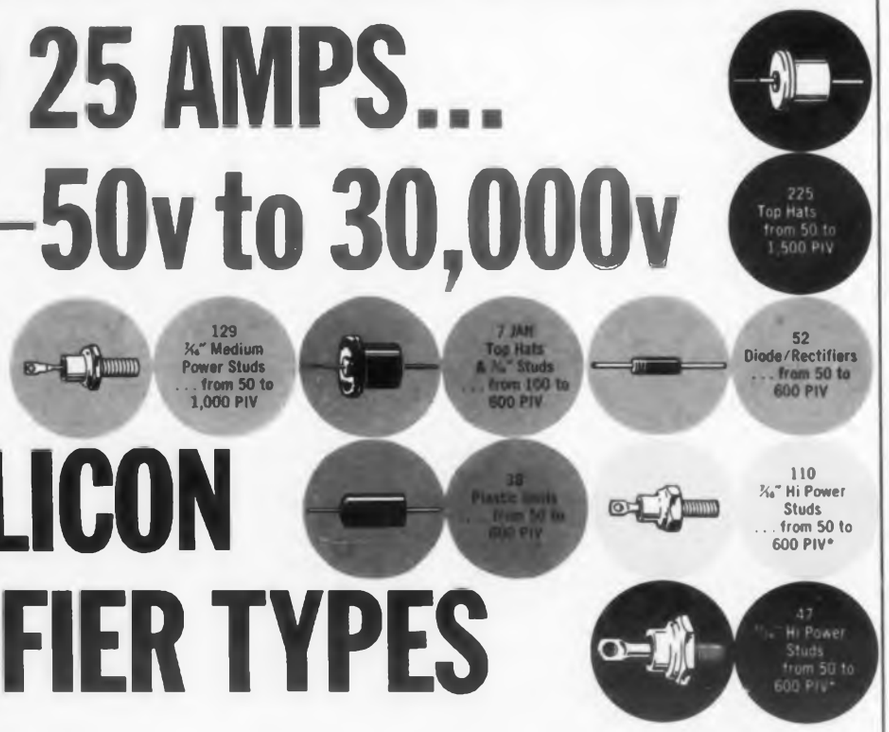
To 1 psi, 100 cfm

Designed to provide continuous quiet operation and long life, these multistage blowers deliver up to 100 cfm and meet pressure requirements to 1 psi. Low noise level makes them ideally suited for computer applications. Ambient temperature range is −55 to 85 C. Power requirement is 60 to 400 cps, 1 or 3 phase, to 440 v.

Air Marine Motors, Inc., Dept. ED, Bayview Ave., Amityville, N.Y.
See at Show Booth 2601.

General Instrument Silicon Rectifiers

UP TO 25 AMPS...
PIV's—50v to 30,000v
1619
G SILICON
RECTIFIER TYPES



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• Whatever your requirement, there is a G type that exceeds military and industrial spec's • Top Hats • ¾" Medium Power Studs • Hi Power Diodes • Plastic • ¾" Hex Hi Power Studs • 1⅛" Hex Hi Power Studs • Insulated Studs • All JAN Top Hats • Rectifier Stacks • Hi Voltage Cartridges • Custom Packages for Special Needs • New 25-Amp Stud Rectifiers

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***Available on request up to 480,000 PIV*

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65 Gouverneur Street, Newark 4, New Jersey

IN CANADA: General Instrument—F. W. Sickles of Canada Ltd., P.O. Box 406, 151 S. Weber Street, Waterloo, Ontario, Canada. Sherwood 4-8181.

CIRCLE 92 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Electrometers 538

Multi-purpose instruments

These two electrometers perform the work of several instruments in the measurement of voltage, current and resistance. The line-operated model 621 has 37 ranges, full-scale current ranges of 10^{-11} to 10^{-4} amp and resistance ranges are 10^{5} to 10^{12} ohms. Model 620 offers 31 ranges, full-scale current ranges from 10^{-11} to 10^{-3} amp and resistance ranges from 10^{6} to 10^{11} ohms. Input impedance of both can be selected from 10^{8} to 10^{14} ohms.

Keithley Instruments, Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

P&A: Model 620, $280; model 621, $390; 90 days.

See at Show Booth 3920.

Logic Trainer 586

For digital circuits

This logic trainer demonstrates digital circuit and logic operations, and serves as a guide in prototype work. Standard, off-the-shelf transistor digital circuit modules are used. There are 50 prewired circuits connected to plug-in pin jacks for jumper interconnection. The eight flip-flops are provided with push-button inputs for setting. Connections for external equipment are furnished.

Epsco, Inc., Components Div., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

P&A: $1,795 less power supply, $2,175 complete; 4 weeks.

See at Show Booth 1216.

This is the time of our annual subscription renewal; Return your card to us.

Terminal Boards 537

Military types

This military terminal board line includes every type designation according to MIL-T-16784B made to BuShips 9000-S6505-73214 drawings with the latest revisions, BuOrd S64101.

Kulka Electric Corp., Dept. ED, 633-643 S. Fulton Ave., Mt. Vernon, N.Y.

See at Show Booth 2900.

Ground Support Plugs 598

The CWLD series of ground support plugs is interchangeable and will mate with similar types in the field. It is designed to function under the most severe conditions.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

See at Show Booth 2727-31.

Sealing Compound 603

Eccoshield VX is a caulking and sealing compound designed to assure the rf integrity of structures. When applied to the seams of an enclosure it is possible to achieve insertion losses of 100 db from 200 kc to 10 Gc. It will not harden with time. Resistivity is less than 0.1 ohm per cm.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

Availability: From stock.

See at Show Booth 3823.

Gear Reducer 543

Planetary type

This 1-1/2 in. planetary gear-reducer is capable of 100 in./lb continuous duty torque with a light-duty head and 500 in./lb output by the use of a heavy duty head. It enables the use of smaller motors where space is a consideration.

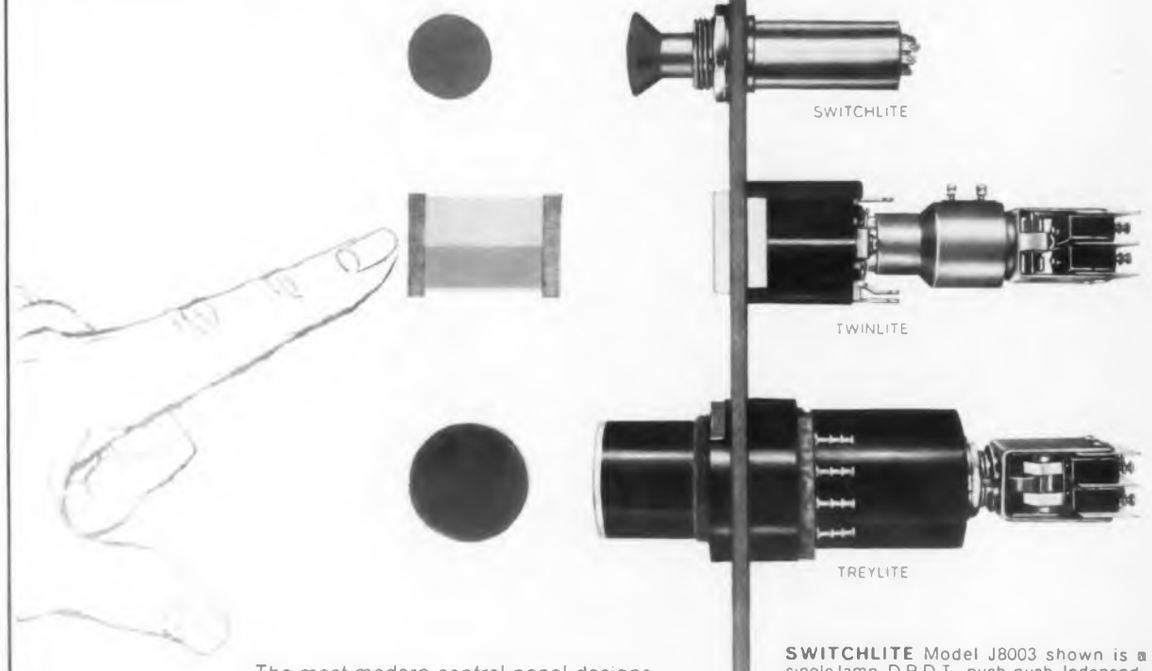
Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

Availability: 60 to 90 days.

See at Show Booth 2827.

CUT CONTROL PANEL COSTS AND SAVE SPACE WITH COMBINED SIGNAL & SWITCH

VISIT CONTROL SWITCH I.R.E.
BOOTH 1727-1731
March 20-23, 1961



The most modern control panel designs combine indicator lights and pushbutton switches wherever possible. This cuts costs by reducing the number of components, and speeds assembly. Overall panel size can often be reduced as much as 75%. And these "human-engineered" controls sell better because operation is obviously simplified. Here are just three of the many lighted pushbuttons available from Control Switch Division...

SWITCHLITE Model J8003 shown is a single lamp, D.P.D.T., push-push. Independent lamp circuit for 6, 14 or 28 volts. Rated 3 amp res., 1 amp ind. @ 28 VDC or 115 VAC. Mounts in ⅝" dia. hole. 4 button styles, several lens colors.

TWINLITE . . . two lamps with independent circuits for 2-color lighting. Lens 1" x .740" in solid or split colors, with or without nameplate slot. Momentary or push-push action, or solenoid-held switch shown above. Rated 4 amp res., 2.5 amp ind. @ 30 VDC; 5 amp @ 125/250 VAC. Mount in groups or singly, using barriers.

TREYLITE . . . three independent lamps, each with color filter so three colors can be sequenced on white pushbutton screen. D.P.D.T. switch rated 4 amp res., 2.5 amp ind. @ 30 VDC; 5 amp @ 125/250 VAC. Select momentary or push-push action. Models for flush-panel mounting (shown above) or subpanel mounting.

Write for FREE CATALOG on LIGHTED SWITCHES.

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Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading parts Distributors.

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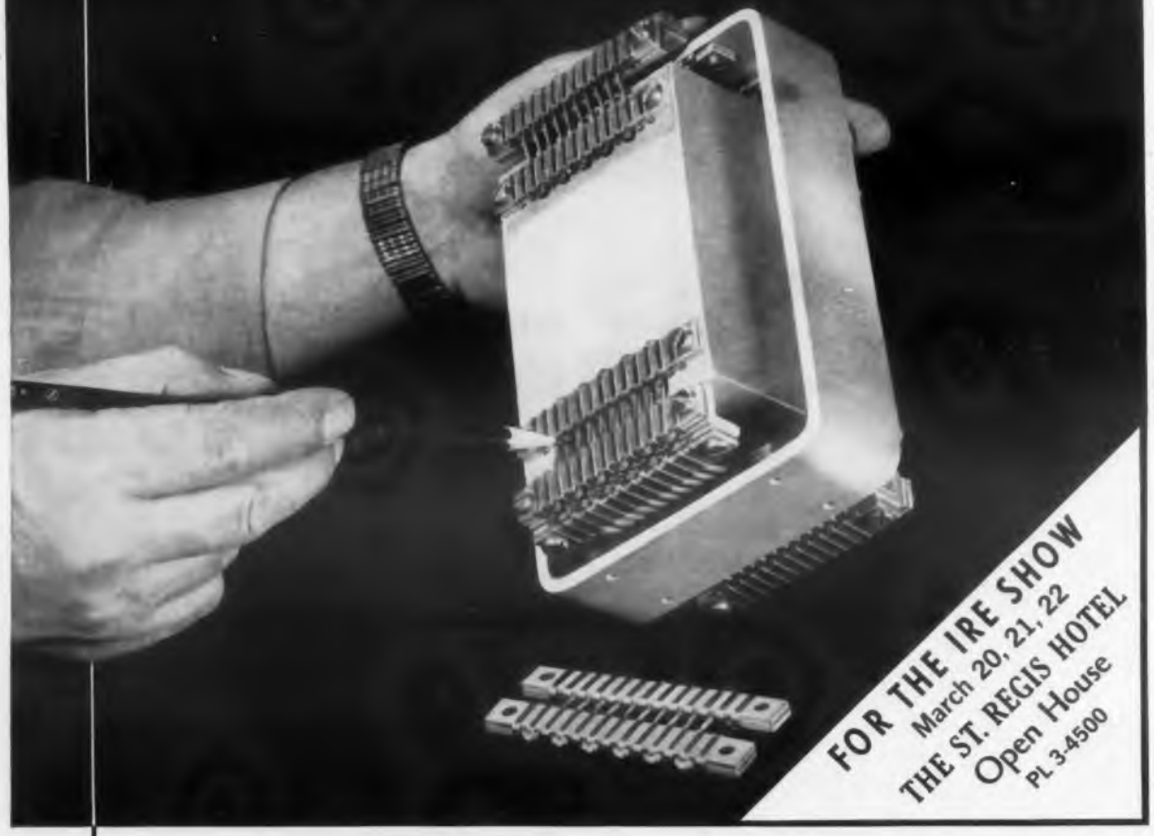
From Aeroflex Laboratories—a major development in the control of vibration and shock—the all new field-proven Cable Isolation System.



FOR THE IRE SHOW
March 20, 21, 22
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NOW YOU CAN:

- Isolate your equipment against shock, vibration and noise, or any combination thereof—even in the presence of constant or long term "G" loading.
- Have three dimensional, all attitude isolation.
- Tune your isolation system in the field.
- Have a vibration control system that does not bottom out under heavy "G" loading and functions in a wide variety of environmental conditions including a temperature range of −100°F to +1000°F.

For information on how an Aeroflex Cable Isolation System can be used to solve your vibration and shock problems, write today to Dept. BR-1.

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AEROFLEX LABORATORIES

DIVISION

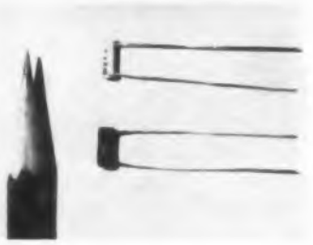
34-06 SKILLMAN AVENUE • LONG ISLAND CITY 1, N.Y.

CIRCLE 94 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Ceramic Capacitor 576

In small size



These miniature ceramic capacitors combine small size, a wide range of capacitances, and high electrical quality. Style 374, enamel-coated, is 0.320 in. long and 0.125 in. in diameter; style 375 is a phenolic-coated capacitor 0.320 in. long by 0.140 in. in diameter. A wide range of dielectrics is available. Capacitance is 2 pf to 56 pf. The unit operates at 100 wvdc to 125 C, and 200 wvdc to 85 C.

Erie Resistor Corp., Dept. ED, 644 W. 12th St., Erie, Pa.

Availability: *Sample quantities only.*

See at Show Booth 3210-12.

Industrial Electrometer 563

Vibrating-capacitor type

Model 33C is a vibrating capacitor electrometer designed for industrial applications and routine laboratory measurement. Current measurements can be made down to 10^{-15} amp. The separate converter unit, connected with an 8-ft cable, is suited for use with ionization chambers. A built-in 90-v polarizing supply is provided. Voltage is measured in 5 ranges from 10 mv to 1 v; resistance, to 10^{10} ohms. Zero stability is ±100 μv for a 12-hr period.

Electronic Instruments Ltd., Herman H. Sticht Co., Inc., Dept. ED, 27 Park Place, New York, N.Y.

P&A: *$1,296 to $1,496; 3-day delivery.*

See at Show Booth 3236.

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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

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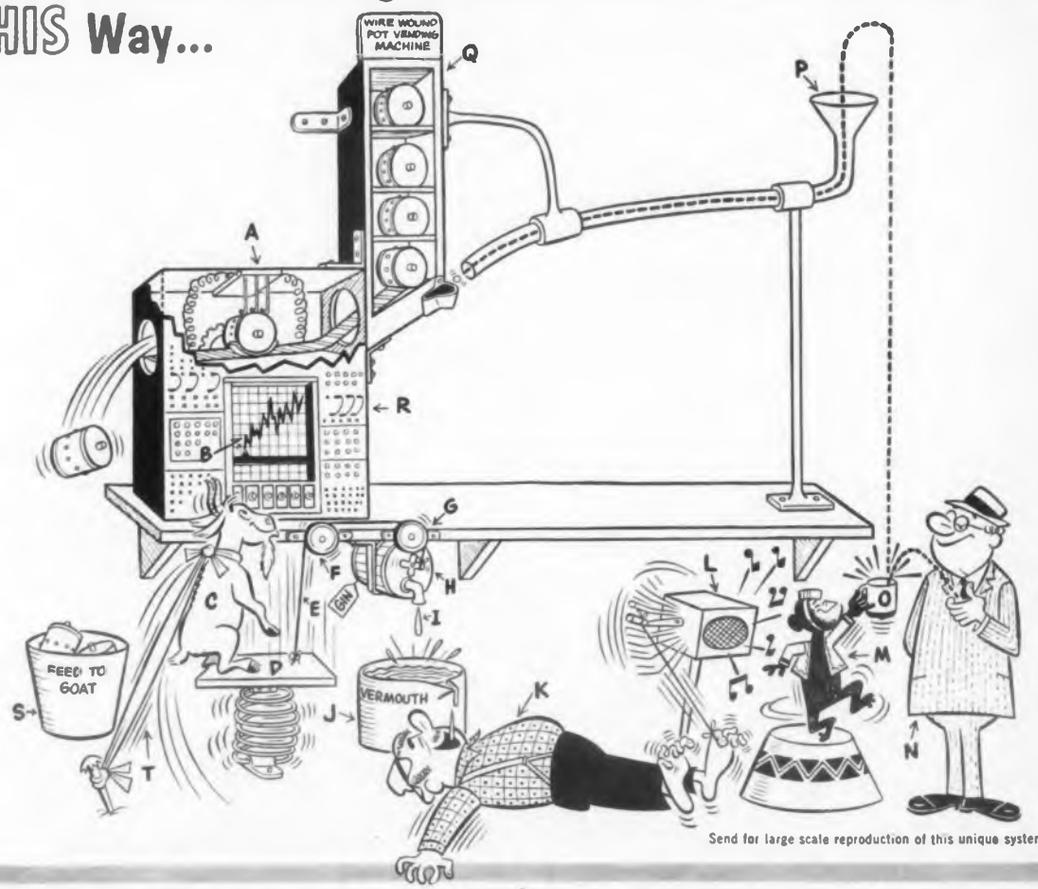
COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 95 ON READER-SERVICE CARD

The Few Engineers Who Don't Know About C.I.C. Film Pots Might Solve "Short-Life" Pot Problems THIS Way...



Send for large scale reproduction of this unique system.

Wire-wound pot (**A**) in analog computer wears down. Vibration of X-Y Recorder Pen, trying to follow resultant noise jiggles, creates erratic pattern (**B**). Mountain goat (**C**) thinks pattern looks like old mountain homestead, leaps on platform (**D**) in attempt to reach home. Platform mounted on coil spring bounces, causes string (**E**) to pull back on pulleys (**F** and **G**). String turns spring-action faucet (**H**) which releases gin (**I**). Gin pours into vermouth vat (**J**) automatically mixing 8 to 1 Martini (how dry can you get?) raising level which forces excess to flow into mouth of happily reclining organ-grinder (**K**). Martini mixture's potency causes grinder's toes to curl, thereby setting organ (**L**) into operation. Conditioned monkey (**M**) hears music, proceeds to dance, impelling bystander (**N**) to toss coin into monkey's tin cup (**O**). Rubber bottom of tin cup bounces coin into funnel-tube (**P**). Coin is carried through tube to automated Wire-Wound Pot Vending Machine (**Q**) and releases new wire-wound pot, which rolls into position on miniature railroad tracks (see cutaway of computer—**R**) and bounces worn-out wire-wound pot into container (**S**). X-Y Recorder resumes normal pattern, goat (tethered with old inner tube—**T**), jumps off platform, starts feeding on worn-out pots, while waiting for new pot to wear down—which can happen before you can mumble "potentiometer" backwards.

BUT THE BEST WAY YET...

Use **C.I.C.** Precision Conductive Film Potentiometers For Proven* Multi-Million Cycle Life!

*Ask us for list of missiles and aircraft currently using C.I.C. Film Potentiometers.

...and Here Are a Few Additional Features:

- INFINITE RESOLUTION
- INHERENT RELIABILITY
- PRECISION LINEARITY
- LOW OPERATIONAL NOISE
- VIDEO FREQUENCY OPERATION

FIRST IN FILM POTS

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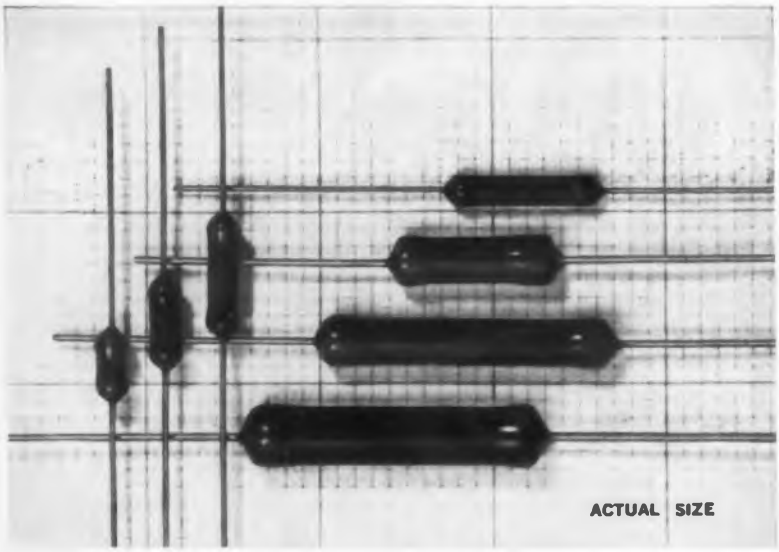
CIRCLE 96 ON READER-SERVICE CARD



THESE "WIRE-WOUNDS" ARE CIRCUIT SHRINKERS . . . . . *newly*

expanded line lets AXIOHM® power resistors go into smaller circuits!

Ward Leonard AXIOHM power resistors are now available in *seven* sizes – down to 2 watts, up to 12.5.

They're ideal for miniaturization in printed-circuits, industrial instrumentation and automation circuitry. But they're recommended for *any* electrical or electronic application where the highest stability and maximum overload capacity are required.

The seven AXIOHM sizes come in a complete range of resistance values (see table) from 0.1 to as high as 75,000 ohms. Naturally, they feature the qualities Ward Leonard has made famous in power resistors:

Vitrohm vitreous enamel; Ward Leonard's specially made ceramic core; specially selected and matched resistance wire; and strong, permanent, low-resistance, spot-welded, lead-to-end-cap junctions. O.9

SIZES AND RATINGS

Rating (in watts)	Type	Resistances (ohms)		Dimensions (inches)	
		Min.	Max.	Length*	Diam.
2	2X	0.1	5,000	3/8	3/16
3	3X	0.1	10,000	1/2	3/16
4	4X	0.1	15,000	11/16	3/16
5	5XM	0.1	20,000	13/16	3/16
7	7X	0.1	25,000	1	3/16
10	10XM	0.1	50,000	1 3/4	3/16
12.5	12.5X	0.1	75,000	1 3/4	3/8

*Less leads.

Get complete details in Supplement C to Catalog 15. Write for your copy and a list of stocking distributors today. Ward Leonard Electric Co., South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)

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NEW PRODUCTS AT THE IRE SHOW

Crimp Contact 564

Accepts 18 to 30 wire

A crimp-type contact, the Varilok will accept all wire sizes from 18 gage to 30 gage. It is said to offer easier and faster production, and positive locking of contacts when inserted into connector castings. Contacts are available loose, for hand crimping, and in reel form for power crimping. Hand and power tools, an insertion tool, and a checking gage are available.

Elco Corp., Dept. ED, M St. below Erie Ave., Philadelphia 24, Pa.

See at Show Booth 1420-22.

Epoxy Resin 602

Self-extinguishing epoxy casting resin Stycast 1223 is suited for potting components and systems requiring fire-retardant capabilities. Low viscosity and room-temperature cure cycle are compatible with encapsulation requirements of temperature-sensitive modules.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

P&A: $0.85 to $1.10 per lb; from stock.

See at Show Booth 3823.

Tandem Receptacle 568

For circuit boards

Designed for ground-support equipment, series 600-7 tandem printed-circuit connectors combine four groups of receptacles in a single 8.63-in. long molding. Two sets of 38 and 32 contacts are separated by an integral center barrier. Either two or four circuit boards can be inserted. Contacts are spring temper phosphor bronze with gold over silver plate. Body material is diallyl phthalate.

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

See at Show Booth 2307-09.

New Miniature

VARIABLE INDUCTOR

FOR VERTICAL OR HORIZONTAL MOUNTING IN PRINTED CIRCUIT BOARDS

This new, ultra tiny Variable Inductor, with amazing subminiature characteristics, has stable inductance at extreme temperature variations and high reliability, along with light-weight and miniature size features.

- **INDUCTANCE RANGE:** 0.10 to 4700 μH
- **INDUCTANCE ADJUSTABLE:** ±20%
- **ENVIRONMENTAL:** Encapsulated in epoxy resin for protection against climatic and mechanical conditions.

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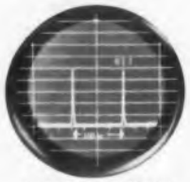
CIRCLE 98 ON READER-SERVICE CARD
CIRCLE 99 ON READER-SERVICE CARD ➤

POLARAD VISUAL MICROWAVE ANALYSIS 10 to 44,000 mc

MODEL TSA
DIRECT-READING SPECTRUM ANALYZER

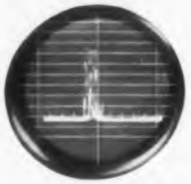
10 to 44,000 mc with five plug-in tuning units

0.4 μSEC PULSE



STANDARD SIGNAL

DECODED MULTIPULSE SPECTRUM

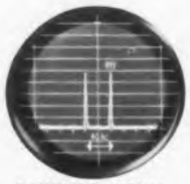


INCIDENTAL FM ANALYSIS

MODEL TSA-S
COMBINATION SYNCHROSCOPE-SPECTRUM ANALYZER

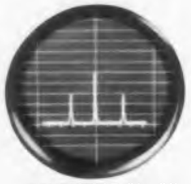
10 to 44,000 mc with five plug-in tuning units

10 μSEC PULSE



STANDARD SIGNAL

ANALYSIS AS A FUNCTION OF TIME

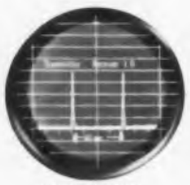


IDENTIFICATION OF AMPLITUDE MODULATION

MODEL TSA-W
WIDE DISPERSION SPECTRUM ANALYZER

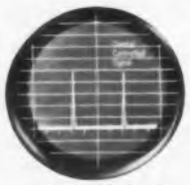
10 to 40,880 mc with five plug-in tuning units—80 mc dispersion

0.1 μSEC PULSE



AFC ACTION

LOG DISPLAY

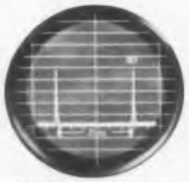


SIGNAL STABILITY MEASUREMENT

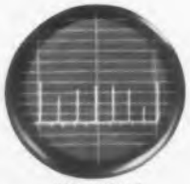
MODEL SA-84
UNIVERSAL SPECTRUM ANALYZER

10 to 40,880 mc in one integrated self contained unit

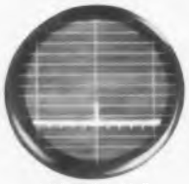
4 μSEC PULSE



STANDARD SIGNAL



FM SIGNAL ANALYSIS

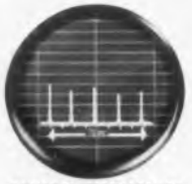


LEAKAGE AND RADIATION MEASUREMENT

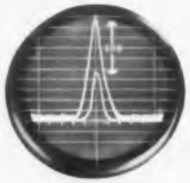
MODEL SA-84W
WIDE DISPERSION UNIVERSAL SPECTRUM ANALYZER

10 to 44,000 mc in one integrated self-contained unit—features over 80 mc dispersion

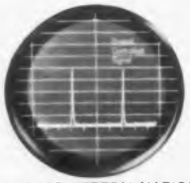
0.08 μSEC PULSE



CRYSTAL HARMONICS



PRECISION ATTENUATION



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Please send me information and specifications on:

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- ☐ Model TSA-S
- ☐ Model TSA-W
- ☐ Model SA-84
- ☐ Model SA-84W
- ☐ Model SA-84W Universal
- ☐ Model R Receiver (see reverse side of this page)

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Company_____

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A MULTI-PURPOSE PRECISION TEST INSTRUMENT

DETECTS AND MEASURES:

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- Field intensity
- R-F power
- R-F noise figure
- Leakage and interference
- Filter characteristics
- Bandwidth of microwave cavities
- Attenuation
- Insertion gain and loss
- Relative power differences between fundamental signal and harmonics

Now — one basic instrument serves for general communications as well as for detection and complete quantitative analysis of microwave energy.

Polarad Model R Receiver accepts all microwave signals: AM, FM, CW, MCW and pulse. Power and frequency are read directly on front panel indicators.

It permits all standard forms of signal monitoring: special output jacks for audio and video; trigger output to reproduce pulse width and repetition rate; recorder output to transcribe signals through commercial recording equipment.

Model R is simple to operate, extremely sensitive, highly accurate, and is designed for quick, easy inspection and servicing. It provides AFC, AGC, and continuous UNI-DIAL tuning. Nine interchangeable tuning units cover the entire frequency range. A tenth tuning unit is available for antenna pattern measurements from 2000 to 75,000 mc.

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POLARAD ELECTRONICS CORP.
43-20 34th St., Long Island City 1, N.Y.

POLARAD

MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements"

DON'T MISS POLARAD AT THE IRE SHOW
Booths 3301—3307

POLARAD ELECTRONICS CORPORATION

FREE LIFETIME SERVICE

Representatives in principal cities

Glass Capacitor 607

Range to 5,100 pf

The CYF-20 extends the capacitance range of fusion-sealed glass capacitors to 5,100 pf. The moisture-resistant unit meets or exceeds military performance requirements. Used in high-reliability systems, the capacitors withstand high levels of radiation. Temperature coefficient is 140 ±25 ppm per deg C over the operating range of —55 to 125 C.

Corning Electronic Components, Corning Glass Works, Dept. ED, Bradford, Pa.

See at Show Booth 2627-33.

Molding Powders 604

Epoxy compression molding powders, stable to 400 F when molded, are available in four resistivities from 6 to 7 ohms per cm to 60 to 130 K per cm.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass. *Availability: From stock.*

See at Show Booth 3823.

AC Motors 565

In G frame

The G frame series of ac motors range from 1/400 to 1 4 hp. Windings are induction or hysteresis synchronous, 1- or 3-phase. Motors are self-cooled or totally enclosed, finned or plain. Ambient temperature range is —55 to 125 C. Units operate on 60 cps, and are offered with or without mounting base.

Air Marine Motors, Inc., Dept. ED, Bayview Ave., Amityville, N.Y.

See at Show Booth 2601.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

◀ CIRCLE 99 ON READER-SERVICE CARD

IMMEDIATE DELIVERY
PRODUCTION QUANTITIES
MILITARY TYPE
1N1731·1N1733·1N1734

VERY HIGH VOLTAGE CARTRIDGE RECTIFIERS to MIL-S-19500/142 (Sig C)

NO VOLTAGE DERATING —55 to 150°C • EXTREMELY RUGGED
NON-METALLIC "COLD" CASE • WIRE-IN LEADS • PRINTED CIRCUITS

These Mil type cartridge rectifiers are available *now* . . . from PSI. Phone, wire or write any PSI sales office for prices and delivery schedules.

Ask about other rectifiers in this series to 30,000v PIV . . . new high current "Super Fuse Clip" rectifiers and the new PSI Micro-Rectifier line.

A new 24-page brochure, "Special Assemblies", describes all PSI cartridge rectifiers in full detail. Your free copy available now!

PSI

Pacific Semiconductors, Inc.

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.

12955 CHADRON AVENUE, HAWTHORNE, CALIFORNIA

CIRCLE 100 ON READER-SERVICE CARD

NEW PRODUCTS
AT THE IRE SHOW

Coil Winder 556

For laboratory coils

A toroidal laboratory coil winding machine, the model LS-1 has interchangeable winding heads. It is capable of performing either random winding or accurate layer winding. Wire size may be No. 20 to No. 46; maximum winding speed is 1,000 rpm. Coils accommodated range from 0.065 in. inside diameter to 5-1/2 in. OD. The machine allows reorientation of a coil during the winding process. A mechanical counter is used, coupled with a photoelectric pickup.

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

See at Show Booth 4004-05.

Plastic Laminates 557

Are flame-retardant

Flame-retardant plastic laminates are made with paper or glass base, and epoxy or phenolic resin binder. Grades FR-2, 3, and 4 are available in sheets or strips, either plain or copper-clad. They have extremely high mechanical strength at room temperature, and good dielectric loss and breakdown qualities under both dry and humid conditions.

Synthane Corp., Dept. ED, Oaks, Pa.

See at Show Booth 4421-23.

Epoxy Resin 615

Pot life is 7 days

XR-5029 is a one-part, fully flexible, Class F epoxy resin system resistant to stresses of mechanical and thermal shock and abrasion. Its Shore D hardness is 18 and it exerts little, if any, pressure on imbedded parts. Pot life is 7 days at 65 C; 4 days at 95 C and cures in 8 to 16 hr at 150 C.

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

Availability: 14 days.

See at Show Booth 3936.

PRODUCTION QUANTITY TI SIL

MAXIMUM 12 nsec t_{on}

MAXIMUM 40 nsec t_{off}

$V_{CE(sat)}$ PRACTICALLY INSENSITIVE TO TEMPERATURE... CONSTANT 1 VOLT FROM −55 to +170°C

The fastest silicon switcher in the industry! Design today with Texas Instruments new 2N743 and 2N744 silicon epitaxial transistors and get *two-times faster switching than possible from any other commercially available silicon transistor!* This outstanding new epitaxial series gives you an optimum combination of ultra-fast switching times, temperature-stable R_{CS}, very low collector capacitance, and high f_T, to make the 2N743 and 2N744 *ideal for application in current ranges from 1 to 100 ma.*

Utilize the low R_{CS}/high current characteristics of these new epitaxial units to *replace large size medium-power transistors* and cut your overall switching times as much as two-thirds. Cut cost and reduce the complexity of your NOR logic designs with the new TI 2N743 series — these new epitaxial units give you a guaranteed I_{CEX} of 30 μa at a V_{CE} of 10 volts and V_{BE} of 0.35 volts to eliminate additional circuits previously required for an I_{B2} turn-off source in your computing systems.

Apply the new 2N743 and 2N744 to your designs today and get *guaranteed d-c betas at three current levels.* The 2N744 gives you a guaranteed h_{FE} of 20 at 1 and 100 ma and a 10-ma beta spread of 40 to 120, while the 2N743 features a minimum h_{FE} of 10 at 1 and 100 ma, and 60 maximum at 100 ma.

New TI 2N743 and 2N744 silicon epitaxial transistors are immediately available from distributor stocks or in mass production quantities at prices competitive with conventional silicon mesa and micro-alloy transistors.

Compare the 2N743 and 2N744 with conventional transistors!

Parameter	Approx. Test Conditions	TI 2N743	TI 2N744	2N834	2N706B	2N708
T_s(nsec)	$I_{B(1)} = -I_{B(2)} = I_C = 10$ ma	14	18	25	25	25
t_{on}(nsec)	$I_{B(1)} = 3$ ma, $I_{B(2)} = -1$ ma, $I_C = 10$ ma	11 (TYP)	10 (TYP)	35	40	35
t_{off}(nsec)		22 (TYP)	25 (TYP)	75	75	75
t_{on}(nsec)	$I_{B(1)} = 40$ ma, $I_{B(2)} = -20$ ma, $I_C = 100$ ma	12 6 (TYP)	12 6 (TYP)	NO SPEC	NO SPEC	NO SPEC
t_{off}(nsec)		40 18 (TYP)	45 23 (TYP)	NO SPEC	NO SPEC	NO SPEC
$V_{CE(sat)}$	$I_B = 1$ ma, $I_C = 10$ ma, $T_A = +170$°C	0.35 v	0.35 v	No High Temp. Guarantee (0.19 v MAX. @ 25°C)	No High Temp. Guarantee (0.4 v MAX. @ 25°C)	No High Temp. Guarantee (0.4 v MAX. @ 25°C)
I_{CEX}	$V_{CE} = 10$ v, $V_{BE} = +0.35$ v, $T_A = 100$°C	30 μa	30 μa	No Guarantee	No Guarantee	10μa (MAX.) @$V_{BE} = +0.25$, $V_{CE} = 20$ v, $T_A = +125$°C

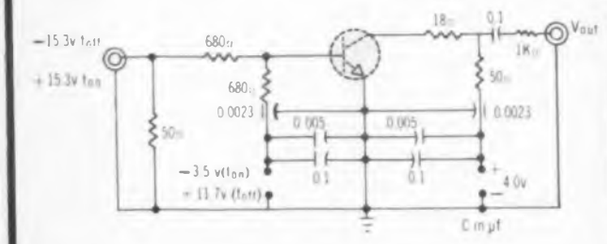
NOTE: All limits are max. unless otherwise noted.

ICON EPITAXIAL TRANSISTORS

@100 ma

MAKE YOUR OWN COMPARISON FROM THESE TYPICAL CIRCUITS

50-ma SWITCHING CIRCUIT



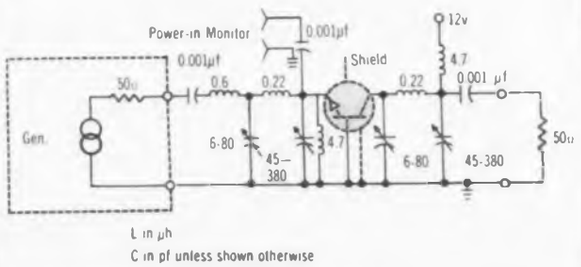
USE THE TI 2N743 TO SWITCH IN 1/3 THE TIME!

2N706	2N743
t_{on} = 10 nsecs	t_{on} = 7 nsecs
t_{off} = 50 nsecs	t_{off} = 15 nsecs
60	22

USE THE TI 2N743 TO DOUBLE POWER OUTPUT AND EFFICIENCY!

2N706	2N743
Pout = 225 mw	Pout = 500 mw
Eff = 32%	Eff = 65%
P.G. = 6 db	P.G. = 6 db

70-mc POWER AMPLIFIER



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DEPTH · DELIVERY · DEPENDABILITY

INDUSTRY'S BROADEST LINE OF TRANSISTORS
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TEXAS INSTRUMENTS
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Epitaxial Transistors 612

Silicon and germanium

Silicon and germanium epitaxial transistors are available in switch and amplifier types. They are electrically equivalent to micro-alloy types, but retain the high power capability and high reliability facets normally associated with mesa transistors.

Motorola Semiconductor Products Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

See at Show Booth 1117-18.

Frequency Error Multiplier 594

Is transistorized

Transistorized frequency error multiplier model 137B is designed to calibrate and check the stability of very stable oscillators. It multiplies the frequency difference between a standard and test oscillator by as much as 10,000, allowing measurement of relative frequency to within 1 part in 10^{12} in a matter of seconds.

Hermes Electronics Co., Dept. ED, 75 Cambridge Parkway, Cambridge 42, Mass.

***Availability:** 120 days.*

See at Show Booth 3038-39.

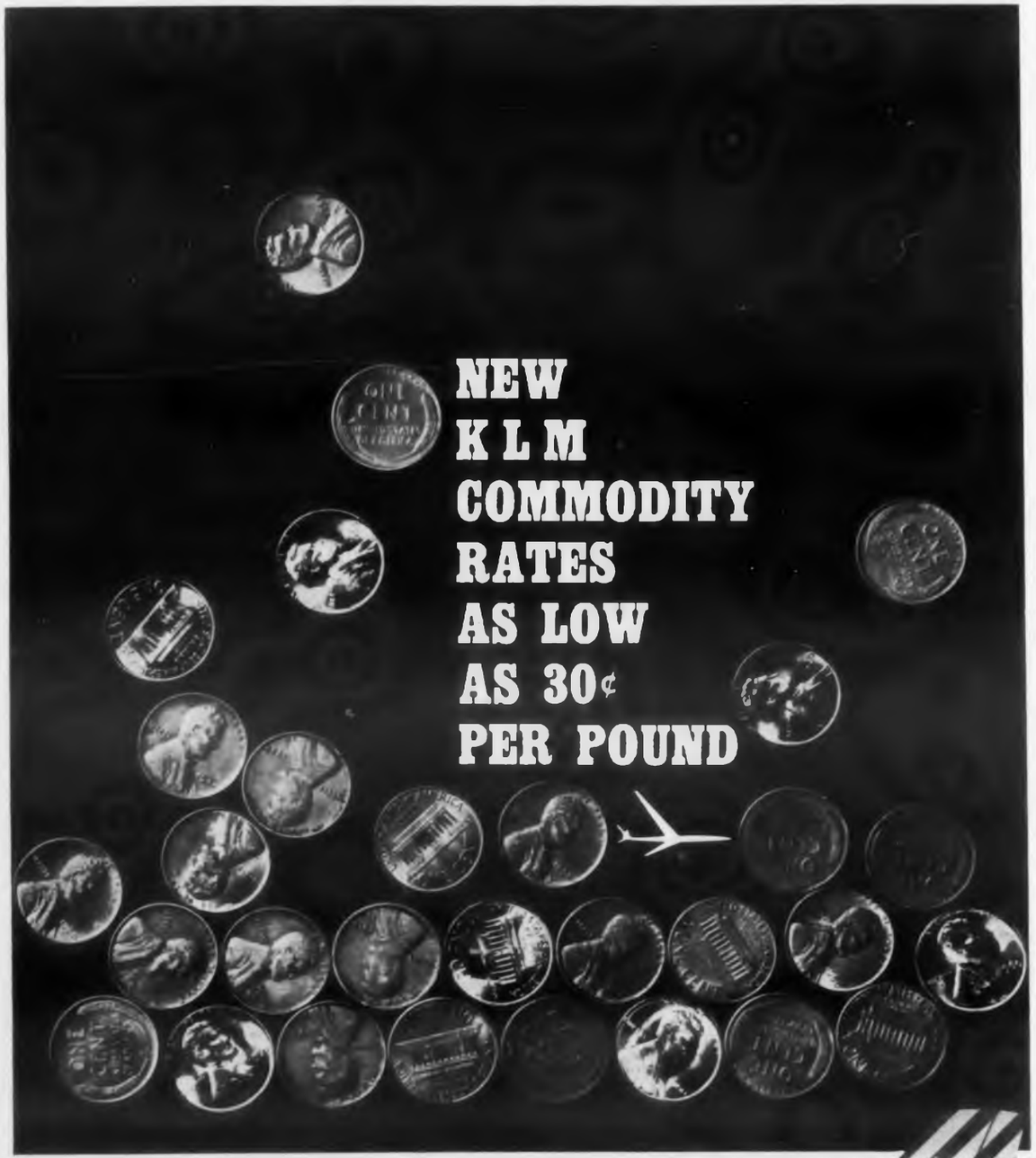
Cathode-Ray Tubes 558

With safety panel

A safety panel bonded to the face plate of these cathode-ray tubes is said to reduce by 50% the number of reflecting surfaces, improve image visibility, increase tube strength, and give built-in face protection. The shield is used on special-purpose cathode-ray tubes ranging from 3 to 27 in. It can be surface-treated against reflection; neutral density glass is used to increase contrast. Tubes can be made with scales or other reference marks printed on the inner surface of the shield.

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

See at Show Booth 2322-32 & 2415-25.



Now only 30¢ speeds your shipment to Europe! Virtually the same rate as surface freight keeps your inventory low—buys you overnight service, daily freighter flights, famous KLM care. Charter a special KLM freighter and you pay even less! New low rates also to the Near East, Middle East, Far East and Africa. Call your cargo agent or nearest KLM office. KLM, 609 Fifth Ave., New York, N.Y.

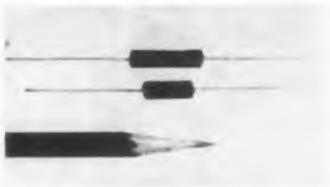
THE WORLD OVER KLM ROYAL DUTCH AIRLINES

CIRCLE 103 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Ceramic Capacitors 613

High temperature types



Style 312 and 313 ceramic capacitors have operating temperatures to +150 C. They exceed the specifications of MIL-C-20C and MIL-C-11015. Capacitance is from 0.5 to 1,000 pf, working voltage is 500 v dc. Body size for the 312 is 0.562 in. long x 0.25 in. in diameter; for the 313 it is 0.812 in. long x 0.25 in. in diameter.

Erie Resistor Corp., Dept. ED, 644 W. 12th St., Erie, Pa.

Availability: *In sample quantities.*

See at Show Booth 3210-12.

Resistance Wire 600

Improved Karma resistance wire has greater long term stability and 20% greater tensile strength than formerly. Negligible change in temperature coefficient after winding and processing and extremely high linearity are claimed.

Driver-Harris Co., Dept. ED, Harrison, N. J.

See at Show Booth 4517-19.

Molded Screws 614

Thread size from 0-80 to 1/4-20

These Delrin screws are molded of thermoplastic materials to precise tolerances. They have excellent electrical insulation properties, high tensile strength, rigidity and resistance to deformation. Resistance to creep, above 150 F is claimed to be superior. Thread sizes range from 0-80 to 1/4-20.

Gries Reproducer Corp., Dept. ED, 125 Beechwood Ave., New Rochelle, N.Y.

See at Show Booth 4030.

Have you sent us your subscription renewal form?

CLEAN • CLASSIC

UNCLUTTERED

Here are meters, free of frills and tinsel, executed in handsome good-taste with sensible proportions to fit and enhance any panel board.

Besides their aesthetic qualities, BECKMAN® Panel Meters do an unbeatable metering job. They are of all-metal construction with steel movement enclosure, and are unaffected by magnetic panel materials or stray RF. They are dust-free and sealed to 2.5" Hg. The 4"x6" model shown has a 4.7" long scale arc for clear, shadowless readability. BECKMAN Panel Meters have a standard mounting configuration, and are interchangeable with other meters of like dimensions. Special scale plates and bezel colors are available.

Best news of all...30 day delivery! Drop us a line or contact your nearest Helipot representative for details on the BECKMAN line, AC and DC Voltmeters, Ammeters, Milliammeters, Microammeters or Expanded Scale Meters.

Beckman® / Helipot®

POTS : MOTORS : METERS

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California

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Servomotor 842

Smallest size 8 is 0.84-in. long

Said to be the smallest size 8, 115 v servomotor sold, the Model 8 SM 461 is 0.840-in. long, weighs 1.1 oz. A precision-control component, it has a rotor inertia of 0.18 gm-cm² coupled with a stall torque of 0.22 oz-in., providing acceleration at stall of 86,500 rad per sec²—three times greater than any equivalent unit, asserts the company. Using stainless-steel and Teflon as insulation throughout permits an ambient temperature rating of −55° to +130° C. Maximum unit operating temperature is 200° C.

Helipot Div. of Beckman Instruments, Dept. ED, Fullerton, Calif.

Precision Potentiometer 843

Has matching 7/8-in. turns-counting dial

Model 7216, 7/8-in. diam. precision pot has standard resistance of 10 to 125,000 ohms and ±0.5 per cent standard linearity. A 7/8-in. diam. 2600 series turns-counting dial is also offered for users desiring a precision pot-and-dial package, counts full turns and hundredths. The model 7216 is a ten-turn potentiometer with 1/4-in. diam. shaft and 3/8-32 bushing mount. It is rated at two w at 25° C with a minimum operating temperature of −55° C. The pot has a molded diallylpthalate housing, bronze front lid and stainless-steel shaft.

Helipot Div. of Beckman Instruments, Dept. ED, Fullerton, Calif.

Panel Meters 844

Built to MIL specs

Built to exact conformity with MIL-M-10304A, 4-1/2-in. round, sealed panel meters have plug-in terminal construction, easy disassembly and good linearity. All-metal construction and modern appearance make the 92 standard models suitable for a variety of applications. Available as volt-meters, ammeters, milliammeters and microammeters.

Helipot Div. of Beckman Instruments, Dept. ED, Fullerton, Calif.

Availability: 30 days.

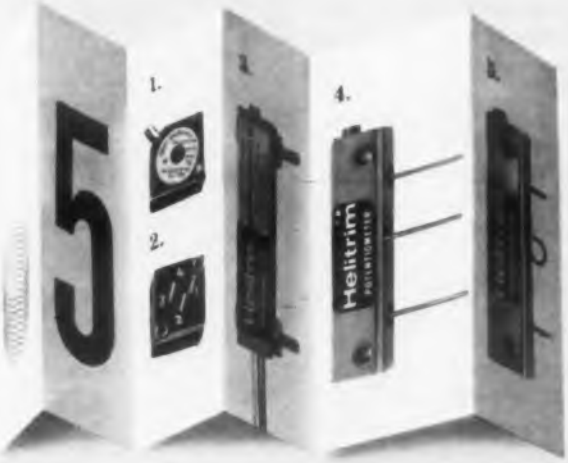
FIVE NEW TRIMMERS FROM HELIPOT! Picking a trimming pot for a troublesome application? Helipot says, "Take *five*, they're small"... and each Helitrim® trimming potentiometer is designed to solve a particular predicament!

1. Take the new Model 70, low-priced ½" square trimmer that offers Teflon leads, humidity resistance, and slip clutch stop as *standard!* (With center tap as spec!)
2. Take the new Model 71, another ½" square trimming pot that's outfitted with all-metal housing and gold-plated pins to pamper printed circuits.
3. Take the stubbornly stable Model 50 with resistances of 50 to 50K ohms. Its cermet resistance element scoffs at environmental stress and strain... even at 200°C!
4. Take the new Model 53. Cermet construction and essentially same electrical specs as the nifty 50... but with pins.
5. Take the Model 54, another 200°C cermet unit, with solder lug terminals!

When you're at the end of your rope, tie your trimming requirements to this line... it's a good one. And remember: whatever your potentiometer needs—trimmers, single-turns, multi-turns, dials or delay lines—call Helipot first, *fast* and always.

More details are available in our new catalog.

Ask for it.



Beckman® / Helipot®

POTS : MOTORS : METERS

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California

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CIRCLE 845 ON READER-SERVICE CARD

NEW PRODUCTS

AT THE IRE SHOW

Synthetic Glass-Mica 560

Withstands 1,200 F

Formed of glass and synthetic mica, Supramica 620 "BB" will operate at 1,200 F. The material will form a true hermetic seal, and mold accurately to intricate shapes. Thermal expansion coefficient is close to that of common insert metals, including titanium. It is impervious to humidity, oil, water, and organic solvents. Dielectric strength is 270 v per mil; arc resistance is 300 sec. Loss factor is 0.020 at 1 mc.

Mycalex Corp. of America, Dept. ED, 125 Clifton Blvd., Clifton, N.J.

See at Show Booth 2517-19.

Vinyl Tape 596

Pressure sensitive

Electrical tape No. 66 is a pressure-sensitive vinyl plastic tape designed for continuous operation at Class A conditions. It is a black, polyvinyl chloride film coated on one side with an acrylic polymer adhesive. The adhesive resists heat, oil, solvents and plasticizers. Specifications are: thickness, 11 mils; tensile strength, 35 lb per in. of width; electric strength, 11,000 v; insulation resistance, 1 x 10^6 meg.

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

Availability: *30 days.*

See at Show Booth 3936.

Push-Button Switch 587

Is lighted

Lighted push-button switch C6-137 is a 4pdt, solenoid-held unit. Electrical rating for the switch is: 5 amp at 125/250 v ac; 4 amp at 30 v dc resistive; 2.5 amp at 30 v dc inductive. Solenoid current is rated 0.038 amp at 18 v dc or 0.060 amp at 30 v dc.

Controls Company of America, Control Switch Div., Dept. ED, 1420 Delmar Drive, Folcroft, Pa.

See at Show Booth 1727-31.

a New and important P&B relay . . .

KHP SERIES SHOWN ACTUAL SIZE

having rare longevity

This small, 4-pole relay has the happy faculty of maintaining its original operating tolerances over an exceptionally long life. Example: tests (by customers!) show this relay has variations in electrical characteristics of less than 5% after more than 100 million operations.

But that's far from all. This is a *small* relay . . . about a one inch cube. This relay is easy to install using the conveniently spaced solder lugs or a socket. Thus you save time and production costs. This relay is versatile . . . its 4PDT contacts will switch loads from dry circuit up to 3 amperes. This relay—well, why not order samples and see for yourself! Order today from your P&B representative or call us at Fulton 5-5251, in Princeton, Indiana.

KHP SERIES SPECIFICATIONS

CONTACTS:
Arrangement: 4 Form C, 2 Form Z.
Material: 3/32" dia. Silver standard. Silver cadmium oxide and gold alloy available.
Rating: 3 amps @ 30 volts DC or 115 volts AC resistive for 100,000 operations.

COILS:
Resistance: 11,000 ohms max.
Temperature: Operating Ambient: —45°C. to +70°C.
Power: 0.5 watts min operate @ 25°C. 0.9 watts nom. @ 25°C. 2.0 watts max. @ 25°C.

TIMING VALUES:

Nominal Voltage @ 25°C.	Max. Values
Pull-in time	15 ms
Drop-out time	5 ms

INSULATION RESISTANCE: 1500 megohms min.
DIELECTRIC STRENGTH:
500 Volts RMS 60 cycles between contacts.
1000 Volts RMS 60 cycles between other elements.
MECH. LIFE: In excess of 100 million cycles.
SOCKET: Solder lug or printed circuit terminals. Available as accessory.
DUST COVER: Standard.
TERMINALS: Solder lug and taper tab.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

Power Supply 591

Solid state

Solid state power supply model TP3-100 measures 6-1/2 x 5 x 5 in. Output is −28 v dc, adjustable ±1.5 v at 1.5 amp; 9 v dc at 0.050 amp. Ripple is 0.010 v rms max; response time is 0.05 msec.

Diehl Manufacturing Co., Dept. ED, Somerville, N.J.

See at Show Booth 1913-15.

Toggle Actuator 588

Has three positions

Model A3-98-T7 is a 4pdt toggle actuator with 3 positions: off, maintained and momentary. Rating is 6 amp at 125/250 v ac; 2.5 amp at 30 v dc inductive; 6 amp at 30 v dc resistive.

Controls Company of America, Control Switch Div., Dept. ED, 1420 Delmar Drive, Folcroft, Pa.

See at Show Booth 1727-31.

Power Line Filters 595

Have lower losses

Lower voltage drop, reactive current and lighter weight that can be found in preceding power line filters are claimed by the manufacturer. Greatly increased attenuation ranges are the result of several years of R&D.

McMillan Industrial Corp., Dept. ED, Ipswich, Mass.

See at Show Booth 3223.

Servo Amplifier 590

Vacuum tube type

Servo amplifier model VA075-OA-300 has an output of 75 w nominal, with a gain of 1,000 v per v. Input impedance is 500 K and noise is 100 mv max, input shorted. Phase shift is less than 2 deg at carrier frequency and less than 10 deg lag of envelope at 1/3 carrier frequency.

Diehl Manufacturing Co., Dept. ED, Somerville, N.J.

Availability: 90 days.

See at Show Booth 1913-15.

CIRCLE 106 ON READER-SERVICE CARD

Need High Purity fused quartz components?

General Electric offers most complete line...plus prompt delivery!

Here's good news for anyone in the semi-conductor field making silicon and germanium and using ordinary crucibles or thin wall tubing for zone refining. General Electric offers the industry's most complete line of semi-conductor components of extremely High Purity Fused quartz.

Stock items available. General Electric now has facilities devoted exclusively to making fused quartz products—and offers a wide range of stock items for *immediate* delivery.

Free engineering assistance—with no obligation on your part.

New! 40-page brochure includes full technical data and prices. It's yours for the asking. Write the "Midwestern" address below.

G-E DISTRICT SALES OFFICES

New England: 50 Industrial Place
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Phone: DEcatur 2-6200

Eastern: 744 Broad Street
Newark 2, New Jersey
Phone: MArket 3-3953

Midwestern: Euclid Ave. & Campbell Rd.
Dept. ED-31, Willoughby, Ohio
Phone: WHitehall 2-9300

Western: 2747 South Malt Avenue
Los Angeles 22, California
Phone: RAymond 3-2541

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 107 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

High-Speed Relay 574

With mercury-wetted contacts

A mercury-wetted contact relay, series V51 is designed to give over a billion reliable operations with complete freedom from contact bounce. Operate time is 3 msec min; release time is about 3 to 3-1/2 msec. Contact and armature assemblies are hermetically sealed in a glass capsule with a hydrogen atmosphere. Switching speed is 100 operations per sec. The relay will switch 250-va loads with a maximum of 5 amp, 500 v. Diameter is 1.105 in., height 3.196-in., weight is 4 oz.

Automatic Electric Co., Dept. ED, Northlake, Ill.

P&A: About $8 to $15 ea; 30 to 45 days.

See at Show Booth 1908-10.

Transparent Encapsulent 610

Silicone resin

Sylgard 182, a silicone resin, cures in place to form a transparent mass having outstanding dielectric properties, good moisture resistance, flexibility and toughness. Curing time is 4 hr at 65 C. The nontoxic material has a hardness of about 40 shores; elongation is about 100%. Tensile strength is 800 to 1,000 psi. Sections may be cut away and refilled for repair.

Dow Corning Corp., Dept. ED, Midland, Mich.

See at Show Booth 4310-12.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

for printed wiring applications

PRECISION

wire-wound resistors

Improved design in Cinema's CE400 resistors offer superior performance characteristics and greater ease of installation in printed-wiring boards. Microminiature in size these precision units are ideal for use in critical applications where space is at an absolute premium.

Encapsulated in epoxy, the meniscus effect of this material is used to excellent advantage at the terminal wires to prevent the resistor from being drawn flush to the printed-wiring board and eliminates the possibility of capillary-effects experienced in soldering and high humidity environments. Performance characteristics as per MIL-R93B and MIL-R-9444. CE400 resistors are available in the following sizes and ratings:

TYPE	WATTAGE RATING	DIA.	LENGTH	MAX RESISTANCE
CE444E	.25	1/4"	5/16"	600K
CE445E	.25	1/4"	1/2"	900K
CE446E	.5	1/4"	3/4"	1.7 Meg
CE447E	.5	3/8"	3/4"	5 Meg.
CE451E	.6	1/2"	5/8"	6.5 Meg.

Also available in axial lead types as CE200 Series. Write for complete technical details to...

CINEMA ENGINEERING
DIVISION AEROVOX CORPORATION
1100 Chestnut, Burbank, California

CIRCLE 108 ON READER-SERVICE CARD

Ceramic Transducers 611

Produce high voltage

Type PZT piezoelectric ceramic transducers can produce up to 4 v per 1 psi of applied mechanical force without any external electrical power supply. Practical operating range is from 0 to 7,000 psi. As mechanical drivers, they deliver a maximum of 0.1 psi per applied volt, or a free displacement of 0.01 µin. per v per in. of field. Maximum applied voltage is about 30,000 v.

Clevite Corp., Clevite Electronic Components Div., Dept. ED, 3405 Perkins Ave., Cleveland 14, Ohio.

See at Show Booth 2622.

Silicon Rectifier 555

Is compact, inexpensive

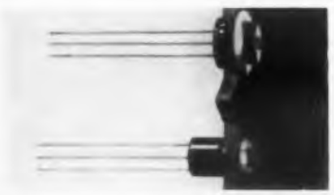
The Power Point silicon bridge rectifier is so compact that it can be installed at the point of use, eliminating long dc power runs. It is available in one-phase and three-phase networks capable of handling from 2 to 7-1/2 kw. Current ratings range from 10 to 25 amp at 45 C, and up to 75 amp in force-cooled applications.

Syntron Co., Semiconductor Div., Dept. ED, Homer City, Pa.

See at Show Booth 2525.

Ultraminiature Trimmers 646

Resistance to 20 K



Ultraminiature trimmers, models 80-3-2 and 80-3-3 are 1/3-in. in diameter and have resistances ranging to 20 K. Specifications are: resistance range, 50 ohms to 20 K; tolerance, ±5%; power rating 1 w at 50 C; shock, 50 g; vibration, 30 g to 2,000 cps; load life, 1,000 hr.

Spectrol Electronics Corp., Dept. ED, 1704 S. Del Mar Ave., San Gabriel, Calif.

See at Show Booth 1907-09.

A PARTIAL LISTING OF INDUSTRY'S **WIDEST LINE!**

VOLTAGE REGULATOR SILICON DIODES

HERMETICALLY SEALED

1584 TYPES AVAILABLE

Ratings and Characteristics at 25°C

Type Number	Nominal Zener Voltage and Typical Dynamic Impedance E_Z(Volts)	@ I_Z(MA)	Z_Z(Ohms) @ I_Z	Type Number	Nominal Zener Voltage and Typical Dynamic Impedance E_Z(Volts)	@ I_Z(MA)	Z_Z(Ohms) @ I_Z
A – 750 Mw Rated Basic Series (5% Closer Tolerance Types Also Available)				**C – 3.5 Watt Rated Basic Series (5% Closer Tolerance Types Also Available)**			
1N1507	3.9	35	14	1N1588	3.9	150	2.6
1N1508	4.7	30	12	1N1589	4.7	125	2.3
1N1509	5.6	26	5.2	1N1590	5.6	110	1.4
1N1510	6.8	22	1.5	1N1591	6.8	100	.58
1N1511	8.2	18	1.5	1N1592	8.2	80	.5
1N1512	10	15	1.8	1N1593	10	70	.7
1N1513	12	12	2.8	1N1594	12	50	1.4
1N1514	15	10	5	1N1595	15	40	3.4
1N1515	18	8	9	1N1596	18	35	6
1N1516	22	6	19	1N1597	22	30	9
1N1517	27	5	50	1N1598	27	25	13
B – 1 Watt Rated Basic Series (5% Closer Tolerance Types Also Available)				**D – 10 Watt Rated Basic Series (5% Closer Tolerance Types Also Available)**			
1N1518	3.9	50	9	1N1599	3.9	500	.84
1N1519	4.7	40	8.5	1N1600	4.7	400	.68
1N1520	5.6	35	5.5	1N1601	5.6	350	.3
1N1521	6.8	30	1.6	1N1602	6.8	300	.2
1N1522	8.2	25	1.1	1N1603	8.2	250	.25
1N1523	10	20	1.5	1N1604	10	200	.55
1N1524	12	15	2.4	1N1605	12	170	.95
1N1525	15	13	5.4	1N1606	15	140	1.5
1N1526	18	10	11	1N1607	18	110	2
1N1527	22	9	18	1N1608	22	90	3
1N1528	27	7	28	1N1609	27	70	4.5

Write for this 6-page folder containing selection data on over 1584 Standard and Special Voltage Tolerance Zener Types. Request SR-260.

SPECIFY THE LEADING LINE . . .
Choose from the most complete zener diode line in the industry . . . Contact your nearest Authorized Industrial Distributor for "off-the-shelf" delivery, or our Industrial Representative in your area.

INTERNATIONAL RECTIFIER

SYMBOL OF QUALITY IN SEMICONDUCTORS

INTERNATIONAL RECTIFIER CORPORATION: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281 • CABLE RECTUSA

NEW YORK CITY: 1640 LEMOINE, FORT LEE, N. J., WINDSOR 7-3311 • SYRACUSE, NEW YORK: 2366 JAMES STREET, HEMPSTEAD 7-8435 • CHICAGO, ILLINOIS: 205 W. WACKER DRIVE, FRANKLIN 2-2466 • CAMBRIDGE, MASS., 17 DUNSTER ST., UNIVERSITY 4-6520 • ARDMORE, PENNSYLVANIA: SUBURBAN SQUARE BLDG., MIDWAY 9-1428 • BERKELEY, MICHIGAN: 3799 COOLIDGE HIGHWAY, LINCOLN 8-1144 • CANADA: 1581 BANK ST., OTTAWA, ONTARIO, REGENT 3-4483

CIRCLE 109 ON READER-SERVICE CARD ➤

BIRD

"Thruline" DIRECT READING Directional RF WATTMETER

MODEL 43

NOW! 2-30 mc
PLUG-IN ELEMENTS

An insertion type instrument used to measure forward or reflected power in coaxial transmission lines in the frequency range 2 to 1000 mc. Directional selectivity is accomplished by fingertip rotation of element to point arrow in direction of power to be measured. Calibration charts or full scale meter adjustments are not needed for this direct reading instrument.

The lightweight and portable Model 43 may be used on mobile or fixed equipment. It is recommended for accurate measurement of forward or reflected power... transmission line loss... insertion loss of components, such as filters, connectors, switches, relays, etc.... antenna matching work... continuous monitoring of transmitter output and... VSWR in complete systems in operation.

SPECIFICATIONS

Each model 43 Directional Wattmeter is made up of a line section, an indicating meter and plug-in measuring elements all contained in an aluminum case.

ELEMENTS: Available in the combinations of power and frequency ranges listed below.

FREQUENCY RANGE: 10 to 1000 Watts in six ranges. (2-30mc) (25-60mc) (50-125mc) (100-250mc) (200-500mc) (400-1000mc)

POWER RANGE: 10 to 1000 Watts in seven ranges: (10W) (25W) (50W) (100W) (250W) (500W) (1000W).

ACCURACY: ±5% of full scale

VSWR: Below 1.05 for complete unit and two connectors.

QUICK-CHANGE CONNECTORS: Two Type "N" FEMALE connectors which mate with (UG-21) Male "N" are supplied **UNLESS ORDER SPECIFIES OTHER CONNECTORS.** Other available quick-change connectors are Male or Female "BNC," "LC," "LT," "HN," "C," Male "N" and Female "UHF."

WEIGHT: 4 pounds

DIMENSIONS: 7" x 4" x 3"

BULLETIN #4360 Sent on Request.

OTHER BIRD PRODUCTS


"Termaline" RF Load Resistors


Coaxial RF Filters


Coaxial RF Switches


"Termaline" RF Absorption Wattmeters

BIRD ELECTRONIC CORP.

CHurchill 8-1200

30303 Aurora Road, Cleveland 39, Ohio

Western Representative:
VAN GROOS COMPANY, Woodland Hills, Calif.

SEE US AT IRE SHOW Booths #3217 & 3219

CIRCLE 112 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Silicone Rubber 609

For thick sections

A fluid silicone rubber for deep-section potting, RTV 601 vulcanizes at room temperature to form solid sections of unlimited thickness. The low-viscosity material cures without heat, pressure, or moisture, even when totally confined. After 24 hr at 77 F, it can be put into full service at temperatures from —100 to 500 F. Set-up time can be lengthened or reduced without affecting the properties of cured parts.

Dow Corning Corp., Dept. ED, Midland, Mich.

See at Show Booth 4310-12.

Ceramic Material 601

Ceramic material AlSiBase is for substrate and microceramic applications. It can be furnished in flat, thin form with dimensionally accurate holes, slots, serrations or other designs.

American Lava Corp., Dept. ED, Chattanooga, Tenn.

Availability: *5 to 6 weeks.*

See at Show Booth 4401.

Cabinet Fan 548

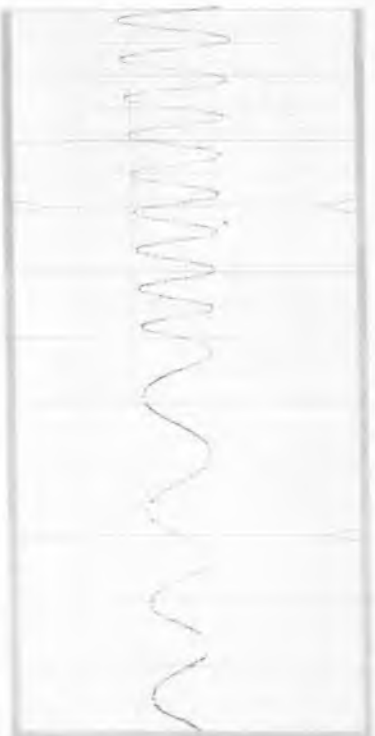
Delivers 450 cfm

The Twinpax cabinet flushing fan delivers 450 cfm in free air, or 400 cfm at 0.1 in. static pressure. The assembly requires 5-1/4 in. of vertical space in a standard rack cabinet. The twin fans are noise-insulated; impingement-type filter is washable. Power requirement is 208 v, 60 cps, 3-phase, or 115 v, 60 cps, 1-phase. Military environmental specifications are met.

Rotron Manufacturing Co., Inc., Dept. ED, Woodstock, N. Y.

See at Show Booth 2822-24.

AO TRACEMASTER PRODUCES SUPERIOR DEFINITION AND UNIFORMITY OF TRACE



The unique carbon transfer writing method of AO's TRACEMASTER 8-channel recorder provides a trace that is a minimum of 2-3 times finer than that of any other direct writing recorder. The trace shown above, taken from a TRACEMASTER record, is an excellent example of the fine trace ...each line is separate and distinct, and reveals significant detail with great clarity.

This allows twice as many lines per millimeter, *or twice the definition*, possible with any other recorder. Notice, also, how the line width and line contrast remain uniform through a chart speed change of 5:1, and through the coincident amplitude change. You continue to see complete signal information.

Superior definition—due to uniform, fine line and excellent contrast—is just one of the many reasons why the AO TRACEMASTER is the world's finest direct writing recorder. Write for complete information, now!

American Optical Company

Instrument Division • Buffalo 15, New York

CIRCLE 113 ON READER-SERVICE CARD

Sweeping Oscillator 539

Range is from 20 cps to 200 kc

Model M is an audio-frequency sweeping oscillator and frequency marker covering the range from 20 cps to 200 kc. It provides a swept-frequency display previously available only at high frequencies. Manual operation permits steady-state measurements.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N.J.

Price & Availability: *$895; 56 to 70 days.*

See at Show Booth 3512-18.

Surface Coating System 605

Eccocoat RF-P is designed for use as color marking to indicate members used in the transfer of rf energy to "earth ground." It is for inside installations. Eccocoat RF-E is an epoxy overcoat to be applied to RF-P for external environmental protection.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

Availability: *From stock.*

See at Show Booth 3823.

Capacitor 540

Temperature compensated

Model VCJ463 is available in fixed capacitance values from 2.0 to 12.0 pf. Operating temperature range is from −55 to 200 C. Capacitance tolerance is 3% at 25 C. Adjustment provides any temperature coefficient between −500 ppm and +500 ppm per C.

JFD Electronics Corp., Dept. ED, 6101 16th Ave., Brooklyn 4, N.Y.

Price & Availability: *$5 ea; 4 to 5 weeks.*

See at Show Booth 1622.

Don't miss an issue of ELECTRONIC DESIGN; Return your renewal card.

VISIT US AT THE IRE SHOW BOOTH NO. 2122-24

RELAY NEWS from Union Switch & Signal

Contact Redundancy in New UNION Crystal Case Relays

The UNION 2-pole double throw General Purpose Crystal Case Relay is designed to consistently meet the requirements of Mil-R-5757D and Mil-R-5757 10. Its essential features . . . from minimum size to optimum reliability . . . permit it to be used in aircraft, guided missiles, shipboard and ground control electronic equipment.

A unique torsion-wire armature suspension system and a rugged all-welded frame construction provide a high level of vibration and shock immunity. Contact redundancy, which assures reliability in dry circuit and higher level contact loads, is provided through the use of bifurcated contacts.

Available with 0.2" grid-spaced header or "S" type header, with various mountings, terminals, and operating voltages. Write for Bulletin 1064.

Why UNION Relays Are So Dependable

There's a good reason why our relays are the standard for reliability. For years, we've been building tough, reliable relays for use in airborne and guided missile electronic equipment and similar vital applications where perfect operation under severe environmental conditions is mandatory.

Our engineers created a compact 6-PDT miniature relay with just three major assemblies . . . instead of a fistful of small parts. This was accomplished by using a balanced rotary-type armature that provided a maximum resistance to the severe shock and vibration environment of aircraft and guided missiles. The rotary principle of operation is utilized in all our relays.

We have a reputation for building reliable electronic components and we intend to maintain our tradition for building reliable relays. And we supply these quality relays in quantity. Stocks are now available for prototype requirements in New York, Pittsburgh, Dallas and Los Angeles.

New 4-PDT-10-amp Relay Most Compact Rotary Type Available

This new durable relay is designed to meet the requirements of Mil-R-6106. It's a rugged relay featuring exceptionally sturdy terminals and husky contacts for high current applications. Glass-coated cylindrical contact actuators attached to the rotary armature provide square mating of contact surfaces, thereby assuring longer relay life. The balanced rotary armature provides maximum resistance to severe shock and vibration.

This small 4-PDT-10-Ampere relay is currently available with 115VAC and various DC operating voltages. Various mounting styles are provided. Write for bulletin 1069.

For additional information, write for Bulletin 1017 or call Churchill 2-5000 in Pittsburgh.

MEMBER OF THE NATIONAL ASSOCIATION OF RELAY MANUFACTURERS

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY — PITTSBURGH 18, PENNSYLVANIA

CIRCLE 114 ON READER-SERVICE CARD

NEW PRODUCTS

AT THE IRE SHOW

Pulse Transformer 559

In transistor size

For high density packaging, the series B350 pulse transformer measures 11/32 in. in diameter by 1/4 in. high. It will give pulse widths from less than 1 to more than 16 μsec, and has other electrical characteristics of larger units. The transformer can be used in pulse coupling or blocking oscillator circuits.

Polyphase Instrument Co., Dept. ED, E. 4th St., Bridgeport, Pa.

See at Show Booth 2839.

Servo Amplifier 592

Transistorized

Transistorized servo amplifier model TA006-OA-100 measures 1-15/16 in. x 2-in. OD. It is capable of driving 60 or 400 cps servomotors. Power output is 10 w max, unmounted, no heat fins, or 4 w max, mounted, with 1/4-in. heat fins. Input impedance is 30 K min; gain is 1,000 v per v, nominal.

Diehl Manufacturing Co., Dept. ED, Somerville, N.J.

***Availability:** 60 days.*

See at Show Booth 1913-15.

Ultra-Stable Oscillator 593

For laboratory use

Ultra-stable oscillator model 101D is a crystal controlled laboratory frequency standard guaranteed to exhibit a frequency drift due to aging of less than 1 part in 10^{10} per day. Resolution is greater than 1 part in 10^{10} and the total range of adjustment is ±0.5 cps.

Hermes Electronics Co., Dept. ED, 75 Cambridge Parkway, Cambridge 42, Mass.

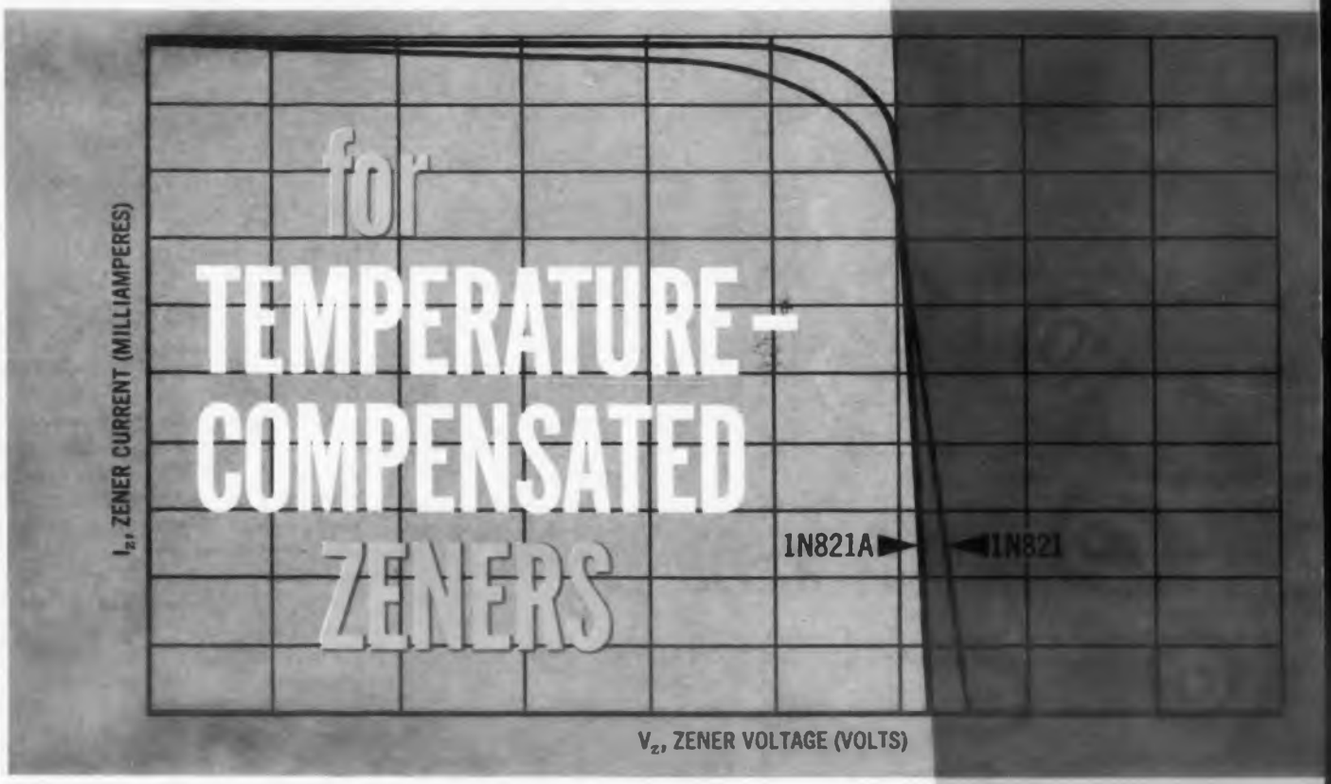
See at Show Booth 3038-39.

T-Switch 589

Hermetically sealed

H16-200 is a hermetically sealed spdt T switch. It measures 0.787 in.

A NEW SLANT for TEMPERATURE-COMPENSATED ZENERS



Typical Operating Characteristics Curve

from MOTOROLA

LOWER DYNAMIC IMPEDANCE MINIMIZES VOLTAGE FLUCTUATIONS ... helps reduce circuit complexity ... eliminates components

The above curve emphasizes the principal advantage of Motorola's new 1N821A series – 6.2 volt temperature-compensated reference diodes. The slant, or slope, of the curve is due to the extremely low dynamic impedance of these new devices ... 8 ohms typical, 10 ohms maximum.

Because of this extremely low dynamic impedance (nearly half that of units available elsewhere), reference voltage fluctuations due to current changes are minimized ... a primary concern in reference applications. This amazing voltage stability allows you to simplify the complex constant-current circuits previously required ... reducing components and increasing reliability. And, this new 1N821A series costs no more than the higher impedance units.

This dramatic achievement in a single zener device is a typical example of Motorola leadership in zener research and development. Motorola refinements have been responsible for making these versatile devices more useful in an ever widening field of applications.

Another facet in Motorola's zener leadership is an emphasis on reliability second to none. Unique production processes, exhaustive in-process control, continuous life-testing and conservative ratings contribute to a growing preference for Motorola zeners. If you are using zener diodes ... be sure you have complete information on the design and production advantages to be gained by specifying "Motorola".

SEE THE LATEST MOTOROLA SEMICONDUCTORS AT IRE BOOTH / 1117•1118

VERSATILE MOTOROLA ZENERS . . .
offer you many design advantages

WIDE SELECTION – enabling you to use the precise device for your exact circuit requirements. Over 2,070 different devices are available covering seven wattages . . . and five temperature-compensated series. Three standard tolerances are offered: 5%, 10%, and ± 20% tolerance for lower-cost, non-critical applications. Matched sets are available in tolerances as low as 1%. Motorola also has a variety of military-qualified zeners.

OUTSTANDING PERFORMANCE – is one of the big advantages you gain when using Motorola zeners. These include lower dynamic impedance, lower temperature coefficients and sharper knees. Units are measured at the 1/4 power level – the point of typical usage. Dynamic impedance is measured at two points and 100% scope-checked.

COMPLETE SPECIFICATIONS – Motorola supplies you with the industry's most comprehensive specifications . . . giving you the complete picture of the diode characteristics. Temperatures are fully specified. Forward current ratings are specified and guaranteed.

RELIABLE OPERATION – exclusive process and quality control procedures assure extreme uniformity, high stability and longer life. Motorola's million-dollar reliability program has resulted in a level of reliability acceptable for the most critical applications.

IMMEDIATE AVAILABILITY – Motorola Zener Diodes are available "off the shelf" from 28 experienced industrial distributors. For fast delivery of any Motorola zener, contact the distributor nearest you.

BIRMINGHAM
Ack Semiconductors, Inc.
3101 Fourth Ave., So.
FAirfax 2-0589

BOSTON
Cramer Electronics, Inc.
811 Boylston St.
COpley 7-4700

Lafayette Radio
110 Federal St.
HUbbard 2-7850

BUFFALO
Summit Distributors, Inc.
916 Main St.
TT 4-3450

CAMDEN
General Radio Supply Co.
600 Penn St.
WOodlawn 4-8560

CEDAR RAPIDS
Deeco Inc.
618 First St., N. W.
EMerson 5-7551

CHICAGO
Allied Radio Corp.
111 N. Campbell Ave.
HAymarket 1-6800

Newark Electronics Corp.
223 W. Madison St.
STate 2-2944

Semiconductor Specialists, Inc.
5706 W. North Ave.
NAtional 2-6860

CINCINNATI
Sheridan Sales Co.
Roselawn Center Bldg.
MElrose 1-2460

CLEVELAND
Pioneer Electronic Supply Co.
2115 Prospect Ave.
SUperior 1-9411

DALLAS
Tekko, Inc.
4308 Maple Ave.
LAkeside 6-8763

DENVER
Inter-State Radio & Supply
1200 Stout Street
TAbor 5-8257

DETROIT
Radio Specialties Co.
12775 Lyndon
BRoadway 2-4200

HOUSTON
Lenert Co.
1420 Hutchins
CApitol 6-2861

JAMAICA, N. Y.
Lafayette Radio
165-08 Liberty Ave.
AXtel 1-7000

LOS ANGELES
Hamilton Electro Sales
11965 Santa Monica Blvd.
EXbrook 3-4441
BRadshaw 2-8453

Kierulff Electronics
820 W. Olympic Blvd.
Richmond 8-7444

MELBOURNE, FLA.
Electronic Wholesalers
1301 Hibiscus Blvd.
PArkway 3-1441

NEWARK, N. J.
Lafayette Radio
24 Central Ave.
MArket 2-1661

NEW YORK
Lafayette Radio
100 6th Ave.
WOrth 6-5300

Milgray Electronics
136 Liberty St.
REctor 2-4400

OAKLAND
Elmar Electronics
140 11th St.
TEmplebar 4-3311

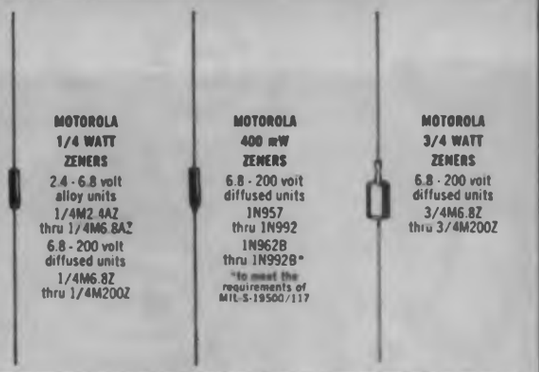
PHOENIX
Electronic Specialties Co.
917 N. 7th St.
ALpine 8-6121

SAN DIEGO
San Deico
3843 Park Blvd.
CYpress 8-6181

SEATTLE
Almac Electronics Corp.
6301 Maynard Ave.
PArkway 3-7310

WASHINGTON, D. C.
Electronic Wholesalers, Inc.
2345 Sherman Ave., N. W.
HUdson 3-5200

CANADA
Canadian Motorola Electronics Co.
105 Bartley Drive
Toronto 16, Ontario
PL 9-2222



MOTOROLA 1/4 WATT ZENERS
2.4 - 6.8 volt alloy units
1/4M2.4AZ thru 1/4M6.8AZ
6.8 - 200 volt diffused units
1/4M6.8Z thru 1/4M200Z

MOTOROLA 400 mW ZENERS
6.8 - 200 volt diffused units
1N957 thru 1N992
1N962B thru 1N992B*
*to meet the requirements of MIL-S-19500/117

MOTOROLA 3/4 WATT ZENERS
6.8 - 200 volt diffused units
3/4M6.8Z thru 3/4M200Z

MOTOROLA 50 WATT ZENERS
6.8 to 200 volt diffused units
50M6.8Z thru 50M200Z
1N2804 thru 1N2846
1N2804B thru 1N2846B*
*to meet the requirements of MIL-S-19500/114

MOTOROLA 10 WATT ZENERS
6.8 to 200 volt diffused units
10M6.8Z thru 10M200Z
1N1351 thru 1N1375
1N1806 thru 1N1815
1N2970 thru 1N3015
1N2970B thru 1N3015B*
*to meet the requirements of MIL-S-19500/124A

MOTOROLA 1 WATT ZENERS
6.8 to 200 volt diffused units
1M6.8Z thru 1M200Z
1N3016 thru 1N3051
1N3016B* thru 1N3051B*
*to meet the requirements of MIL-S-19500/115

MOTOROLA 1.5 WATT ZENERS
6.8 to 200 volt diffused units
1.5M6.8Z thru 1.5M200Z

MOTOROLA 400 mW TEMPERATURE-COMPENSATED ZENERS
6.2 volt diffused units coefficients to .001%/°C
1N821 thru 1N827
1N821A thru 1N827A
8.4 volt diffused units coefficients to .001%/°C
1N3154 thru 1N3157
(Replaces 1N430, although only 1/50 the size)
1N3154A thru 1N3156A

MOTOROLA 3/4 WATT TEMPERATURE-COMPENSATED ZENERS
9.3 volt diffused units coefficients to .0005%/°C
1N2620 thru 1N2624

MOTOROLA 1/2 WATT TEMPERATURE-COMPENSATED ZENERS
9.0 and 11.7 volt diffused units coefficients to .0005%/°C
1N935 thru 1N939
1N941 thru 1N945

FOR COMPLETE TECHNICAL INFORMATION on the specific Motorola Zeners most applicable to your circuits, write to Technical Information Department, Motorola Semiconductor Products, Inc., 5005 East McDowell Road, Phoenix 10, Arizona. Or contact your nearest Motorola Semiconductor Distributor.

ZENER-RECTIFIER APPLICATIONS HANDBOOK—Motorola's new Zener Diode-Rectifier Handbook is a valuable reference book for circuit engineers. This 200-page guide to basic theory, design characteristics and applications is available through your Motorola Distributor. Price $2.00.

MOTOROLA
Semiconductor Products Inc.
A SUBSIDIARY OF MOTOROLA INC.
5005 EAST McDOWELL ROAD • PHOENIX 10, ARIZONA

MOTOROLA ZENER DIODES

in length and weighs 7 g. Electrical ratings are: 7.5 amp at 125/250 v ac, 60 cps inductive and resistive; 3 amp at 125/250 v ac, 60 cps motor; 7.5 amp at 28 v dc resistive; 2.5 amp at 28 v dc inductive; 3 amp at 28 v dc motor.

Controls Company of America, Control Switch Div., Dept. ED, 1420 Delmar Drive, Folcroft, Pa.
Availability: *6 to 8 weeks.*
See at Show Booth 1727-31.

Silicone-Alloy Insulators 616

Resist moisture film

Insulators made from silicone alloy are highly resistant to moisture filming in atmosphere change. Loss factor is 0.00211 at 14 Gc. Water absorption is 0.05% to 0.15% during 24-hr immersion. Dielectric strength is 670 to 1,950 v per mil. The material is suitable for molding or casting into intricate shapes.

Isolantite Manufacturing Corp., Dept. ED, Warren Ave., Stirling, N.J.

Phase Comparator 645

Accurate to 1 part in 10^9

Model VLA phase comparator is a self-contained system for measuring the rate of phase change between the output of a local oscillator and the signal received from one of the vlf standard broadcast stations. Accuracy is better than 1 part in 10^9 with relative short measurements. A precision 1-kc output is provided for aural monitoring of time signals. Available frequencies are 16, 18 or 20 kc.

Specific Products, Dept. ED, 21051 Costanso, Woodland Hills, Calif.
Price: *$1,490.*
See at Show Booth 3908.

Chassis Slide 570

With circulating balls

Capable of supporting 1,000 lb, this heavy-duty circulating ball slide functions smoothly and easily. Even weight distribution enables operation in all conditions of shock and environment. The slide is made in standard sizes from 16 to 24 in., in 2-in. increments, and from 24 to 60 in., in 6-in. increments, on special order. It is 1-1/8 in. wide and 3-in. high. The whole slide is coated with a bonded film of molybdenum disulfide, a permanent lubricant.

Chassis-Trak, Inc., Dept. ED, 525 S. Webster, Indianapolis, Ind.

See at Show Booth 4001.

Torque Calibrator 553

Accuracy is ±0.2%

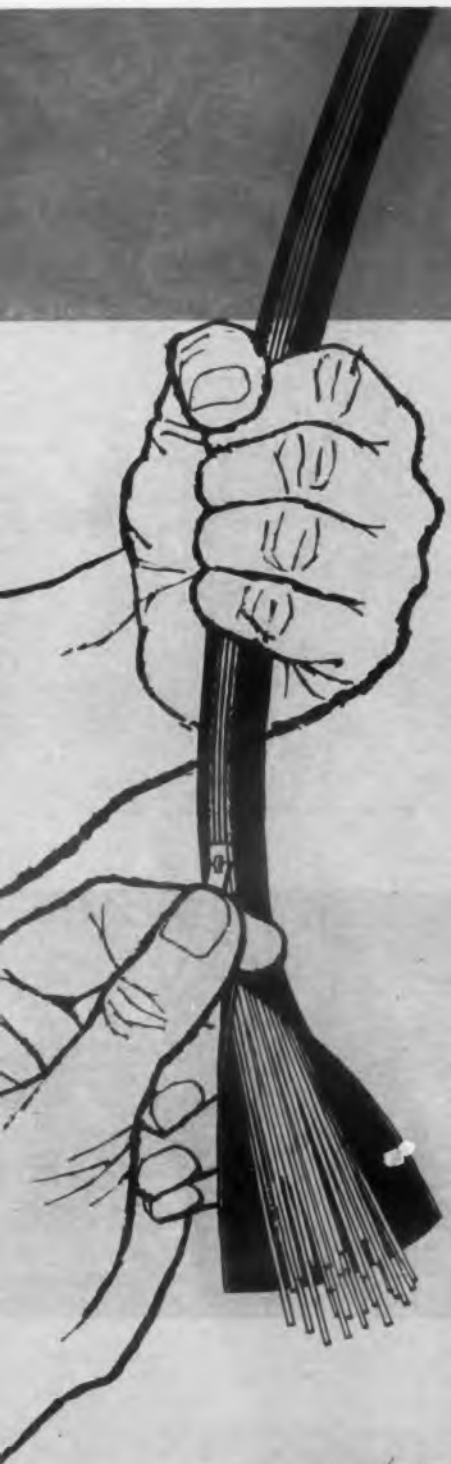
Used to calibrate any torque measuring equipment, model 6500-T2 also checks breakaway and static torque. Three scales provide a measuring range of 0.5 to 40.0 oz-in. and 20 to 2,800 g-cm at an accuracy of ±0.2% of indicated reading. Operating on weight-vector principle, the device uses no springs. It weighs 24 lb, and measures 14-1/4 x 16 x 8 in. over-all.

Waters Manufacturing, Inc., Dept. ED, Boston Post Road, Wayland, Mass.

Price & Availability: *$240; stock.*

See at Show Booth 1233.

Don't miss an issue of ELECTRONIC DESIGN; Return your renewal card.



Another breakthrough
for Brand-Rex Cablemanship!

NOW ZIPPER TUBING OF BRAND-REX MILITARY VINYL COMPOUNDS

Unique properties and advantages are now yours with TURBOZIP®

All the advantages of zipper tubing have been combined with Brand-Rex formulated military vinyl compounds. Turbozip tubings provide high dielectric strength; perform efficiently in temperature ranges in excess of military specifications; and are fungus resistant, too. And to withstand rugged mechanical abuse, Turbozip closures are fabricated of special extra-tough compounds.

Ask your Brand-Rex sales engineer to show you the four new Turbozip types. Ask to see Turbozip 40 or Turbozip 105 made from vinyls meeting MIL-I-7444 and MIL-I-631 grade C respectively. He will also have Turbozip VG made from vinyl-impregnated glass that meets MIL-I-3190. And, if you are interested in zipper tubing for 100% shielding, he will show you Turbozip SH, aluminum foil laminated to vinyl-impregnated glass sheet.

Turbozip zipper tubings are available in all preferred sizes and thicknesses. Standard colors include black, yellow, clear, and grey.

For custom cabling or volume production runs, you will save time and money with these new Turbozip zipper tubings. Ask for samples and complete information, today!

BRAND REX

WILLIAM **BRAND-REX** DIVISION
American ENKA® Corporation
DEPT. TC, 39 SUDBURY ROAD, CONCORD, MASSACHUSETTS
Telephone: EMerson 9-9630

Turbo Vinyl, Teflon, Polyethylene, Nylon, and Silicone Insulated Wires and Cables, Electrical Tubing and Sleeving, Rexolite UHF Cast Plastics

CIRCLE 115 ON READER-SERVICE CARD

BRAND-REX TURBO† INSULATING SLEEVINGS

Circle the entire range of Tubular Dielectrics

To spot the insulation materials that will solve your problem, just glance through this list of Turbo tubings and sleevings:

Applicable Specifications	Operating Temperature
TURBO† Varnished Cotton and Rayon	
MIL-I-3190A NEMA VSI-1957, Type 1 A.S.T.M. D-372	-10° to +105°C
TURBOGLAS† Varnished Glass	
MIL-I-3190A NEMA VSI-1957, Type 2 A.S.T.M. D-372	-10° to +130°C
TURBOTUF† Vinyl Coated Glass	
MIL-I-21557 MIL-I-3190A NEMA VSI-1957, Type 3	-10° to +130°C
TURBONITE† Isocyanate Coated Glass	
CLASS F MATERIAL	-10° to +155°C
TURBOSIL† Silicone Varnished Glass	
MIL-I-3190A NEMA VSI-1957, Type 4	-10° to +200°C
TURBO 117† Silicone Rubber Coated Glass	
NEMA VS2-1957 TYPE 3*	-73° to +200°C
TURBOTHERM 105† Vinyl	
U/L A.S.T.M. D-922 GRADE C	-17° to +105°C
TURBOLEX 105† Vinyl	
MIL-I-631C GRADE C	-20° to +105°C
TURBOLEX 85† Vinyl	
A.S.T.M. D-922 GRADE A	-32° to +60°C
TURBOLEX 70† Vinyl	
MIL-I-631C GRADE A	-39° to +80°C
TURBOLEX 40† Vinyl	
MIL-I-22076	-55° to +80°C
TURBOZONE 40† Vinyl	
MIL-I-7444B	-67° to +75°C
TURBOTEMP Teflon	
MIL-I-22129A' AMS-3653 B**	-200° to +250°C

**Also meets applicable performance requirements of MIL-I-631C and MIL-I-3190A

*Meets performance requirements of MIL-I-3190A

†Registered trade mark

Turbo Tubings are available in all sizes from #24 to 2½". Write for complete information.

BRAND REX

WILLIAM BRAND-REX DIVISION

American ENKA Corporation

SUDBURY ROAD, CONCORD, MASS.

CIRCLE 116 ON READER-SERVICE CARD

Placard Indicator 566

For multiple messages

With four message areas, this placard indicator performs the function of a group of indicator lights. The compact device measures 4-3/4 x 1-5/16 in. The one-piece lens is removable for lamp insertion. Legend is amber when lit, black when unlit. Four separate lamps and lamp circuits are used.

Control Switch Div., Controls Co. of America, Dept. ED, Folcroft, Pa.

See at Show Booth 1721-31.

Multiple Switch 550

With square push-buttons

The series 21000 switches have a square button design with a concave face. Illumination is to the side as well as the front; jewels are available in colors selected for best operation. The buttons can be keyed in any of four planes for horizontal or vertical mounting. Number of stations ranges from 1 to 37. Depth required behind panel is 3-17/64 in.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

See at Show Booth 2825.

Indicator Light 608

In small size

Measuring 1-5/8 in. over-all, this indicator light has a cylindrical lens 0.425 in. in diameter which accommodates up to three stamped digits. Lamp cartridge is replaced from panel front; voltage ranges from 1.35 to 28 v. Neon cartridges are available. The assembly mounts in a 3/8-in. hole.

Dialight Corp., Dept. ED, 60 Stewart Ave., Brooklyn 37, N.Y.

See at Show Booth 2829-31.

if you have a problem involving

crystal controlled frequency sources and filters

spend your IRE SHOW TIME to advantage

stop at BOOTH 1820

HILL ELECTRONICS INC.

MECHANICSBURG, PENNSYLVANIA

CIRCLE 117 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Miniature Resistors 552

Rated at 2 to 12.5 w

Designed for printed circuit and miniaturization use, Axiohm resistors are made in seven standard sizes from 2 to 12.5 w. The vitreous enamel, wirewound resistors have high stability and overload capacity. Resistance range is 0.1 ohms to 75 K; tolerance is ±5%. Capped axial leads are hot tin dipped for easy soldering.

Ward Leonard Electric Co., Dept. ED, Mount Vernon, N. Y.

See at Show Booth 2231.

Power Triode 577

With platinum grid

A forced-air cooled triode, type 7900 has a specially processed platinum grid for lower drive power requirements. It is designed for power amplifier use up to 220 mc, and is particularly suitable for TV applications. Class B power output, at 220 mc in an approved cavity, is 5.6 kw. Plate dissipation rating is 4 kw.

Amperex Electronics Corp., Transmitting Tube Div., Dept. ED, 230 Duffy Ave., Hicksville, N.Y.

P&A: $175, OEM; immediately delivery.

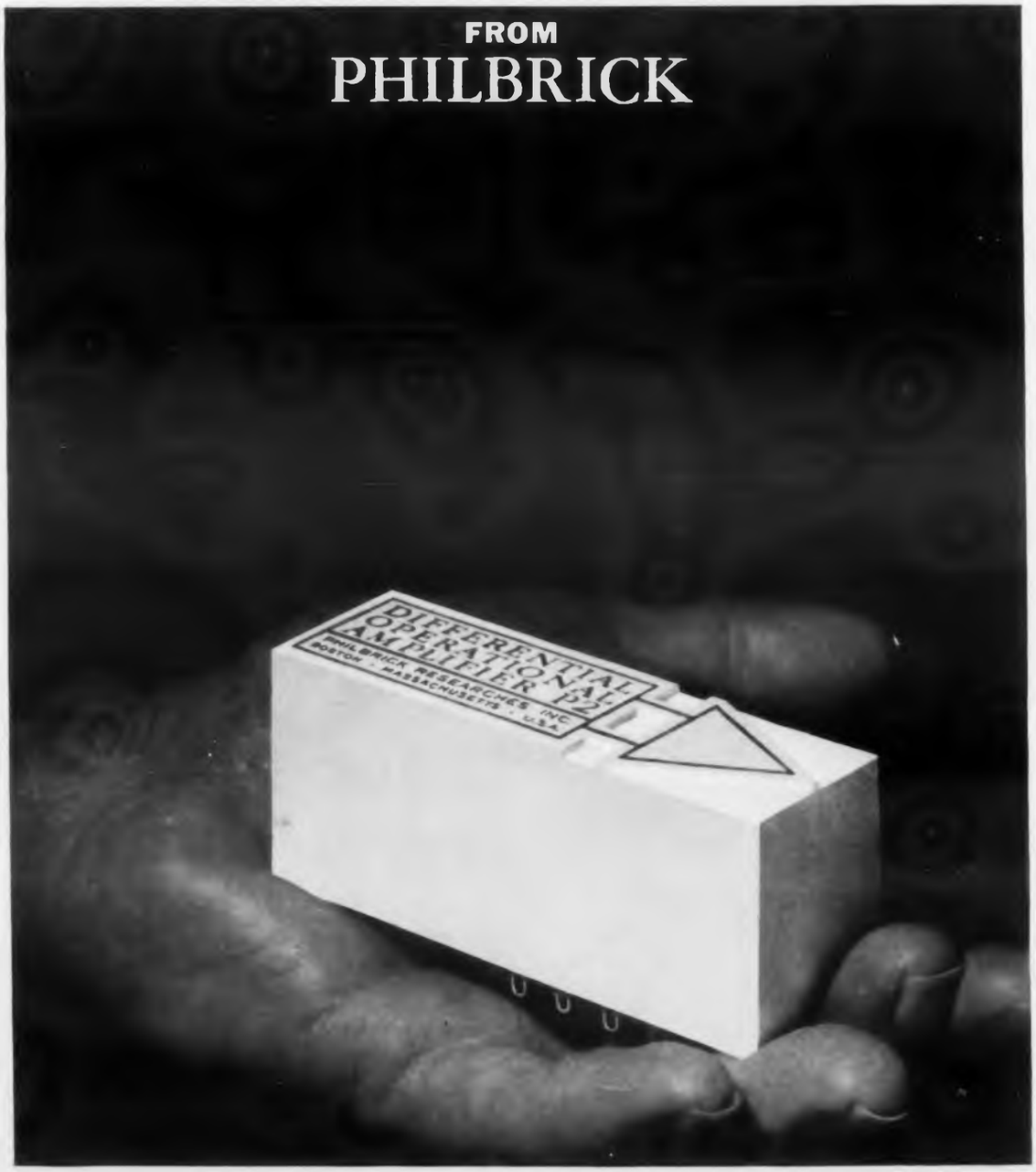
See at Show Booth 2522-24.

Logic Panels 585

With digital circuitry

This series of 200 kc digital logic panels is designed for simple, rapid patchcord connection. The panels are useful for logic breadboarding,

THIS IS
THE NEW
P2
SOLID STATE
FULLY FLOATING
DIFFERENTIAL OPERATIONAL AMPLIFIER
FROM
PHILBRICK



NO TUBES, NO CHOPPERS, NO COMMON MODE ERROR, VIRTUALLY NO INPUT CURRENT

(LESS THAN ONE TEN THOUSANDTH OF ONE MICROAMP)

AND ALMOST NO NOISE... NOTHING BUT PERFORMANCE

THE P2 IS UNIQUE — It is very likely that here — inside this rugged 4″ cast aluminum housing — is packed more performance and more versatility than you will find in any operational amplifier available in the world today.

A strong statement. One we're happy to back up with facts.

THESE ARE ITS FEATURES: Full differential input (truly floating with respect to ground). **Low input current** (typically less than 2×10^{-11} amp). **Low noise** (typically under 10 microvolts in the frequency range between DC and 1 KC). **Long term drift stability in sub-millivolt region. Coolness** (about 330 milliwatt dissipation). **Compactness** (4″ L x 1¾″ W x 1 11/16″ H; weight 11 oz.). **Economical operation** (no heater supply or tube replacement.) **Low price: $210**

HERE'S WHAT THE P2 CAN DO

The P2 is a dc amplifier with differential inputs, designed for analog computation and other instrument applications. These run all the way from high reliability process control to biological measurements. You can add, integrate, scale, and invert with it. Its differential inputs permit high impedance voltage following and amplification, subtraction, precise current driving to grounded loads, and many other esoteric and desirable operations.

Since inputs are electrically isolated from ground, there is no limit on the input common mode signal, except for the dielectric strength of the insulating materials. In addition, the P2's high input impedance and low input leakage accommodate the same resistors and capacitors normally used in vacuum tube circuitry: but with lower voltage ratings, greater compactness, and longer life.

Typical drift, when connected as a ten-second integrator using a one microfarad capacitor, is typically less than 100 microvolts per second.

The P2 requires 11 ma at plus and minus 15 volts from conventional supplies. Where portability is desired, it will operate continuously for about 75 hours in the field on just two pairs of small mercury batteries (TR-136 type).

SPECIFICATIONS

(Tentative)

ELECTRICAL

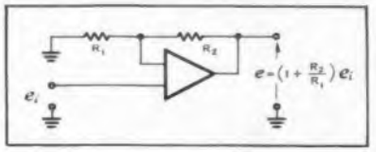
	Design	Q.C. pass limit
Gain	30,000	20,000
Output range	± 11V at 1.1 ma	± 10.0 volts at 1.0 ma
Minimum recommended load resistance	10 KΩ. Will not be damaged by short circuit. Resistance loads below 10 KΩ tend to degrade the amplifier performance, but are feasible from the standpoint of safety.	
Input:		
Tolerable common mode signal level range		± 200 volts
Admittance	600 μμf	
Current: (at room temperature)	2×10^{-11} amp	10^{-10} amp
Drift: (referred to inputs) (20°-45°C.)	2 mv	5 mv
	typically less than 100μV in 8 hours at constant temperature	
Bandpass	Small signal — unity open-loop gain at 75 kc	
	Large signal — output becomes amplitude limited at 1 kc	
	Output range will be reduced by 12 db/octave above 1 kc	
Power requirements	± 15vdc at less than 11 ma (worst case load)	

MECHANICAL

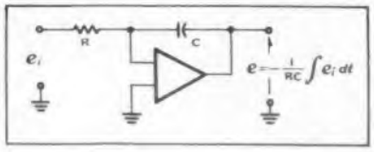
Dimensions	4″ L x 1¾″ W x 1 11/16″ H plus ⅜″ additional clearance for terminals
Mounting	3 15/16″ centers, 2 holes for No. 8 screws (furnished with unit)
Weight	Mounted: 11 oz. Packed: 1 lb.
Enclosure	Potted, cast aluminum case

For aid with your applications and for a demonstration of P2's capabilities, write, wire or phone Philbrick or your nearest Philbrick representative.

Ideal for computing instruments like these

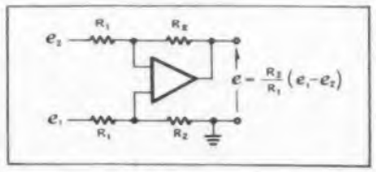


ELECTROMETER (ISOLATION) AMPLIFIER (non-inverting application): This circuit presents an extremely high dc input impedance to the source (actually higher than that of a K2-W amplifier by several decades). The gain ratio is determined by the feedback elements and is positive in polarity. Applications of this circuit include potentiometer unloading, peak-reading instrumentation, preamplification, and portable low-level electrometer-type measurements.



INTEGRATOR-MEMORY: P2's low input current and drift allow one to use high impedance values for R and C not usually considered feasible for transistor amplifiers. Considerable saving in the cost and bulk of polystyrene capacitors is inherent.

Example: R = 10 Megs and C = 1 μf gives a 10 second integration circuit.
Less than 30 millivolts error in the output is typical for a 5 minute period.



DIFFERENTIAL AMPLIFIER: The common mode rejection of this circuit is high indeed, being determined by the accuracy with which feedback ratios are maintained. Because of the input isolation, hundreds of volts of common mode signal are feasible without causing damage. The dc load on the source is almost entirely caused by the resistors alone. Using this circuit in conjunction with two pre-amplifiers of the type shown in Fig. 1, a precision differential electrometer is feasible.

GEORGE A.
PHILBRICK
RESEARCHES, INC.
127 CLARENDON ST. BOSTON 16, MASS.
COMMONWEALTH 6-5375. TWX: BS 1032. FAX: BSN
REPRESENTATIVES IN PRINCIPAL CITIES
EXPORT OFFICE: 240 W. 17TH ST., N. Y. 11, N. Y.
TEL. CHELSEA 3-5200. CABLE: TRILRUSH

CIRCLE 119 ON READER-SERVICE CARD

small system construction, programable test control, and timing equipment, and instruction. Each panel is an independent unit, containing standard encapsulated transistor circuit modules. The 16 panels cover the complete range of logic, storage, control, and timing functions.

Epsco, Inc., Components Div., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

P&A: $100 to $600; stock to 4 weeks.

See at Show Booth 1216.

Transistor Socket 575

For spacesaver types

The complete series of spacesaver transistors is accommodated by this socket. Narrow width permits utilization of the space saved by the mating transistor. It is designed to fasten beneath the chassis, and provides direct mounting of the transistor with its mica insulator to the chassis. The transistor is thus provided with maximum heat dissipation by conduction.

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

See at Show Booth 1227.

Trimmer Capacitor 547

Temperature is +125 C

Style 538 ceramic trimmer capacitor is 3/8-in. in diameter and has an operating temperature to +125 C. Specifications are: working voltage, 200 v dc; Q factor, 500 min at 1 mc; flash-test voltage, 400 v dc. Capacitance ranges are from 2 to 7 pf to 9 to 40 pf.

Erie Resistor Corp., Dept. ED, 644 W. 12th St., Erie, Pa.

Availability: In sample quantities.

See at Show Booth 3210-12.

Don't miss an issue of ELECTRONIC DESIGN; Return your renewal card.

TARZIAN TUNERS

Acclaimed by the Industry for High Quality . . . Reliability and Low Cost

SILVER SEALED (switch-type) | HOT ROD (turret-type) | HI FI (FM) Tuner

It's only natural that the world's leading set manufacturers should rely on the TARZIAN TUNER . . . acclaimed as the world's finest.

Today, TARZIAN TUNERS are providing unexcelled performance in millions and millions of television receivers. Since the beginning of television (Sarkes Tarzian was a pioneer in the industry) leading set manufacturers have been equipping their receivers with TARZIAN TUNERS because they are assured of dependable performance. And, at LOW COST.

Sarkes Tarzian, Inc. is recognized as the world's leading commercial tuner manufacturer with licencees in Canada, Mexico, Brazil, Argentina, Australia and Italy.

Only Tarzian offers manufacturers both the HOT ROD (turret-type) and SILVER SEALED (switch-type) . . . as well as the Hi Fi FM Tuner. All embody the high standards of QUALITY . . . DEPENDABILITY . . . and OUTSTANDING PERFORMANCE that have made TARZIAN products a leader in the field.

For more information, write to: Sales Department, Tuner Division

SARKES TARZIAN INC

east hillside drive • bloomington, indiana

Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • Magnetic Tape • Semiconductors

CIRCLE 120 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Power Meter 541

Range is 1 μw to 10 mw

Model 431A power meter has a drift stability of less than 2 μw per deg C over a range of 1 μw to 10 mw. One zero adjustment is needed for all seven ranges. The meter face is also calibrated in dbm with 5 db between ranges.

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

See at Show Booth 3205-15.

Voltage Control 544

For critical loads

The Sta-Vo-Trol static voltage control maintains constant voltage automatically regardless of line or load changes. Accuracy is within 0.25% bandwidth for line voltage and/or load magnitude changes, provided load is a constant power factor. Rated output is 1 kva, response is 1/10 to 2/10 sec. There are no moving parts.

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

Price: $475 ea.

See at Show Booth 2904-32.

Construction Kit 578

Uses plug-in units

A plug-in unit construction system is used for

Art Wire specializes in wire forms designed for today's automatic production lines . . . manufactured with the precision and uniformity that assure the economy of an uninterrupted work flow. Reduced down-time, and the lower costs made possible by Art Wire's modern production methods mean greater savings to you, and greater profit in your operations.

ART WIRE AND STAMPING CO.
17 Boyden St., Newark 2, N. J.

CIRCLE 121 ON READER-SERVICE CARD

Self-locking, wear-resistant, machined, stainless steel threaded inserts for use in aluminum and brass. Easily applied, their dependable grip in the parent metal as well as their permanent self-locking ability make them ideal for a diversity of critical uses. The complete line includes one basic type in four sizes. Each of the four sizes are available for insertion into any of five metal thicknesses. All National Radio Company self-locking captive nuts are made to conform with the following specifications:

Material Stainless steel Class 303 per FED QQ-S-763b.
Finish Passivated per MIL-P-12011.
Threads Size 4, 6, and 8 NC-2B.
Size 10 NF-2B

National Radio Company also manufactures other captive nuts and studs including the line of exclusive "Flush Mount" types. Available in five sizes for use in metal thickness from 1/16" up, this type of captive nut fits flush on both sides of aluminum or brass sheet to provide strong permanent tapped holes.

National Radio Company's engineering staff will be glad to discuss your applications and possible variations to best meet your requirements.

NATIONAL RADIO COMPANY, INC.
MELROSE 76, MASSACHUSETTS
A wholly owned subsidiary [illegible]
Export: AD AURIEMA, INC. [illegible] New York, N.Y., U.S.A. In Canada: ATLAS RADIO CORP. LTD., Toronto 17, Ont.
Specifications subject to change [illegible]

IRE BOOTHS 1405-07, 3506-08
CIRCLE 122 ON READER-SERVICE CARD

rapid fabrication of prototype equipment with kit No. 40. Associated circuit planes can be grouped by function as snap-in circuits; a terminal card mounting system simplifies planning and layout. All basic chassis types, a three-level rack and a universal tool for staking, eyeletting, and punching are included.

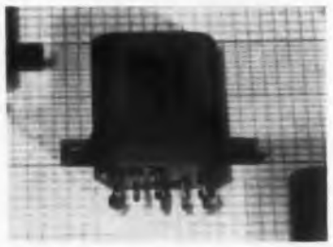
Alden Products Co., Dept. ED, 36 N. Main St., Brockton, Mass.

P&A: $395; immediately delivery.

See at Show Booth 1613-15.

Crystal-Case Relay 554

Rated at 2 amp



This 2pdt crystal-case relay is rated at 2 amp, 26.5 v dc, resistive. A torsion-wire armature suspension system enables the relay to withstand 20-g vibration to 20 kc, and shock to 50 g. Weight is 0.6 oz. Coil resistance is 660 ohms; ambient temperature range is −65 to 125 C. Several mounting styles are available. Body height is less than 1 in.

Westinghouse Air Brake Co., Union Switch & Signal Co., Dept. ED, Pittsburgh 18, Pa.

See at Show Booth 2122-24.

Miniature Plugs 572

To MIL-C-26482

The KPT and KSP styles of miniature MS-type plugs were designed to MIL-C-26482 and SCL-6019. A molded polychloroprene, two-shore insulator holds crimped contacts in positive alignment and maintains a continuous seal from front to back.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

See at Show Booth 2727-31.

Have you sent us your subscription renewal form?

The versatile transistor servo amplifier by DIEHL

Designed for operation with any DIEHL 1, 5 or 10 watt servomotor at 60 and 400 cycle carrier frequencies, this new series of Transistor Servo Amplifiers is also capable of driving any DIEHL size 11 or 15 servomotors, or equivalent.

Superior electrical performance is typified by near-perfect linearity over a wide range of input voltage and by the absence of measurable phase shift over a 20 cps. passband.

The use of advanced packaging techniques in 2 inch diameter modules produces continuous power outputs of 6 watts in a 1⅞ inch long can or 35 watts in a 3¼ inch long can. Units are *not potted*, for accessibility and ease of maintenance; air-tight cases are filled with inert aluminum oxide particles for maximum heat transfer.

Also available is DIEHL TP 3-100 solid state power supply which accommodates either 6 or 35 watt units by means of direct plug-in.

Please write for additional information. 4178

SEE US AT IRE SHOW
BOOTH 1913-15

SPECIFICATIONS

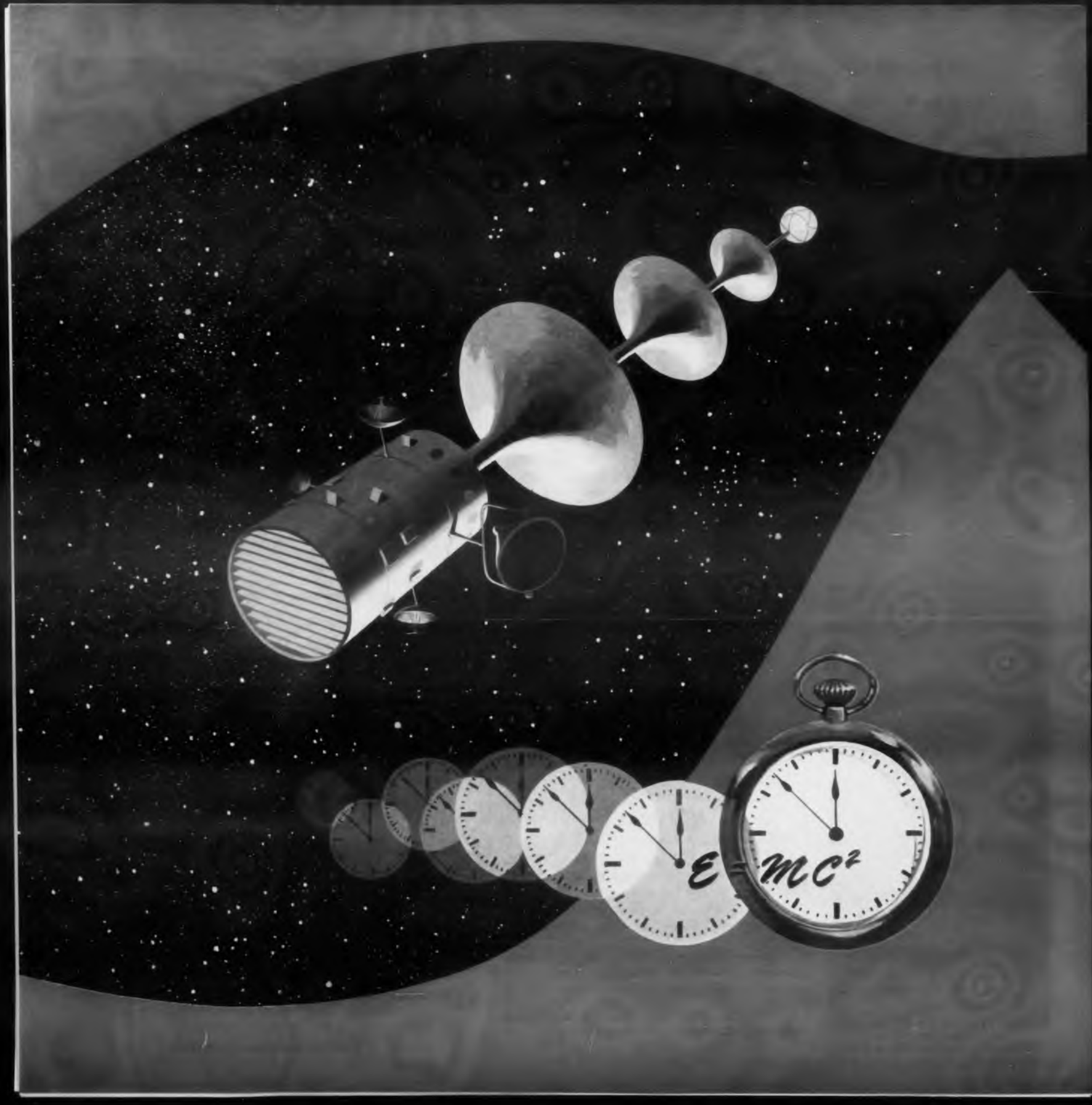
Cat. No.	TA006-OA-100
Output	Continuous 10 watts, max. (unmounted, in free air at 25 c ambient; no heat fins) 4 watts, max. (mounted on 12 x 12 x 1/8 aluminum plate at 71 c ambient, with 1/4" heat fins)
Gain	1000 volts/volt, nominal
Input Imp.	30K minimum
Phase Shift	a) No measurable phase shift in 20 cps passband for 60 cps carrier. b) Less than 10° phase shift in 100 cps passband for 400 cps carrier.
Noise	.013 volts, input shorted
Power Req.	−28 ± 2 volts DC at 600 amps; +9 ± 1 volts DC at .015 amps

Diehl

†A Trademark of THE DIEHL MANUFACTURING COMPANY

DIEHL MANUFACTURING COMPANY
A SUBSIDIARY OF THE SINGER MANUFACTURING COMPANY
Somerville, New Jersey

CIRCLE 123 ON READER-SERVICE CARD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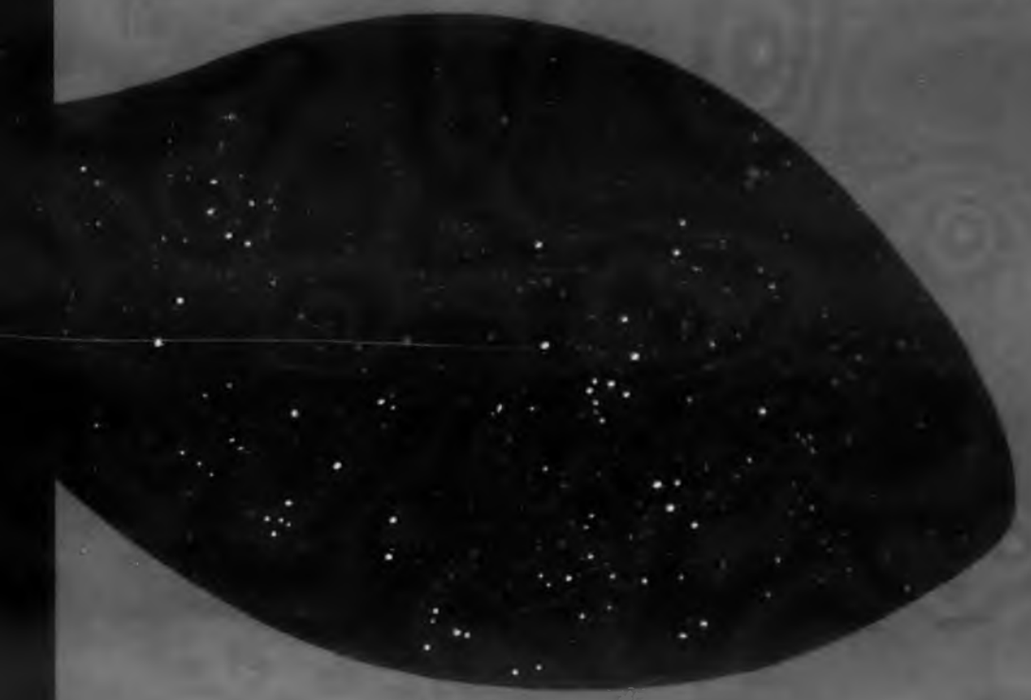


FACING THE FOURTH DIMENSION IN PROPULSION DEVELOPMENT

Whether the universe has a "saddle shape," or any shape at all, is a matter of interesting conjecture. The matter of space travel, however, is the subject of intense experimentation. A nuclear/thermionic/ionic propulsion system, currently being studied at Lockheed Missiles and Space Division, might well become the power source for space vehicles.

Its design incorporates a nuclear reactor only one foot in diameter, generating heat at a temperature of 1850°K. This is transmitted to banks of thermionic generators, converting the heat directly into electrical energy for the ion beam motor which uses cesium vapor as a fuel. The entire system is designed without any moving parts, minimizing the possibility of failure.

Lockheed's investigation of propulsion covers a number of potential systems. They include: plasma, ionic, nuclear, unique concepts in chemical systems involving high-energy solid and liquid propellents, combined solid-liquid chemical systems. The fundamentals of magnetohydrodynamics, as they might eventually apply to propulsion systems, are also being examined. Just as thoroughly, Lockheed probes all missile and space disciplines in depth. The extensive facilities of the research and development laboratories—together with the opportunity of working with men who are acknowledged leaders in their fields—make association with Lockheed truly rewarding and satisfying.

Lockheed Missiles and Space Division in Sunnyvale and Palo Alto, on the beautiful San Francisco Peninsula, is an exciting and challenging place to work. For further information, write Research and Development Staff, Department M-24B, 962 West El Camino Real, Sunnyvale, California. U. S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and [illegible] Programs

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

201 ROTARY SWITCH TYPES FOR IMMEDIATE OFF-THE-SHELF DELIVERY... FROM DAVEN!

Standard switches, adjustable stop switches, ceramic switches, subminiature Series G switches . . . available for immediate delivery from Daven or your local Daven Distributor.

This solves your problem of obtaining Daven precision rotary tap switches overnight . . . in breadboard, prototype or production quantities.

Write today for complete listings and technical data.

THE DAVEN COMPANY, Livingston, New Jersey

General Mills | SWITCHES

TODAY, MORE THAN EVER, THE DAVEN ® STANDS FOR DEPENDABILITY

NEW PRODUCTS
AT THE IRE SHOW

Digital Counter 551

For coil winding

Model TRO-60 is a transistorized, four-digit counter for use with a toroidal coil-winding machine. Wire turns are counted photoelectrically. Count is displayed on an in-line readout. Automatic cut-offs are provided for wire length and number of turns. Plug-in circuits for preset tap-pulling may be added. The counter has a built-in deceleration feature for high-speed winding.

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

See at Show Booth 4004-05.

Interlock Switch 567

Is cheat-proof

A four-station switch for military aircraft, model WC1730 has an interlock or anti-defeat function whereby one button is always down. Actuating any other button causes the depressed button to return to normal position. The dpdt switch is rated at 5 amp, 125/250 v ac; 5 amp resistive, 30 v dc; and 2.5 amp inductive at 30 v dc. Over-all length is 3-3/4 in. The 9-oz unit has illuminated push-buttons, available in 6 colors. It is designed to meet military requirements.

Control Switch Div., Controls Co. of America, Dept. ED, Folcroft, Pa.

See at Show Booth 1721-31.

◀ CIRCLE 124 ON READER-SERVICE CARD

AC Supply 582

With dual meters

These variable ac supplies have output voltage adjustable from 0 to 140 v ac. Model 1073 has output current of 0 to 3 amp; model 1078, 0 to 7-1/2 amp. Dual range ammeters may be switched under load. There is no waveform distortion or significant voltage drop from no load to full load. Meters are accurate to ±3% of full scale. Size is 6-1/2 x 5-3/4 x 7 in.

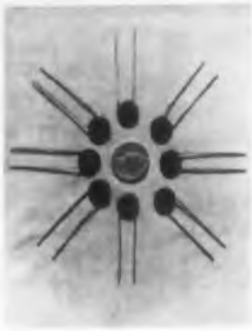
Electronic Instrument Co., Inc., Dept. ED, 33-00 Northern Blvd., Long Island City 1, N.Y.

P&A: Kit $39.95, wired $47.95; stock.

See at Show Booth 3509.

Epoxy Dip Coat 584

Is drip-free



Eccocoat D30, a one-part epoxy dip coat, is drip-free. An initial gel develops on the surface of a preheated component dipped into the high-viscosity resin. Thickness of the coating will be determined by the temperature of the component and time of immersion. Parts may be placed immediately in a 300-F oven without drips. Pot life is 6 months.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

P&A: $1.45 to $1.30 per lb; stock.

See at Show Booth 3823.

CIRCLE 125 ON READER-SERVICE CARD ➤

Now these 5 modules put BEAM-X® switch to work — Binary Decoders — Low Cost Counters — Multiposition Distributors — Transistorized Decade Counters — Multiposition Scanners —

DC-113
LOW COST DECADE COUNTER
This 1 KC Counter utilizes unique input circuitry which eliminates the need for active elements such as tubes or transistors to drive succeeding decades. Particularly useful in machine control and automation fields for reliable medium speed counting.

DC-115
TRANSISTORIZED BINARY DECODER
Converts 1248 or 1224 binary coded decimal information directly to decimal form in less than 20 μsecs. Provides electrical outputs to drive NIXIE tubes and printers. Used in computer readout, data conversion and electronic instrumentation.

DC-114
TRANSISTORIZED DECADE COUNTER
Utilizes the new shielded BEAM-X switch, BX-2000, to resolve pulses at 110 KC. NIXIE tube readout is provided on the plug-in module. Designed for use in military systems, electronic instrumentation, computers and test equipment.

DC-111
TRANSISTORIZED DECADE COUNTER
Utilizes the BX-1000 BEAM-X switch with transistors to resolve pulses at 110 KC. Ten electrical outputs drive remote NIXIE® tubes, printers and perform other circuit functions. This is the lowest cost, transistorized decade counter available.

DC-112
"UNIVERSAL MODULE"
Used for counting, distributing, multiplexing and scanning. Functions as a parallel to serial converter by utilizing the unique 4th electrode of the BEAM-X switch. All functions can be performed merely by reconnecting the input and output terminals of the module. Frequency capabilities to 110 KC.

5 NEW MODULES PUT BEAM-X® SWITCH TO WORK

All 5 modules drive 200,000 hour life NIXIE Indicator Tubes directly, without need for decoding matrices or amplifiers, as required by other techniques.

Write today for BEAM-X folder with complete technical information.

SEE THEM AT BOOTHS 1211-1213-1215, IRE SHOW.

Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

looking for a special potentiometer?

. . . reach for **EDC**

Your copy of EDC lists 157 different types of potentiometers in its PRODUCT LOCATOR. 27 categories from "AC" to "Wirewound" are included. Each sub-listing such as "Clutch," "Linear Motion," "Microminiature," "Precision," or "Self-trimming" gives manufacturers' name and thumbnail specs to aid in rapid selection. 52 items are further described by special literature bound in sections 2 or 3 of EDC.

This is only one example of the more than 7,000 products from 2,212 companies which are displayed.

Handy Inquiry Cards or Application Data Forms are bound in to make it easier for you to obtain additional data — and manufacturers' reps are also listed if you wish to phone for quick price and delivery information.

Electronic Designers' Catalog is one more service provided by the publishers of *Electronic Design.*

NEW PRODUCTS AT THE IRE SHOW

Right-Angle Connectors 569

For printed circuits

Right-angle printed-circuit connectors are available in a variety of contact sizes from 4 to 38. All dip-solder to a circuit board at a right angle to the plug and receptacle contacts. Terminations include solder cups, turret terminals, and others. Pin contacts are brass and stainless steel, gold plate over silver plate. Socket contacts are phosphor bronze with gold plate over silver plate. A variety of molding compounds are available.

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

See at Show Booth 2307-09.

Crimp Tools 599

The CCT-2016 crimp tool has interchangeable heads for No. 16 and 20 size contacts. MS3191-1 is ratchet-controlled for No. 12, 16 and 20 size contacts. A portable pneumatic and a portable, semi-automatic pneumatic crimping tool are also available.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

See at Show Booth 2727-31.

Rack/Panel Plugs 571

With crimp contacts

Rack/panel plugs are now offered with crimp snap-in contacts. Affected types are DPX, DPA, DPD, and D subminiature plugs, together with the environmental types such as DAD and DED. The gold-plated, copper contacts are rated at 5 amp. Coaxial inserts are also available. Monobloc insulation is diallyl phthalate. Accessories such as floating mounts and a variety of junction shells are available.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

See at Show Booth 2727-31.

CIRCLE 43 ON READER-SERVICE CARD ➤

this is
the Brush
Mark II...
anyone
can
plug
it in

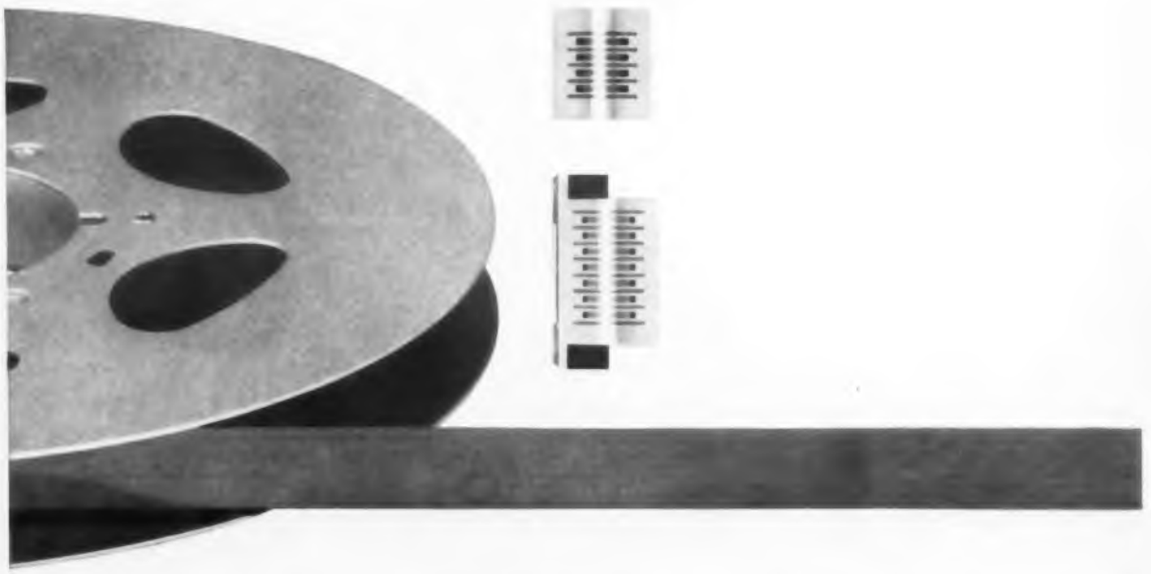
put it
in writing
anywhere

There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Ink or electric writing models. Immediate shipment from stock.

brush INSTRUMENTS

DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

standard heads by Brush fill 90% of all Magnetic Head Applications



Why such an all-out claim? Because only Brush has kept pace with the many design requirements in recording technology. Continuous analysis of current and future trends enables us to maintain a design improvement program incorporating all field-proven advances in our *standard* heads. It's a must . . . to satisfy *all* customer requirements. The result? We've been able to standardize and meet all but a few highly specialized applications. You save engineering and testing time . . . and money. If you're one of the few with a "special" problem, Brush obviously has the engineering capability and manufacturing facilities necessary to fulfill *your* magnetic head application. With both standard and special heads, detailed mechanical drawings and specifications plus actual electrical characteristics are available *before the fact*. You can accurately predict system performance without costly time-consuming tests. *Write now for our design and specification bulletin "Optional Characteristic Heads".*

brush INSTRUMENTS

DIVISION OF

37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

Magnetic Amplifiers 378

For two-phase servos

Designed to drive instrument-type two-phase servo motors, these amplifiers control the current to both phases, reducing standby power. Input is dc, polarity-reversible; output is ac, phase-reversible. Input may be as low as 75 μa for maximum output.

Airpax Electronics Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

Price: *$93 ea, 1 to 6.*

Availability: *3 to 4 weeks.*

Potentiometer 416

For industrial processes

This industrial potentiometer, known as the ElectroniK 17, incorporates an electromechanical strain gage as the rebalancing element. Infinite resolution is obtained by elimination of the conventional slide-wire. All critical components are isolated within an electrical shield. The unit has one true reference junction compensation for all types of thermocouple actuation. Transistorized plug-in control units are available up to a maximum of eight set points for zone control.

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

Availability: *8 weeks.*

CIRCLE 128 ON READER-SERVICE CARD ➤

◄ CIRCLE 127 ON READER-SERVICE CARD

ELEVEN DOZEN ZENERS

132 BASIC ITT TYPES COVER 33 VOLTAGES IN 4 POWER RATINGS

The complete ITT "Gold Crown" line of zener voltage regulator diodes offers all the most widely used power ratings in a very extensive range of zener voltages. Backed by the world-wide research, development and production facilities of the great ITT System, these outstandingly reliable diodes feature sharp zener characteristics, low dynamic impedance and conservative power ratings. Welded cases with hermetic glass-to-metal sealing assure total environmental protection for the most critical commercial and military applications. Write for Bulletin No. 230, containing complete data.

- 4 power ratings: ¾, 1, 3½ and 10 watts
- 33 zener voltages (nominal): 3.9 to 100 volts
- standard tolerances: ±20%, ±10%, ±5%
- temperature range: —65° to 175° C.

ITT

SEMICONDUCTOR DEPARTMENT ■ COMPONENTS DIVISION

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION, CLIFTON, NEW JERSEY

ITT COMPONENTS DIVISION PRODUCTS: SELENIUM RECTIFIERS • SILICON DIODES AND RECTIFIERS • TANTALUM CAPACITORS • POWER TUBES • IATRON STORAGE TUBES • HYDROGEN THYRATRONS • TRAVELING WAVE TUBES

NEW PRODUCTS

DC Power Supply 352

Output is 12 v dc

This transistorized, regulated dc power supply operates from 115 v ac, 400 cps and produces 12 v dc at up to 7-amp output. Ripple and noise level are less than 100 mv peak-to-peak. Output impedance is less than 0.025 ohm measured at 400 cps. It has a noninductive filter, self-protecting circuits and continuous operation to 55 C.

Kaiser Electronics, Inc., Dept. ED, 1160 Monroe St., Union, N.J.

Availability: *Six to eight weeks.*

Environmental Chamber 443

3-cu-ft capacity

With a chamber capacity of 3 cu ft, this environmental unit provides controlled high and low temperatures, altitude, and humidity. Temperature range is —100 to 500 F, accurate to ±2 F. Altitude of 100,000 ft is attained in 30 min, 150,000 in 60 min. Humidity range is 20 to 95% ±5% at temperatures from 35 to 200 F. The chamber is 18 x 18 x 18 in., with a 12 x 12-in. multipane window.

Cincinnati Sub-Zero Products, Dept. ED, 3932 Reading Road, Cincinnati 29, Ohio.

Price: *About $8,000.*

Availability: *30-day delivery.*

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

New Automatic Continuous Evaporation Process— Minimizing the "human variables," the new process makes maximum use of automatic precision control of temperature, vacuum and deposition rates. The result is a predictable life of 80,000 hours or more, and unexcelled functional reliability. The sphere (see larger photo) holds each cell at an equal distance from the "boiler," creating even, uniform deposition cell to cell.

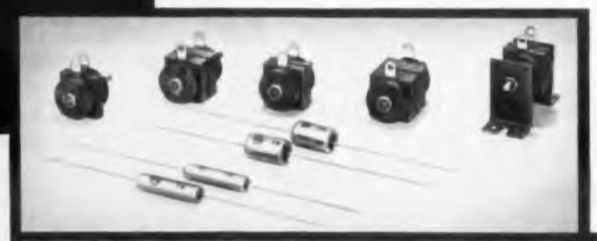
NEW PRECISION PROCESS USED TO PRODUCE NEW G-E THYRECTOR DIODES FOR TRANSIENT VOLTAGE PROTECTION

Unexcelled functional reliability and predictable life of 80,000 hours or more . . . that's the story of General Electric selenium rectifiers as a result of the introduction of the new *Automatic Continuous Evaporation Process* at the Lynchburg, Virginia facility. Another extremely important result is the development of the new G-E Thyrector diode. The Thyrector diode is a new AC transient voltage protective device. It offers you maximum reliability and significant reductions in over-all circuit cost.

Acting as an insulator up to 100% of the voltage, the Thyrector diode quickly becomes conductive above 100%, dissipating transient energy in its built-in heat sink. A much steeper breakdown characteristic makes it more effective than other devices of this type, and a very low temperature coefficient makes it effective over a wider range of temperature. When the Thyrector diode is used with General Electric silicon rectifiers and controlled rectifiers (with transient PRV ratings), you have the best available transient voltage protection.

Design around General Electric Thyrector diodes. Your General Electric Semiconductor District Sales Manager has applications and pricing information, or write to Rectifier Components Department, Section 23C4, General Electric Company, Auburn, New York.

CHECK INTO THE ADVANTAGES OF THE NEW GENERAL ELECTRIC THYRECTOR DIODES ● Higher reliability at reduced cost ● No aging problem ● Eliminates auxiliary resistors ● Eliminates parasitic oscillations, commutation transients and ringing effects otherwise developed by capacitive filters ● High voltage spikes won't damage the G-E Thyrector diode ● Sharp breakdown characteristic, low temperature coefficient



Thyrector Diodes for Transient Voltage Protection — The cells used in Thyrector diodes are high temperature, high voltage types, so each "stack" can be made with fewer cells, without cell spacing, keeping size and cost to a minimum. Cell sizes will be available to cover a complete range of power ratings. An extremely important feature is that Thyrector diodes allow circuit designers to use *lower PRV* silicon rectifiers and controlled rectifiers with greater safety and at much lower cost.

Miniature, Standard and Special Type Rectifiers — Vac-u-Sel® rectifiers are manufactured using the Automatic Continuous Evaporation Process, and are available in thousands of different ratings, sizes and construction types to suit your requirements for temperature, atmospheric conditions, ease of assembly and electrical characteristics. Selenium rectifiers usually cost less per watt than any other types. The higher quality of the new Vac-u-Sel rectifier types does not add to the price.

GENERAL ELECTRIC

CIRCLE 130 ON READER-SERVICE CARD

Electric Counter 696

Speed to 1,000 per min

Preset quantities may be counted at speeds up to 1,000 per min with the CE-901 electrically actuated predetermining counter. A spdt control relay, with contacts rated at 4 amp, 115 v ac, may be used to initiate any desired action at completion of the preset count. Standard models are available with 2 to 5 digits.

General Controls Co., PIC Automation Controls Div., Dept. ED, 8078D McCormick Blvd., Skokie, Ill.

Thermoelectric Kit 412

For experimental use

Type 300 thermoelectric experimental kit is designed to make it possible to obtain empirical knowledge directly of thermoelectric materials, principles and techniques. Contained in the kit are Frigistor cooling modules made of Neelium as well as hardware to conduct a broad spectrum of basic experiments. A 38-page instruction book is included.

General Thermoelectric Corp., Dept. ED, Princeton, N.J.

Availability: *10 days.*

DC Power Supply 743

Regulation is 0.1%

The series R transistor-regulated power supply provides dc from 105 to 130 v. Output is regulated to less than 0.1% variation; ripple is less than 0.01%. There are 11 models ranging from 10 v dc at 2.5 amp to 300 v dc at 85 ma. The octal-mounting supplies have floating output and a temperature range of —54 to 45 C.

Control Circuits, Inc., Dept. ED, 66 Marlborough St., Portland, Conn.

Price: *$298 ea.*

Availability: *2 to 4 weeks.*

Tung-Sol exciter lamps deliver the photon energy to *Westrex* phototransmission equipment

Westrex phototransmission system, Pressfax, works at such high speeds that it can flash the entire content of a page twice this size — pictures and all — thousands of miles in minutes via telephone or radio links. Newspapers both here and abroad are making use of facsimile transmission and receiving equipment for simultaneous publication in several locations with copy and photographs transmitted from a central editorial office.

Photon energy for Pressfax is delivered by specially designed Tung-Sol high current exciter lamps. To guarantee uninterrupted operation, Tung-Sol developed a highly rugged unit containing a reinforced filament that withstands the shock associated with the traveling optical carriage. In addition, Tung-Sol eliminated the problem of contact resistance variation in the lamp socket by developing a heavy screw terminal for the center contact. All lamps are pre-focused by Tung-Sol so that Westrex customers can replace exciter lamps without requiring a service expert. As Westrex summed it up: "The ruggedized lamps developed for us by Tung-Sol have met all of our expectations".

Tung-Sol's long and outstanding background in the design, development and production of low voltage lamps is readily available to you. With more than half a century of lamp making experience behind Tung-Sol, you can be sure that your lamp needs, no matter how exacting, will be met exactly. Like all Tung-Sol components — including tubes, semiconductors and flashers — Tung-Sol instrument lamps are the product of the highest manufacturing standards and quality assurance practices which have made Tung-Sol the name synonymous with the finest in componentry. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK 193

Technical assistance available through Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. In Canada: Montreal, P. Q.

TUNG-SOL®

NEW PRODUCTS

Test Facility 377

Walk-in type

For testing under simulated conditions of altitude, temperature and humidity, this walk-in facility has an all-welded stainless steel interior. It will produce temperatures from —100 to 300 F, relative humidities from 20 to 95%, and altitudes to 100,000 ft.

The American Research Corp., Dept. ED, Farmington, Conn.

Ultrasonic Cleaner 423

Is self-contained

Both generator and cleaning tank are housed in a one-piece stainless steel cabinet in the model 940 ultrasonic cleaner. Generator capacity is 250 w average; the three-gallon cleaning tank measures 10 x 11 x 6 in. The cleaner weighs 85 lb and requires 115 or 230 v at 6 or 3 amp.

National Ultrasonic Corp., Dept. ED, 111 Montgomery Ave., Irvington 11, N. J.
Price: $725.

Voltage Regulators 455

Range from 10 to 10,000 va

This line of filament-voltage, line-voltage and power-supply regulators is available with any of 31 different output voltages from 2.5 to 1,055 v rms. They have up to

◀ CIRCLE 131 ON READER-SERVICE CARD

three secondary windings with a total output rating of 10 to 10,000 va. Temperature range is −10 to +40 C.

Sorensen & Co., Inc., Dept. ED, Richards Ave., South Norwalk, Conn.

Pressure Transducer 422

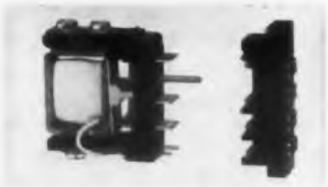
Variable reluctance type

Model CP49 combines a variable reluctance pressure transducer and a dc-energized carrier-demodulator in a single package. Ranges are 5 to 10,000 psi, gage, differential, or absolute. Overpressure is 700 psid or 200% of range; zero shift with line pressure is less than 1% full scale. With an output of 0 to 5 v dc, the unit is regulated against input voltage changes from 25 to 30 v dc. Linearity is within 1/2%, hysteresis within 1/2%. Ambient temperature is −65 to 250 F.

Pace Engineering Co., Dept. ED, 13035 Saticoy St., North Hollywood, Calif.

Wire-Contact Relay 359

For computer use



The director is a wire-contact relay designed to set up circuits in the logic or arithmetic section of computers. The 4pdt relay has contacts rated at 3 amp, and an operating time of 5.5 msec max. Coil voltage is 20 to 115 v dc. Plug-in terminal and mating terminal block eliminate soldering.

Essex Wire Corp., RBM Controls Div., Dept. ED, Logansport, Ind.

How To Design High Performance Voltage Regulator For Military Applications

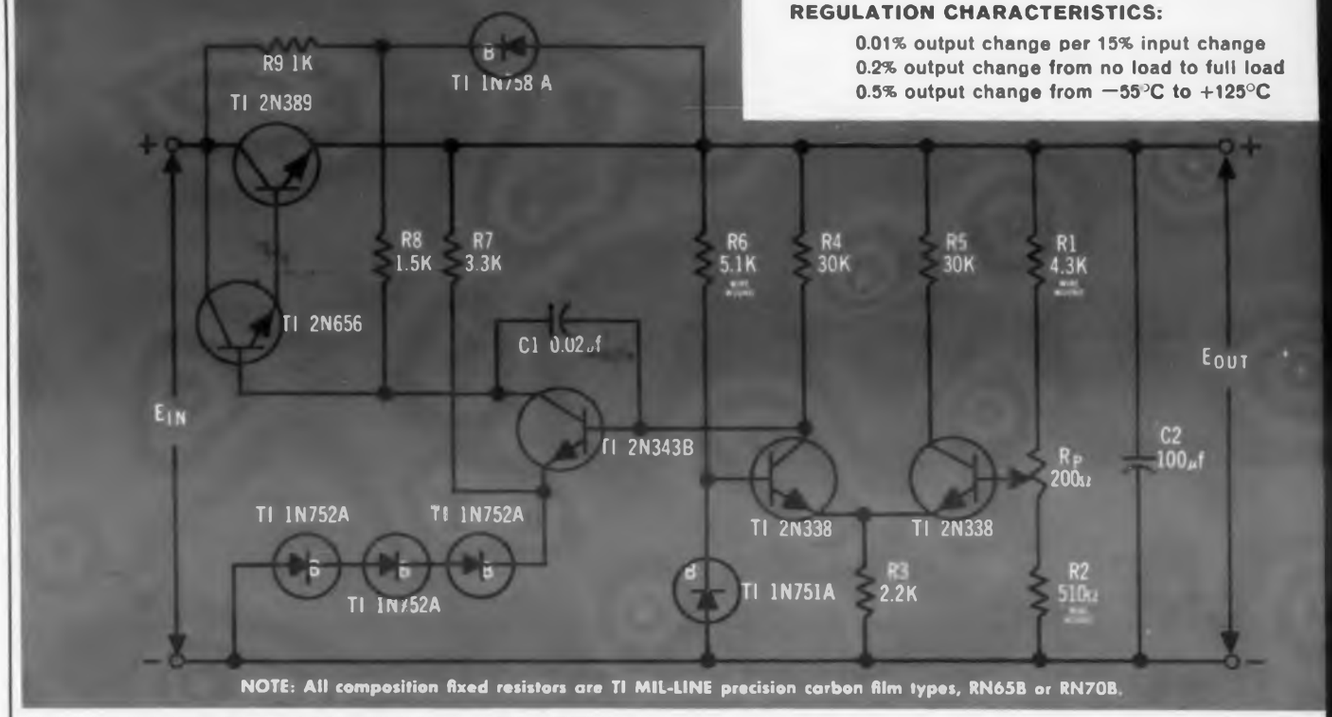
TRANSISTORIZED DC REGULATOR

NOMINAL CHARACTERISTICS:

Input - 75 volts DC
Output - 50 volts DC - 0 to 400 ma
Output Impedance - less than 0.25 ohms
Operating Temperature - −55°C to +125°C

REGULATION CHARACTERISTICS:

0.01% output change per 15% input change
0.2% output change from no load to full load
0.5% output change from −55°C to +125°C



NOTE: All composition fixed resistors are TI MIL-LINE precision carbon film types, RN65B or RN70B.

...with TI MIL-TYPE Semiconductors & Components

You can depend on your circuits to give the high performance/high reliability/low maintenance you demand when you design-in TI semiconductors and components. The DC regulator circuit above contains... transistors which meet or exceed MIL-S-19500B... diodes which meet or exceed MIL-E-1/1258... resistors which meet or exceed MIL-R-10509C. ■ Your TI sales engineer is qualified to assist you in selecting TI devices and components to meet your particular military design requirements. ■ Get your personal copies of TI Application Report, "DC Regulator Power Supply Design" and TI Application Note, "Silicon Transistor Voltage Regulator Overload Protection" by writing on your company letterhead to Military Marketing, Dept. M-1, Texas Instruments Incorporated, P. O. Box 5012, Dallas 22, Texas.

TI MIL-TYPE semiconductors and components are immediately available "off-the-shelf" from TI's national distributor network.

SEMICONDUCTOR-COMPONENTS DIVISION

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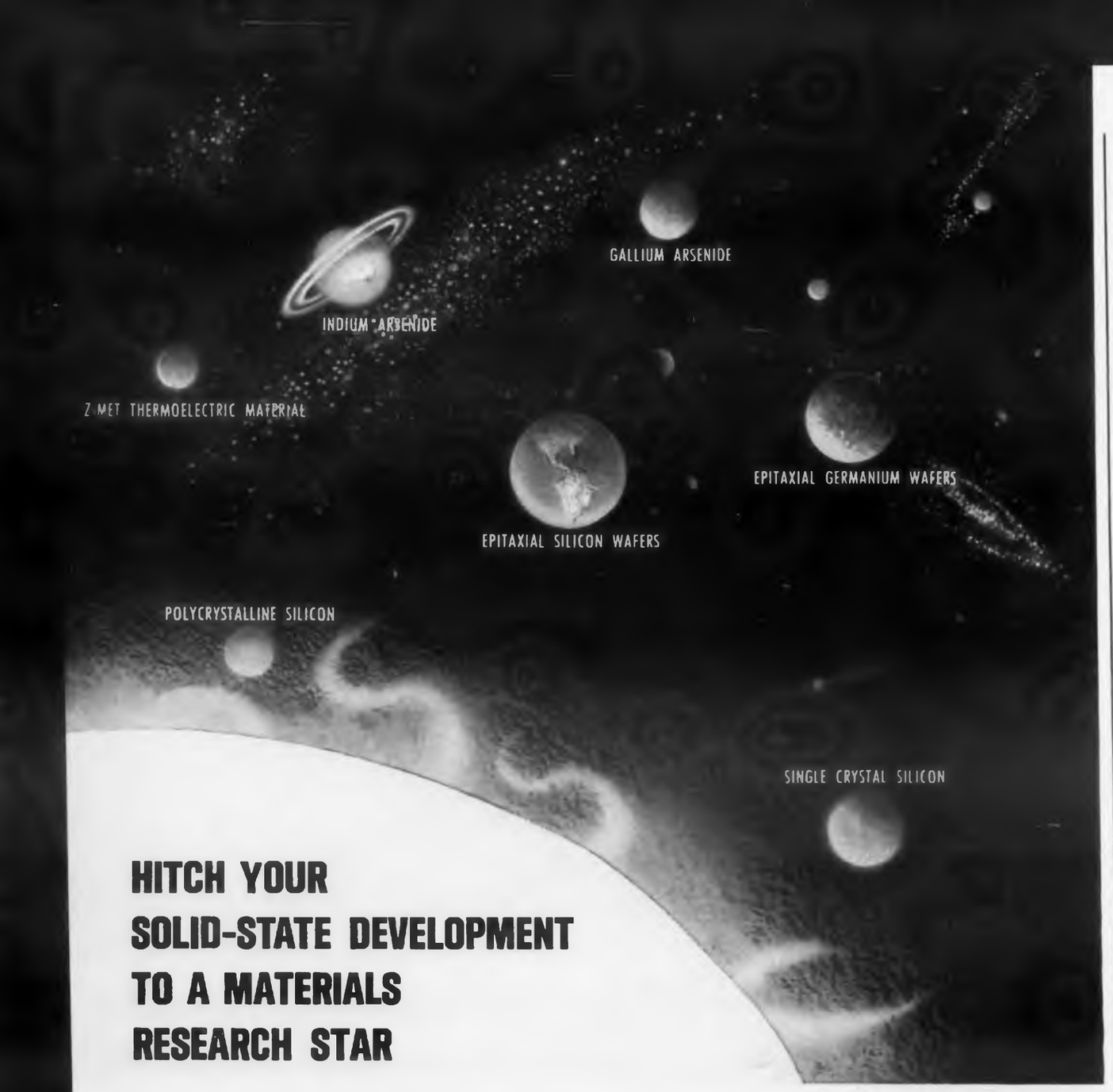

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Your profits in the next decade will be greatly benefited by the right choice of supplier of solid-state materials.

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Judged on this basis the Electronic Chemicals Division of Merck & Co., Inc. deserves your attention. In just four short years, it has achieved these exclusive major breakthroughs:

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Electronic Chemicals Division

MERCK & CO. Inc. · RAHWAY, NEW JERSEY

RESEARCH and PRODUCTION FOR BETTER SOLID-STATE MATERIALS

NEW PRODUCTS

Digital Multimeter 421

For automatic checkout

Developed for use in automatic checkout applications, the model M7 multimeter is a solid-state, analog-to-digital converter. Frequency measurements from 1 cps to 100 kc, to an accuracy of 0.01% ±1 count, can be made in 0.1 sec. Periods from 0.001 to 0.1 sec can be measured to an accuracy of 0.01%. Voltage and resistance ranges extend to 1 kv ac or dc and 1 meg. The requirements of MIL-E-16400 are met.

Packard Bell Computer Corp., Dept. ED, 1905 Armacost Ave., Los Angeles 25, Calif.

Availability: *120-day delivery.*

Current Meter 711

For differential rate control

Model 202 differential current meter measures and meters the current from two transducers either separately or differentially. Dynamic range of the instrument is 10^5 and it will measure currents as low as 10^{-9} amp full scale. Frequency response is 1/2 cps per sec at the lowest range, increasing to 30 kc at the least sensitive range. Preamplifiers with gain of 10^3 are available for low-level work.

Eldorado Electronics, Dept. ED, 2821 Tenth St., Berkeley 10, Calif.

Price: *$1,195.*

Availability: *30 days.*

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TRIMPOT®

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Yes! Schweber can sell any model of BOURNS TRIMPOT® at factory prices. Sizeable quantities are available for immediate shipment from stock from Schweber's warehouse.

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This Top Team of Application Engineers Represents You at Bourns!

NUMBER 12 — APPLICATION SERIES

See us March 20-23 at the IRE Show/Booths 1816-1818.

Consider this crack Trimpot® engineering group an extension of your own staff... because that's exactly what it is. Each of these men is a graduate engineer; each has extensive experience in potentiometer applications; and each is responsible for technical subjects within a specific geographic area. The Bourns specialist assigned to your region therefore becomes well acquainted with your requirements—to help you solve today's problems today!

Because Bourns offers the widest selection of adjustment potentiometers in the nation, these men are in the best possible position to steer you to fast answers for your potentiometer needs. If modifications or specials are in order, they'll come up with sound, low-cost solutions. If your problems require direct engineer-to-engineer contact on problems involving design, quality control, or testing, they'll provide it... on the phone or in your office.

Here, in short, is a group of engineers devoted to giving you personal service and personal follow-through on your projects. The phone is right there on your desk—call anytime!

Exclusive designers and manufacturers of Trimpot® potentiometers. Pioneers in transducers for position, pressure, acceleration,

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NEW PRODUCTS

Film Viewer 489

With 27.5-in. screen

This 16-mm film viewer presents data magnified 20 times on a viewscreen that measures 27.5 x 11.5 in. Film speed can be continuously varied from 1.3 cm per sec; film can be traversed in either direction at 120 cm per sec. Distortion is less than ±1%.

The Geotechnical Corp., Dept. ED, 3401 Shiloh Road, Garland, Tex.

Miniature Differential 366

For loads to 75 in. per oz

Designed for loads up to 75 in. per oz, the model X-1943 miniature differential is suited for use in servo systems and for mathematical integration. Backlash is held to 1-1/2 min with a 0.5-in. per oz checking load. Starting torque is 0.1 in. per oz. All parts are stainless steel. The X-1943 can be supplied in a wide range of end gear ratios.

Bowmar Instrument Corp., Dept. ED, 8000 Bluffton Road, Fort Wayne, Ind.

Modulator 470

Is solid state

Known as the Microchopper, this solid-state modulator is designed to alternately connect and disconnect a load from a signal source. It is capable of linearly switching or chopping voltages from a fraction of a millivolt to 10 v. It can be driven from dc to 100 kc.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.

Price: *$39 ea.*

Availability: *From stock.*

OVER 180 COMBINATIONS

CIRCLE ESS STANDARD FLEXIBLE SHAFT ASSEMBLIES are versatile enough to fill the demands of many different applications and yet offer the advantages of economy in time and money.

They are composed of stock components, the finest steel cable, vinyl covered steel casing and cadmium plated coupling type steel and fittings.

We solicit your inquiry on Circle Ess Flexible Shafting.

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West Coast Plant: 2404 So. Grand Ave., Los Angeles 7, California

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success in the palm of your hand... with new hi-capacitance sub-miniature

CERAMIC CAPACITORS by STATNETICS

replaces plastic and paper with all the known advantages of ceramic capacitors

BRIEF SPECIFICATIONS

CAP. MFD.	LENGTH in.	WIDTH in.	THICKNESS in.
.00001 thru .001	.3	.095	.095
.001 thru .01	.3	.15	.125
.05	.52	.25	.20
.10	.52	.3	.3

Cap. Tol. = GMV, ±20%, ±10%
P.F. = 2% Max.
Working Voltage = 100 VDC to 125 C.
Series Resistance < .25 ohms at 8 to 10 mc.
Leads axial #22 gauge 1½" long (fine silver)

For full specifications, prices, or delivery dates, please write to Statnetics Corp., Department ED-2

STATNETICS *Corporation*

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Lockheed Electronics offers:

Complete Circuitry Facilities

Cadillac Presents

THE CASE OF THE RELUCTANT E. E.

His motto on changing jobs, is "a bird in the hand is worth two in the bush"—AND HE'S RIGHT. Even though his work and income may be less than his ability dictates, making a job change can be a risky task.

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JACK L. HIGGINS, *Vice President*

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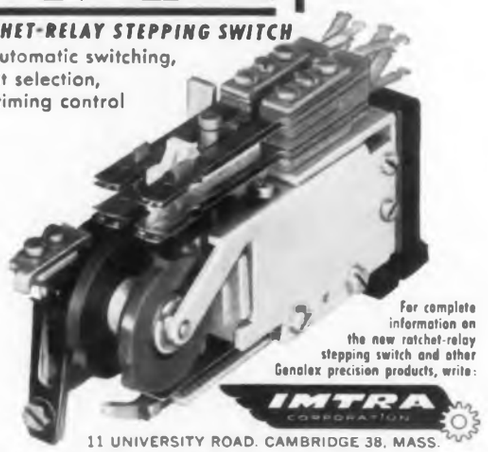
CIRCLE 881 ON READER-SERVICE CARD

NEW!!! from GENALEX

- Occupies small mounting space.
- Does not overheat.
- Accurate, dependable, sturdy.

Featuring:
36 steps per second on self-interruption.
20 steps per second from external pulses.
Operation on 75% nominal voltage.
Life in excess of 50,000,000 steps.

RATCHET-RELAY STEPPING SWITCH
for automatic switching, circuit selection, and timing control



For complete information on the new ratchet-relay stepping switch and other Genalex precision products, write:

IMTRA CORPORATION
11 UNIVERSITY ROAD. CAMBRIDGE 38, MASS.

U. S. Sole Distributors for the General Electric Co., LTD. of England.

CIRCLE 197 ON READER-SERVICE CARD

COMPLETE CIRCUITRY FACILITIES from artwork to finished boards . . . on both inexpensive commercial etched-copper circuitry through the most sophisticated "plated through hole" (mil. spec.) type boards.

ENGINEERING AND DESIGN assistance in the development of printed circuit artwork.

ASSEMBLY OF COMPONENTS of all types – commercial, miniature and sub-miniature, using either hand soldering, automatic flow soldering, or welding techniques.

MAXIMUM QUALITY CONTROL is maintained in every phase of operation with individual inspectors specializing in artwork, photography, plating and etching, fabrication and assembly.

For further information regarding your printed circuitry requirements write Marketing Department, Lockheed Electronics Company, Avionics and Industrial Products Division, 6201 E. Randolph Street, Los Angeles, California.

LOCKHEED ELECTRONICS COMPANY LEC

Operations Monitor 487

Up to 100 channels

Response time of this operations monitor is less than 4 msec. Multiple high-speed events are recorded from start to stop, on a common-time basis, at rates up to 500 per sec. Portable, 30-channel models, or rack-mounting 100-channel models use fixed-stylus electric writing. Transistor switching is optional.

Clevite Corp., Brush Instruments Div., Dept. ED, 37th & Perkins, Cleveland 14, Ohio.

Modular Converter 419

Frequency to dc

The FR-500 series modular frequency-to-dc converter provides three simultaneous outputs: 0 to 5 v dc; amplified pulse; direct reading indicator on front panel. Input frequency range is from 5 to 3,200 cps in 6 overlapping steps. Output is not affected by an input variation of from 5 mv to 100 v rms.

Waugh Engineering Co., Dept. ED, 7842 Burnet Ave., Van Nuys, Calif.

Solid-State Analyzer 473

For recorder checkout

This solid-state analyzer is for checkout of any digital tape recorder. It is capable of performing all fundamental measurements to determine operational status of a recorder. Specifications are: distance measurements, 0.01- to 0.003-in. resolution; skew measurements, 2% at 1-v peak per μsec; speed variations, 1% on 100-μsec range, 0.2% on other ranges.

Telemetrics, Inc., Dept. ED, 12927 S. Budlong Ave., Gardena, Calif.

◀ CIRCLE 172 ON READER-SERVICE CARD

ENGINEERING

REPORT

ON BENDIX COMPONENTS

Now available in production volume:

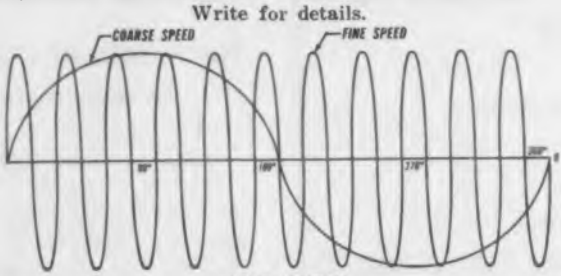
BENDIX AUTOSYN® SYNCHROS AND SYSTEMS with 30-SECOND ACCURACY

The Bendix two-speed Autosyn synchro was developed to meet the need for accurate data transmission with maximum system simplicity. Two electrical outputs are produced from the Autosyn single shaft, eliminating both inaccuracies of two-speed gearing and the installation and maintenance costs of an additional unit.

Autosyn units can be supplied with leads or terminal boards. Units can be used back-to-back or can be coupled with mechanical two-speed transmitters or control transformers. They measure only 2.34" in length by 1.75" in diameter.

Other features: **Accuracy unaffected by thermal or mechanical stress—Adaptability to gyro pick-off—Elimination of gear error of mechanical two-speed system—High signal-to-null ratio.**

Write for details.



EXAMPLES OF APPLICATIONS: Fire Control Systems—Navigation Computers—Inertial Guidance Systems—Radar Antenna Tracking

Eclipse-Pioneer Division

Teterboro, N. J.

Bendix

District Offices: Burbank, and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C.
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

CIRCLE 138 ON READER-SERVICE CARD

NEW PRODUCTS

Control Amplifier 727

Has 2% linearity

This control amplifier is designed primarily for driving recorders from low-energy dc sources. It has 2% linearity over an operating temperature range of 0 to 75 C for loads from 600 to 3,000 ohms. It has a full-wave unfiltered dc output with complete isolation from line sources. Input dc impedance of signal winding is 400 ohms ±20%.

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

Delay Line 411

Phase linearity is ±0.1%

Type L894C audio delay line has a delay of 5,000 μsec ±1%. It has a phase linearity of ±0.1% in the center frequency band from 3,050 to 3,550 cps. The phase linearity to cut-off is ±0.2%. The unit has an impedance of 600 ohms, and a low frequency insertion loss of 1.5 db. Attenuation is 3 db at 3.5 kc and 6 db at 4.8 kc.

Columbia Technical Corp., Dept. ED, Woodside, N.Y.

Pressure Transducer 703

Is piezoresistive

This miniature piezoresistive pressure transducer has a sensitivity of 40 mv per v. There are 3 ranges, from 0 to 25, 100, and 500 psig. Temperature range is from −65 to 350 F. Natural frequency is greater than 4 kc; dynamic frequency response ranges from 0 to 1 kc. Vibration sensitivity is rated at less than 0.008 mv per v per g.

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

ENGINEERING
REPORT
ON OTHER BENDIX COMPONENT PACKAGES

NEW 2-SPEED "PANCAKE" SYNCHRO TRANSMITTER

Resists stresses and temperature extremes

This compact, two-speed "pancake" synchro transmitter consistently exhibits an accuracy within thirty seconds of arc under dimensional stresses and wide temperature variations. The same order of accuracy is maintained when the transmitter is used back-to-back with a conventional two-speed control transformer. The synchros are operable from −55°C. to +200°C. They are logical replacements for existing mechanical two-speed transmitters. Their bantam weight (5 oz.) and small size (2.685" O.D. x 1.002" I.D. x 0.562" thick) suits them ideally to vertical gyro gimbals and other assemblies where size and weight are critical factors. Write for complete information.

Manufacturers of
GYROS • ROTATING COMPONENTS
RADAR DEVICES • INSTRUMENTATION
PACKAGED COMPONENTS
Eclipse-Pioneer Division

Bendix
Teterboro, N. J.

CIRCLE 139 ON READER-SERVICE CARD

Mylar Capacitors 500

Are 0.225-in. thick

Type MCA epoxy-dipped mylar capacitors are 0.525-in. wide and 0.225-in. thick at 0.01 μf. Operating temperature range is —55 to 100 C, or to 125 C with 50% voltage derating. Capacitance change is 1.5% at 85 C. Power factor is less than 1% at 1 kc and 25 C. Values range from 0.01 to 0.33 μf.

Hopkins Engineering Co., Dept. ED, 12900 Foothill Blvd., San Fernando, Calif.

Cooling Unit 396

Capacity is 1.3 kw

This cooling unit contains an aluminum, plate-fin, counterflow, air-to-air heat exchanger, two axial-flow fans and a temperature control system. Rated cooling capacity is 1.3 kw. Over-all dimensions are 35.9 x 11.9 x 6.8 in.

The Cosmodyne Corp., Dept. ED, 12833 Simms Ave., Hawthorne, Calif.

Cathode-Ray Tube 512

With flat 5-in. face

Cathode-ray tube type 5BWP has a flat, 5-in. diameter face plate. It has a spiral linear post accelerator operating at 24,000 v. Focus and deflection are electrostatic. Astigmatism and pattern controls ensure distortionless displays. The screen face is aluminized.

Fairchild Camera and Instrument Corp., Allen B. Du Mont Laboratories Div., Electronic Tube Div., Dept. ED, Clifton, N.J.

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NEW BINARY DECODING DIGITAL READOUT

Prices start at $50.00 each.

Available in individual units or assemblies.

Write today for complete detailed specifications.

Translates Direct— Coded Binary-to-Decimal and Alpha-numeric

Now, with the new Bina-View, digital readouts take on an added dimension. Here is a readout that operates direct from binary input, has its own retentive memory, and offers one-plane in-line presentation. Realistically priced and designed with the user in mind, it is not to be confused with other readout devices on the market.

The Bina-View Digital Readout fills the long-standing need for a fast, accurate, binary operated display in the fields of digital computers, missile checkout systems, ground support equipment, etc. Its ability to operate within a wide range of binary codes makes it the most versatile readout available today.

Self-Decoding. The new Bina-View Digital Readout accepts any BCD or teletype code up to six bits, does its own translating, and displays the proper character. There are no auxiliary translators, relays, or diodes required.

Low Power. The Bina-View Digital Readout may be operated with as little as ten milliwatts per bit of signal power. It may be connected directly into computers and other electronic equipment.

Character Storage. The Bina-View Digital Readout will continue to display the last character entered after the signal input power has been removed.

Memory and Verification (Optional). When required, contact closures may be provided for verification that the input signals have been properly accepted.

Practical. The Bina-View Digital Readout offers clear distinct characters, high even brightness, and wide viewing angle. Extremely durable and vibration-free, it is designed for thousands of hours of trouble-free operation.

Representatives in principal cities.

IEE

INDUSTRIAL ELECTRONIC ENGINEERS, INC.

Engineers and Manufacturers of Fully Automatic Systems and Digital Readouts

5528 Vineland Avenue, North Hollywood, California

CIRCLE 140 ON READER-SERVICE CARD

a new UHF OSCILLATOR

450 to 1050 Mc

Type 1361-A Oscillator.....$285.

- Butterfly Tuning Circuit — no sliding contacts
- Frequency Scale Calibration Accuracy ±1%; constant 0.1% frequency change for each vernier division. Warm-up frequency drift is 0.2%, maximum.
- Modulation Capabilities — sine wave, square wave, or pulse from external source; 40v required to produce 30% sine-wave modulation.
- High Output — 100 mw minimum into 50-Ω load, adjustable at panel by calibrated 80-db attenuator.
- Complete Shielding, including use of ferrite-loaded filters and ceramic shaft, reduces stray fields to very low values.
- Sweep Drive Capability using G-R sweep and dial drives.
- Small Size: 8" x 7" x 8¼"; only 7 lbs.
- Power Supply Recommended: 1201-A Regulated Power Supply $85, for cw; 1263-B Amplitude Regulating Power Supply $355, for constant output level; 1264-A Modulating Power Supply (below).

Type 1361-A Oscillator and Type 1264-A Modulating Power Supply conveniently mount in a relay rack with Adaptor Plates, Type 480-P416, $6.

NEW MODULATING POWER SUPPLY

. . . for high-level pulse and square-wave modulation of Vhf-Uhf Unit Oscillators.

OUTPUTS: Square Waves — adjustable from 160v to 210v; internally generated 850 to 1150 cps, with high stability; externally generated 20 to 50,000 cps from sine or square-wave source.

Pulses (externally generated) — 160v to 210v at rates up to 100 kc, pulse durations from 1.5 μsec to square wave (determined by external generator), less than 1.5 μsec rise and decay times for typical oscillator load, overshoot less than 5%.

Regulated DC — adjustable from 200v to 300v, 50 ma (max)

Unregulated AC — 6.3v; 2.1a (max)

INPUT: 115v or 230v, 50-1000 cps, 85 watts
Small Size: 7" x 8" x 8"; 12 lbs. **Price: $285.**

12 Other Unit Oscillators Cover the Range from 20 cps to 7,425 Mc

See 21 NEW Instruments at the IRE Show
including a Counter with a Memory and a new 1000-Mc Frequency Standard.
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NEW PRODUCTS

Wire-Contact Relays 418

For rack-mounted circuitry

These wire-contact, plug-in relays are designed for rack-mounted circuitry where space is at a premium. Contact arms are double-wire, silver-alloy springs that are removable. Contact rating of each form "C" arm is 1-amp resistive at 25 v dc or 115 v ac for 1,000,000 operations life. They operate in 4-1/2 msec and release in 2 msec. They are available in 4-, 6- and 12-pole models.

Wheelock Signals, Inc., Dept. ED, 273 Branchport Ave., Long Branch, N.J.

Price: *From $4.55 to $16 ea.*
Availability: *From stock.*

Reaction Torquemeter 364

Has no moving parts

Designed for use with water brakes and other auxiliary-driven, power-absorbing devices, the series PT torquemeter has no rotating or moving parts. The pickup is installed in the same manner as an adaptor flange, and is available in sizes from 200 to 20,000 in. per lb. The rotating shaft of the unit under test passes through the center of the pickup without contact.

Bytrex Corp., Dept. ED, 50 Hunt St., Newton 58, Mass.

Price: *From $1,800 to $3,300 ea.*
Availability: *90-day delivery.*

◀ CIRCLE 141 ON READER-SERVICE CARD

Rectifier Tube 363

Shock rating is 450 g

A half-wave, high-vacuum rectifier tube, the 3B24WA has a shock rating of 450 g. The JAN tube has filament voltage of 2.5 v at 3.0 amp ac. Peak plate current is 300 ma; piv is 20 kv. It is designed to operate in installations subject to shock, vibration, and filament fatigue.

Cetron Electronics Corp., New Products Dept., Dept. ED, 717 Hamilton St., Geneva, Ill.

Ferrite Storage Core 472

Needs no compensation

The XCWT 508-10, a 0.050-in. ferrite storage core, is designed for coincident current memory operation. It will operate without temperature or current compensation over a temperature range of −55 to +100 C.

Ampex Computer Products Co., Advanced Memory Div., Dept. ED, P.O. Box 329, Culver City, Calif.

Relay 420

For bias protection

The RMC-400-1 is a magnetic amplifier controlled relay designed for bias protection in airborne radar systems. Specifications are: power required, 102 v, 380 to 420 cps; control power, 105 v dc, 7 ma max; relay pull-in voltage, 95 v max; relay drop-out voltage, 85 v min.

Marshall Industries, Wahlgren Magnetics Div., Dept. ED, 1900 Walker Ave., Monrovia, Calif.
Availability: *Four to six weeks.*

CIRCLE 142 ON READER-SERVICE CARD ➤

13 MOVES TO RELIABLE TRIMMING

SPECTROL'S FULL LINE of trimming potentiometers features 10 of the smallest square trimmers ever made, plus the only *transistor-size* units for solid state circuitry. This selection covers almost every conceivable application—a sure way to avoid checkmate when you need reliable trimmers.

SQUARE TRIMMER DATA. Models 50 and 60 measure ⅜" and ½" square respectively • humidity proofing a standard feature • available in resistances to 100K • greater surface contact between mandrel and aluminum case for better heat dissipation, no external heat sinks needed • dual wiper for positive contact under all conditions of shock and vibration.

SINGLE TURN TRIMMER DATA. Model 80 built into TO-9 transistor type case • measures less than ⅓" in diameter, weighs 1 gram—smallest trimmer on the market • completely sealed against moisture and humidity • resistance element twice as long as ordinary trimmers • designed for complete package encapsulation with other printed circuit components • available in 3 case styles with resistance range to 20K.

IMMEDIATE DELIVERY. Your nearby Spectrol distributor stocks standard models of trimmers and miniature potentiometers as well as other standard Spectrol precision potentiometers and turns indicating dials. Prices are $6 to $8 in quantities of 1-9 for most styles and resistances.

MORE DATA AVAILABLE. Contact your Spectrol engineering representative or drop us a line at the factory. Please address Dept. 36.

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Phone: WEIls 8-4000

See the complete Spectrol line at I.R.E. Show—Booth 1907-09

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pretty well describes the clear-cut structure of electronic systems management within Alpha Corporation. The engineer who supervises team development of a program proposal is in direct contact with the client. After the contract is signed, management, engineering and administrative talents are coordinated within the project division, and the engineer, as Project Director, has complete authority and responsibility for the project's execution.

Alpha offers opportunities on creative teams for people with specialized capabilities in determining system parameters; integrating a complex of equipments; directing subsystems suppliers. Write: P. C. Nelson, Employment Manager

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CIRCLE 901 ON CAREER INQUIRY FORM, PAGE 219

NEW PRODUCTS

Delay Lines 441

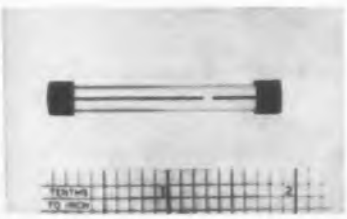
Lumped constant type

The DL-1000 series of lumped constant delay lines achieve delay-to-rise time ratios as high as 175 to 1. They are available in delays to 500 μsec with impedances ranging from 100 to 1,000 ohms. Operating ambient temperature range is from −55 to +125 C.

Allen Avionics, Inc., Dept. ED, 255 E. 2nd St., Mineola, L.I., N.Y.

Ampere-Hour Meter 523

With negligible drain



This reversible, direct-reading ampere-hour meter operates on negligible current. The device integrates time vs current by electrolysis between mercury electrodes. Uses include battery life indicator, elapsed time meter, and analog integrator and indicator. It is available for 1.5 or 6 v dc, 100 to 5,000 hr.

Curtis Instruments, Inc., Dept. ED, 45 Kisco Ave., Mount Kisco, N.Y.

Rotary Switch 398

Has removable wafers

Series RS 15 rotary switch has removable wafers, any one of which lifts out without disas-

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SHOW TIME

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WHERE

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WILL SHOW

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R. F. POWER METER

2 x 10⁻⁹ to 10⁻² WATTS

10 KC to 1000 MC

WE WILL ALSO DISPLAY

- RF Voltmeters
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VEECO manufactures a complete line of high vacuum equipment . . . Leak Detectors, Components, Evaporators, Pumping Systems . . . accepted as the *quality* line for over a decade. For individual Bulletin or Complete Catalog write Dept. 86-G.

VACUUM ELECTRONICS CORP.
Terminal Drive, Plainview, L. I., N.Y.

HIGH VACUUM & LEAK DETECTION EQUIPMENT
CIRCLE 145 ON READER-SERVICE CARD

sembling or unsoldering. The unit measures 1-5/8 x 1-3/8 x 2-7/8 in. for a six-wafer type. Up to 18 epoxy rhodium-plated flushed wafers are available in a 10-position single-pole configuration.

Chicago Dynamic Industries, Inc., Precision Products Div., Dept. ED, 1725 Diversey Blvd., Chicago 14, Ill.
Availability: *30 days.*

Solid-State Inverter 506

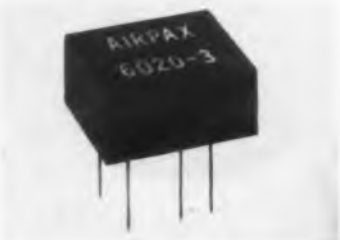
For military or commercial use

Developed for use under extreme environmental conditions, these inverters exceed military requirements. Efficiency ranges from 70 to 85%. The solid-state inverters are available in several standard sizes from 15 va to 200 va.

Globe Industries, Inc., Electronics Div., Dept. ED, 525 Main St., Belleville 9, N. J.

Transistor Chopper 379

Range is dc to 100 kc



A molded transistor chopper, the type 6020-3 operates over a chopping range of dc to 100 kc. Drive voltage may be 2- to 20-v peak square wave or 5- to 20-v peak sine wave. Temperature range is —55 to 125 C. Peak signal voltage may be as high as 30 v; maximum signal current is 3.0 ma.

Airpax Electronics Inc., Cambridge Div., Dept. ED, Cambridge, Md.
Availability: *6 weeks.*

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model 1890

DYNAMIC BETA® IN-CIRCUIT TRANSISTOR TESTER

Measures AC Beta — SILICON / GERMANIUM — In Circuit with 5% Accuracy

The new Model 1890 has been designed to measure parameters of all small and medium power transistors directly in their circuits. The Hickok-developed (and patent applied for) method of neutralizing circuit impedance before tests are made prevents the inaccuracies inherent in other test methods. AC Beta measurements can be made in circuits with as low as 25 ohms impedance. In addition, Dynamic Input Resistance of low and medium power diodes can be measured in or out of circuit.

The Hickok-RD Model 1890 also measures these other in-circuit parameters: R_{in}, Z Ohms (Base-emitter circuit impedance), and I_c. With equal accuracy, measurements of AC Beta, I_{cbo}, I_{ceo} and I_c can be made out of circuit.

Completely transistorized, battery operated, JAN-ized. 17 pounds net. Write today for full technical information.

For full information on Hickok Model 1890-M (Military), write to Hickok, Government Division.

The HICKOK Electrical Instrument Co.

10525 Dupont Ave. • Cleveland 8, Ohio

CIRCLE 146 ON READER-SERVICE CARD

NEW PRODUCTS

Digital Computer 385

Arithmetic center

A solid-state component for computing, process control, and test systems, the model DAC-2500 digital arithmetic center is compatible with all varieties of input and output units and systems concepts. Word length is 18 decimal digits and signs. A magnetic drum storage has a nonvolatile capacity of 16 words per channel, with two channels standard and 10 available. Access time averages 8.5 msec. The unit is 28 x 19 x 13 in. and weighs 97 lb. Power requirement is 117 v ac ±10%, 60 cps, 1 phase, 100 w.

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

Availability: *From stock.*

Resistance Meter 429

0 to 200 milliohms

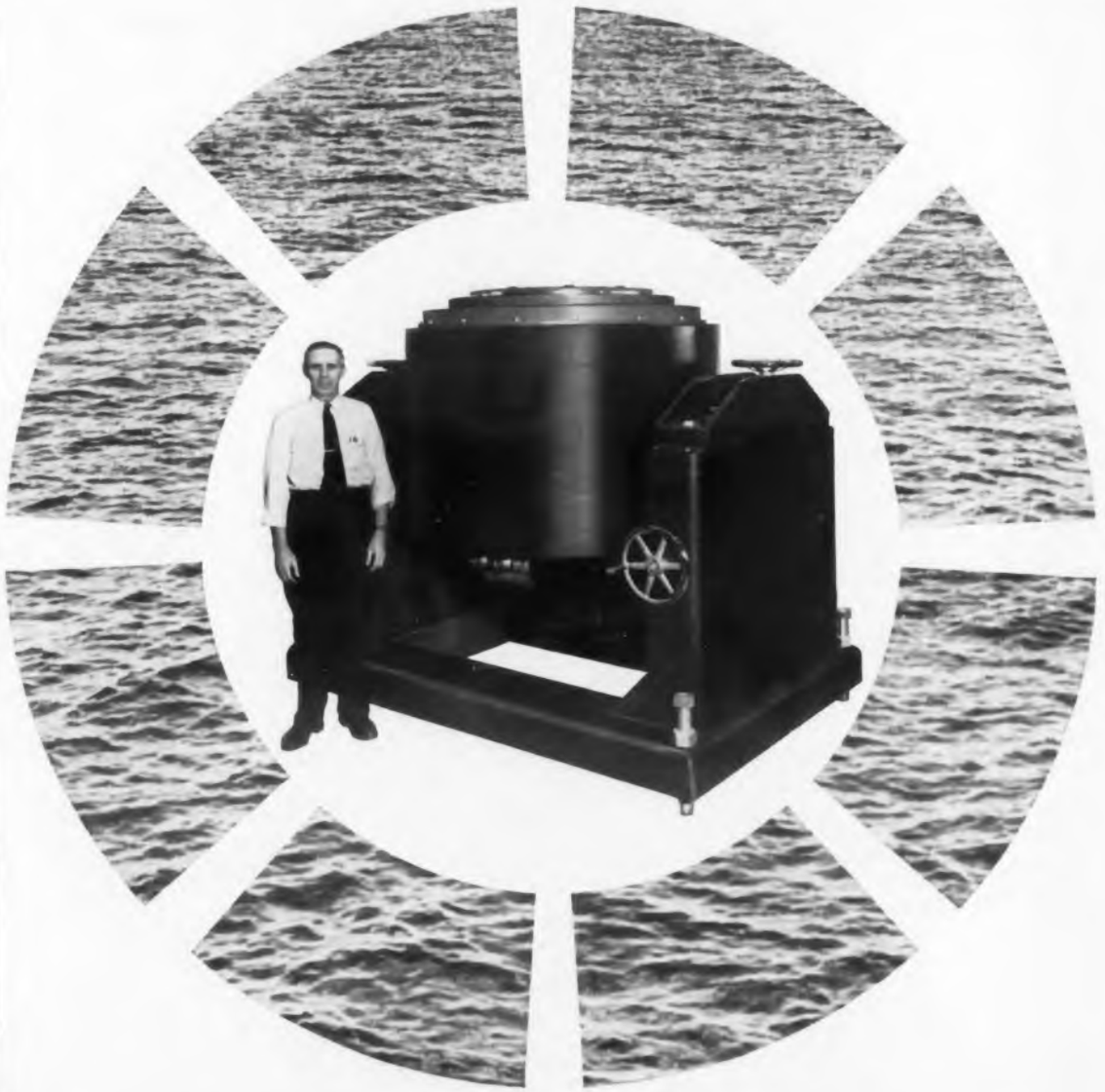
Designed for testing printed circuit boards and cable assemblies, this circuit resistance meter has a range of 0 to 200 milliohms. A safety circuit protects meters from overload damage. The solid-state device is permanently calibrated, and may be operated from 115/230 v, 50/125 cps, or from 30 v dc power supply. It measures 8 x 10 x 8 in. and weighs 11 lb.

Lytle Corp., Dept. ED, 1404 San Mateo S.E., Albuquerque, N.M.

Price: *$144.55.*

Availability: *45-day delivery.*

Have you sent us your subscription renewal form?



GET PROVEN RELIABILITY WITH LING'S LIQUID-COOLED SHAKERS Improved system efficiency goes with the liquid-cooled shakers. For instance, Model 249 shown above not only offers an impressive 30,000 pound force rating, but a number of other advantages. The new closed-loop cooling system, employing clean raw or distilled water, dissipates heat so efficiently that less is dumped on the testing site. The series also features a new web-design armature of lightweight aluminum. Force is transmitted to the table with maximum rigidity. Finally, special construction details make these liquid-cooled shakers adaptable for environmental chamber testing without special accessories. Tests can be conducted from −100°F to 300°F, at any altitude and humidity. Ling's unique low voltage armature and field design eliminates corona problems in altitude operation. Special thermal barriers can be supplied which control heat flow from the shaker to the chamber. This built-in adaptability, high efficiency and reliability grow from Ling research. For details on the liquid-cooled shaker series, write to Dept. ED-361 at address below.

LING-TEMCO ELECTRONICS, INC.

LING ELECTRONICS DIVISION

1515 SOUTH MANCHESTER, ANAHEIM, CALIFORNIA • PRospect 4-2900

LING ELECTRONICS

The shaker at the left is just one of many design improvements to grow out of Ling's continued research and development program. Its high 30,000 pound force rating—one of the highest force ratings available—is another result of Ling's constant search for better equipment and better methods of vibration testing.

In addition to the special advantages offered by the efficient liquid-cooling system, this new series offers other important features which it has in common with the air-cooled shaker series.

Ling's dual magnetic field structure provides a low stray field and improved force-current linearity. Ling shakers are engineered to operate continuously at maximum force on low input, feature simplified compensation over wide bandwidths.

Check the ratings on the entire liquid-cooled series. The performance of the series is just one more proof that whatever your needs in high power electronics—vibration testing, acoustics or sonar—you can rely on Ling for the most advanced design and practical engineering.

LING'S LIQUID-COOLED SHAKERS cover this useful range of force ratings:

Model 245—2,250 lb. force rating
Model 300—5,000 lb. force rating
Model A246—7,500 lb. force rating
Model 275—10,000 lb. force rating
Model 249—30,000 lb. force rating

LING-TEMCO ELECTRONICS, INC.
LING ELECTRONICS DIVISION

HIGH-POWER ELECTRONICS FOR VIBRATION TESTING • ACOUSTICS • SONAR

CIRCLE 147 ON READER-SERVICE CARD

Command Receiver 452

For satellites

This miniaturized command receiver, for satellite use, weighs 1.5 lb. The solid-state unit is 6.3-in. in diameter and 1.13-in. high. A decoder section can be mounted with the receiver to activate on-off controls. The decoder weighs 2 lb and accepts 7 commands. Both systems withstand high vibration and shock levels. Less than 1 w is needed to operate the two units.

Avco Corp., Electronics & Ordnance Div., Dept. ED, Cincinnati 15, Ohio.

Digital Module 503

Half-adder circuit

A half-adder digital building-block module, model 1281 is used in systems where it is necessary to compare the outputs of flip-flops and registers. One in a series of modules, it consists of 2 identical circuits, each of which performs a comparison function.

Harvey-Wells Electronics, Inc., Dept. ED, 14 Huron Drive, Natick, Mass.
Price: *$125.*
Availability: *Delivery from stock.*

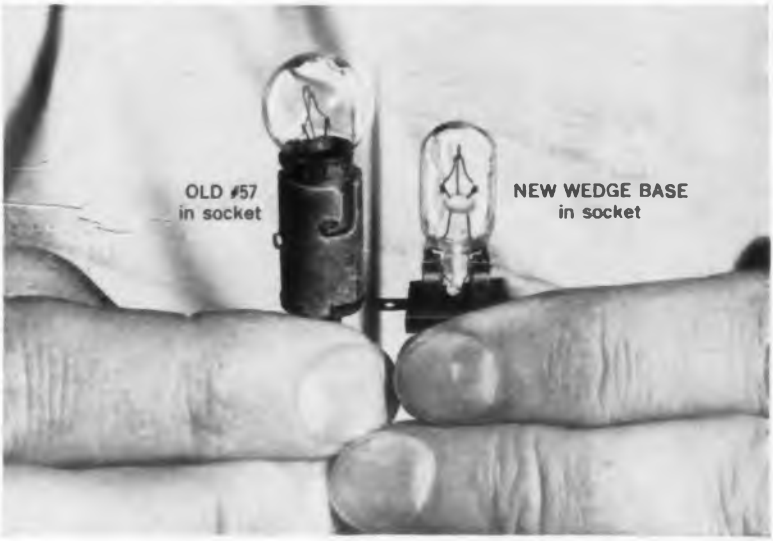
Piston Capacitor 498

With variable slope

Capacitance range of this piston capacitor may be varied from 1 to 85 pf to 1 to 95 pf. Slotted cylindrical plates are rotated to provide the variation. A glass dielectric is used. Temperature coefficient is ±100 ppm per deg C; operating range is —55 to 125 C. Other values are available.

JFD Electronics Corp., Dept. ED, 6101 16th Ave., Brooklyn 4, N.Y.
Price: *$20 ea in production quantities.*
Availability: *4-week delivery.*

NEW G-E "WEDGE BASE" LAMP SAVES SPACE, SAVES MONEY, SAVES TIME, SAVES MANPOWER



The new "Wedge Base", all-glass, incandescent indicator lamp is an exclusive G-E development designed to replace the old #57 and other similar bayonet-based lamps. It's available in 6.3 and 12 volts. See below.

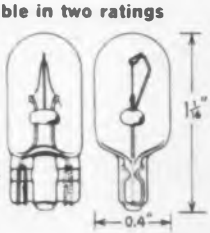
The Wedge Base saves space because, with its holder, it is considerably smaller than the old #57. It saves money because the holder and total installation costs are less. It saves time because the holder is easier to install and the lamp can be seated with just a push. And it saves manpower because installation can be automated and holders can be molded into plastic circuits. The G-E Wedge Base lamp can withstand ambient temperatures up to 600°F because it has no basing cement.

A major automobile manufacturer is already using G-E Wedge Base lamps; they're available in mass quantities. For more information write: General Electric Co., Miniature Lamp Department M-12, Nela Park, Cleveland 12, Ohio.

The Wedge Base is available in two ratings

G.E. Lamp No.	158	159
Circuit Volts	12	6.3
Amperes	0.24	0.15
Design Volts	14	6.3
Rated Av. Life at design volts	500 Hrs.	*
Filament	C-2V.	C-2R
L.C.L.	½"	½"
Bulb	T-3¼	T-3¼
Base Type	Wedge	Wedge
Candlepower	2	.35

*In excess of 5000 hrs. at 6.6 volts



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GENERAL ELECTRIC

CIRCLE 148 ON READER-SERVICE CARD

CIRCLE 149 ON READER-SERVICE CARD

NEW PRODUCTS

AC Potentiometer 617

A 3-in. diam., single-turn ac potentiometer, the model 5803 has high input impedance and low output impedance. Frequency range is 400 to 1,000 cps; impedance range is 1 K to 75 K. Linearity is said to be exceptional. Beckman Instruments, Inc., Helipot Div., Dept. ED, 2500 Fullerton Road, Fullerton, Calif.

TV Zoom Lens 618

A newly designed dc motor for remote control of the Mark VI zoom lens has no rf noise and is claimed to be more than 10 times as quiet as the most silent motors of the size. A plastic cover hermetically seals the armature. Zoomar, Inc., Dept. ED, 55 Sea Cliff Ave., Glen Cove, L. I., N. Y.

Mercury-Wetted Relays 619

These mercury-wetted relays are available in self-contained units for mounting on circuit boards. The switch capsule is potted in a plated steel enclosure for mechanical protection and magnetic shielding. Switch capsule may be model HG, standard, or model HGS, super-fast. C. P. Clare & Co., Dept. ED, 3101 Pratt Blvd., Chicago 45, Ill.

CIRCLE 150 ON READER-SERVICE CARD

Push-Button Station 620

Called the Flextite switch, this heavy-duty push-button station is of all-rubber construction. It incorporates micro-type 1- or 2-pole switches with normally open and/or normally closed contacts. Joy Manufacturing Co., Electrical Products Div., Dept. ED, 1201 Macklind Ave., St. Louis 10, Mo.

Delay Lines 621

All-metal, 2-in. diam delay lines of the 8810 series are continuously variable, distributed constant units with delay times of 1 μsec to 0.1 μsec. Rise time is less than 10% of total delay time. Ambient temperature range is −55 C to 80 C. Beckman Instruments, Inc., Dept. ED, 2500 Fullerton Road, Fullerton, Calif.

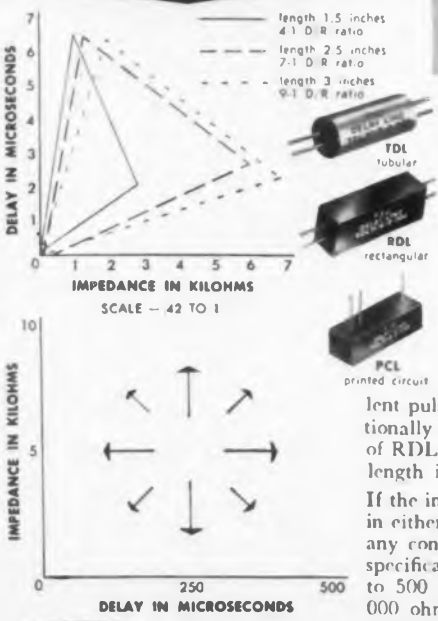
Low-Drain Solenoids 622

Type PS high-power solenoids use a coil with 2 windings. One is a high-surge pull-in winding that starts the solenoid plunger in motion; the second is a low-drain winding for holding the plunger in a seated position. They are rated for continuous duty. Anderson Controls, Inc., Dept. ED, 9959 Pacific Ave., Franklin Park, Ill.

Plot your lumped constant delay line needs on these charts!

TIC DELAY LINES

FEATURE:
- HIGHER RELIABILITY
- LOWER ATTENUATION



TIC's lumped constant delay lines are available in three standard configurations, TDL (tubular), RDL (rectangular), PCL (printed circuit), PDL series (are made to customer specifications). They feature a higher delay to rise time ratio per cubic inch than is available with conventional techniques. Every TIC Delay Line is hermetically sealed and complies with applicable MIL specs. TIC Delay Lines are M derived, phase and frequency compensated with excellent pulse response characteristics and exceptionally low attenuation. Standard lead lengths of RDL and TDL units is 2". The PCL lead length is ¾".

If the intersecting lines of your plot are within either of the graphs TIC standard type in any configuration is your answer. For other specifications PDL type provides Delay time to 500 microseconds, Impedance 25 to 10,000 ohms, Delay to Rise ratios to 150-1.

TIC of California

TECHNOLOGY INSTRUMENT CORP. OF CALIFORNIA

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NEW MODERN BUTTONS

JEWELS IN A CHOICE OF COLORS

3 LAMP VOLTAGES
6 and 28 volts and Neon (115v A.C.)

SERIES 21000

NEW FEATURES IN SWITCHCRAFT ILLUMINATED "MULTI-SWITCH"

Outstanding New Ultra-Modern Square Button Design gives added beauty and utility to the popular Switchcraft "Multi-Switch". New Square Styling, with concave face, gives ample area for engraving identification and side as well as front illumination.

Jewels are available in "eye-rest" colors, such as—white, red, yellow and green and others. A new dimension in lighting is provided through the use of DIFFUSERS that snap over the lamp to provide "shadow-free" illumination.

. . . plus all of the PROVEN FEATURES of the "Multi-Switch", such as choice of many different functions, innumerable switching and lighting arrangements.

PUSH TO LOCK—PUSH TO RELEASE SWITCH
SERIES 15000L

Companion Switch to the Series 21000. Illuminated single position push-button switch with all the advantages of the long frame leaf-type switch. Convertible to momentary action. Also non-illuminated Series 5000L.

Write for new Bulletin No. E-502 or see the new "Multi-Switch" at—

IRE SHOW BOOTH NO. 2825
N. Y. Coliseum - March 20-23

SWITCHCRAFT INC.

[illegible] Chicago 30, Ill.

[illegible]

CIRCLE 153 ON READER-SERVICE CARD

NEW PRODUCTS

Current Transformers 521

Range is 25 to 800 cps

These current transformers are made in a wide number of ranges, at lower cost than previous models. They can be used with wattmeters as well as ammeters. Case is high-impact, abrasive-resistant plastic. They operate at a frequency of 25 to 800 cps. The model 605 is available in 100:5 through 400:5 ratios in 5 types; model 607 is supplied in 6 types with ratios from 500:5 through 1,500:5.

Daystrom, Inc., Weston Instruments Div., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.

Code Generator 430

For manual entry

A portable, real-time manual entry code generator, the MG-100 produces perfectly formed Morse characters. Transmission speeds from 6 to 42 words per min may be selected. The 43-character keyboard activates a magnetic-core memory. Rechargeable nickel-cadmium batteries permit 5 hr of continuous operation. Other outputs, such as binary-coded decimal, can be provided.

Ling-Temco Electronics, Inc., Ling Electronics Div., Dept. ED, 1515 S. Manchester, Anaheim, Calif.

Price: *$1,275.*

Availability: *30-day delivery from stock.*

This is the time of our annual subscription renewal; Return your card to us.

AUGAT

COMPLETE LINE OF SOCKET ASSEMBLIES FOR MICRO-MINIATURE RELAYS

Combining Holding Clip And Built-In Socket For Unmatched Reliability Under Severe Conditions Of Shock And Vibration.

Patent Pending

These assemblies will accomodate Micro-Miniature relays as manufactured by G. E., Elgin, Sigma, Allied, Potter & Brumfield, Clare, Iron Fireman, Babcock and many others.

For additional information write for catalog RS-160

AUGAT BROS., INC.

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CIRCLE 154 ON READER-SERVICE CARD

LATEST DATA ON ULTRASONIC DELAY LINES!

THIS NEW CATALOG

gives you up-to-date specs on the industry's most complete line of ultrasonic delay lines for missiles, MTI, radar countermeasures and computer applications. Send for it today.

LFE

LABORATORY FOR ELECTRONICS, INC.
Computer Products Division
1079 Commonwealth Avenue
Boston 15, Mass., Dept. E-114

CIRCLE 155 ON READER-SERVICE CARD

DC Power Supply 432

Has 0.1% regulation

Output of this voltage-regulated dc power supply is continuously variable from 0 to 36 v, at 0 to 10 amp. Load regulation is 0.1% or 3 mv, no load to full load; line regulation is 0.1% for 105 to 125 v ac. Stability is 0.1% or 6 mv over 8 hours. Ripple is less than 1 mv rms. Temperature coefficient is less than 0.05% per deg C.

Kepco, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N. Y.

Price: *$625.*

Availability: *30 to 60 days.*

Instrument Switches 478

Have up to 20 decks

This line of multipole precision instrument switches may have up to 20 decks. The units conform to military specifications and are designed for dry circuits as well as other applications. Contacts, collector rings and one-piece brushes are all fine silver and have contact resistance of 1.3 milliohms.

Sonotec Inc., Langevin Div., Dept. ED, 503 South Grand Ave., Santa Ana, Calif.

Synchro Assembly 479

For attitude-pressure use

This synchro assembly provides visual indication of attitude-pressure being measured by remote transmitters. A gear train reduces the motor speed of 5,600 rpm to 10 rpm at the coarse and 1/3 rpm at the fine synchro. The transmitters position visual dials, each acting independently.

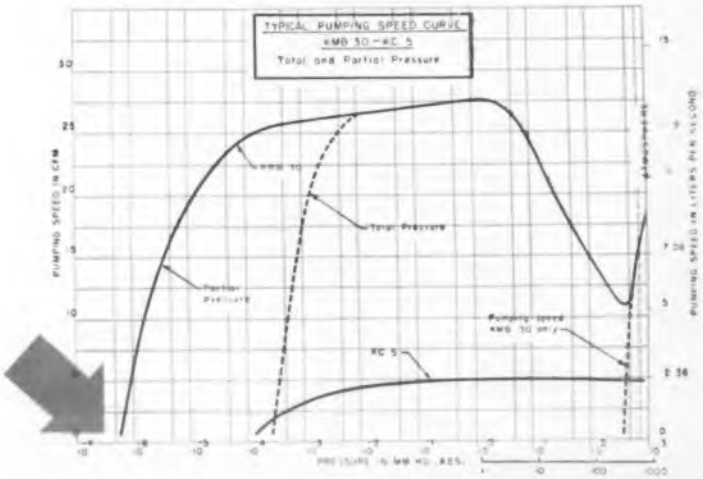
Sterling Precision Corp., Dept. ED, 5 Sitsink Drive, Port Washington, L.I., N.Y.

For HIGH Pumping Speed and LOW -LOW -low Ultimate Pressure

Kinney®

KMB-30

MECHANICAL BOOSTER HIGH VACUUM PUMP



With a rated displacement of 30 cfm and *starting from atmospheric pressure*, the KMB-30 attains ultimate pressure of .0005 micron as measured on a trapped ionization gage. Obviously, this exceptional performance has wide application in Electronic, Metallurgical, Chemical and Nucleonic fields and excites particular interest in laboratories where clean, dry Vacuum is required. The KMB-30 is one of a large family of KINNEY High Vacuum Pumps which includes the most comprehensive selection of Single Stage, Compound and Mechanical Booster Pumps in the world. Full information on KMB-30 is contained in Catalog Bulletin 3180.1. Write for it today.

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CIRCLE 156 ON READER-SERVICE CARD

CIRCLE 157 ON READER-SERVICE CARD

NEW PRODUCTS

Transmitter Adapter 433

For single sideband

The model SSB-58-1B adapts am transmitters to produce peak-envelope power of from 3 to 4 times their carrier ratings for single-sideband operation. Range is 1 to 50 mc, covering hf communications bands, with Class C operation for scatter transmission. Independent modulation of the upper and lower sideband with reduced carrier levels operation is provided.

Kahn Research Laboratories, Dept. ED, 81 S. Bergen Place, Freeport, N. Y.

Dual-Trace Oscilloscopes 438

Display 2 vertical signals

Types 1120 Portable and 1120-R Rack-Mountable permit the simultaneous display of two vertical signals against time, against each other, or versus a third variable fed externally to the X-axis. These main-frame indicators have 64 contacts to mate with plug-in circuits. Both are designed for safe off-ground operation up to 500 v dc.

Analab Instrument Corp., Dept. ED, 30 Canfield Road, Cedar Grove, N.J.

Price: *$525 without plug-in.*

Availability: *30 days.*

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

Specify SPERRY for

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SILICON PNP TRANSISTORS

New low levels of I_{co}; baked at 200° C for 200 hours for utmost stability

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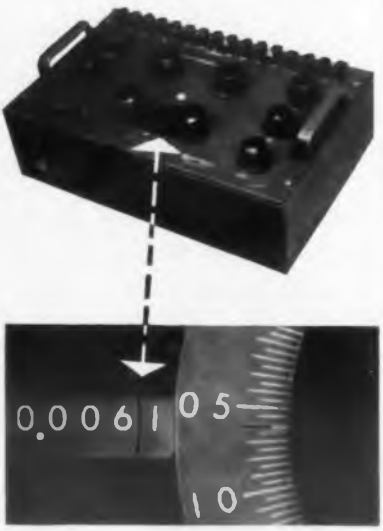
CIRCLE 158 ON READER-SERVICE CARD

Rapid, precise emf measurements with this L&N Type K-3 Universal Potentiometer



Emf's read as digits plus scale value

Fast, accurate d-c voltage measurements free of effects of static, humidity and leakage are made with L&N's Type K-3 Universal Potentiometer. In calibrating d-c wattmeters or voltmeters, checking thermocouples, etc., measurements are speeded as emf's are read directly as a single row of digits plus a scale value.

Ranges—High: 0 to 1.611 v. Medium: 0 to 0.1611 v. Low: 0 to 0.01611 v.

Limits of Error—Standardized and read on range in use: High range: ±(0.01% + 20 μv). Medium range: ±(0.015% + 2 μv). Low range: ±(0.015% + 0.5 μv).

Internal Resistance—Changes from about 180 Ω at full scale to about 110 Ω at zero setting.

Galvanometer Sensitivity Keys—Four tap keys provide sensitivities of approx. 1, 1/20, 1/400 and 1/10,000. Fifth key for reversal of connections.

Standard Cell Dial—1.0174 to 1.0205 v.

Case—Aluminum, 19¼" long x 12½" wide x 5¾" high to top of panel.

Price—**$730.00**, f.o.b. Phila. or North Wales, Pa., (subject to change without notice). Specify List No. 7553 when ordering from Leeds & Northrup Company, 4908 Stenton Ave., Phila. 44, Pa.

LEEDS & NORTHRUP
Instruments · Automatic Controls · Furnaces

CIRCLE 159 ON READER-SERVICE CARD

Tachometer Generator 481

Frame diameter is 1-1/8 in.

Model SU-780D-1 is a 45-v/1,000-rpm precision tachometer generator. It has a 1-1/8-in. diam frame and an over-all body length of 3-1/2 in. The outer shaft bearing is sealed to prevent the entrance of contaminants.

Servo-Tek Products Co., Dept. ED, 1086 Goffle Road, Hawthorne, N.J.

Price: *$57.50 ea.*

Availability: *Immediate.*

Attenuator 484

Range is dc to 3 Gc

Type DPU attenuator covers the range from dc to 3 Gc with settings between 0 and 99 db in steps of 1 db. Electrical length is practically constant and corrections are given for both electrical length and propagation time for each attenuator position. Maximum power load is 0.4 w.

Rohde and Schwartz Sales Co., Dept. ED, 111 Lexington Ave., Passaic, N.J.

Reed Relay 392

Controls 10 circuits

Up to 10 separate switching functions can be remotely controlled with this 1-oz vibrating reed relay. They are available in 30- to 3,000-ohm coil resistances. Driving voltages vary from 1-1/2 to 15 v ac. Reed contacts will pass up to 5 ma. Reed frequencies to within ±0.05% are available.

W. S. Deans Co., Dept. ED, 8512 Gardendale St., Downey, Calif.

Price: *$22.50.*

$E_b = 10\,Kv$

ACTUAL SIZE
VICTOREEN 7234
(PENTODE)

CONSIDER USE IN HIGH VOLTAGE REGULATOR CIRCUITS OR HIGH VOLTAGE AMPLIFIERS.

CHARACTERISTICS	7234 PENTODE	6842 PENTODE	7683 PENTODE
E_f	6.3V	6.3V	6.3V
I_f	150ma	150ma	150 ma
E_b MAX	10,000V	4,000 V	1,000V
I_p MAX	5ma	10ma	20ma
G_m	3800	2500	5500
R_p	1 Megohm	930Kohm	300K
SIZE	T-6-½	T-5-½	T-6-½

A-1483A

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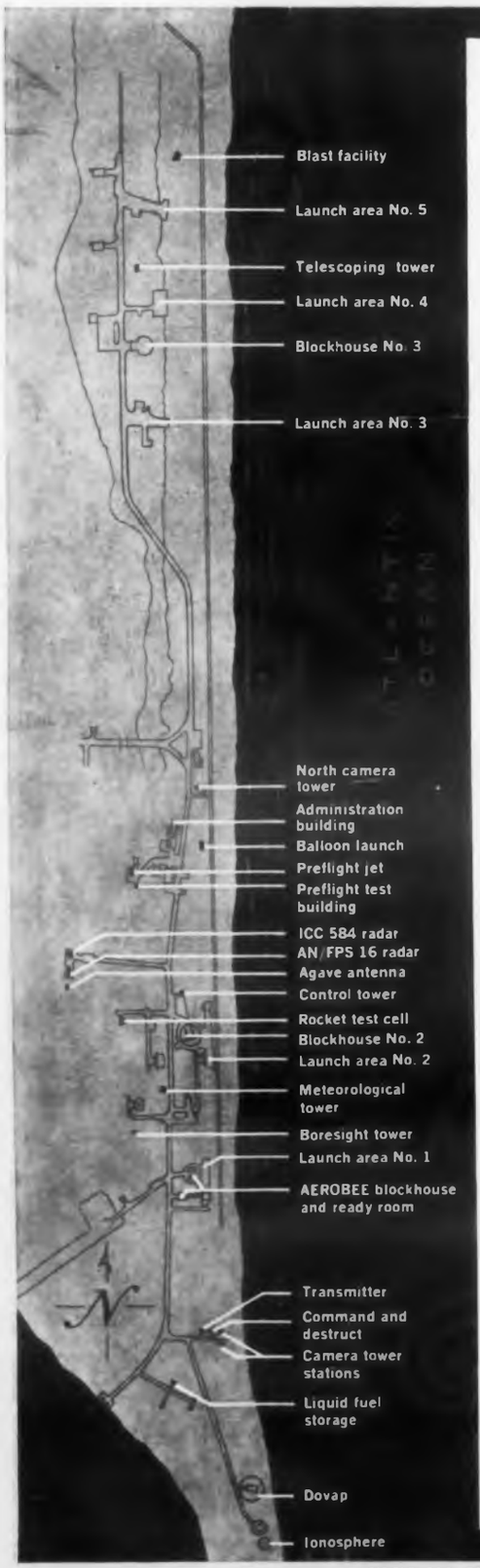

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Wallops Space Flight Station is located on Virginia's historic Eastern Shore a scant 120 air miles from the Nation's Capital. Here on the beaches, where the famed wild ponies of Chincoteague run free, the mysteries of the cosmos are explored.

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NASA Wallops Space Flight Station, Wallops Island, Va.—NASA Ames Research Center, Mountain View, Calif.—NASA Flight Research Center, P.O. Box 237, Edwards, Calif.—NASA Goddard Space Flight Center, Greenbelt, Md.—NASA Langley Research Center, Hampton, Va.—NASA Lewis Research Center, Cleveland 35, Ohio—NASA Marshall Space Flight Center, Huntsville, Ala.

NASA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CIRCLE 911 ON CAREER INQUIRY FORM, PAGE 219

NEW PRODUCTS

Voltage Divider 516

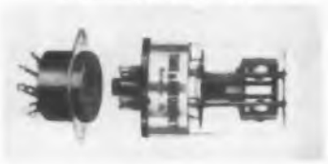
Linearity from 1/2 ppm

Model DT-72 is a laboratory standard, transformer-type ac decade voltage divider. Linearity is 1/2 ppm at the larger settings, improving to better than 1/100 ppm at the small settings. All units are certified for use as primary ratio standards.

Electro Scientific Industries, Dept. ED, 7524 S.W. Macadam Ave., Portland 19, Ore.
Price: *$795.*
Availability: *30 days.*

Tuning Fork 474

Accuracy is 0.005%



Type TF-4 high-vacuum tuning fork provides an accurate frequency source for precise electronic instruments. Enclosed in a high-vacuum glass tube, it is 1-1/2-in. in diameter and 2-1/2-in. tall. It will operate on any frequency from 240 to 10,000 cps with an accuracy of 0.005% or better from −56 to +125 C. Output is either a sine or square wave of 1.3 to 3.0 v rms across a 10,000-ohm load.

Time and Frequency, Dept. ED, 127 S. Batavia Ave., Batavia, Ill.

DC Amplifier 517

With 10-kc bandwidth

Gain of more than 10,000 over a bandwidth of 0 to 10 kc is provided by the model D441C dc amplifier. It is a high-gain direct-coupled differential amplifier, especially suited for use as a general-purpose operational amplifier in analog computer circuits. It may be used with either

CIRCLE 162 ON READER-SERVICE CARD ➤

Dependability PROVED!

...in tests at 5 Times mil specs for shock, vibration and acceleration

Potentiometers Type J and Type K | Potentiometers Type G and Type L | Adjustable Fixed Resistors Type R | Hermetically Sealed Ceramic Encased Resistors Type TS, Type CS, Type ES

About the test

At the United States Testing Co., Inc.* the above Allen-Bradley resistors and potentiometers were subjected to a constant acceleration of 300g, impact shock of 150g and vibration of 50g from 55 to 2,000 cps. All tests were conducted in accordance with procedures outlined in the latest Mil Specs.

*Test Report #71801, Sept. 1960.

In these severe tests, Allen-Bradley resistors and potentiometers have demonstrated their complete dependability in environmental extremes.

The ruggedness of A-B fixed resistors is obtained through an *exclusive* process in which the resistance element and the insulating jacket are hot molded into an integral unit of unusual mechanical strength. This unit is then hermetically sealed in a ceramic tube. Also, please remember, A-B fixed resistors are *completely free from catastrophic failures.*

A-B potentiometers have the resistance elements molded into, and are an integral part of, the base: therefore, they are virtually indestructible. In addition, operation is quiet and smooth when the potentiometer is new, and these characteristics improve with use.

For maximum reliability under severe operating conditions, insist on Allen-Bradley *quality* electronic components.

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

3-61-E

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Television

H. F. Fluorescent Lights

ALLEN-BRADLEY QUALITY

FERRITES

A-B QUALITY

HAVE SOLVED THESE DESIGN PROBLEMS

...they can also be the Answer to Yours!

Missiles

From the broad line of Allen-Bradley *quality* ferrites, more and more designers are finding they can obtain the exact characteristics to meet their specific needs. Allen-Bradley's precise quality control methods insure continuously uniform electrical and mechanical properties—and A-B has the facilities for supplying ferrites in quantity. Listed below are a number of areas in which A-B ferrites have helped the manufacturer to reduce the product size or weight, or cost, and frequently the performance has been improved. If you have problems along this line, please let our engineers work with you in solving them.

Radio

APPLICATION	A-B FERRITE	PREFERRED CHARACTERISTICS
TELEVISION, RADIO Deflection Yokes	W-03 W-01	High permeability High resistivity
Flyback Transformers	W-04	Low losses, high B_{max}, high permeability, high Curie temp
Convergence Cores	W-01	Low residual with large gap
I. F. Transformers	R-02	Low losses at low amplitudes. Good temperature stability of permeability
R. F. Tuning Coil (fixed or permeability tuned)	R-02	Low losses. Temperature stable permeability, minimum hysteresis for permeability tuning
TELEPHONE SYSTEMS Interstage and Matching Transformers	W-03	High permeability, low losses
H. F. FLUORESCENT LIGHTS Loading Reactors	W-07	High flux density
Transformers	W-04	High permeability, low losses, high B_{max}
ELECTRIC ORGANS AND HI-FI STEREO Oscillator Inductors	W-03	High permeability, temperature stable, linear B vs. H
Output Transformers	W-04	High permeability, high B_{max}, low losses
AUTOMATIC MACHINE TOOLS Magnetic Amplifiers	R-03	Rectangular hysteresis loop, high B_{max}
Logic elements for high-power levels	R-03	Rectangular hysteresis loop, high B_{max}
Matching Transformers	W-04	High permeability, low losses, high B_{max}
MOBILE POWER SUPPLIES Static Inverters	R-03	Rectangular hysteresis loop, high B_{max}.
RADAR, MISSILES Pulse Transformers	W-04 R-02 (for short pulses)	High pulse permeability, high B_{max}, low losses
PERMANENT MAGNETS	M-01	High energy factor Good mechanical strength

Electric Organs

Hi-Fi Stereo

Automatic Machine Tools

ALLEN-BRADLEY

Quality Electronic Components

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single-ended or push-pull input or output. All power supplies are included.

Elcor, Inc., Dept. ED, 1225 W. Broad St., Falls Church, Va.

Price: *$169.*

Availability: *3 weeks.*

Tape Programer 448

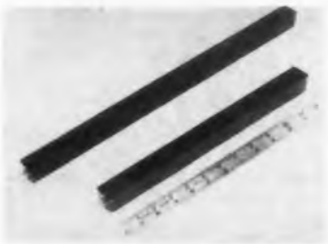
For automatic control

This tape transport programer automatically controls digital tape machines to run in forward and reverse. Run times and stop times are adjustable from 2.5 msec to 1 sec. Outputs are capable of driving the actuator control circuits of the tape machine. The unit is contained in a case measuring 4 x 7 x 8 in.

Binary Electronics Co., Dept. ED, Bldg. E, 824 E. Walnut Ave., Fullerton, Calif.

Precision Potentiometers 394

Linear-motion type



These precision linear-motion potentiometers have infinite resolution in stroke lengths up to 30 in. Designed for operation on ac or dc inputs they provide outputs without amplification as great at 350 v per in. of shaft movement, with sensitivity of 5 millionths of an inch. They have a guaranteed life in excess of 10 million strokes, depending on circuitry.

Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L.I., N.Y.

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◀ CIRCLE 162 ON READER-SERVICE CARD

SYMBOL OF ORIGINALITY
MONITOR OF RELIABILITY

* patents pending

*POWER-O-MATIC 60
MECHANICAL CONVECTION OVENS
with SATURABLE POWER REACTOR CONTROL
and *Range-Lock* PROTECTION

Combining for the first time a SATURABLE POWER REACTOR with a thermostatic sensing device without contacts, moving parts or auxiliary mechanisms to wear, burn or arc.

2 RANGES: 356° F. and 650° F.

RANGE-LOCK built-in Overtemperature Protection – AT NO ADDED COST!

GUARANTEE: FIVE (5) YEARS

Upon request, it will be our pleasure to forward free 12 page Bulletin No. 1960, and name of nearest representative.

ECONOMICAL POWER-O-MATIC 60 Ovens are competitively priced with conventional ovens utilizing ON-OFF cycling type of control systems.

PERFORMANCE CHARACTERISTICS
- STRAIGHT-LINE CONTROL with absolutely no "OVERSHOOT"
- REPEATABILITY throughout entire unit range
- There are no TRANSIENT VOLTAGES DUE TO ARCING CONTACTS

HOW POWER-O-MATIC 60 OPERATES
Circuit is constructed to produce full-range proportional temperature control. Variable impedence driven by temperature-sensitive mechanical drive; control winding circuit in series with voltage source. Provides means to convert small mechanical motion into wide range of voltage change and corresponding wide range of pre-set constant temperatures.

AN UNPARALLELED BREAKTHROUGH IN THE ART OF PROPORTIONAL TEMPERATURE CONTROL

BLUE M Electric Company 138th and Chatham St., Blue Island, Illinois

BRANCH: BLUE M ENGINEERING COMPANY, 2312 So. Main Street, Los Angeles 7, California

CIRCLE 163 ON READER-SERVICE CARD

NEW PRODUCTS

Drum System 360

For delay and memory

This magnetic drum delay and memory system, designed for process or equipment-control systems, has 20 channels with storage densities up to 9,000 bits per channel. Recording heads adjust to provide continuously variable delays from 2 to 60 sec. The system receives input from standard transducers; output is digital in the form of on-off pneumatic, hydraulic or electrical process control signals. Drum drive is by synchronous motor, servo-controlled synchro, or direct coupling.

Electron-Ohio, Inc., Dept. ED, Box 9527, Solon, Ohio.

Decade Counter 365

Plug-in module

The DC-114 has a shielded Beam-X switching tube and a Nixie readout mounted on a single plug-in module. Designed for frequencies to 110 kc, it provides visual readout and 10 individual constant current outputs for printing, gating, or presetting. A transistor driving circuit is used to activate the 50,000-hr life switching tube. Input is 12 v.

Burroughs Corp., Electronic Tube Div., Dept. ED, Box 1226, Plainfield, N.J.
Price: *$100.*

The new NLS 481A digital voltmeter features both plug-in stepping switches and a snap-out readout that virtually eliminate use of a solder gun or other tools in servicing. Note the "finger-control" leverage bars for easy switch removal.

Applications include production testing, instrument calibration, laboratory testing, receiving inspection.

The 481A features the basic circuitry of the NLS 481, today's most widely used digital voltmeter.

Announcing the NLS Low-Cost 481A Digital Voltmeter

Here is the time-proved 481 with new features to permit replacement of all stepping switches and decade resistors in minutes instead of days. Plug-in stepping switch assemblies in the 481A also allow trouble-shooting by the substitution method. Like the thousands of 481s in use today, the new 481A features ±0.01% accuracy and completely automatic operation at low cost. It measures DC volts from ±0.001 to ±999.9; AC or low-level DC with plug-in accessories. Input impedance is 10 megs . . . balancing time is 1 second, average . . . internal standard cell verifies calibration.

Although the 481A features exclusive plug-in stepping switches previously found only on higher cost NLS digital voltmeters, it sells for only $1,525, complete. Delivery is from stock – 15 days are required if stocks are temporarily depleted. NLS will continue to manufacture the 481 in volume for customers who have standardized on this instrument or where initial price is more important than the long-term savings in servicing offered by the 481A.

A statement of policy: The 481A – like other new NLS instruments to be announced in the coming months – is not a "pie-in-the-sky" instrument or prototype. It has long since undergone complete testing and is now in volume production to assure you prompt delivery of a fully-tested, quality instrument.

See the new NLS 481A at IRE, Booth 3041-42.

Originator of the Digital Voltmeter

non-linear systems, inc.
DEL MAR, CALIFORNIA

CIRCLE 164 ON READER-SERVICE CARD

See It in Action . . .

For a demonstration of the new 481A, 481 or any digital measuring instrument, call any of the following NLS offices or sales representatives. If you prefer, please contact NLS for additional information.

Northeast
NLS District Office
Nutley, New Jersey
NOrth 1-1228 or
BRyant 9-7999
NLS Division Office
Garden City
Long Island, N. Y.
Pioneer 7-6222
Howard J. Shuft Co.
Newtonville, Mass.
LAsell 7-5304

Middle Atlantic
NLS Division Office
Haddonfield, N. J.
HAzel 8-1663
SBM Associates, Inc.
Rochester, New York
OLympic 4-8440
SBM Associates, Inc.
Utica, New York
REdwood 2-4410
SBM Associates, Inc.
Binghamton, New York
RAymond 2-2648
SBM Associates, Inc.
Syracuse, New York
HOward 8-5041

Southeast
NLS Division Office
Washington, D. C.
FEderal 7-4315
W. A. Brown & Assoc.
Indian River City, Fla.
AMherst 7-0411
W. A. Brown & Assoc.
Orlando, Fla.
GArden 5-5682
W. A. Brown & Assoc.
Huntsville, Alabama
JEfferson 6-8393
W. A. Brown & Assoc.
Winston-Salem, N. C.
PArk 5-5384
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Alexandria, Virginia
TEmple 6-1800

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Ohio Instrument Co.
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CHapel 4-2744
Engineering Services Company
St. Louis, Missouri
PArkview 6-2233
Engineering Services Company
Kansas City, Missouri
JEfferson 1-7765
Engineering Services Company
Wichita, Kansas
MUrray 3-3751
Engineering Services Co.
Cedar Rapids, Iowa
EMpire 5-6183
Gaine Engineering Co.
Detroit, Michigan
FOrrest 6-5353

Mountain and Southwest
Burt Porter Company
Seattle, Washington
EAst 3-8330
Burt Porter Company
Portland, Oregon
ATlantic 4-1718
Brooks, Feeger & Assoc.
Albuquerque, N. M.
AMherst 8-1724
Brooks, Feeger & Assoc.
Englewood, Colorado
SUnset 1-7375
Brooks, Feeger & Assoc.
Scottsdale, Arizona
WHitney 6-2111
Brooks, Feeger & Assoc.
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Mitchell Spears Co.
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Palo Alto, California
DAvenport 6-5291
Burt Porter Company
Seattle, Washington
EAst 3-8330
Burt Porter Company
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ATlantic 4-1718

Canada
AeromotiveEngineering Products, Ltd.
147 Hymus Blvd.,
Point Claire, Quebec
OX 7-0810 (Montreal)
AeromotiveEngineering Products, Ltd.
1912-A Avenue RD
Toronto, Ontario
RU 3-4288

Export, Excluding Canada
Frazer & Hansen, Ltd.
301 Clay St.,
San Francisco, Calif.
EXbrook 2-5112

NLS

Originator of the Digital Voltmeter

non-linear systems, inc.
DEL MAR, CALIFORNIA
CIRCLE 165 ON READER-SERVICE CARD

Data-Transmission System 397

Transmits 10-μv signals

This system will allow transmission of signals as small as 10 μv for distances up to 1,000 miles with accuracies of 0.1%. It will monitor up to 250 channels of low- or high-level data. Level changes of 10 μv dc can be sensed and digitized.

Communications Control Corp., Dept. ED, 14707 Keswick St., Van Nuys, Calif.

Noninductive Resistor 413

In 10-w size

A 10-w size has been added to the series of noninductive, vitreous enameled resistors. A tubular type, it mounts on 2-3 16-in. centers. Core size is 1-3 4 x 5/16-in. in diameter. It has less than 1% of the inductance of regular resistors, with low-effective reactance, and can be used throughout the broadcast band.

Ohmite Manufacturing Co., Dept. ED, 3654 Howard St., Skokie, Ill.

Potentiometer 483

High-frequency type

Model R potentiometer can be applied to circuits with frequencies as high as 10 mc with a minimum of distortion. It has a rotational life of 100,000 cycles and is operable from —55 to 125 C. Capacitance is 8 pf. Ratings are 2 and 3 w, 100 ohms to 5 meg.

Reon Resistor Corp., Dept. ED, 155 Saw Mill River Road, Yonkers, N.Y.

Don't miss an issue of ELECTRONIC DESIGN; Return your renewal card.

start clean!

with this new ultra-low distortion, stable-amplitude oscillator

When the specs get critical, you need an oscillator that won't add distortion and instability of its own. Here's a stable-amplitude, low-distortion oscillator — Krohn-Hite's new Model 446 — that gives you a *cleaner* sine wave than any other oscillator you've ever worked with!

Amplitude stability is ultra-high: 0.001 db (0.01%), due to a unique infinite-gain AVC circuit (patent pending). Amplitude bounce near line frequency is no longer a problem — less than 0.05%. Distortion — phenomenally low: less than 0.01%.

But that's not all. The 446 push-button oscillator offers continuous frequency coverage from one cycle to 100 kc. Voltage output is continuously adjustable from 0 to 10 volts, with infinite resolution all the way.

And when you need *power* along with stable amplitude and low distortion, team up the Model 446 oscillator with Krohn-Hite's Model UF-101A ultra-low distortion 50-watt amplifier. Here's an amplifier which preserves the stability and distortion-free characteristics, even at a full 50 watts. Frequency response of the amplifier — from 20 cps to 20 kc at full power. A convenient load impedance switch offers a choice of 1, 2, 4, 8 and 225 ohms.

Together, this oscillator and amplifier provide a highly-stable, low-distortion, variable-frequency Power Source (Model LDS-115) — for the most critical meter calibration or measurement needs. Send for technical literature on these new Krohn-Hite instruments.

See us at IRE—Booth 3708-3710

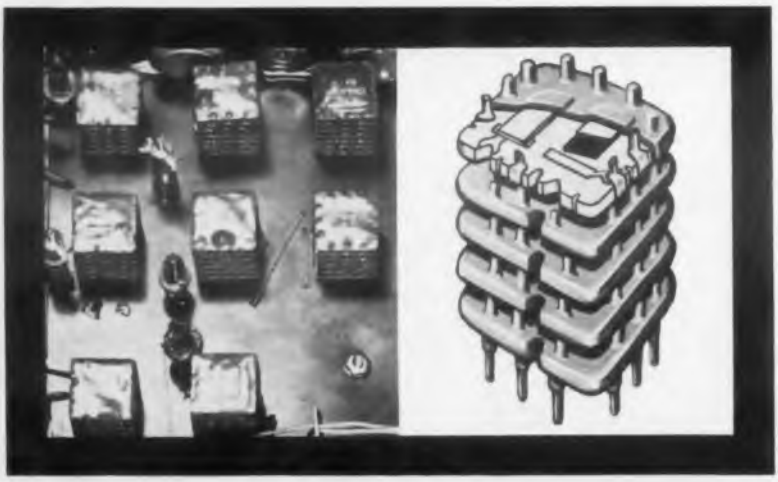
KROHN-HITE CORPORATION

580 Massachusetts Avenue • Cambridge 39, Mass.

Pioneering in Quality Electronic Instruments

CIRCLE 166 ON READER-SERVICE CARD

FROM CLUTTER...
TO CLEAN DESIGN...



WITH INTEGRATED ELECTRONIC COMPONENTS FROM...

PAKTRON

PACKAGED ELECTRONICS

itw

DIVISION OF ILLINOIS TOOL WORKS

1321 LESLIE AVENUE ALEXANDRIA, VA.

CIRCLE 167 ON READER-SERVICE CARD

NEW PRODUCTS

Telemetry Receiver 389

For 216- to 260-mc band

Model TMR-1 telemetry receiver is designed for the 216- to 260-mc band. Frequency is continuously tunable or crystal-controlled. Receiver stability, crystal-controlled, is 0.005%; continuously tunable, it is approximately 0.001% per deg C. Plug-in amplifiers are available for bandwidths of 100, 200, 300, 500 and 750 kc. Weight is approximately 45 lb.

Defense Electronics, Inc., Dept. ED, 5451-B Randolph Road, Rockville, Md.

Price: *$2,300 with two if amplifiers, fob Rockville.*

100-Kc Filter 486

Stable from —60 to 80 C

Used as a frequency standard in fixed-frequency oscillators, the EM 3000 magnetostriction rod filter is designed for 100-kc operation. It is more stable than its crystal counterparts with an operating range of —60 to 80 C.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.

Price: *$18.75 in 1 to 9 quantities.*

Availability: *Immediate from distributors.*

Pointer Knobs 467

Parallax has been minimized in these bar-pointer knobs. They are built to MIL-K-3926. Available in black or gray, the 90 series is for 1/4-in. shafts.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.

This is the time of our annual subscription renewal; Return your card to us.

METERS

You can SEE and READ

by Hoyt

New **Series 1025-1026 Interchangeable with Round Bakelite Case Types**

Brilliantly new in their high visibility polystyrene cases are these modern type Meters by HOYT which give a true reading at a glance! Here longer scale length and the elimination of shadows plus clean design add up to a topnotch combination to incorporate in any panel.

The Famous HOYT high torque movement with precise and rugged craftsmanship give you what you've been looking for in Meters. These models are directly interchangeable with all round Bakelite meters, and are available in all AC and DC ranges as Ammeters, Milliammeters, Microammeters, Voltmeters and Millivoltmeters. Similar styles #1037 3½" and #1060 6" meters are also available for any modern panel meter application.

The HOYT square plastic case series (#649 and #653 shown) is available in 2½", 3½" and 4½" types. Just right for use where equipment needs to be revised to meet modern design requirements. These instruments are interchangeable with square Bakelite meters and can be supplied with a frosted or colored band on the case front in any AC and DC range. Extra long scales in shadow free cases give you the most value and quality for your money.

Write us for the NEW HOYT PANEL METER Brochure showing a complete line of plastic and Bakelite models.

VISIT THE HOYT BOOTH NO. M-13 AT THE I.R.E. SHOW

Hoyt SINCE 1904 **ELECTRICAL INSTRUMENTS**

BURTON-ROGERS COMPANY

Sales Division, Dept. ED-3

42 Carleton Street, Cambridge 42, Mass.

CIRCLE 168 ON READER-SERVICE CARD

Winding Machine 376

For yoke coils

TV vertical deflection coils may be toroidally wound on the TVL 59 winding machine. Both halves of a split ferrite coil are wound simultaneously, ensuring positive symmetry of cosine winding. Resultant shorter wire lengths reduce resistance and dissipate less power. The width of each layer, and the number of layers, can be automatically adjusted. Wire diameter may be from 0.006 to 0.020 in. for winding at the rate of 400 rpm. Winding angle is 120 deg max, 15 deg min.

Associated American Winding Machinery, Inc., Dept. ED, 750 St. Ann's Ave., New York 56, N.Y.

DC Power Supplies 425

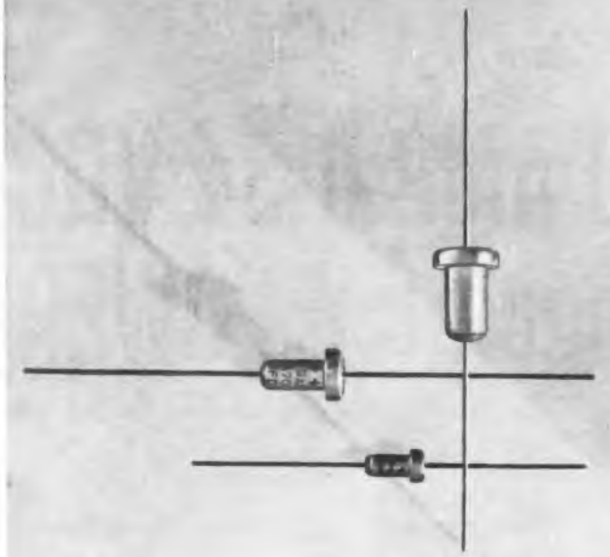
Regulated to 0.02%

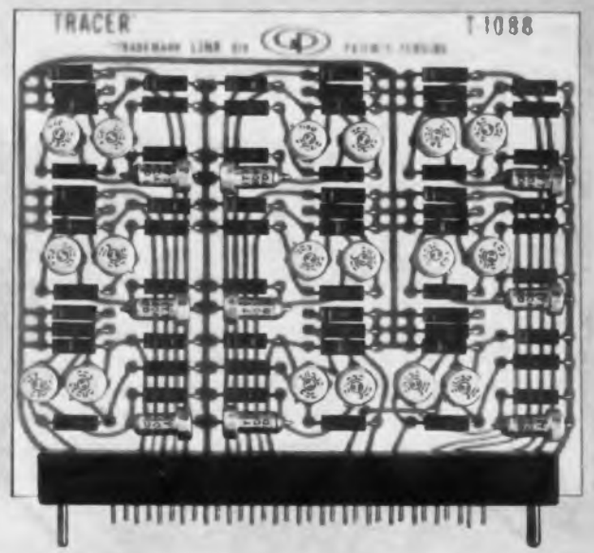
These solid-state dc power supplies are lightweight, stable, and closely regulated. The 9 models have outputs from 0 to 10 v dc up to 0 to 150 v dc, with a wide range of amperages. Static regulation as low as 0.02% load and 0.02% line are available with dynamic regulation of 20 μsec load and ±0.03% line. Any model can be floated up to 500 v peak above or below ground. Input is 105 to 125 v, 55 to 65 cps.

Magnetic Research Corp., Armour Stablvolt Div., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

During the I.R.E. Show, be sure to visit us at Booths 2510 through 2520. ▶

CIRCLE 169 ON READER-SERVICE CARD ▶





Link Division of General Precision, Inc. specified ITT capacitors for this vital portion of its Tracer Identification and Control System, which demands utmost reliability and long life expectancy from every component.

TOTAL PROCESS CONTROL AND DISCIPLINED PRODUCTION DELIVER

HIGH-RELIABILITY WET-ANODE TANTALUM CAPACITORS FROM ITT

ITT wet-anode tantalum capacitors meet MIL-C-3965B—a fact proved by independent laboratory qualifications tests on ITT capacitors. The reliability and long life expectancy of these competitively-priced capacitors are direct results of ITT's total process control and disciplined production procedures, above and beyond testing standards more stringent than normal industry practice—and backed by ITT's world-wide facilities and experience.

ITT
COMPONENTS DIVISION
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
915 SAN ANTONIO RD., PALO ALTO, CALIF.

Phone these ITT-CD Capacitor Sales Offices:

Albuquerque	AX 9-8013	Los Angeles	HI 6-6325
Boston	CA 7-2980	Miami	MI 4-3311
Chicago	SP 7-2250	Minneapolis	WE 8-0457
Cleveland	GR 5-3080	New York	LO 5-1620
Dallas	EM 1-1765	Philadelphia	TR 8-3737
Dayton	BA 8-5493	Phoenix	WN 5-2471
Denver	KE 4-5091	Rochester	FI 2-1413
Detroit	TO 8-3322	San Francisco	LY 1-7321
Fort Wayne	MA 0641	Seattle	MA 2-5433
Kansas City	JE 1-5236	St. Louis	EV 2-3500

IN STOCK AT ITT DISTRIBUTORS:

- TWO TYPES—M-Type and P-Type, for applications from −55 to 85 and 125 C. respectively
- 29 VALUES—from 1.75 to 330 mfds over a working voltage range to 125 VDC and maximum surge voltages to 140 VDC
- COMPACT AND RUGGED—sintered tantalum slug in fine-silver cases for 2000-hour life at maximum temperature and working voltage
- GUARANTEED—to 80,000 ft. and accelerations of 20 G's with a 0.1 in. excursion in 50-2000 cps range
- LONG STORAGE LIFE—tantalum-oxide dielectric is completely stable; assures trouble-free operation

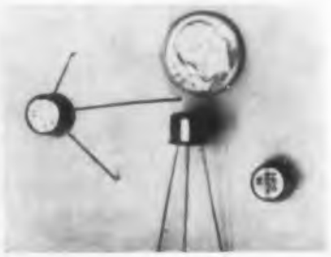
COMPLETE SPECIFICATIONS ON ITT wet- and solid-anode tantalum capacitors are available on request. Write on your letterhead, please, to the address below.

ENGINEERS: Your ITT representative has a complete set of qualifications and quality control tests for your inspection.

NEW PRODUCTS

Germanium Transistor 424

With 100-C operation



A high-voltage germanium pnp transistor, type 2N398A has 100-C junction operation and 150-mw power dissipation. With a 105-v collector-base rating, it is intended as a driver for Nixie tubes, indicator and neon-bulb applications. Collector current rating is 200 ma. Housed in a TO-5 package, the unit passes stringent shock, vibration, and 20,000 g acceleration tests.

Motorola Semiconductor Products Inc., Technical Information Center, Dept. HVM, Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

Availability: *Production quantities.*

Trimming Potentiometer 368

Sealed in plastic

A sealed, all-plastic multi-turn potentiometer, the model 3010 has high-humidity resistance. It can be potted without danger of leakage. Resistances are 10 to 100 K; power rating is 1.0 w at 70 C. Operating temperature is 175 C max and temperature coefficient is 70 ppm max. The 0.1-oz unit measures 1-1/4 x 1/4 x 5/16 in.

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

Price: *From $13 to $21.*

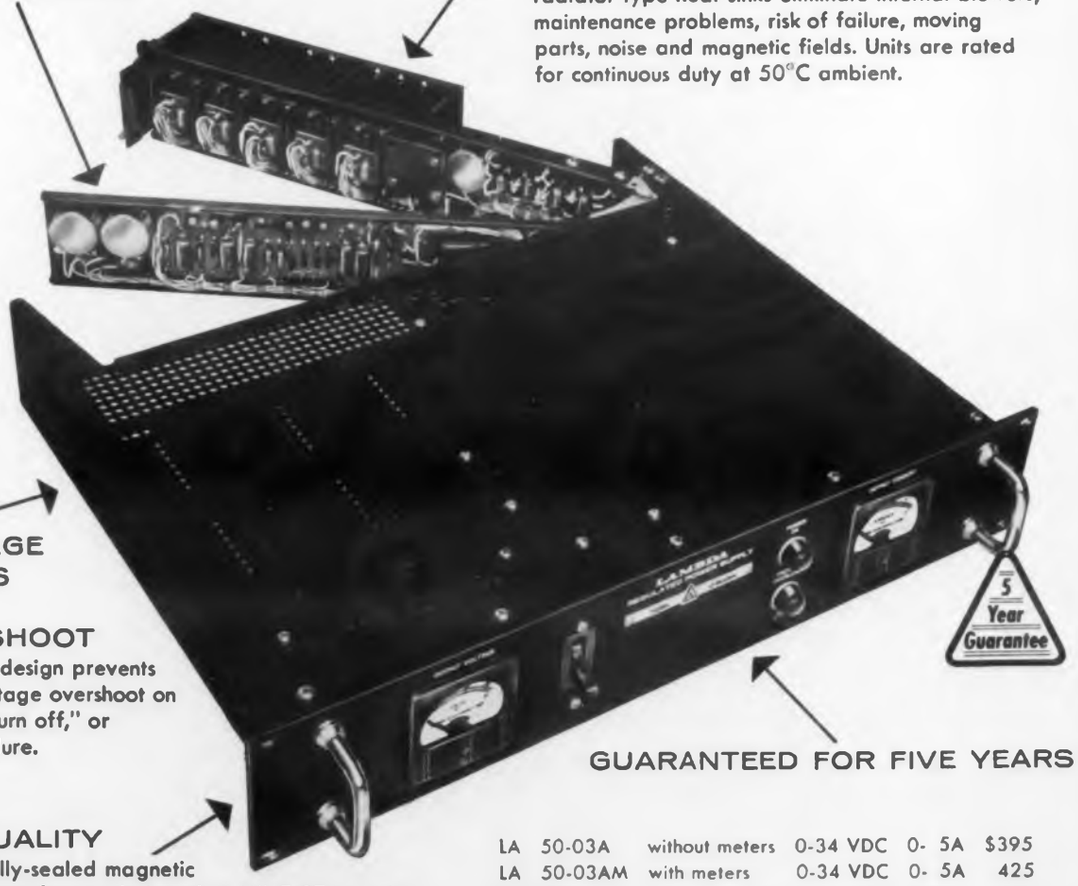
Availability: *Immediate delivery.*

NEW 20 AMP 0-34 VDC Regulated POWER SUPPLY joins

Visit Lambda at the IRE Show Booths 2917-18

EASY SERVICE ACCESS
Dual-deck, swing-out back construction provides simple and fast service access without the need to remove unit from rack. All major component terminals are accessible from rear.

CONVECTION COOLED— no blowers or filters— maintenance free
Advanced design and special, highly efficient, radiator type heat sinks eliminate internal blowers, maintenance problems, risk of failure, moving parts, noise and magnetic fields. Units are rated for continuous duty at 50°C ambient.



NO VOLTAGE SPIKES OR OVERSHOOT
Lambda's design prevents output voltage overshoot on "turn on, turn off," or power failure.

GUARANTEED FOR FIVE YEARS

MIL QUALITY
Hermetically-sealed magnetic shielded transformer designed to MIL-T-27A quality and performance. Special, high-purity foil, hermetically-sealed long life electrolytic capacitors.

LA 50-03A	without meters	0-34 VDC	0- 5A	$395
LA 50-03AM	with meters	0-34 VDC	0- 5A	425
LA 100-03A	without meters	0-34 VDC	0-10A	510
LA 100-03AM	with meters	0-34 VDC	0-10A	540
LA 200-03A	without meters	0-34 VDC	0-20A	795
LA 200-03AM	with meters	0-34 VDC	0-20A	825

COMPACT
NO BLOWERS

5 AMP 3½" HIGH
10 AMP 7" HIGH
20 AMP 10½" HIGH

PATENTS PENDING

Lambda LA Series Power Supplies are compact, convection cooled and rated for continuous duty at 50°C ambient temperature.

LAMBDA Transistorized 5 and 10 AMP LA Series

COMPLETE SPECIFICATIONS OF LAMBDA LA SERIES (Including improved data on 5 and 10 AMP Models)

DC OUTPUT (Regulated for line and load)

Model	Voltage Range[1]	Current Range[2]	Price
LA 50-03A	0-34 VDC	0-5A	$395
LA 50-03AM	0-34 VDC	0-5A	425
LA100-03A	0-34 VDC	0-10A	510
LA100-03AM	0-34 VDC	0-10A	540
LA200-03A	0-34 VDC	0-20A	795
LA200-03AM	0-34 VDC	0-20A	825

[1]*The output voltage for each model is completely covered in four steps by selector switches plus vernier control and is obtained by summation of voltage steps and continuously variable DC vernier as follows:*

MODEL	VOLTAGE STEPS
LA 50-03A, LA 50-03AM	— 2, 4, 8, 16 and 0-4 volt vernier
LA100-03A, LA100-03AM	— 2, 4, 8, 16 and 0-4 volt vernier
LA200-03A, LA200-03AM	— 2, 4, 8, 16 and 0-4 volt vernier

[2]*Current rating applies over entire output voltage range*

Regulation (line) — Better than 0.05 per cent or 8 millivolts (whichever is greater). For input variations from 100-130 VAC

Regulation (load) — Better than 0.10 per cent or 15 millivolts (whichever is greater). For load variations from 0 to full load.

Transient Response (line) — Output voltage is constant within regulation specifications for step function line voltage change from 100-130 VAC or 130-100 VAC

Transient Response (load) — Output voltage is constant within regulation specifications for step-function load change from 0 to full load or full load to 0 within 50 microseconds after application.

Internal Impedance — LA 50-03A less than .008 ohms
LA100-03A less than .004 ohms
LA200-03A less than .002 ohms

Ripple and Noise — Less than 1 millivolt rms with either terminal grounded.

Polarity — Either positive or negative terminal may be grounded.

Temperature Coeffiicent — Better than 0.025 %/°C

AC INPUT — 100-130 VAC, 60 ± 0.3 cycle[3]
LA 50-03A 360 watts[4]
LA100-03A 680 watts[4]
LA200-03A 1225 watts[4]

[3]*this frequency band amply covers standard commercial power lines in the United States and Canada.*
[4]*with output loaded to full rating and input at 130 VAC.*

AMBIENT TEMPERATURE AND DUTY CYCLE — Continuous duty at full load up to 50°C (122°F) ambient.

OVERLOAD PROTECTION:

Electrical — Magnetic circuit breaker front panel mounted. Special transistor circuitry provides independent protection against transistor complement overload. Fuses provide internal failure protection. Unit cannot be injured by short circuit or overload.

Thermal — Thermostat, manual reset, rear of chassis. Thermal overload indicator light front panel.

INPUT AND OUTPUT CONNECTIONS — Heavy duty barrier terminal block, rear of chassis. 8 foot, 3 wire detachable line cord.

METERS — Voltmeter and ammeter on metered models.

CONTROLS:

DC Output Controls — Voltage selector switches and adjustable vernier-control rear of chassis.

Power — Magnetic circuit breaker, front panel.

Remote DC Vernier — Provision for remote operation of DC Vernier.

Remote Sensing — Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

PHYSICAL DATA:

Mounting	Standard 19" Rack Mounting		
Size	LA 50-03A	3½" H x 19" W x 14⅜" D	
	LA100-03A	7" H x 19" W x 14⅜" D	
	LA200-03A	10½" H x 19" W x 16½" D	
Weight	LA 50-03A	55 lb Net	85 lb Ship. Wt.
	LA100-03A	100 lb Net	130 lb Ship. Wt.
	LA200-03A	140 lb Net	170 lb Ship. Wt.

Panel Finish — Black ripple enamel (standard). Special finishes available to customers specifications at moderate surcharge. Quotation upon request.

Send for complete Lambda Catalog.

LAMBDA ELECTRONICS CORP.
515 BROAD HOLLOW ROAD, HUNTINGTON, L. I., NEW YORK 516 MYRTLE 4-4200

LA114

Digital Voltmeter 370

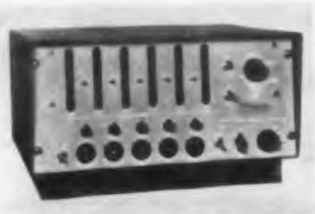
Is automatic

The model 4011 digital voltmeter gives a four-digit indication of dc voltages with a linearity of 0.01% of full scale. Applied voltages select appropriate range to 1 kv, polarity sign, and decimal point. Sensitivity is better than 1 mv. Measurements appear as in-line, in-plane readout. Binary-coded signals are also available. A self-adjusting stepping switch drive employs sealed reed relays.

Beckman Instruments, Inc., Berkeley Div., Dept. ED, 2200 Wright Ave., Richmond, Calif.
Price: $995 with cabinet.

Computer-Scaler 371

Provides count rate



The model QS-6 computer-scaler provides the calculated quotient of count vs time in digital form. Decimal point is automatically placed. Ratio counting may be performed. Input sensitivity is 0.25 v; impedance is 1 meg. There are six-decade count channels, with visual readout, and five-decade time channels with readout, accurate to 0.1 sec. A tape-printer output is provided. The scaler may be rack-mounted or housed in a cabinet measuring 19-1/2 x 11 x 13 in.

C. W. Reed Co., Inc., Atomation Inc. Div., Dept. ED, 5959 S. Hoover St., Los Angeles 44, Calif.

THE 'HEART' OF THE MARKITE POTENTIOMETER

1. A potentiometer element – embodying resistance track and take-off track of conductive plastic co-molded to an insulator base. 2. An I-S cantilever dual spring (with precious metal wipers); maintains contact with conductive tracks even under 70g vibration at 5-2000 cps, 100g shock and 100g acceleration!

SEE US AT THE IRE SHOW • BOOTH 4313

Instrument Specialties' cantilever springs provide high reliability in potentiometers, servomechanisms, electro-mechanical controls and instruments for aircraft, missiles and similar continuous-duty applications.

Employed in Markite conductive plastic precision potentiometers, I-S beryllium copper cantilever springs *maintain* their high spring forces . . . thereby complying with Markite's standards for infinite resolution and minimal contact noise over an operational life span of more than 50 million revolutions.

If you have a spring problem—Ask I-S engineers for a recommendation on your specific application; or request catalog containing complete data on I-S Beryllium Copper Compression Springs, Flat Springs, Contact Strips, Strip Springs, Contact Rings and Screw Machine Parts.

SEE OUR CATALOG IN SWEET'S

TWX:LTFS. N. J.-1023

INSTRUMENT SPECIALTIES COMPANY • INC.

270 Bergen Blvd., Little Falls, N. J.—Telephone: CLifford 6-3500

CIRCLE 173 ON READER-SERVICE CARD

NEW PRODUCTS

Circuit Analyzer 386

For automatic testing

Model 20 ac-dc automatic circuit analyzer automatically performs ac and dc testing of wiring harness and electric cabling. Capacity is 20 to 200 circuits, expansion to 800 circuits is possible. Dwell time is fully adjustable. Each circuit is tested for predetermined limits of continuity and checked against all other circuits commoned together.

DIT-MCO, Inc., Electronics Div., Dept. ED, 911 Broadway, Kansas City 5, Mo.

Plug-In Chopper 380

Range is −65 to 125 C

The series 310 chopper is unaffected by extremes of temperature over a −65 to 125 C range. Driving voltage is 6.3 v rms, 400 cps. Dwell time is 147 ±18 deg; phase angle is 65 ±15 deg. Noise is less than 200 μv average. Contacts are spdt, break before make.

Airpax Electronics Inc., Cambridge Div., Dept. ED, Cambridge, Md.

Price: *$49 ea, 1 to 6.*

Availability: *1 to 3 weeks.*

Clear Adhesive 494

A resilient epoxy adhesive, No. 0151 dries to a clear film in 1 hr at 77 F. Tensile shear value is 2,400 psi from −50 F to 150 F. Resin and hardener are packaged in flexible tubes. It will bond glass, pyroceram, and metal to glass.

Hysol Corp., Dept. ED, 322 Houghton Ave., Olean, N.Y.

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ORTHO HAS EXACTLY THE FILTER TO DO EXACTLY THE JOB YOU WANT! Select from many low pass, high pass, band pass, and band eliminate types — each designed to yield networks with a minimum number of elements. Why buy more filter than you need when Ortho offers a wide choice of shape factor and minimum stop band loss. All are tested for use from −40°C to +85°C; all are hermetically sealed; all meet MIL-F-18327A. Elements are temperature cycled to prevent aging. Standard impedances available: 600, 1,500, 3,000, 10,000 ohms unbalanced. Miniaturized and ruggedized versions for missiles and printed circuits also available. All are **economically priced** and ready for immediate delivery. For complete specifications and prices, write to:

of ortho filter CORPORATION
a division of ORTHO INDUSTRIES INC.
7 PATERSON ST. • PATERSON 1, N. J.

SEE YOU AT THE I. R. E. SHOW — BOOTH 1626
CIRCLE 174 ON READER-SERVICE CARD

NOW produce up to 6,000 welds per hour . . . automatically . . . with one operator.

TWEEZER WELD

Precision Resistance Welding Equipment

BENCH MOUNTED STORED ENERGY WELDER

- New TW5 low friction welding head
- Stored energy panel of 80 Watt second capacity
- Discharge time of 0.0008 to 0.0012 second
- Permits welding of difficult materials, i.e.: copper, silver, tungsten, etc.
- Reliable welds without discoloration, deformation, metallurgical change

TRANS-SYNC WELD-TIMER

- 1 KVA capacity utilizing semiconductors.
- Also ideally suited with high speed automatic machinery.
- Operates at a rate up to 1200 welds per minute . . . welds partially oxidized materials with ease.
- Welding time: ½ cycle (8 milliseconds) to 10 cycles (160 milliseconds).

FEDERAL TOOL ENGINEERING CO.
1400 Pompton Ave.
Cedar Grove, New Jersey

I.R.E. BOOTH #4428

CIRCLE 175 ON READER-SERVICE CARD

Plug-In Relay 427

With clear enclosure

Class 88CP is a clapper-type relay with 8- or 11-pin octal plug and transparent plastic enclosure. Contacts are silver alloy, spdt, dpdt, or 3pdt, rated at 10 amp. Actuation may be 6, 12, 24, or 115 v ac or dc current. Over-all dimensions are 1-3/4 x 1-3/8 x 2-1/16 in. above socket.

Magnecraft Electric Co., Dept. ED, 3350D W. Grand Ave., Chicago 51.

Price: *$5.35 to $8.20 ea.*

Availability: *Immediate delivery from stock.*

Monitoring System 415

For 18 or 36 functions

This system can monitor any condition that can be represented by an electrical contact closure. Scanning rate is 75 or 1,000 bits per sec, for 18 or 36 functions. Error-checking circuits permit only valid information to be displayed. Continuous scanning makes interrogation unnecessary so that only one direction of transmission is required. Printed-circuit plug-in modules, with solid-state circuitry, are used.

Lynch Communication Systems Inc., Dept. ED, 695 Bryant St., San Francisco 7, Calif.

Temperature Meter 426

With thermistor probe

This direct-readout temperature meter, for the range of 50 to 150 F, uses thermistor probes for rapid response. It is easily used in systems for measuring gas temperatures or the surface temperature of solids. Probes are corrosion-resistant; wire leads are covered with Teflon. Special models to 1,000 F are available.

MHD Research, Inc., Dept. ED, 1535 Monrovia Ave., Newport Beach, Calif.

NOW

Design your own Voltage Regulating Transformer with NEW Sorensen Series M

A new concept in magnetic regulator engineering—custom design at standard model prices and delivery.

Sorensen's new Series M line of magnetic voltage regulators offers you a choice of thousands of design combinations to meet your specific requirements for line, filament or power supply application.

Line regulation to ±1%. Complete line isolation. Low external field. Four convenient case styles. Output ratings from 10 to 10,000 VA. Includes all popular a-c voltages and windings rated for d-c supply service at voltages from 2.3 to 1000 vdc. Harmonic filtered units available.

Get complete information on this new concept in voltage regulating transformers today. Write for Sorensen's 10-page Series M bulletin. Sorensen & Co., Richards Ave., South Norwalk, Connecticut, or contact your local Sorensen representative.

Sorensen

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CONTROLLED POWER PRODUCTS

The widest line—your wisest choice

VISIT US AT BOOTH 2604 AT THE IRE SHOW

CIRCLE 176 ON READER-SERVICE CARD

The Leaders Specify **ALPHLEX™ ZIPPER TUBING**

ALPHA electronic WIRE

- constant flexibility
- cuts time and labor
- outer jacket is replaceable
- wire changing is simplified
- eliminates costly jacket extrusion
- immediate delivery from your local Alpha distributor

For all these benefits, Alphlex Zipper Tubing is used by such OEM leaders as IBM, IT&T, Librascope, Lockheed, Martin, Sperry Rand and Government agencies. Write for free Alphlex Catalog Z-2.

The new Alphlex Closing Tool (above) designed to save you time, labor and money in your cable production requirements is free with each order of 1,000 feet of Zipper Tubing.

TYPES OF ZIPPER TUBING	
ZIP-31	fabricated from .020" polyvinyl sheet made from MIL-I-631C materials. All purpose type for general applications to 105°C. Standard colors: Clear, Black, Yellow.
ZIP-31M	heavy duty construction. Similar to ZIP-31 type except nominal wall thickness of .040". Standard colors: Clear, Black.
ZIP-44	polyvinyl sheet made from MIL-I-7444B materials. Extremely flexible; for aircraft and low-temperature uses to –67°C. Standard colors: Clear (amber), Black.
ZIP-44M	heavy duty construction. Similar to ZIP-44 type except nominal wall thickness of .040". Standard colors: Clear (amber), Black.
ZIP-50	"sandwich" of aluminum foil laminated between two sheets of polyvinyl. For 100% RF shielding applications to 105°C. Standard color: Silver Grey.
ZIP-90	polyvinyl bonded to woven fibreglass sheet per MIL-I-3190A. For rough usage, abrasion resistance, and high temperature uses to 130°C. Standard color: Black.
	All types available in inside diameters from ¼" to 2" in increments of ⅛"; and from 2" to 4" in increments of ¼". Alphlex Zipper Tubing covered by Patents #RE24,613 and #2,558,367 and other patents.

ZIPPER SPECIFICATIONS FOR ALL TYPES OF ALPHLEX ZIPPER TUBING	
Material	Polyvinyl Chloride
Track Thickness (when closed)	.095"
Dielectric Strength, V/mil	750
Tensile Strength P.S.I.	3810
Ultimate Elongation	255%
Operating Temperature, Upper Limit	105°C
Cold Brittleness	–65°C
Fungus-proof	will not support fungus
Flammability	self-extinguishing
Lateral Pull Strength (unsealed)	42.7 pounds/inch
Lateral Pull Strength (permanently sealed)	59.8 pounds/inch
Standard Colors	Black, Clear, Yellow

ALPHA WIRE CORPORATION Subsidiary of LORAL Electronics Corporation
200 Varick Street, New York 14, N. Y.
Pacific Division: 1871 So. Orange Dr., Los Angeles 19, Calif.

ALPHA WIRE

See Alpha at I.R.E. BOOTH 4103 CIRCLE 177 ON READER-SERVICE CARD

See the Most Advanced New

TOROIDAL WINDING MACHINES

at IRE BOOTH 4004-4005

Model S with New Counter and IC-601 Inductance Comparator

including—

The NEW MODEL S—the FIRST to have fully transistorized in-line digital "read-out" counter, with simple photo-diode and photocell pick-up, minimizing maintenance. Number of turns on coil flashes onto screen above. Model S toroidally winds #16-#50 wire and down to .065" finished I.D. #16 wire tightly wound down to ¾" finished I.D. Attachable comparator allows winding directly to desired inductance. Interchangeable heads for random and precise layer windings.

The NEW MODEL TVW—for toroidal TV Vertical Deflection Coil Winding.

The NEW TRUE BANK WINDER—for variable auto-transformers.

The NEW HI-SPEED LABORATORY SLIDER-TYPE WINDER with interchangeable heads, new economy features.

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CIRCLE 178 ON READER-SERVICE CARD

NEW . . . TYMETER

ELAPSED TIME COUNTER AND DIGITAL CLOCK

12 and 24 HOUR READ OUT

- FRONT PANEL MOUNT
- DESK or BENCH USE
- DIGITS RESETTABLE

150-12H

TYMETER ELAPSED TIME COUNTER

- **TIME REGISTERED:**

1—Hours, to a total of 99,999 Hours
2—Hours, and Tenths of Hours, to a total of 9,999.9 Hours
3—Minutes, to a total of 99,999 Minutes
4—Minutes, and Tenths of Minutes, to a total of 9,999.9 Minutes

Resettable • Counter and Motor enclosed • Independent Time Counter Control Switch • Jewel Light Panel Indicator.

FOR OPERATION AT:
120 Vac, 50 or 60 Cps
240 Vac, 50 or 60 Cps
115 Vac, 400 Cps

TYMETER DIGITAL CLOCK

• Large ⅜" easy-to-read digits • Rotating visual 1 RPM calibrated seconds wheel • Digits resettable individually • Front panel time reset controls • Movement completely enclosed in anodized aluminum dustproof case • Height 7½", Width 6", Depth 3¾". Wt. 5 lbs. • Precision instrument accuracy 0.1% • UL approved motor and cord • Guaranteed 1 year.

Write for Catalog on Complete Line Showing Specifications

PENNWOOD NUMECHRON CO.
ELECTRONIC TIMING DIVISION
7249 FRANKSTOWN AVE. PITTSBURGH 8, PA. FRemont 1-4200

CIRCLE 179 ON READER-SERVICE CARD

NEW PRODUCTS

Centrifugal Fans 485

Deliver 45 to 325 cfm

This series of single-inlet, single-wheel centrifugal fans are designed for cooling and pressurizing requirements in the electronic and control fields. Scroll widths range from 3-7/8 to 9-1/4 in. These units have air deliveries from 45 to 325 cfm over a wide pressure range.

Robbins and Myers, Inc., Propellair Div., Dept. ED, Springfield, Ohio.

Delay Generator 351

With digital circuitry

Designed for precision in generating and measuring time intervals, this digital delay generator performs a variety of functions. Digital circuitry and crystal-controlled stability of 1 ppm permit accuracy better than ±0.003 μsec per 1,000 μsec. Continuous calibration is unnecessary; decimal input simplifies control.

Electronic Designs, Dept. ED, 2311 Farrington St., Dallas 7, Tex.

Delay Timer 692

For microminiature circuits

In a size compatible with microminiature magnetic relays, the type 406 timing module provides a factory-set delay from 0.1 to 60 sec. The solid-

state timer operates on 24 to 30 v dc, at ambient temperatures from —55 C to 100 C. It will withstand 20-g vibration up to 2,000 cps, and shock of 50 g for 11 msec. Timing tolerance over the voltage and ambient range is within ±10%.

G-V Controls Inc., Dept. ED, Okner Parkway, Livingston, N.J.

Price: *From $135 to $75.*

Availability: *30 to 75 days.*

Power Supply 509

For computers

This three-unit, two-bearing motor-alternator was developed to supply accurately regulated 400-cps power for computers. It will reduce errors caused by transients on the input line. Brushless design is incorporated. Units with a continuous output rating from 1 to 5 kva are available.

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

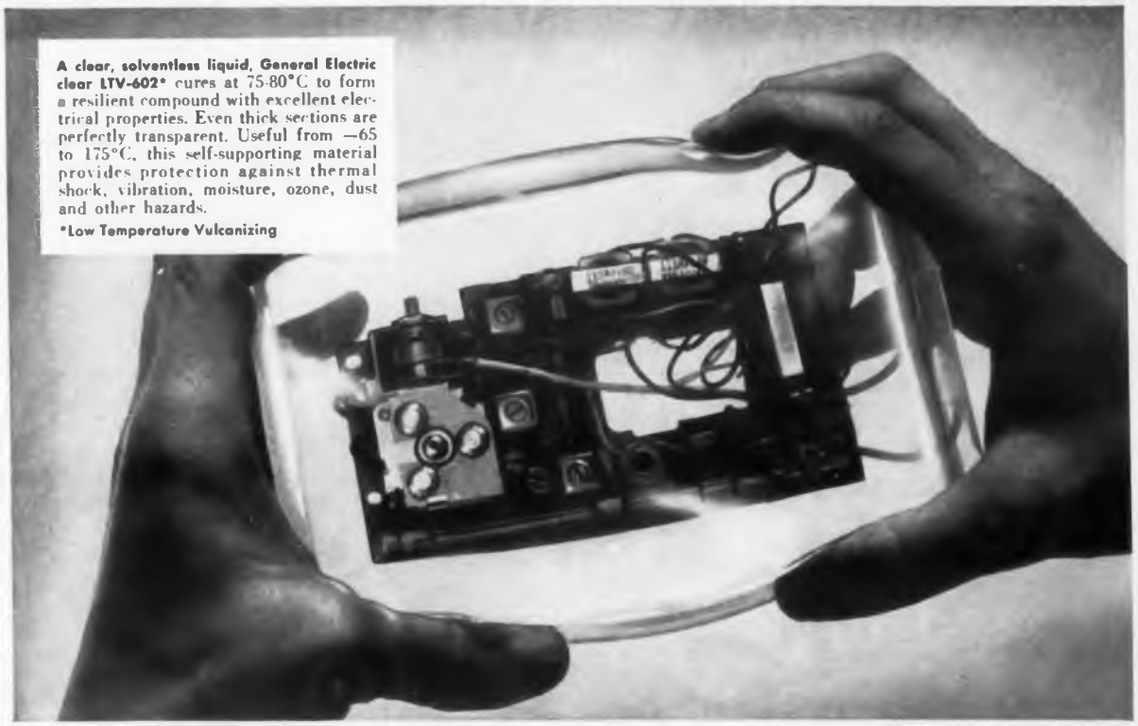
Transistor Sockets 435

Save space

Engineered for use with space-saver transistors, these sockets function at maximum voltages and high temperatures. Contacts are silver-plated brass, with floating action to assure proper alignment. Weight is about 3 g. Designated No. 74-010, they are built to resist shock and vibration.

Jettron Products Inc., Dept. ED, 56 Route 10, Hanover, N. J.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.



A clear, solventless liquid, General Electric clear LTV-602* cures at 75-80°C to form a resilient compound with excellent electrical properties. Even thick sections are perfectly transparent. Useful from —65 to 175°C, this self-supporting material provides protection against thermal shock, vibration, moisture, ozone, dust and other hazards.

*Low Temperature Vulcanizing

General Electric clear LTV silicone compound for potting and embedding

Transparent, resilient, self-supporting and easy to repair

LTV-602 is easily applied, flows freely in-and-around complicated parts. Having a low viscosity in the uncured state, 800-1500 centipoise, LTV is ideal for potting and embedding of electronic assemblies. Unlike "gel-like" potting materials, LTV-602 cures to a flexible solid. Oven cure is overnight, or from 6 to 8 hours at 75 to 80°C.

LTV-602 is easy to work with and easy to repair. To repair parts embedded in LTV, merely cut out and remove section of material, repair or replace defective part, pour fresh LTV into opening and cure. Pot life, with catalyst added, is approximately 8 hours and may be extended with refrigeration. When desirable, LTV may also be cured at room temperature.

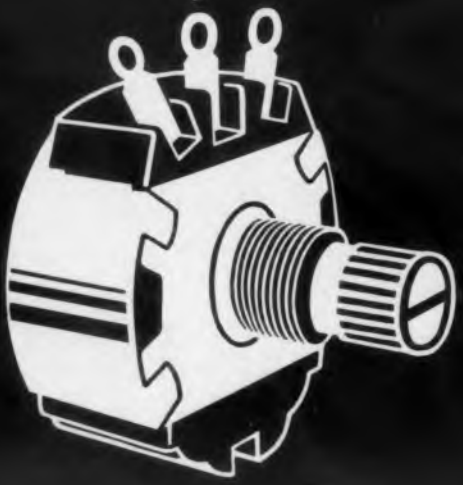
Resiliency offers excellent shock resistance. LTV-602 easily meets thermal shock tests described in MIL-STD-202A test condition B which specifies five temperature cycles from —65 to 125°C. Tests indicate that LTV retains protective properties even after 1800 hours aging at 175°C. Other tests confirm LTV's resistance to moisture and water immersion.

LTV-602 is the newest addition to the broad line of G-E silicone potting and encapsulating materials which also include the RTV silicone rubbers. For more information, write to General Electric Company, Silicone Products Department, Section Waterford, New York.

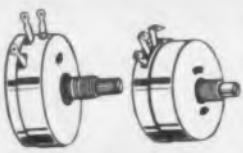
GENERAL ELECTRIC

CIRCLE 180 ON READER-SERVICE CARD

For reliable service in wire-wound controls—



make sure they're Mallory...



Take the 2-watt Type R control for instance: you can't beat it for long, quiet service. Insulated dual contact arm gives double wiping action, positive contact. Metal-to-metal lock holds tight, won't break or loosen.

Mallory can supply just about anything you need in wire-wound controls . . . the 2-watt Type C with grounded contact arm . . . the 4-watt Type M . . . the 7-watt Type E. Wide variety of resistance values, tapers, shafts, mounting arrangements and tandem constructions. And specials, too, at attractive prices. Mallory Controls Company, Frankfort, Indiana.

P. R. MALLORY & CO. Inc.

MALLORY

carbon controls

vitreous enamel resistors

rotary switches

plugs & jacks

CIRCLE 181 ON READER-SERVICE CARD

NEW PRODUCTS

Vacuum Gage 476

Cold-cathode type

This cold-cathode vacuum gage provides continuous pressure measurement in the 10^{-1} to 10^{-6} mm Hg range of dry air. Tube design provides for disposal of contaminated anode or cathode. Except for seals, the gage tube is made entirely of metal. The anode is of ring design for concentrated ion-beam discharge.

Temperature Engineering Corp., Dept. ED, Riverton, N.J.

Tunable Inductors 395

Have OD of 0.275 in.

These 11 tunable inductor models have an OD of 0.275 in. and a nominal inductance range of 0.03 to 40 μh. Adjustment range is approximately ±10%. Minimum Q ranges from 120 to 220. Maximum current rating is 1/2 amp. Ideal operating characteristics lie between 10 and 250 mc.

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

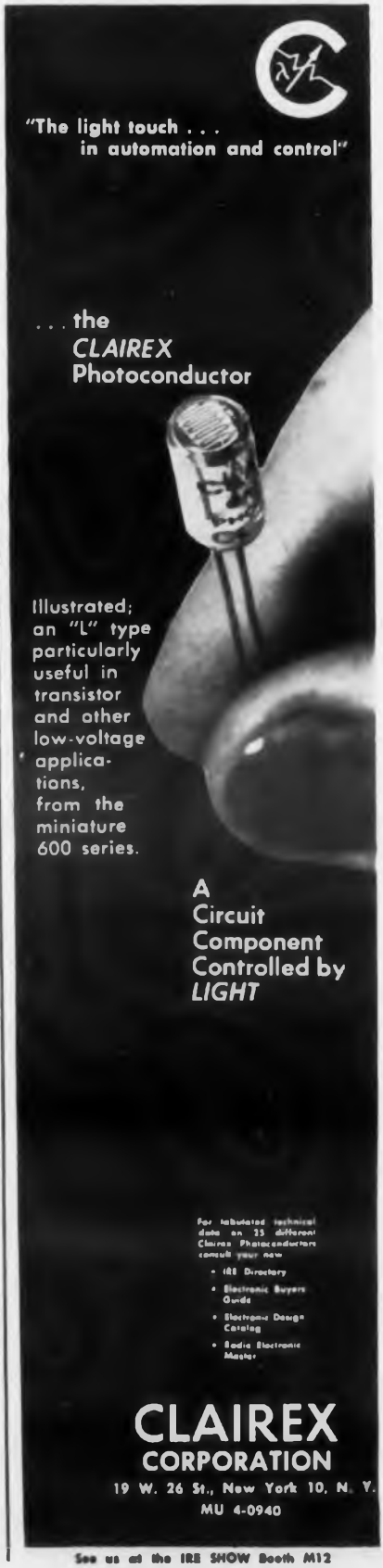
Polyethylene Compound 469

Bakelite DFDA-0173 Natural is an unmodified, very high-molecular weight polyethylene compound containing only antioxidant. Designed for primary insulation of transoceanic submarine telephone cables, it has a dielectric constant of 2.283 and a dissipation factor of 0.00012 at 23 C and 10^3 to 10^6 cps.

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

***Availability:** In commercial quantities.*

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.



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SELECT YOUR HEATERS FROM ANY OF THESE PRECISION DESIGNS

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Precision Filaments Specified by Leading Manufacturers

SEND BLUE PRINTS FOR ESTIMATES — COMPLETE FABRICATION OF TUNGSTEN WIRE PRODUCTS AVAILABLE

PRECISION has the facilities either to recommend a standard tungsten filament or to design one for your particular need.

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Delay Relays 384

Tolerance is ±10%

These thermal time-delay relays, enclosed in metal dust covers, have a delay of 2 to 180 sec, tolerance ±10%. The spst or spdt contacts are rated at 3 amp, 115 v ac resistive. Operating voltage is 2.5 through 130 v ac or dc. Ambient temperature range is −65 to 85 C. The timers withstand shock to 50 g and vibration of 5 to 500 cps.

Clairtron Manufacturing Co., Dept. ED, Box 171, Orange, N.J.

Thermoelectric Generators 409

Have ratings from 5 to 100 w

These four thermoelectric generators, in ratings of 5, 10, 50 and 100 w are completely static and suited for remote applications. They operate at core temperatures between 300 and 600 C. The basic outputs are as follows: 5 w, 1.7 v at 4 amp; 10 w, 3.4 v at 4 amp; 50 w, 4.7 v at 13 amp; 100 w, 9.4 v at 13 amp.

Westinghouse Electric Corp., Dept. ED, Box 2278, Pittsburgh 30, Pa.

Volt-Ammeter 695

Clip-on type

The Miniclip volt-ammeter consists of a current transformer and a rectifier instrument housed for one-handed operation. The thumb-operated range selector switch also selects the appropriate scale so that the use of multiplication factors is avoided. There are five current ranges and three voltage ranges.

Ferranti Electric, Inc., Electronics Div., Dept. ED, Industrial Park No. 1, Plainview, N.Y.

Price: *$90 ea, 1 to 5; $85.50 ea, 6 to 50.*

Availability: *Delivery in 30 to 60 days.*

HYREL® FB

DEPOSITED CARBON RESISTORS

Send for Bulletin: 7010-B

BLUE JACKET®

VITREOUS ENAMEL-PROTECTED, POWER WIREWOUND RESISTORS.

Send for Bulletins: 7410-A (Axial Lead), 7400-A (Tab Type)

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CERAMIC INSULATED-SHELL, POWER WIREWOUND RESISTORS.

Send for Engineering Bulletin: 7300-A

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CAST EPOXY HOUSING, PRECISION WIREWOUND RESISTORS.

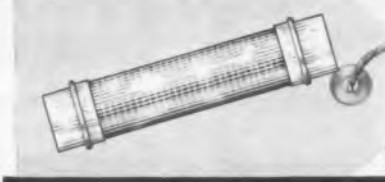
Send for Engineering Bulletin: 7500

SPRAGUE RESISTORS

FILMISTOR®

PRECISION CARBON FILM RESISTORS.

Send for Bulletins: 7000 (Molded shell), 7010-B (Ceramic shell)



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GLASS JACKET HIGH VOLTAGE, HIGH POWER RESISTORS.

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SPIRAMEG®

HIGH-RESISTANCE SPIRAL ELEMENT RESISTORS.

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SPRAGUE COMPONENTS: RESISTORS • CAPACITORS • MAGNETIC COMPONENTS • TRANSISTORS INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS

CIRCLE 184 ON READER-SERVICE CARD

TO BUILD ELECTRONIC EQUIPMENTS ...INDUSTRY SPECIFIES NARMCO'S METLBOND 408...

and cuts fabrication costs as much as 40%

This new concept in industrial adhesives systems has led to new techniques in the fabrication of electronic equipments... techniques which actually eliminate the necessity for screws, bolts, rivets, spot welds, and other mechanical means of fastening electronic housings. New METLBOND 408 permits the assembly and production of complete systems—comprising several bays, and including all doors, panels, racks, chassis, drawer assemblies and consoles—better, faster, and more efficiently. RESULT: greatly reduced labor and materials costs.

METLBOND 408 is a one-component, dry, non-supported, Epoxy-based adhesive system. It can be used to bond similar or dissimilar metals faster, better, more economically. No skin primer is required.

FEATURES OF METLBOND 408

- Qualified to MIL-A-5090D, and MIL-A-25463.
- Excellent for either small area, or very large-area bonding.
- Excellent dielectric properties.
- High adhesive strength virtually eliminates panel torque, warping.
- Easy to use—can be cut, placed in position, and cured with moderate temperatures and pressures.

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get the complete facts in this new informative brochure.

ALLOYS UNLIMITED CHEMICALS INC.

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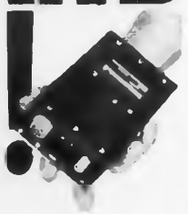
LOUD AND CLEAR!



RADIATION MODEL 3115
FM TELEMETRY TRANSMITTER PROVIDES...

- Carrier frequency stability to within ±0.01%
- Frenquency response within 0.5 db from 100 to 100.000 cps
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- Virtual immunity to extreme environments
- Low microphonics
- Reliability proven in Tiros I, Redstone, Jupiter, Snark and other missile programs
- Off-the-shelf availability

For complete information on the Model 3115 ask for: Technical Bulletin RAD B-102. Write Dept. ED-3.

RADIATION INCORPORATED

Melbourne, Florida

CIRCLE 187 ON READER-SERVICE CARD

NEW PRODUCTS

Miniature Counter 383

With light

The three-digit counter, the model CE-L has lighted counter wheels. It is available in additive or subtractive versions, for 6, 12, 24, and 110 v dc. Rate is 20 pulses per sec. Rated for continuous duty, it has a minimum life of 1 million counts. Counter current is 0.300 amp; light current is 0.040 amp. It is 1-5/16 x 2 x 2-5/8-in. overall and weighs 3-3/4 oz. The environmental specifications of MIL-E-5272A-1 are met.

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

Magnetic Alloys 495

Used as source material in the production of thin-film memories, Vapalloy high-purity magnetic alloys are formed by vacuum induction melting. The alloys are compounded of iron, nickel, and cobalt. Hydrogen and nitrogen are usually less than 1 ppm, and other impurities are held to low levels.

Hamilton Watch Co., Dept. ED, Lancaster, Pa.

Signal Simulators 437

Resolver and synchro types

Model S-200 series of transmitter signal simulators are synchro and resolver transmitters in a configuration for easy front-panel mounting. They require only 7/8 in. front-panel space. Units may be positioned with 3/4-deg accuracy and 1/4-deg resolution.

Angler Industries, Dept. ED, 3 Lexington Drive, Metuchen, N.J.

Price: *$89.50.*

Availability: *One week.*

Have you sent us your subscription renewal form?

Electric Ovens 447

Use gravity convection

Made for accelerated aging tests, these gravity convection ovens provide temperatures to 650 F. A saturable power reactor control system gives stepless, switchless and infinitely proportional wattage for straight-line, repeatable temperatures throughout the range. There are 4 standard sizes, up to 37 x 20 x 25 in. internal dimensions.

Blue M Electric Co., Dept. ED, 138th & Chatham Sts., Blue Island, Ill.

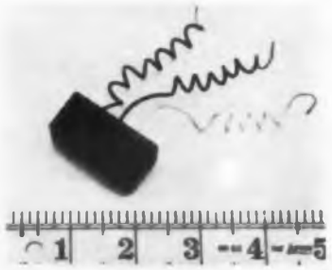
Umbilical Connector 463

The Tang Mark III umbilical connector uses a peripheral tang-locking mechanism and resonance compensation to maintain contact during vibration. It will withstand accelerations up to 60 g. Materials are compatible with exotic fuels.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

Telemetering Filters 524

Weigh 1 oz



Designed for airborne systems, these telemetering filters measure 23/32 x 23/32 x 1-3/8 in. and weigh 1 oz. Center frequencies range from 1.7 kc to 70 kc, with an impedance of 51 K. Attenuation is less than 3 db at ±7-1/2% and more than 20 db at ±27% of the center frequency. The filters are encapsulated and environmentally tested to military specifications.

Control Electronics Co., Inc., Filter Div., Dept. ED, 10 Stepar Place, Huntington Station, N.Y.

Availability: Delivery in 2 to 3 weeks.

CW MAGNETRONS

attuned to new applications

This Litton continuous wave magnetron is one of a family of ten that gives coverage from P to X bands at minimum power outputs from 250-500 watts.

The dependability and versatility of Litton CW magnetrons has been time-proved by the many thousands in field service. There are undoubtedly long years of operation ahead in new military and commercial applications.

These Litton CW magnetrons are mechanically-tuned and liquid-cooled. We also manufacture CW magnetrons with versatile hydraulic tuning and, at lower powers, can supply them with forced air cooling.

Litton CW magnetrons are being applied in a pulse width modulated navigation system. Pulse rate, amplitude and frequency modulation techniques make possible other communication applications. This family also offers many advantages in such CW applications as RF drivers, industrial processing and component testing. They can be pulsed to approximately 2 KW peak power at a .25 duty cycle, a desirable attribute in component testing.

Investigation of these magnetrons and Litton pulse magnetrons, the international standards of excellence, may lead you to new applications. If we have stimulated your thinking a little, we *would* like to hear from you. Write to: 960 Industrial Road, San Carlos, California.

CW MAGNETRONS

Type Number	Frequency Range Megacycles	Minimum Power Watts
L-3456	350-590	500
L-3459	590-975	500
L-3465	975-1500	400
L-3464	1500-2350	400
L-3460	2350-3575	500
L-3461	3575-4975	400
L-3467	4975-6175	400
L-3468	6175-7275	300
L-3462	7275-8775	300
L-3463	8775-10,475	250

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actual size

BRISTOL chopper helps put Navy TARTAR on target

. . . Every component in the U.S. Navy's TARTAR, newest supersonic surface-to-air guided missile must meet the highest standards for statistical reliability.

No exception is the Bristol Syncroverter* chopper used in the TARTAR's guidance system. The TARTAR, produced for the Bureau of Naval Weapons by Convair (Pomona) Division of General Dynamics Corporation, is slated to form the primary antiaircraft weapon aboard destroyers and secondary antiaircraft batteries aboard cruisers.

The Bristol Syncroverter chopper has a long history as a component in U.S. guided missiles. It's the ideal miniature electromechanical chopper for use in d-c analog computers or wherever utmost reliability is required.

BILLIONS OF OPERATIONS have been completed without a failure on Bristol's continuing life tests—aimed at improving the Syncroverter's already superlative characteristics. Just one sample: A group of five choppers, with 400 cps drive and 12v, 1 ma resistive contact load have been going for more than 26,000 hours without failure. That's more than 2.96 years continuous operation or more than 37 billion complete cycles!

No matter what your chopper requirements, we're sure you can find the model you need among the wide selection of Syncroverter choppers and high-speed relays available . . . including low-noise, external coil types. For complete data, write: The Bristol Company, Aircraft Equipment Division, 150 Bristol Road, Waterbury 20, Conn. C-15

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NEW PRODUCTS

Infrared Optical Head 417

Range is from 120 to 1,200 F

This infrared optical head senses surface temperatures from 120 to 1,200 F. It connects to the firm's Radiometer direct-reading unit. Field of view is 1/30 of working distance of approximately 30 in. Stability is ±2 F; accuracy is ±2 F over the 100- to 300-F range. Sensing system works down to 2 microns. It can be used where electromagnetic fields prevent the use of thermocouples.

Williamson Development Co., Inc., Dept. ED, 317 Main St., W. Concord, Mass.

Analyzer Preamplifier 361

For low-level measurement

Designed to measure strains and low-level electrical parameters simultaneously on separate channels, the model RD 4627 00 analyzer has a strain-gage carrier section and a chopper-stabilized, high-gain dc section. Sensitivity is 100 μv per 1 mm chart line, with a range of 100 μv to 400 v. Transducer excitation of 2 kc is provided. The unit will accept resistive gages and transducers from 100 to 1,000 ohms.

Clevite Corp., Brush Instruments, Dept. ED, 37th & Perkins, Cleveland 14, Ohio.

Price: *$900.*

Availability: *30-day delivery.*

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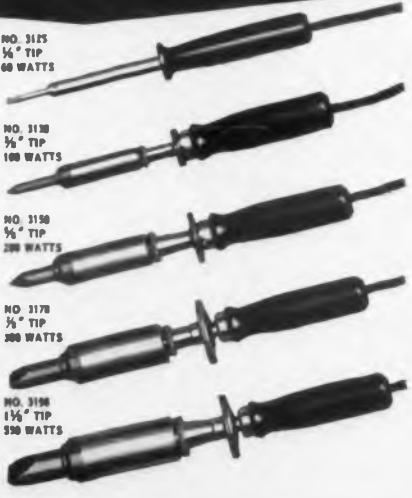

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AMERICAN ELECTRICAL HEATER COMPANY
DETROIT 2, MICHIGAN

CIRCLE 190 ON READER-SERVICE CARD

Transistor Tester 728

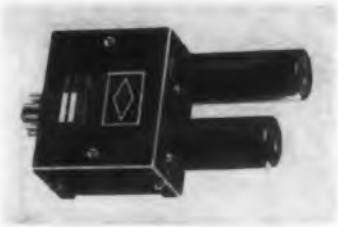
Measures four parameters

Model T-340 transistor tester is for npn and pnp transistors. It measures the four basic parameters necessary to check a transistor's performance. The I_{CO} range is 0 to 500 μa; I_{EO} range is 0 to 5 ma; I_{CBO} range is 0 to 50 ma. Beta ranges cover eight different collector current levels, I_C set levels are up to 500 ma and V_C ranges are 0 to 10 v and 0 to 100 v. Results are read directly from a meter.

Magnetic Research Corp., Armour Stablvolt Div., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

Operational Amplifier 358

Gain is 20,000

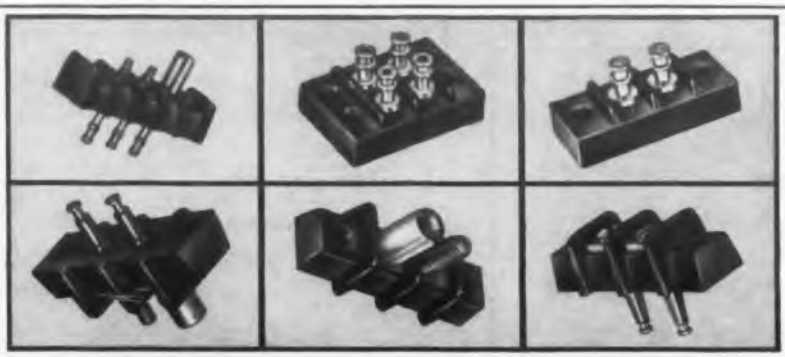


The model B/100/M, a plug-in operational dc amplifier for analog computers, system simulation, and control applications, has a gain of 20,000 dc min. Output is ±100 v dc; drift is within 100 mv over four days. Frequency response is flat to 4 kc with 15-K load. The unit has an 11-pin plug base; width is 3 in., depth 1-1/2 in., height 5-1/4 in.

Embree Electronics Corp., Dept. ED, 993 Farmington Ave., West Hartford 7, Conn.

Price: *$40 ea, 1 to 5.*

Availability: *2-week delivery.*



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For faster, better, and more appropriate terminations, Kulka offers all their popular terminal blocks with **your choice of terminal.** Now you can choose from regular screw-type, solder-turret, feed-through, threaded stud, or any combination of terminals to best suit your specific requirements. And, you can call your own choice of finishes — electro-tinned, silver-plated, or even gold-plated over silver. Kulka maintains complete design and consultation services to aid customers in the proper terminal selection. Send us your requirements, or...

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No one type of enclosure meets all environmental and physical demands. AMCO has developed 3 complete systems integrated into 1 system with interchangeable accessories, applicable for both commercial and military use.

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ELECTRO PRECISION CORPORATION'S VERSATILE MODEL DLA-41

The unusual combination of bandwidth plus stability make this amplifier easier to apply to your problem than any other. Only the DLA-41 offers you a 40KC bandwidth, and yet is so stable with various feedback configurations.

NEED MORE?

The Model DLI-520 Amplifier Group contains five DLA-41 Operational Amplifiers, yet only occupies only 5¼" of panel space in a standard 19" rack. Ideal for building special purpose computers and you have the assurance of the finest amplifiers for precision computing.

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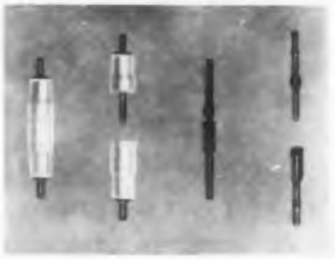
2528 West Bradley Place, Chicago 18, Illinois

CIRCLE 195 ON READER-SERVICE CARD

NEW PRODUCTS

One-Pin Connector 434

With fixed-distance contact



Design of this one-pin connector assures that contact is made continually at a single point on the male shaft through use of a fixed, spun female contact ring. Engaged over-all length is 1.42 in. The compression-mounted device has Teflon insulation. Environmental tests, with temperature to 200 C, are met.

Jupiter Electronics, Inc., Dept. ED, 225 E. 144th St., New York 51, N. Y.

Conductive Paint 466

This conductive paint is available in any resistance from 1 to 500 x 10^6 ohms. It may be applied to any surface and has applications in heating, controlled resistance of all values and microwave absorber coatings.

Topper Manufacturing Co., Inc., Dept. ED, 84-56 Parsons Blvd,. Jamaica 32, N.Y.

Exciter Control 475

Maintains constant rates

Model N572 automatic vibration exciter control is an all-electronic servo which maintains constant acceleration or displacement at the vibration exciter as frequency changes. The transfer of control function is completely automatic. Sweep rate is adjustable from 1 to 100 min, through 10 to 2,000 cps and back.

Textron Electronics, Inc., MB Electronics Div., Dept. ED, 781 Whalley Ave., New Haven 8, Conn.

Don't miss an issue of ELECTRONIC DESIGN; Return your renewal card.

Induction Motor 698

For axial-vane blower

Designed to drive an axial-vane blower, the DE-30-1 induction motor can be used up to 30,000-ft altitude, and in temperatures up to 180 C. Thermal overload protection eliminates smoke hazard. The motor is rated at 1-1/4 hp, 7,500 rpm, with full-load torque of 0.875 lb ft. Full-load current is 4.4 amp; voltage is 200 v, 400 cps, 3 phase. The motor meets military specifications. Weight is 10 lb 2.5 oz.

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

Shaft-Position Encoder 407

Has 1,024 counts per turn

Model ADC-ST10-BNRY encoder has 1,024 discrete counts per shaft rotation in pure binary without extensive external brush-selection logic. It needs only a three-transistor driver to accomplish its function of providing a parallel readout of its full 2^{10} resolution. Applications include antenna positioning and all computers which accept pure binary presentation of a shaft position to an accuracy of 20 min of arc.

United Aircraft Corp., Norden Div., Dept. ED, Norwalk, Conn.

Acceleration Switch 699

For low milligram range

Designed as an acceleration sensing switch, the A9548-01 has a threshold sensitivity of 0.150 g ±25%. Damping, springs, mass, or material can be varied in the 0.1- to 5-g range. Contacts are rated at 0.1-amp noninductive. The hermetically sealed unit meets requirements of MIL-E-5272C. It may be used as a tilt switch, with threshold at a tilt angle of 8-1/2 deg.

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

vernistat® design report

Information on Vernistat a c potentiometers for design engineers

TERMINAL CONFORMITY—THE RAINBOW AT THE END OF THE POT

Let's run with the basic facts: the Vernistat is a precision **a.c. potentiometer.** It differs from the ordinary pot because the input voltage is spread across an evenly and precisely tapped **autotransformer.** A low-resistance **interpolating pot,** which operates between adjacent taps of the autotransformer, pulls out a smoothly-rising, precisely **linear** voltage.

IMPEDANCE

The input voutage of the Vernistat looks into a **very high** impedance because the autotransformer consists of many turns of wire around a high-permeability core. The load, however, looks back to a **very low** impedance, because output impedance of the Vernistat is determined mainly by the resistance of the interpolating pot. Hence, as far as the load is concerned, the impedance of the autotransformer never goes above a few ohms.

"Now what", you may ask "has this high Z_i — low Z_o ratio got to do with linearity?"

Simply this: In addition to high initial terminal conformity, the Vernistat has an extremely low loading error. Output voltages remain linear and accurate!

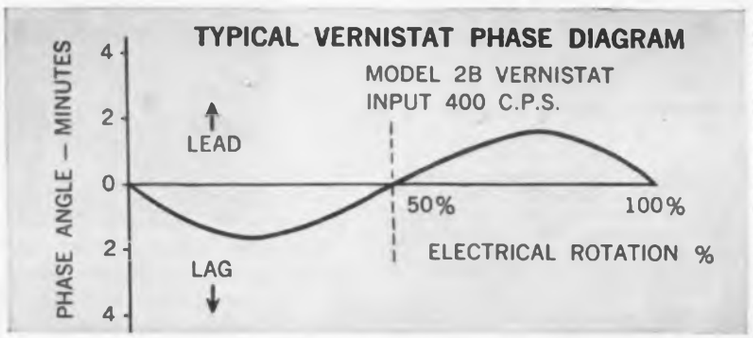
To give this statement figures: if a 500 K load is applied to an ordinary 50 K pot, a maximum loading error about 1.4% will result. This obviously is ruinous to system accuracies requiring a linearity of ±0.1% — a common figure in analog computer and servo work. With the same 500 K load, a Model 3B Vernistat goes to the head of the class with a maximum loading error of only ±0.008%.

PHASE SHIFT

What's more, if phase shift is a problem, the Vernistat may well be your answer. The tapped autotransformer acts as an almost perfect voltage divider. That is, tap voltages remain almost exactly in phase with input voltage! (Take a look at the phase diagram below). Unlike many voltage dividers, the Vernistat does not develop excessive phase shift at higher frequencies. Operation at 5 KC is not uncommon.

In sum: the Vernistat provides high angular resolution (0.002%) and high linearity. It operates with essentially no power losses and can be continuously rotated.

Paradoxically, the Vernistat can be made into an excellent nonlinear potentiometer simply by varying tap distances of the autotransformer. Other nonlinear variants of the Vernistat are available, too. Ask us about our Adjustable Function Generators.



Yes, there may be a pot of gold under the rainbow for the designer who realizes what Vernistat can do to reduce size and weight of equipment and increase reliability and accuracy. But first you've got to know! So, send for our design literature. It's downright enlightening!

SIZE II VERNISTAT AC POTENTIOMETERS

These miniature, ten-turn components are approximately 1⅔ inches long, a little over an inch in diameter, and weigh only 2 ounces. The Series 4 operates at 400 c.p.s. at 20-40 volts maximum input. Input impedance is 2,500 to 30,000 ohms; output impedance, 40 to 200 ohms. Terminal conformity is ±0.05%. Series 4 Vernistats are 10-turn units and provide continuous rotation, since they have no stops.

Four Series 4 Vernistat models are available which cover the above ratings. They are useful as data transmitters, computer elements, driving elements for resolvers, servo follow-up components... for mathematical operations, voltage step-up, and phase reversal. Write for complete data on these high-precision components today!

vernistat division
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The missile weighs tons, the weight of the thermistor is measured in milligrams, yet engineers know that VECO thermistors are rugged enough to do the job — they can always be depended upon to perform their function accurately and reliably.

More manufacturers specify VECO **thermistors** and **varistors** than any other, because VECO is a leading pioneer in the field of high reliability thermistors and varistors and can **guarantee** they'll do the tough jobs engineers require. Be sure to find out how VECO products can help solve **your** particular problem in thermal or electrical measurement and control.

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FREE: Write for Thermistor-Varistor Catalog SB 52 for additional information on VECO thermistors, varistors and other products.
Cataloged in EEM and Radio Master

VECO glass enclosed thermistors are not adversely affected by radiation.

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CIRCLE 751 ON READER-SERVICE CARD

NEW PRODUCTS

Stepping Switch 453

With decimal cycle

The type 40 rotary stepping switch has 10 points per wiper cycle. It provides up to 30 contacts per cycle and is available with from 1 to 5 bank levels of 10 contacts each. Stepping is by external impulse or self-interruption. Coil voltage is 6 to 110 v dc. The switch will operate up to 65 steps per sec.

Automatic Electric Co., Dept. ED, Northlake, Ill.

Price: *$10 to $24 ea, 1 to 9.*

Availability: *60-day delivery.*

Lead Straightener 468

This diode lead straightener handles all axial-lead components including diodes, capacitors and resistances. It does not bend, swage or coin the leads during the electrically operated straightening operation.

Semiconductor Equipment Co., Dept. ED, P.O. Box 1382, Walteria, Calif.

Price: *$1,200.*

Availability: *30 days.*

Cable Isolator 381

Controls vibration

This cable isolator system controls vibration and shock in the presence of high steady-state loads. It may be tuned after installation for optimum performance or changed field requirements. It is designed for three-dimensional, all-attitude isolation in all environments. Anti-resonance features are provided.

Aeroflex Laboratories, Inc., Dept. ED, 34-06 Skillman Ave., Long Island City 1, N.Y.

NEW!

direct-current

TACHOMETER GENERATOR

permanent-magnet

APPLICATIONS

SERVOS The highly linear output and wide speed range are ideal for velocity or integrating servos. Low driving torque permits its use as a damping or rate signal in all types of servos.

INDICATING TACHOMETER Matching indicating meters available from stock in various speed ranges.

SPEED TRANSDUCER Ideal for use as a speed transducer in connection with fast-response direct-writing oscillographs.

FEATURES

SIZE Miniature. Approx. Dia 1⅛"

OUTPUT Various models with outputs as high as 45 v/1000 rpm.

LINEARITY Linearity from 0 to 12,000 rpm is better than 1/10 of 1% of voltage output at 3600 rpm.

BRUSH LIFE Better than 100,000 hours (10 years) of continuous operation at 3600 rpm.

BIDIRECTIONAL OPERATION Output in either direction is held to a ¼ of 1% tolerance.

RIPPLE The rms value will not exceed 3% of the d-c value at any speed in excess of 100 rpm.

CONSTRUCTION Aluminum housings with protective treatment; stainless steel shafts; fully shielded ball bearings; Mylar insulation.

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This 24-page book on the Kodak Photo Resist way to etch dependable circuits tells the whole story about using a simple 6-step KPR routine. Each step is explained so even beginners will catch on fast. The book costs you nothing—only the 4¢ postage on your letter—a tiny investment that could pay the handsome return of more circuits that pass inspection. The 6 KPR steps:

1. Clean the metal. Power brush does it fast.

2. Rinse in acid. A quick way to assure total KPR adhesion.

3. Coat the plate. Dip, whirl, or spray. Stable KPR won't change exposure time even after months of storage, so coating can be done ahead of time.

4. Expose to high-intensity arcs. Always short exposures with KPR, no matter what the temperature, humidity, or storage.

5. Develop. Do it fastest in vapor-spray degreasers. Or in tank or tray.

6. Etch with standard techniques. KPR guards the circuit image in component assembly, strips off clean when panel is skated on tin-lead solder.

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Silicon Diodes 391

Recovery is 30 nsec

The DW series of all-purpose glass silicon computer-rectifier diodes combine 400-ma conductance at 1 v, 30-nsec recovery time and 0.025-μa reverse leakage current. Individual numbers are available with piv from 40 to 275 v. The glass package has a 600-mw heatsink.

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

Terminal-Setting Machine 464

Model 61 automatic terminal-setting machine has a one-hand, concentric-dial wire and insulation selector. Swagging terminals to any of six wire sizes with any of 12 insulation diameters is accomplished by one-hand setting of the double-deck, concentric selector dial.

Ark-Les Switch Co., Dept. ED, 51 Water St., Watertown, Mass.

DC Magnetic Amplifier 442

Output is ±7.5 v dc

Type M-5175 dc magnetic amplifier delivers a linear output voltage of at least ±7.5 v dc into a 1-K load with signal levels in the mv range. Power is 115 v rms at 400 cps. Operating temperature range is −55 to +85 C.

Airpax Electronics, Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

***Price:** $148 ea in quantities of 1 to 6.*
***Availability:** One to three weeks.*

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for transistorized applications

■ tantalum reliability at low cost ■ highest capacity-voltage values ■ six standard case sizes ■ personalized service ■ quick delivery of standard items ■ write for Bulletin 2661

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operating temperature: −55°c to +85°c

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An Example of

Synthane *You-shaped* Versatility

From the day this plant started it has been shaped by the needs of customers like you. And so you find under one roof at Synthane your complete answer in laminated plastics—sheets, rods, tu' es, molded-laminated, molded-macerated and fabricated parts. Synthane has all the facilities necessary for designing and producing tools, dies, jigs and fixtures for fabrication, a mine of information on the proper methods for machining laminated plastics. Versatility from one source. One high quality. One responsibility.

You-shaped Versatility makes Synthane a Better Buy in Laminates.

SYNTHANE CORPORATION OAKS, PENNA.

Synthane Corporation, 42 River Rd., Oaks, Pa.

Gentlemen:

Please send me information relating to Synthane as a source for laminated plastic materials and parts.

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Address_____

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CIRCLE 755 ON READER-SERVICE CARD

NEW PRODUCTS

Decimal Converter 449

For analog-to-digital use

The model F decimal converter changes potentiometer input resistances to decimal output. It is compatible with any equipment having maximum output resistance of 5 K. Decimal readings are obtained in a single scan from a resistance bridge. An error detector prevents readout if the converter balances incorrectly or if the input changes during balancing.

Benson-Lehner Corp., Applications Engineering Dept., Dept. ED, 11930 Olympic Blvd., Los Angeles 64, Calif.

Conductive Adhesives 493

These Isochemduct epoxy-silver conductive adhesives are available in no-mix and two-part forms. They have tenacious adhesive qualities with most materials and may be soldered. Specific resistivity is about 0.10 ohm per cm.

Isochem Resins Co., Dept. ED, 221 Oak St., Providence 9, R.I.

Price: *2-oz kit, $11; 1-lb kit, $44.*

Availability: *3-day delivery.*

Control Center 393

For eight circuits

This portable control center is controlled by punched tape for fully automatic, semi-automatic or manual programing. It initiates an "on" and "off" circuit in eight separate switches, at any time interval from 30 msec to 2 years. The unit is portable and measures 16-5/8 x 12 x 4-1/2 in.

Crestmont Consolidated Corp., Crestmont Electronics Div., Dept. ED, 2201 W. Burbank Blvd., Burbank, Calif.

Price: *$895 complete.*

Availability: *Up to two weeks.*

Other packaging available

10 mc–1,000 mc Frequency Response with new INCREDUCTOR® Wideband RF Transformer

FREQUENCY RESPONSE within ± ½ db over 20 mc—500 mc frequency range and ± 1½ db from 10 mc—1,000 mc.

AVERAGE INSERTION LOSS 1 db between 20 mc—500 mc and 2 db between 10 mc—1,000 mc.

SIZE 1 15/16" x 2 1/4" x 1 3/16", Hermetically sealed.

AVAILABLE IMPEDANCE RATIOS presently 200 ohms balanced to 50 ohms unbalanced. Other ratios to be announced.

TYPICAL APPLICATIONS Antenna matching, Input and Output matching of broad band push-pull for single ended amplifiers.

MILITARY SPECIFICATIONS On special order.

MAGNETIC COMPONENTS DEPARTMENT

TRAK ELECTRONICS CO. INC.

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OVER 1,200,000 in 20,000 DIFFERENT TYPES MOST MAKES

DELIVERY WITHIN 72 HOURS
Items requiring assembly and/or adjustment

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Demagnetizer 439

For bulk recording tape

This demagnetizer produces complete erasure of recorded signals on all brands of tape and 1/4-in. to 35-mm magnetic sound film, on plastic or metal reels of any size from 5 to 15 in. Erasure is effected on the reel. Background noise level is lowered 3 to 6 db below that of unused tape.

Amplifier Corporation of America, Dept. ED, 398 Broadway, New York 13, N.Y.
Price: *$24 ea.*

Power Modules 444

With 0.05% regulation

The series 5VT power supply packages deliver 150 to 425 v dc, at 100 to 400 ma. Output regulation is 0.05%, line and load. Ripple is less than 1 mv with either output terminal grounded or both terminals floating. Designed to mount in customer equipment, the supplies may be joined for higher outputs.

California Magnetic Control Corp., Dept. ED, 11922 Valerio St., North Hollywood, Calif.

Power Filters 414

Less than 1% distortion

Used with dc to ac 400-cps converters, the model PF400 power-filter series changes square-wave output to sine-wave output with less than 1% harmonic distortion. They are available in four stock sizes: 12-1/2 w, 25 w, 50 w, and 100 w. All are used with 115-v, 400-cps power sources. The filters may be cased, open, or epoxy-molded.

Polyphase Instrument Co., Dept. ED, E. 4th St., Bridgeport, Pa.

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MAX/MIN *a message of economy to electronic engineers*

SHOULDN'T YOU SPECIFY A NEW SF IRE METER INSTEAD...

...of purchasing three separate instruments to do the work of only one versatile Smith-Florence Model 810 IRE meter?

This flexible new instrument combines all the desirable functions of a multimeter, vacuum tube voltmeter, and exceptionally wide range AC and DC ammeter in one space-saving, easy-to-use package.

The Model 810 is a case in point of the Smith-Florence max/min concept. Here is an instrument that makes a maximum number of measurements and delivers a maximum number of features at minimum cost.

Measure

I AC and DC 10^{-9} to 10 amps ±2% DC, ±3% AC.

R 10 ohms to 10 megohms ±5% center scale.

E AC 1 mv to 1 kv ±3%, 20 cps to 1 mc. DC 1 mv to 1 kv ±2%.

Use the IRE Meter To—

Measure power consumption, both dc and ac ✱ Calibrate ac and dc shunts ✱ Check transistor diode leakage currents ✱ Measure transducer outputs directly ✱ General ac and dc voltage, resistance, current and db measurements.

FEATURES

Simultaneous two function insertion through separate input terminals on the front panel permit voltage or current measurements to be made while leaving the other probe connected.

Automatic scale selection by means of a unique mechanical design is incorporated into the function switch.

Two calibrating output voltages: 1 v dc and 1 v ac rms square wave controlled by a zener reference circuit to an accuracy of 1%.

Scope and recorder output provides 1 v dc ±20%, ac 400 cps. 1 mc db scale for audio work.

OTHER SPECIFICATIONS

Input Impedance
10 megohms

Power Requirements
117 vac ±10%, 50-60 cps

Dimensions
13" W x 7½" H x 13" D (cabinet);
19" W x 7" H x 13" D (rack)

Weight
16 lbs.

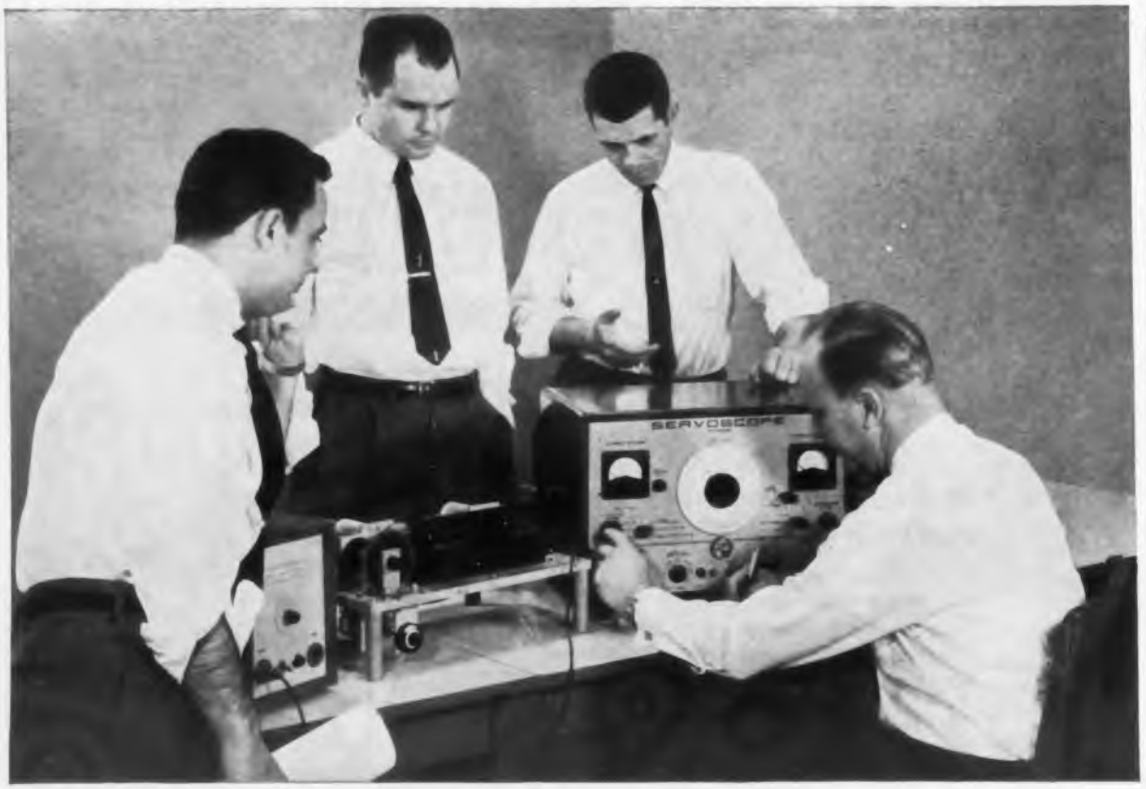
Model 810 IRE meter. Price $445, rack or cabinet.

For more information and a copy of our new 4-page bulletin on the Smith-Florence 810 IRE meter, call your nearby S-F engineering representative or write directly to:

SF Inc.
SMITH-FLORENCE, INC.
4228-36 23rd West
Seattle 99, Washington
Phone: ATwater 4-0170

*Your S-F rep wants to show you the versatile 810. Why not give him a jingle today?

CIRCLE 758 ON READER-SERVICE CARD



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Especially when everybody wants it at the same time?

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Engineering is complaining that the Design Lab has been hoarding the SERVOSCOPE all week . . . Production has had to throw together a couple of makeshift servo analysis rigs . . . and Assembly is counting more bottlenecks, all because . . . not enough SERVOSCOPES.

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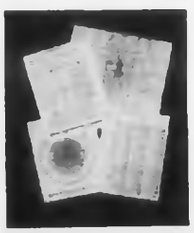
It's so easy, as a matter of fact, that even a new man can plot Nyquist, Bode, and Nichols diagrams after only a few minutes familiarization.

You know your own time and cost picture best. A small investment stands to save you many times the purchase cost. Can you really afford *not* to be equipped with these remarkable servo standards?



If you're one of the minority who has never seen SERVOSCOPE work (or who may still have doubts), prove it to yourself. *Ask for a demonstration.* No obligation.

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CIRCLE 759 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supply 519

Output is 1.5 v dc

This solid-state power supply, designed for use with thermo-electric cooling units, changes 115 v, 60 or 400 cps, to 1-1/2 v dc. Ripple content is less than 10%. The 4-1/2-lb unit measures 3 x 4 x 5 in. It is available with adjustment and meter.

Digitrols, Inc., Dept. ED, 8223 Old Philadelphia Road, Baltimore 6, Md.

Price: *$95 to $167.*

Availability: *10-day delivery.*

Mylar Jackets 402

Made from Mylar film laminated to polyethylene, these insulating jackets may be shrunk or expanded. The transparent jackets are available in practically any shape or size, plain or color-striped. They are useful for hermetic sealing on production line or automated assembly operations.

Precision Paper Tube Co., Dept. EI-2, Dept. ED, 2035 W. Charleston St., Chicago 47, Ill.

Frequency-Time Meter 515

Solid-state, digital

Model 851 is a solid-state, digital frequency-time meter designed for inexpensive application. Basic units are two identical 1-2-4-8 binary-coded decimal counting trains in combination with a pair of input-amplifier channels and a switching unit. Readout may be by Nixie or a lamp system. The set is easily made compatible to control and data systems. Panel height is 5-1/4 in.

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

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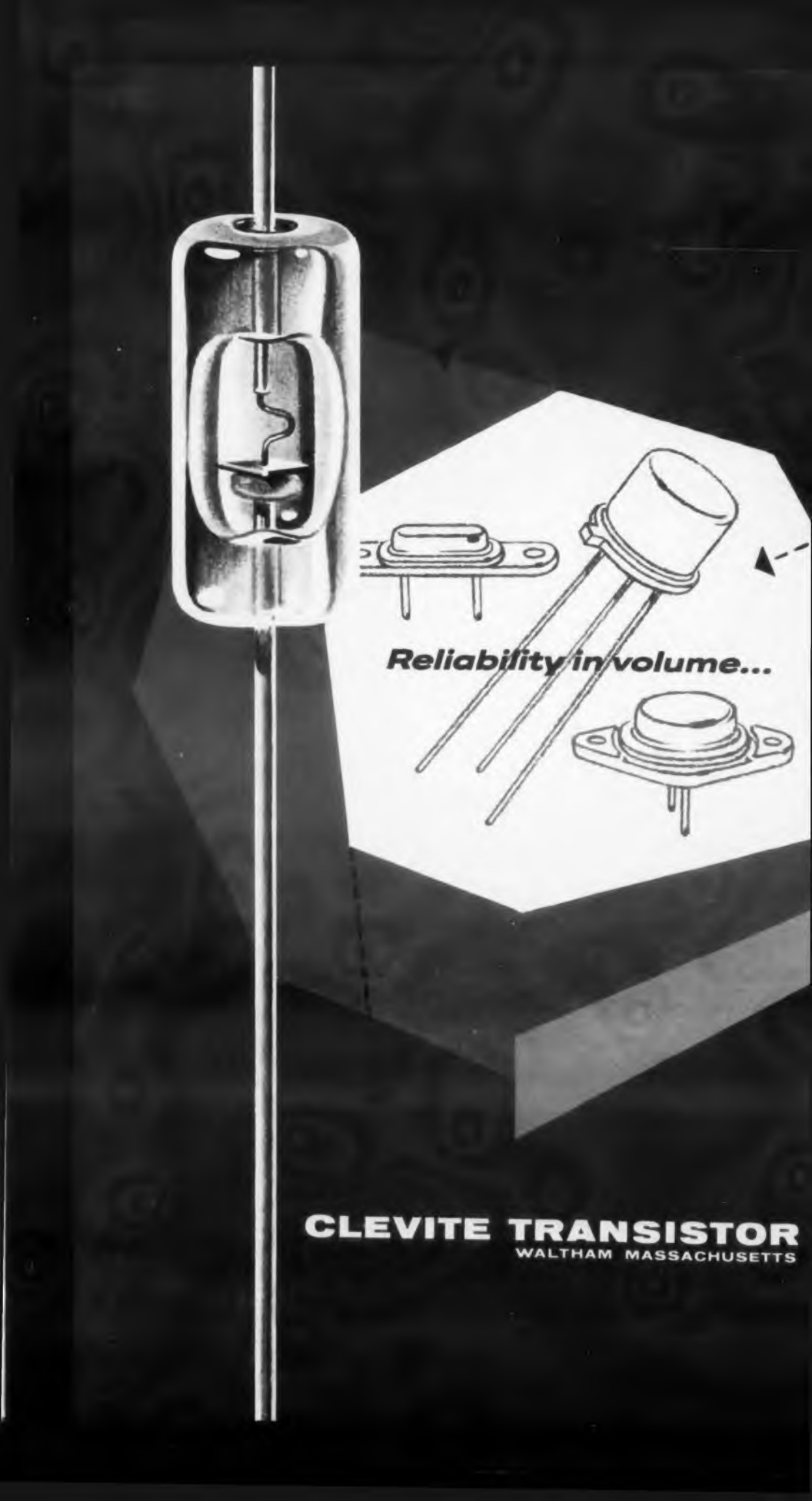
CIRCLE 760 ON READER-SERVICE CARD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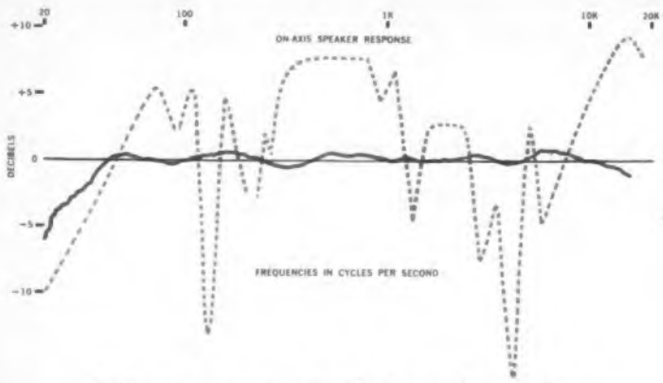

New transistorized speaker-amplifier system sets high standards in fidelity

A significant new design advance by Intergrand uses a unique servo-feedback between speaker and amplifier. Result: an amazing reduction in acoustic distortion.

By ROBERT CHASE — Applications Engineer Clevite Transistor

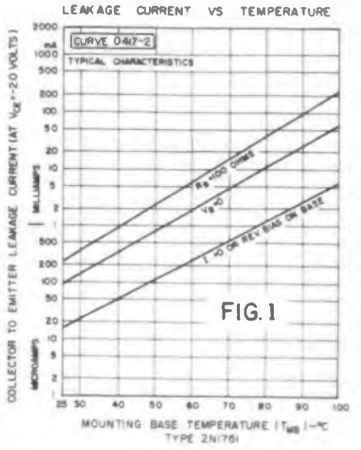

FIG. 1

Utilizing servo feedback techniques, this new integrated sound reproducing unit treats the amplifiers loud speaker and enclosure as one electromechanical-acoustic network. The frequency requirements of this feedback system would have required prohibitively expensive output transformers had tubes been used. Inherent properties of power transistors that makes them suitable for output transformerless design made a reality of what was formerly considered an uneconomical but ideal acoustic theory.

The degree of success in this design is clearly shown by the curves that compare the pressure response of this system with a high quality, low efficiency speaker driven by a quality tube amplifier. The total technical specifications of this achievement are too detailed to be presented here. Crosby Telectronics of Syossett, Long Island, New York, has become exclusive sales and manufacturing agent for this system. This firm can supply all details.

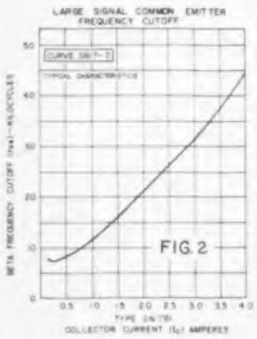

FIG. 2

Key elements in this design were power transistors incorporating precise electrical characteristics and extreme reliability. These were found in the Clevite 2N1761 units.

The three transistor amplifiers used to cover the entire audio spectrum must meet stringent requirements as to gain, stability, frequency response and power output.

The transistors that help meet these requirements are Clevite type 2N1761 (see chart). These are relatively new, fully specified at high temperatures to allow stable, predictable operation in DC coupled circuits. Figure 1 shows leakage current versus temperature for various common emitter operating conditions. The Clevite Spacesaver transistor exhibits low phase shift at high audio frequencies, allowing its use in systems having large amounts of negative feedback. Frequency response of the 2N1761 versus collector current is shown in figure 2.

A pair easily provides 10 watts output at 20 Kc with low distortion. Designers of high fidelity amplifiers, series regulated power supplies, DC to DC converters, servo motors and computor equipment requiring fast switching at high current will find the Clevite Spacesaver series of interest. Send for Bulletin TB226-2.

Electrical Characteristics	Symbol	Measurement Conditions	2N1761 Min	2N1761 Meets	2N1761 Max	Units
D.C Current Gain	h_{FE}	I_C = 0.5 A, V_{CE} = -2.0V	80	100	150	
Base Input Voltage	V_{EB}	I_C = 3.0A, I_B = 700mA		0.5	1.0	Vdc
Collector to Emitter Saturation Voltage	$V_{CE(SAT)}$	I_C = 3.0A, I_B = 300mA		0.3	0.7	Vdc
Large Signal Cutoff Frequency	f_{hfe}	I_C = 1.0A, I_C = 500mA, V_{CE} = -2.0V	10	15		Kc
Thermal Resistance	R_t			1.4	2.5	°C/W
Collector to Base Breakdown Voltage	BV_{CBO}	I_{CBO} = 3.0mA	80			Vdc
Emitter to Base Breakdown Voltage	BV_{EBO}	I_{EBO} = 3.0mA	30			Vdc
Collector to Emitter Sustain Voltage	$V_{CE(SUS)}$	I_C = 100mA, Shorted Base V_{EB} = 0	65			V
Collector to Emitter Sustain Voltage	$V_{CE(SUS)}$	I_C = 500mA, Open Base I_B = 0	55			V
Collector Cutoff Current	I_{CBO}	85°C, 40 Vdc; 60 Vdc; 80 Vdc; 100 Vdc		4.0	7.0	mAdc
Collector Cutoff Current	I_{CBO}	25°C, V_{CB} = -2V		25		mAdc

CLEVITE TRANSISTOR Waltham, Massachusetts

Magnetic Tape Recorder 436

Records 1 to 14 channels

Model TR-1875 simultaneously records 1 to 14 channels, in line or interlaced. It is available with 4 speeds from 1.875 to 15 ips, with a capacity of 150 ft of 1-mil tape. It measures 4-1/4 in. in diameter and 4-3/4 in. in length and weighs less than 3.5 lb. Wow and flutter under static conditions is less than 1%.

Aero Data Manufacturing Co., Dept. ED, 12780 B Western Ave., Garden Grove, Calif.

Readout Lamps 408

Can be read up to 150 ft

These readout lamps measure 3-5/16 x 4-3/4 in. and can be read at distances up to 150 ft, depending on ambient lighting conditions. They operate at either 240 or 460 v and at 60 or 400 cps. When all segments are lighted the lamp uses 0.01 w. Power packs are available for converting 60 cps or low-voltage dc to 400 cps when higher brightness is needed.

Westinghouse Lamp Div., Dept. ED, MacArthur Ave., Bloomfield, N.J.

Price: *Less than $25 per lamp.*

Availability: *Immediate.*

DC Power Supply 504

Output is 0 to 320 v

A general-purpose laboratory power supply, model 890A provides 0 to 320 v dc at 0 to 6 amp. Line and load regulation is 0.007% or 20 mv. Ripple and noise is less than 2 mv rms. A current-limiting circuit protects against overload. Output may be remotely programed. The supply has low internal impedance over a wide frequency band. Line input is 105 to 125 v, 60 cps.

Harrison Laboratories Inc., Dept. ED, 45 Industrial Road, Berkeley Heights, N.J.

Price: *$495.*

Availability: *Delivery in 20 to 30 days.*

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One piece finned aluminum extrusion, achieving high heat dissipation. Most units need no external heat sink to 55° C ambient. All units have adjustable output. Platform mounted standardized subassemblies and components enable quick delivery of a wide range of voltages and currents.

Specifications:

Input: 105 to 125V AC, 45 to 420 cps, single phase
Regulation: 0.1% (line or load)
Stability: Better than 0.25% for 8 hours
Ripple: 0.02% rms
Response time: less than 100 microseconds
Low dynamic impedance

Designed primarily as a component power supply, units are widely used in computors, electronic instrumentation, production test equipment, and quality control check out systems. Best of all, the unique design makes these units available at the lowest possible cost to you.

(Unit pictured above: Model =1R 90-.1; 85-95 V; 0-100 ma; Price $145.00) Prices on other units range from $100 to $200.

All solid state — zener diode reference; transistor amplifiers and regulator
Output Voltages: from 2.0 to 300V DC
Output Power to 30 Watts
Reliable short circuit protection
All components readily accessible

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CIRCLE 762 ON READER-SERVICE CARD

NEW PRODUCTS

Modular Gates 457

Response is dc to 10 mc

With a volume of 0.35 cu in., these AND/OR and OR/AND gates have a frequency response of dc to 10 mc. The modules weigh 7.6 g; operating temperature range is −55 to 55 C. Base is standard 7-pin.

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

***Price:** $78 ea, 10 to 24.*

***Availability:** From stock.*

Motor-Generator 373

In size 8

Both motor and generator in the size 8 model 9008-1106-0 are wound for 115-v, 400-cps excitation. Output of the generator is 0.30 v per 1,000 rpm, and phase shift is 0 deg ±10 deg. The motor has a stall torque of 0.33 oz per in., no-load speed of 6,000 rpm and an acceleration at stall of 70,700 rad per sec^2. The units turn on a common shaft and are contained in a one-piece stainless steel housing. The 2.6-oz unit is 1.850-in. long.

Beckman Instrument, Inc., Helipot Div., Dept. ED, 2500 Fullerton Road, Fullerton, Calif.

Selenium Rectifiers 491

In reduced size

Minisel rectifiers use cells made from thin, dense selenium plates to reduce the size of high-voltage rectifier cartridges. The cells measure 0.019-in. in thickness. A typical cartridge, rated at 5 kv piv, has 25% of the volume of the standard component. The cartridges are en-

LOW COST—HIGH PERFORMANCE

"EFB" for transistor design work $120 net

Only one at this price offering:

- 0-32V. TO 4 AMPS.
- 0-16V. TO 8 AMPS.
- LESS THAN 1 10% (10 MV) RIPPLE

Better-than-average components . . . reliable performance . . . top value . . . these are just a few of the reasons why users prefer the Electro "EFB" for testing and operating transistor circuits, radios and electronic equipment requiring a DC power source. (*Rack Mounted "EFBR" . . . $145 net.*)

INDUSTRIAL POWER SUPPLIES

"NFB" for universal servicing $235 net

Only one at this price offering:

- 0-32V. TO 15 AMPS.
- 0-40V. TO 3 AMPS.
- LESS THAN 1% RIPPLE

New, fast-action Heinemann circuit breaker safeguards equipment and "NFB" if accidentally shorted. Silicon rectifiers increase efficiency. "NFB" operates aircraft and missile electronic equipment, other low voltage devices and radios. (*Rack Mounted "NFBR" . . . $265 net.*)

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4501-U Ravenswood, Chicago 40, Ill.
Canada: Atlas Radio Corp., Ltd., Toronto

CIRCLE 763 ON READER-SERVICE CARD

cased in phenolic tubes, or completely insulated with epoxy-sealed leads. Piv values range from 50 to 20,000 v, with current ratings to 50 ma dc.

Electronic Devices, Inc., Dept. ED, 50 Webster Ave., New Rochelle, N.Y.

Brake Clutches 367

Electrically operated

These size 8 and 11 brake-clutch components are electrically operated. The size 11 unit weighs less than 5 oz and is 1.839-in. long. Brake or clutch torque is 16 in. per oz min; total response time from brake-disengage to clutch-engage is 23 msec. The size 8 unit is 1.530-in. long and weighs 2.5 oz. Torque is 8 in. per oz min; response time is 12 msec. Both sizes have coaxial input and output shafts, operate on 28 v dc, and meet requirements of MIL-E-5272.

Bowmar Instrument Corp., Dept. ED, 8000 Bluffton Road, Fort Wayne, Ind.

Trimmer Potentiometer 456

Has 2-w rating

Type W5 trimmer potentiometer has a 2-w rating to 70 C. Resistance range is to 100 K. Measuring 0.210 x 0.312 x 0.890 the unit is designed to exceed MIL-R-27208.

Atohm Electronics, Dept. ED, 7648 San Fernando Road, Sun Valley, Calif.

Price: *From $4.90 to $11.85.*

Availability: *Two to three weeks for production quantities.*

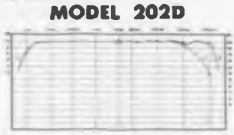
SKL WIDE BAND CHAIN AMPLIFIERS

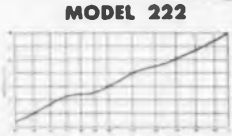
Designed to achieve stable gain and faithful reproduction over great bandwidths, SKL amplifier models are available for a broad range of applications in laboratory and systems work.

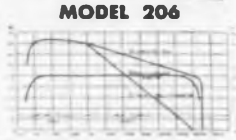
MODEL 202D

MODEL 222

MODEL 206







CHARACTERISTICS	MODEL 202D	MODEL 206	MODEL 211C	MODEL 222
Bandwidth	1kc - 210 mc	600 cps - 320 mc	15 mc - 100 mc	40 mc - 216 mc
Voltage Gain	20 db	18 db	33 db	28 db
Maximum Output	4 volts rms	6 volts rms	*4.2 volts peak	*4.2 volts peak
Impedance	200 ohms	200 ohms	75 ohms	75ohms

* 0.1 volt, with less than 1% intermodulation distortion, for multi-channel operation.

Write for further information to:

SKL SPENCER-KENNEDY LABORATORIES, INC.
1320 SOLDIERS FIELD ROAD, BOSTON 35, MASS.

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a tube in this... fails 12 times more often than in these!

Tubes, properly shielded with IERC Heat-dissipating Electron Tube Shields, instead of with harmful, obsolete JAN types, can extend tube life up to 12 times in new or retrofitted equipments.

For reliability and extended MTBF in your equipment, write for IERC's report, "Heat-dissipating Electron Tube Shields and Their Relation to Tube Life and Equipment Reliability." From it, you'll find the most effective, practical way to reduce bulb temperatures, neutralize critical environmental conditions, minimize down-time and tube failure-replacement costs!

IERC DIVISION

International Electronic Research Corporation
135 West Magnolia Boulevard, Burbank, California

Foreign Manufacturers: Europelec, Paris, France. Garrard Mfg. & Eng. Co., Ltd., Swindon, England

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Mechanically Convected Oven Perfect for Transistor Aging in Inert Atmospheres

Hotpack's 52 years of engineering experience are reflected in these compact units. Built-in features such as two rear entrance ports and stainless steel chambers (not to mention *extra* insulation and improved chamber design) means: maximum performance for all heating, baking, drying, etc. Critical temperatures are quickly and accurately attained with an indicating-controlling thermostat, sensitive to within ±1°C; optional, *true* Saturable-Core-Reactor allows variable heater input every step of the way. Added protection is afforded by a Limitstat control. Hotpack's modern crafted recessed panel and plexiglass cover discourages unauthorized or accidental disturbance to controls.

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See Complete Line at IRE Booths 3846-48

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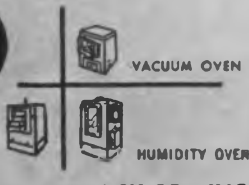

THE ELECTRIC HOTPACK CO., INC.
5065 COTTMAN AVENUE • PHILA. 35, PA.

CIRCLE 766 ON READER-SERVICE CARD

NEW LITERATURE

Instrument Panels And Dials 261

This eight-page, two-color catalog, No. K, describes complete facilities for producing instrument panels and dials, including finishing, engraving and silk screening. It illustrates new pantograph engraving machines with a driving head for calibrating to an accuracy of one-minute. Also described are facilities for production or job-lot enameling, painting, and iriditing to MIL or customer specifications. Technical Enameling Co., 1208 Isabel St., Burbank, Calif.

Microwave Instrumentation 262

This eight-page brochure is entitled "Microwave Instrumentation." It describes the firm's line of twt amplifiers, microwave oscillators, power-leveling systems, solenoid and electrostatically focused amplifiers, and solenoids for twt's and bwo's. Menlo Park Engineering, 711 Hamilton Ave., Menlo Park, Calif.

Current Transformers 263

This four-page data sheet describes the firm's line of ac-to-ac current transformers. These units control, measure, or protect high-power circuits and are suitable for use in the electrical systems of aircraft and missiles. Specifications, dimensional drawings and typical linearity curves for the 876 and 875 units are given. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Precision Waveguides 264

Waveguides and precision tube forming for electronic, aviation and aerospace applications are described in this eight-page, illustrated brochure. Dimensional diagrams, specifications and typical applications are given. A description of manufacturing facilities for forming aluminum, stainless steel, copper, brass, inconel, silver and magnesium is included. F. C. Kent Corp., 135 Manchester Pl., Newark 4, N.J.

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Designers and Manufacturers of

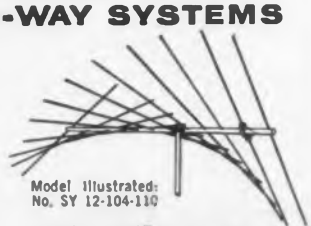
COMMERCIAL SERVICE "BEAMED-POWER" ARRAYS AND TWO-WAY SYSTEMS

Model Illustrates a wide-spaced, 12 element circular polarized optimum-tuned skewed dipole "SPIRALRAY" antenna. Provides unusually high gain, even response, in all polarization planes, vertical, horizontal or oblique with unusually high signal-to-noise ratio.

NO OTHER CIRCULAR POLARIZED ARRAY known to the art today can provide the linear high gain and signal-to-noise ratio in all radiation planes.

The ideal antenna for missile tracking, telemetering and no-fade response to mobile (or moving) stations.

Models available to extend the practical range of 2-Way Communication Systems.



Model Illustrated: No. SY 12-104-110

Electrical Specifications—Model No. SY-12-104-110: Polarization, circular, linear within ½ db. Gain 13 db. F/B-Ratio 30 db. V/S/W/R (50 ohm cable) 1.1/1. Beamwidtn at half power points 33 degrees. Max. power input 300 w, with "Balun" supplied.

Mechanical Specifications: Boom diameter 2" O.D. x 25 ft. All aluminum boom and elements. Weight approx 25 lbs. Rated wind-load 90 mph. No ice load. Available for 120 mph wind load. (Model No. MSY-104-110).

Model SY-12-104-11 **$285.00**

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- Telrex is equipped to design and supply to our specifications or yours, Broadband or single frequency, fixed or rotary arrays for communications, FM, TV, scatter-propagation, etc.
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VISIT BOOTH 1317 IRE SHOW

CIRCLE 767 ON READER-SERVICE CARD

Electronics Catalog

Catalog 200A, 576 pages, lists over 48,000 electronic items and has 240 of these pages in rotogravure. Listings of parts and equipment for industrial maintenance, research, production requirements and delivery prices and discounts are given. The list of items includes diodes, transistors, meters, thermistors, tubes, fans, cleaning equipment, testers, components, fuses, tools, wire and cable, photoelectric devices, communications equipment, TV systems, motors, timers, batteries, generators and power supplies. A technical book section contains publications on all phases of radio, electronics and electricity. *Write on company letterhead to Allied Radio Corp., Dept. ED, 100 N. Western Ave., Chicago 80, Ill.*

Direct-Writing Oscillograph 265

Bulletin CEI-321, four pages, describes model 440 Ultragraph, a direct-writing oscillograph. Features and specifications data are given. Century Electronics & Instruments, Inc., P.O. Box 6216, Pine Station, Tulsa 10, Okla.

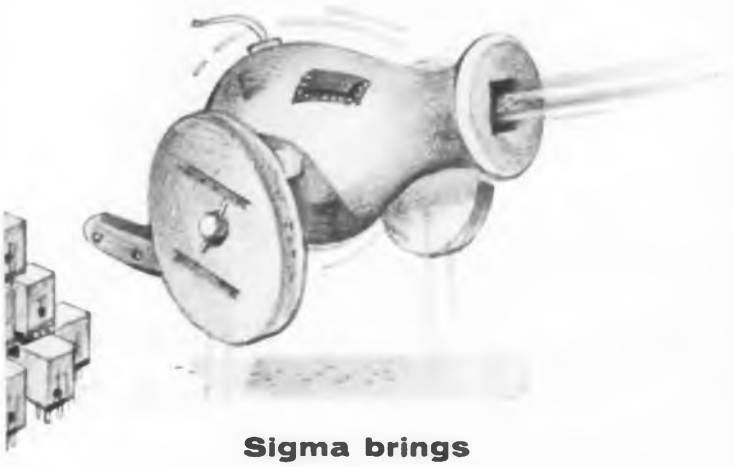
DC Power Supplies 266

Bulletin GED-4184, eight pages, describes the firm's standard line of transistorized dc power supplies for missile GSE systems, helicopter- and jet-aircraft power systems, computer installations and nuclear applications. General Electric Co., Schenectady 5, N.Y.

Semiconductor Products 267

This 12-page brochure describes the firm's complete line of industrial and military semiconductor products. It lists such key specifications as breakdown voltage, current capacity, operating temperatures, and power dissipation. Included are germanium power transistors, audio and switching transistors, silicon- and germanium-mesa transistors, silicon rectifiers, and silicon Zener diodes. Information concerning the firm's "Meg-A-Life" reliability program, which makes "military equivalent" semiconductor devices available to commercial users of transistors, is given. Motorola Semiconductor Products Inc., 5005 E. McDowell Road, Phoenix, Ariz.

CIRCLE 768 ON READER-SERVICE CARD



Sigma brings big gun to bear on commercial relay field

There's a new Sigma relay just coming into the picture that's so disarmingly simple in design, construction and operation that Believers in Complexity will probably get mad when they see it. (After all, if you give someone a simple answer to anything nowadays they think that you couldn't possibly have understood the problem.) But the reaction around here is that the designer's really got something, and there was even talk about erecting a small monument to him in the parking lot.*

We were going to call this new general purpose AC-DC relay the "Series 90" until there was some rumbling in the number department, so now it has the much more economical, sensibly conservative number of 46. It's an honest-to-goodness *good* heavy duty commercial relay, that will switch up to 10 amp, 120-volt resistive loads on as little as 200 mw. DC or 0.5 v-a AC. What the big simplicity pitch Means To You is that there are so few parts it's almost impossible for anything to get out of whack; the few parts it *does* have aren't hard to make or assemble (translated, $3 or $4 per relay in quantity); a big motor and fat DPDT contacts efficiently use every bit of the volume and give a long mechanical life — from 500,000 operations on 10 amp loads to 10 million operations at no load. Since we hope the "46" will find its way into such things as machine tool controls, timers and laundry equipment (and even smarter Electronic Devices as well), the octal plug-in base has the same pin connections as the relays already sitting in this type of equipment. If you want to call this a retrofit, go right ahead. That's it there in the picture, in a revealing $1\frac{1}{16}$" x $1\frac{5}{16}$" x $2\frac{1}{16}$" plastic enclosure.

The first few thousand are now beginning to roll, and while we're not quite ready to talk delivery by the carload, anyone interested in trying out 46's in sample quantities will get to sit in the sales manager's padded office for $8\frac{1}{2}$ glorious minutes.

*We decided not to overdo it and gave him a Rolls Royce instead.

Series 46 Relays and other selected Sigma products and personnel on display at booths 2628-2630, New York Coliseum, March 20 to 24. Come energize them.

SIGMA

SIGMA INSTRUMENTS, INC.
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CIRCLE 769 ON READER-SERVICE CARD

. . . for maximum reed relay compactness, contacting versatility and mounting convenience

Dunco encapsulated units bring you dry reed relays in their most compact, convenient form for either panel or printed board wiring. Five encapsulated types, 1 to 20 poles, provide any needed normally open and normally-closed contact combination. Break-Make action is available to assure *non*-overlapping of contact closures. Multi-coil units can be supplied. Write for Dunco Reed Relay Data Bulletin RR-2 to: STRUTHERS-DUNN, Inc., Pitman, N.J.

Dunco 4-pole reed relay panel mounted with aluminum-end Plastostrap. Relays are also suited for printed board wiring.

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CIRCLE 770 ON READER-SERVICE CARD

NEW LITERATURE

Increment Computers 268

Eight-page bulletin No. 2154M2 describes the firm's variable increment digital computer (GEVIC). Guidance and navigation application in air and space vehicles, missiles and portable surface-based equipment is explained. The bulletin also describes a conditional variable increment computer (CVIC) and tunnel diode, thermal and cryogenic GEVIC units. Graphs and diagrams are included. General Electric Co., Light Military Electronics Dept., 600 Main St., Johnson City, N.Y.

Wirewound Resistors 269

Catalog No. 14-RE, 20 pages, describes the firm's line of wirewound resistors including encapsulated- and bobbin-type units. Performance characteristics, illustrations, and size rating charts are given. Microminiature units for printed-wiring applications are included. Aerovox Corp., Cinema Engineering Div., 1100 Chestnut St., Burbank, Calif.

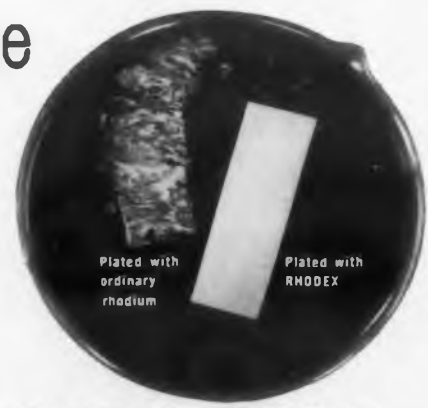
Salary Rating

This eight-page brochure aids individuals in estimating the salary they deserve on the basis of their background, education and experience. A graph is included for plotting past and present salary against the salary rating. The brochure is applicable to engineers. *Send $2 and a stamped, self-addressed 9 x 4 in. envelope to Salary Rating Service, P.O. Box 9218, Dept. ED, San Diego 9, Calif.*

Instrument Brochure 270

Instrument summary brochure No. 2, 20 pages, gives specifications on pressure transducers, position instruments, accelerometers and instrument systems. Applications, features and operating principles are included. It also contains a brief description of the firm's engineering, production, quality control and environmental testing departments. Bourns, Inc., Instrument Div., 6135 Magnolia Ave., Riverside, Calif.

Rhodium Plate Won't Curl, Crack or Peel!



Sel-Rex® RHODEX

produces compressively stressed deposits

assuring crack-free, peel-free service. Here's proof! The photograph demonstrates the high tensile stress of conventional rhodium electroplate and the CS of RHODEX. Dissolving the basic metal caused the conventional rhodium electroplate to disintegrate into small crystalline flakes. The Sel-Rex RHODEX electroplate remained unimpaired, and in a continuous film. RHODEX does not peel or crack regardless of thickness! Write for details.

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The world's largest selling precious metal electroplating processes

CIRCLE 771 ON READER-SERVICE CARD

Flexible-Shaft Handbook 271

This flexible-shaft handbook, fourth edition, 104 pages, gives a simplified approach to the selection of flexible-shafts. The six chapters of the book are: general flexible-shaft information (gives details of flexible-shaft application, construction and selection), standard flexible-shafts, pre-engineered flexible-shafts, custom-designed flexible-shafts, adapters and accessories and the appendix of tables and statistics. Charts, tables and drawings are included. S.S. White Industrial Div., 10 E. 40th St., New York 16, N.Y.

Specially Engineered Lamps 272

Eight-page bulletin 1106-R gives specifications of specially engineered lamps. Dimensional drawings, range of voltages, current capacities and light output on many lamps for use in instrumentation, computers, electronic equipment, surgical instruments and other specialized functions, are given. Chicago Miniature Lamp Works, 1500 N. Ogden Ave., Chicago 10, Ill.

Electric Control Systems 273

Bulletin E74-1, four pages, describes and illustrates the 720 solid-state electric control systems designed to produce process variable outputs. Applications include power plants, atomic and nuclear plants, and marine installations. Block diagrams and component illustrations are given. Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.

Microwave Multiplier 274

Bulletin EM-4A two pages describes model FM-4A microwave frequency multiplier, a phase-locked oscillator that can transfer the accuracy and stability of a vhf driver into the microwave region of 500 to 30,000 mc. The instrument can be used with the firm's models FM-3, -6 and -7 as a driver. The unit measures and generates frequencies with accuracy and stability equal to that of the driving source. Specifications and illustrations are given. Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

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*Add $5 for switch, pilot light and fuse combination. Prices are f.o.b. Pasadena Calif.

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CIRCLE 773 ON READER-SERVICE CARD

ELECTRONIC DESIGN's

1960 "Idea of the Year" Award To Be Made First Day of IRE International Convention

Contributor to receive $500 for outstanding idea published during the sixth anniversary of Ideas for Design

THE recipient of ELECTRONIC DESIGN's 1960 Design of the Year Award, for the outstanding idea appearing in the Ideas for Design section, will receive $500 in cash and a plaque on March 20, upon the occasion of the opening of the 1961 IRE International Convention.

The winner will be named in the March 15 issue of ELECTRONIC DESIGN. ELECTRONIC DESIGN's editorial staff has been reviewing and analyzing all ideas published in Ideas for Design in 1960 and will make its decision early in February. Ideas are being evaluated on the basis of their usefulness and ingenuity.

The 100 most valuable ideas appearing in 1960 are being published in book form and will be available for inspection and purchase at ELECTRONIC DESIGN's booth at the IRE show in the New York Coliseum.

Since the inception of Ideas for Design in 1954, ELECTRONIC DESIGN has published more than 600 clever and useful ideas submitted by its engineer-readers. It has been a very popular department from the start.

The Seventh Anniversary Design of the Year Award will be $1,000 cash, to be given in March, 1962. Rules governing the eligibility of ideas and the judging for this award follow on this page. Note that the payment for each idea has been raised and a Most Valuable Idea of Issue award of $50 has been added.

Announcing The Seventh-Anniversary Awards

Idea of the Year Award ..... $1,000 cash

Most Valuable Idea of Issue Award .... $50 cash

For each Idea for Design published .... $20 cash

NOW entering its seventh year, the Ideas for Design department of ELECTRONIC DESIGN has triggered a steady flow of useful tips and suggestions for design engineers.

To stimulate an even greater outpouring, the editors are pleased to announce the new Seventh Anniversary Awards for Ideas for Design. We hope that they will enable us to publish a greater number of Ideas in every issue.

The new awards give you a chance to earn as much as $1,050 for a single Idea for Design. For the first time, ELECTRONIC DESIGN is offering $50 Most Valuable Idea of Issue Awards and a $1,000 Idea of the Year Award. The least any published Idea can earn is $20.

Here is how you can qualify for a Seventh Anniversary Award:

Submit an Idea for Design on the accompanying application blank. Your entry will be judged for publication by an Editorial Review Board, made up of ELECTRONIC DESIGN's staff of technical editors.

Once your Idea is published, you are in the running for the $50 Most Valuable of Issue Award. The judging of this award is up to our readers. Every Idea for Design published will carry a key number, which will appear on the ELECTRONIC DESIGN Reader-Service Card. Readers merely circle the key numbers of Ideas they feel have merit. There is no limit to the number of choices any one reader may make. As a "judge," you may find that two Ideas or three have equal merit; you may vote for all.

As a guide to your selection, consider whether the Idea for Design suggests a solution to a problem of your own, is usable either immediately or in the future, or stimulates your thinking toward new solutions to problems. Then vote.

The Idea receiving the most votes from all readers wins $50 as the Most Valuable of Issue. All other Ideas in same issue get a minimum of $20.

The Ideas voted "Most Valuable" are then eligible for the year's grand prize of $1,000. The single Idea to receive the award will be chosen from among these by ELECTRONIC DESIGN editors.

The 100 Ideas that the editors consider most interesting will be incorporated into a book and distributed at the time of 1962 IRE show. Each Idea will have the author's byline and company affiliation as it appeared originally in ELECTRONIC DESIGN.

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 the Official Entry Blank.

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. Ideas judged Most Valuable of Issue will receive $50.
3. The Idea judged to be Idea of the Year will receive the Grand Prize of $1,000 in cash.

The Idea of the Year will be selected from amongst those judged to be Most Valuable of Issue.

Most Valuable of Issue and Idea of the Year will be selected by the readers of ELECTRONIC DESIGN. Votes will be cast by circling keyed numbers on 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.

Note to Previous Contributors

Ideas already submitted to the Ideas for Design department, but not yet published, will be eligible for the Seventh Anniversary Awards.

SEVENTH ANNIVERSARY AWARDS

IDEAS-FOR-DESIGN

Entry Blank

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

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

(Use separate sheet if necessary)

Here is my Idea for Design for possible publication in ELECTRONIC DESIGN. I understand that it will be eligible for the Seventh Anniversary Awards—$20 if published, $50 if chosen as Most Valuable of Issue, $1,000 if chosen as Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation.
Hayden Publishing Company, Inc. shall have the exclusive publication rights to these Ideas for Design selected for publication in ELECTRONIC DESIGN. This right extends to the subsequent use of the Idea for Design by Hayden in any of its other publications. Honorariums, if any, for subsequent publication shall be solely in the discretion of Hayden Publishing Company, Inc.

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IDEAS FOR DESIGN

The Most Valuable Ideas Need Your Votes

Be sure to vote for the Ideas which you think deserve the $50 Most Valuable of Issue Award. You may vote for one or more by circling the corresponding number on the Reader-Service card. Choose the Ideas which suggest a solution to a problem of your own, or which stimulate your thinking. The Most Valuable of Issue Ideas will be eligible for the $1,000 Idea of the Year Award, with each Idea published receiving a $20 honorarium.

Pulse Technique Measures Power Transistor DC Parameters

745

Power transistor dc parameters can be measured accurately at low junction temperatures with a simple laboratory setup of usually available equipment. The measuring method applies short-duty-cycle pulses to the transistors and uses a Tektronix 575 curve tracer and a differential amplifier. Because of the short pulses, little power is dissipated in the transistor and the junction temperature remains near ambient. Elaborate heat sinking is thus obviated.

The pulser is set, at 300-μsec pulse width, 60 pulses per second, to synchronize with the power-line frequency. A trimmer at the rear of the pulser chassis allows synchronization adjustment so that the pulses occur at the peaks of the line-current sine wave, as in Fig. 2. The droop in collector voltage on the leading and trailing edge of the pulse is less than 0.4 per cent.

The curve tracer is used in the ordinary manner, with the pulse system substituted for the internal base-step generator. This requires that the "Zero Current (Open Circuit)" switch on the curve tracer be in the "up" position. A simple jig may be bent from sheet metal or stiff wire for this purpose, or the switch itself may be modified. The curve tracer display is a small "pip" instead of the usual complete trace.

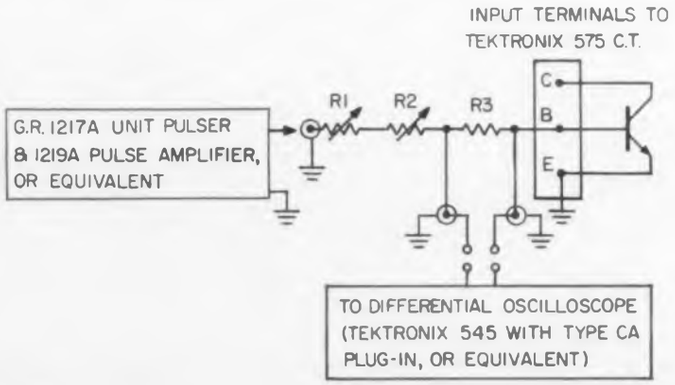

Fig. 1. Basic components of measuring set-up are pulse generator, transistor curve tracer and differential oscilloscope.

Fig. 2. Base current pulses are synchronized to peak of line-current sine wave.

Resistors *R1* and *R2*, Fig. 1, are used to adjust the base-drive pulse. They are typically 1 meg and 10 K. Other series resistors may be substituted if necessary. Resistor *R3* is a 1 per cent resistor whose value is a convenient multiple of 10, depending on the current to be measured.

Examples For 2N1722 Transistor Illustrate Measurement Steps

The following examples show the steps involved in making a set of measurements for a 2N1722 silicon power transistor.

1. Measure h_{FE}, where $V_{CE} = 4$ v and $I_C = 3$ amp.
   - A. Set curve tracer horizontal scale knob to 0.5 v/div.
   - B. Set curve tracer vertical scale knob to 500 ma/div.
   - C. Simultaneously adjust the horizontal sweep voltage and *R1* or *R2* on the test jig until the pip on the crt of the curve tracer is located at 4 v and 3 amp.
   - D. Read I_b from the pulse height shown on the differential oscilloscope.
2. Measure V_{BE}, where $V_{CE} = 4$ v and $I_C = 6.3$ amp.
   - A. Perform steps, *A*, *B*, and *C* as outlined in the h_{FE} test.
   - B. Turn curve tracer horizontal knob to "Base Volts."
   - C. Read V_{BE} on horizontal scale.
3. Measure $V_{CE(sat)}$, where $I_C = 3$ amp and $I_B = 0.3$ amp.
   - A. Set I_B to 0.3 amp by adjusting *R1* and *R2* and reading on the differential oscilloscope.
   - B. Set curve tracer horizontal scale knob to "Collector Volts."
   - C. Set curve tracer vertical scale knob to 500 ma/div.
   - D. Adjust the horizontal sweep voltage until the pip on the curve tracer crt lies on the $I_C = 3$-amp line.
   - E. Read V_{CE} on the horizontal scale.

The separate differential oscilloscope may be eliminated, at the cost of some convenience, by using one pair of the differential input terminals at the rear of the curve tracer. When the control knob is then turned to "Ext," input pulse height will be indicated by a straight line along one of the crt axes.

Results obtained using this test method were found to compare very favorably with those obtained by the manufacturer on his production test equipment.

James M. Doherty, Texas Instruments Inc., Semiconductor Components Div., Dallas, Tex.

Cathode-Follower Coupling Yields High Gain Bandwidth 746

Here's a circuit configuration which can provide voltage gain bandwidths of over 650 mc. Low capacitive loading of the cascode amplifier, Fig. 1, by the direct-coupled cathode follower permits a high plate load resistance, and hence high gain, in the cascode stage. Capacitive loading of a following stage is virtually eliminated by the low output impedance of the cathode follower.

If low-noise, high-transconductance dual triodes are used, this circuit can be readily applied to amplifying low-level signals.

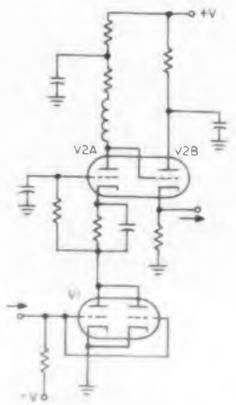

Fig. 1. Voltage gain bandwidths of over 650 mc can be obtained with cathode-follower coupled to cascode stage.

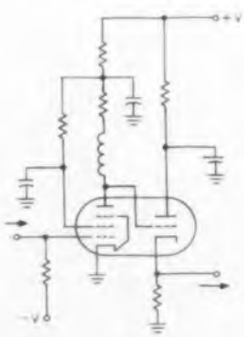

Fig. 2. With a single pentode-triode tube, gain-bandwidth is still high, but somewhat decreased.

The circuit of Fig. 2 yields somewhat less gain-bandwidth, but uses only a single pentode-triode vacuum tube.

H. F. Stearns, Engineer, Technical Products Operation, General Electric Co., Syracuse, N.Y.

BE SURE TO VOTE for all of the ideas you consider valuable! Simply circle on the Reader-Service card the numbers matching those next to the ideas which appear valuable to you.

NOW priced up to 20% LESS than comparable power supplies

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WEIGH . . . the importance of a warranty that covers both lines for *five full years*. And this includes all semiconductor components.

ADD UP . . . other POWER SOURCES advantages such as Transient-Free Output . . . Cooling Systems designed for long life, trouble-free operation . . . Compactness . . . New low prices. And . . . 10-day delivery!

ASK YOURSELF . . . "Aren't these the benefits I've been looking for in a transistor-regulated power supply?" Then . . .

WRITE OR PHONE . . . today, for complete specifications on POWER SOURCES high and low voltage solid state power supplies.

SPECIFICATIONS	LOW VOLTAGE			HIGH VOLTAGE		
	MODEL PS4305M	MODEL PS4315M	MODEL PS4330M	MODEL PS4222M	MODEL PS4230M	MODEL PS4232M
Voltage Range (VDC)	0-36	0-36	0-36	32-215	90-300	115-325
Current Range (amps)	0-5	0-15	0-30	0-1.5	0-1.5	0-1.5
AC Input (Volts)	105-125	105-125	105-125	105-125	105-125	105-125
AC Input (CPS)	50-60*	50-60*	50-60*	50-60*	50-60*	50-60*
Regulation-Line (105-125V)	0.025%	0.025%	0.025%	0.1%	0.1%	0.1%
Regulation-Load (0 to full load)	0.05%	0.05%	0.05%	0.1%	0.1%	0.1%
Cooling	Free Air Convection	Forced Air	Forced Air	Forced Air	Forced Air	Forced Air
Ripple (RMS) in Millivolts	1	1	1	3	3	3
Panel Height	3½"	5¼"	8¾"	5¼"	5¼"	5¼"
Price	$525	$825	$1375	$685	$710	$750

(Note: If meters not desired deduct $30 and drop "M" from model number)

*400 cps available on order

Specify POWER SOURCES BY

See a demonstration, 1961 IRE Show, Booth 1719.

POWER SOURCES, INC.
BURLINGTON, MASSACHUSETTS

CIRCLE 774 ON READER-SERVICE CARD

3 NEW DEVELOPMENTS FROM ETC

SLIP RINGS Throw away your expensive wave-guide joints. ETC has developed high-frequency slip-ring assemblies for TV, radar, UHF and VHF applications. These new units have achieved the low VSWR of (1.1 to 1), insertion loss of only 0.3 db and an unbelievably low level of cross talk (—55 to —80 db from 5 to 60 megacycles.) **TELEMETRY** ETC's miniature 8-ounce marvel can handle up to 450 circuits with 5 poles... 1/5 the weight and 1/8 the space of comparable units. In addition, the switch boasts a life expectancy of 1000 hours. **RELAYS** ETC engineers have done it again. The new Type 1000 Mark II Relay features the proven performance of WEDGE ACTION operation, with a life of 100,000 cycles in —65°C to 125°C ambients. Write today for the full story on these ETC developments.

SEE THEM AT IRE BOOTH 1620 FIRST FLOOR

ELECTRO-TEC CORP. South Hackensack, N. J. Blacksburg, Va.—Ormond Beach, Fla.

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CIRCLE 822 ON READER-SERVICE CARD

IDEAS FOR DESIGN

Try This For Noise Figure Measurements 747

The noise figure of a system can be measured using only the following equipment: a) a power meter, b) two attenuators, c) a noise source, d) a switch.

The circuit is set up as shown in Fig. 1. The

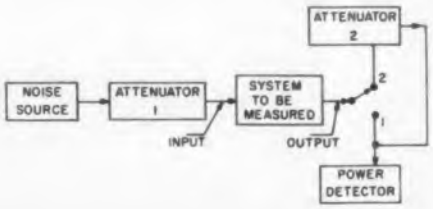

Fig. 1. System noise figure is measured by setting calibrated attenuator 2 at 3 db and switching it into and out of system.

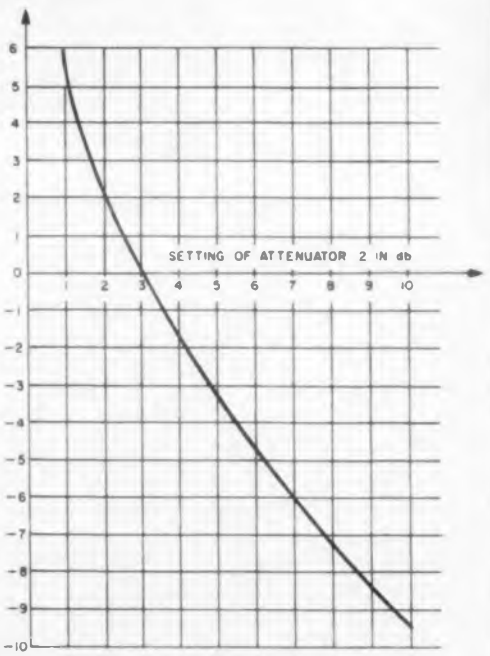

Fig. 2. Correction factor C can be found from curve when attenuator 2 is set at value other than 3 db.

switch is set on position *1* and attenuator *1* is set for more than 60 db. The power meter will indicate the noise being generated by the system with zero input. This indication is noted.

Attenuator *2* is then set to 3 db and the switch is put on position 2. The power meter will now indicate half of its initial reading. Next, the power meter's needle is brought back to its original reading by decreasing the attenuation presented by attenuator *1* to the noise source.

When the power meter again indicates its first reading, the setting of attenuator is noted. This reading is, say, *X*.

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With the value in db of the noise power output of the noise source (call it Y), the noise figure F of the system is given by:

$$F = Y - X \tag{1}$$

However, if the system detects input signals by heterodyne action, 3 db must be subtracted from Y before it is put into Eq. 1.

This measurement can also be made by using attenuation values from 1 db to 10 db for attenuator 2. For values other than 3 db for attenuator 2, the noise figure F (found from Eq. 1) must have a correction factor, C db, added to it. This factor may be found from Fig. 2, where it is plotted as a function of attenuator 2's setting.

Thus the noise figure for any value of attenuator 2 (from 1 db to 10 db) is:

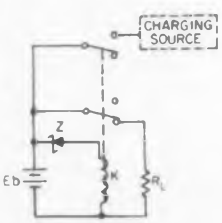
$$F' = F + C \tag{2}$$

Lawrence Silverman, Microwave Engineer, W. L. Maxson Corp., New York, N. Y.

Relay-Zener Circuit Protects Nickel-Cad Batteries 748

When individual nickel-cadmium cells are used to make up a battery, excessive discharge may cause permanent damage to some of the cells. This occurs because all of the cells do not have identical capacities. The lower capacity cells become completely discharged while other cells are still capable of delivering volt-amperes. Thus, the cells which are discharged first, reverse polarity, gas profusely, and blow up. The circuit shown can protect the battery by recharging it when danger signs are near.

Relay K should be a low current type to keep the drain on the battery low. The Zener diode voltage should be about 60 per cent of E_b. (The charging source and additional set of contacts are of course optional.)



If individual nickel-cadmium cells reverse polarity after discharging, relay K is activated and battery is recharged.

Robert A. Durand, Electrical Engineer, Martin Co., Baltimore, Md.

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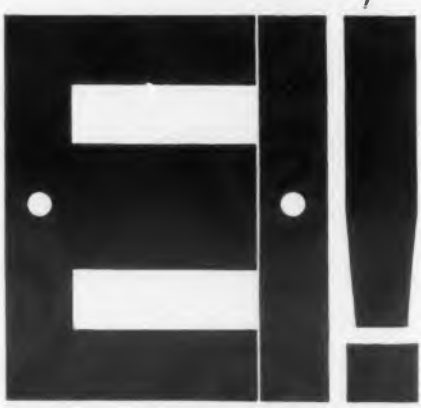

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IDEAS FOR DESIGN

Salvaged Tank Coil Yields Precision Potentiometer 749

A military surplus transmitter was the source of a precise, low-resistance balance potentiometer, capable of extra-fine adjustment, resolution and repeatability. The basic component of the pot was the adjustable tank coil taken from an ARC-5 transmitter.

These units can still be bought at retail, complete with tubes, for less than ten dollars—a small fraction of their original cost.

The tank coil, Fig. 1, is wound on a threaded

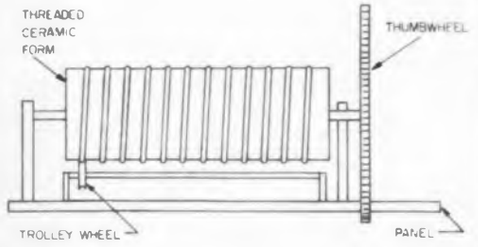

Fig. 1. Adjustable tank coil from ARC-5 transmitters can be converted into a precision pot. (Or, if the coil is unavailable, the pot can be built from the materials shown.)

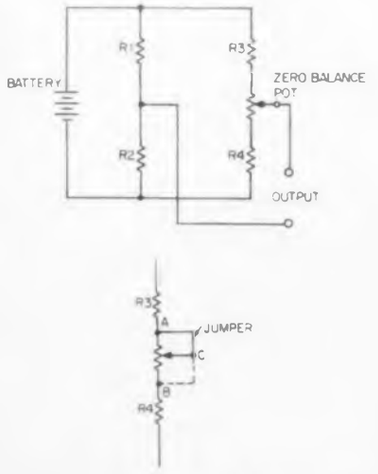

Fig. 2. If pot does not have sufficient range for zero-balancing, Wheatstone Bridge can be modified as in (a) or as in (b). Jumper is connected from either *A* to *C*, or from *B* to *C*, whichever permits the Bridge to be balanced.

ceramic form 2 in. in diameter by 3-3/4 in. in length. A trolley wheel, riding on a guide bar, makes continuous contact with the wire on the coil. There is no jumping from turn to turn, as in the potentiometer of conventional construction. The thirty-odd turns on the coil form are the equivalent of a slidewire some 18 feet long!

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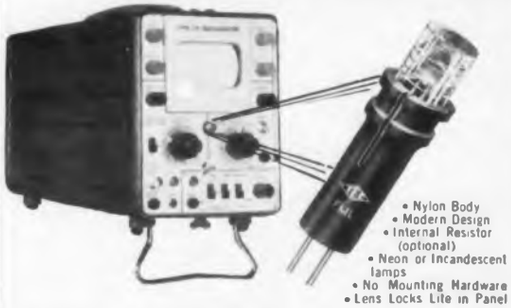

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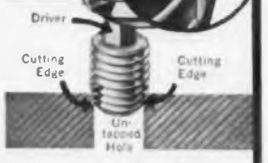

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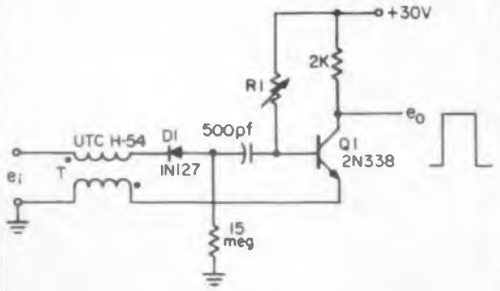
If, when used in a Wheatstone-bridge circuit, the improvised pot does not have sufficient range for zero-balancing, the copper wire may be removed and replaced with wire of suitable resistance. Before changing the wire, however, one should try balancing the bridge with the pot connected first as in Fig. 2a or as in Fig. 2b.

Joseph Leeb, Project Engineer, Engelhard Industries, Inc., Paramus, N.J.

Feedback Helps Flip Output of 750 Zero-Crossing Detector

One of our designs required that we obtain a pulse each time a 400-cps sine wave crossed the zero reference, going negative. The pulse had to have a fairly fast rise time in order to trigger a flip-flop within 1 μsec of the zero crossing.

We used the modified voltage comparator shown in the figure.



With input crossing zero and going negative, diode D is forward biased and transistor Q_1 begins to cut off. Cut-off is hastened because emitter pulse is fed back to base through pulse transformer. Fast rise time pulse results at output.

Transistor Q_1 is biased on, almost to the saturation point. As long as the input voltage is positive, diode D_1 is reverse-biased and the transistor continues to conduct.

As soon as the input reaches zero going negative, the diode is forward biased and the transistor begins to cut off. This change in emitter current is coupled back to the base through pulse transformer T. Since the feedback is negative with respect to the emitter, Q_1 is cut off further. The result is an output pulse with a fast rise time. Its amplitude can be adjusted by changing the value of the bias resistor R_1.

William D. McCulley, Electronic Engineer, U.S. NOTS, China Lake, Calif.

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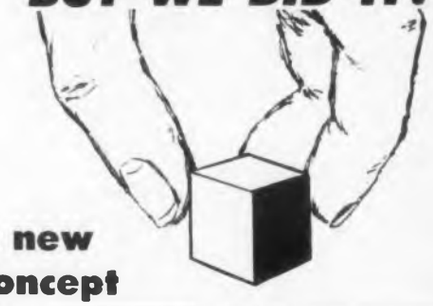

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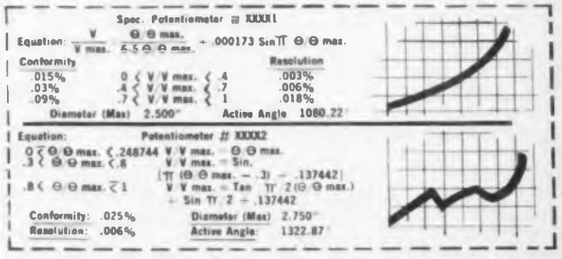

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PATENTS

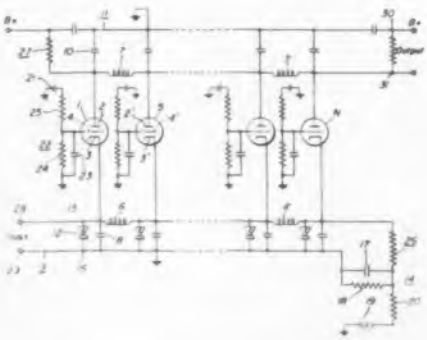
Benjamin Bernstein

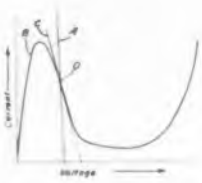
Distributed Amplifier

Patent No. 2,958,046. R. L. Watters (Assigned to General Electric Co.)

The frequency response of a distributed amplifier is improved by inserting a tunnel diode in parallel with the input of each stage. When the negative resistance of the diode approximates the resistance of the input line, the DA amplifies from dc to 1,000 mc.

In the typical circuit, the amplifier comprises the conventional input and





output lines, 9 and *11*, which are coupled by grounded grid triodes. The bias on diodes *12* is set by battery *19* so that the amplifier's ac load line *C* intersects the diode characteristic in the negative resistance region of the low forward voltage range. Since the resistances are approximately equal and opposite in sign, the parallel combination is sufficiently large for amplification to occur at very high frequencies; the amplifier would otherwise cut off at about 300 mc.

Resonant Cavity Electron Discharge Device

Patent No. 2,959,708. J. Sharpe (Assigned to EMI Ltd.)

The rate at which a cavity is tuned is

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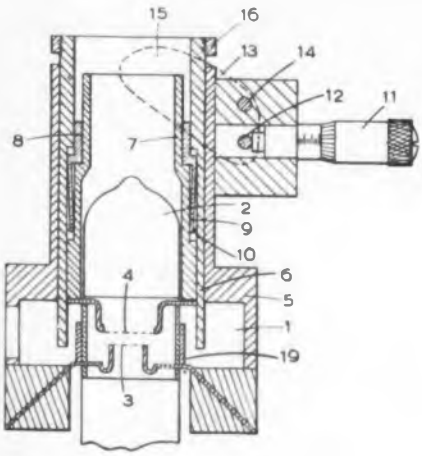


kept constant by providing means for reducing the rate of change as the resonant frequency varies.

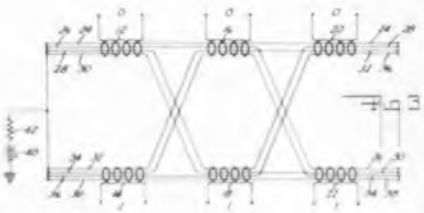
Tuning a reflex klystron is accomplished by moving a cylindrical body *6* into radial cavity *1*. A screen element *19* clamps to the tube body to reduce the reactive effect at the gap as electrode *6* moves into the cavity. This reduction increases as the electrode projects further into the cavity. The tuning rate is kept constant over a range of 2,000 mc at X-band.

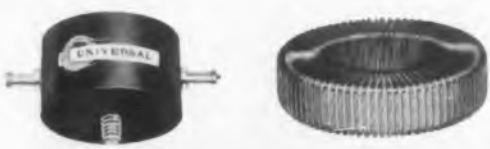
Multiple Gate Cryotron Switch

Patent No. 2,959,688. D. A. Buck (Assigned to A. D. Little, Inc.)

A high-speed switch is made up of interconnected cryotrons which are responsive to digital control signals.

Essentially each cryotron element comprises conductors *2* and *4;* the central conductor is tantalum while the control coil is niobium. At 4.2 K, both conductors are normally superconductive. However, current through the control coil develops a magnetic field of 50 to 100 oersteds, and the transition temperature is sufficiently lowered to make the central conductor resistive.





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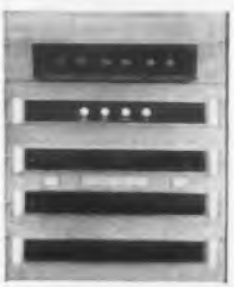

Series 2000

UNIVERSAL MAGNETIC TAPE SEARCH UNIT, SERIES 2000, is used to control a magnetic tape transport during periods of data reduction for automatically searching the tape on the basis of time indices previously recorded. Changing from one time code to another is accomplished by changing time code detectors. All tape times are displayed in decimal regardless of tape time code format.

Model 220

RETARDED BIT RATE UNIT, MODEL 220, operates in conjunction with Timing Generators, Models 270 or 206A to provide a pulse-height, pulse-width signal for recording time on other than magnetic tape recorders. Operating with Tape Search Unit, Series 2000, it can reproduce previously recorded time on oscillographs.

Model 225

RUN CODE SELECTOR, MODEL 225, is used with either Model 270 or 206A Timing Generator for inserting data run code numbers, or year, month, and days in between timing words.

Model 230

TAPE SEARCH PROGRAMMER, MODEL 230, is designed for automatically programming Tape Search Unit, Series 2000, in searching for several sequential start and stop times. The input to Model 230 can be from any digital programming device such as a paper tape reader or computer.

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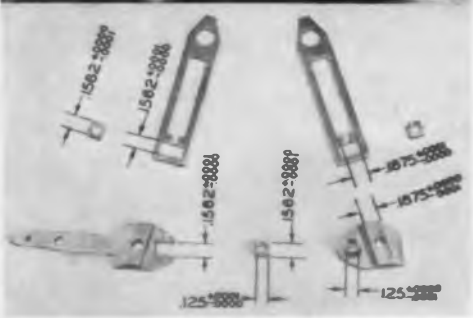

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BOOKS

Electrical Noise

W. R. Bennett, McGraw-Hill Book Co., 330 W. 42 St., New York 36, N.Y., 288 pp, $10.00.

How noise originates in electrical circuits, the terms in which noise is described, how it is measured, and how circuits may be designed to minimize undesirable effects from noise are discussed in this newly published text. It describes in qualitative and quantitative terms the physical nature of various important noise sources, including thermal agitation or resistance noise, shot noise in vacuum tubes and semiconductor junctions, noise from spontaneous emission of electromagnetic radiation, and noise in gas discharges. Fundamentals needed for analyzing basic sources of noise are covered, and methods of measurement and design are stressed. A discussion of the relation of signal and noise in communication systems of various types is included.

Coverage of recent advances includes a treatment of noise in transistors, masers, and parametric amplifiers. Among the subjects are thermal noise and its relation to black body radiation, and an introduction to elementary mechanics which is included with the discussion of the maser and of noise in semiconductors. Fundamental facts about such devices as junction diodes, transistors, gas discharge tubes, klystrons, traveling wave amplifiers, and nonlinear reactive amplifiers are given as an adjunct to their noise properties. In addition to the standard theory of

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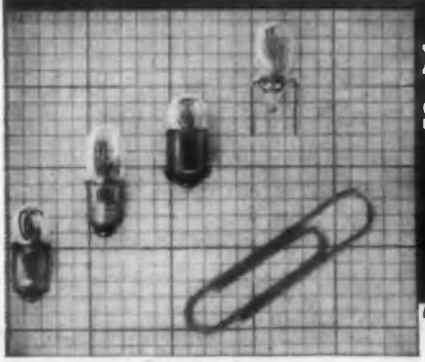

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noise figure and its significance, a treatment is given of the more comprehensive Haus-Adler theory of noise measurement. The book also presents a comprehensive review of noise in the various methods of signal transmission such as amplitude modulation, frequency modulation, and the different kinds of pulse modulation.

Infrared Radiation

Henry L. Hackforth, McGraw-Hill Book Co., 330 W. 42 St., New York 36, N.Y., 303 pp, $10.00

Presented in this volume is information on infrared radiation, the laws of physics by which infrared devices operate, sources of radiation, methods of transmission, and the analysis and design of infrared systems. With a minimum of mathematics, many illustrations and practical examples, the book explains the versatility and inherent possibilities of infrared. It also describes hundreds of applications in many fields, ranging from optical system and medical devices to specialized instruments for satellites. Very recent material is presented on infrared artificial sources, research in wavelength transmission, new optical materials and systems, recent types of detectors, and new types of infrared instruments. Included is a special treatment of spectroscopy, particularly in its application to science and industry.

Neutron Detection

W. D. Allen, Philosophical Library Inc., 15 E. 40 St., New York 16, N.Y., 260 pp, $10.00.

This volume is aimed at those who, with some background knowledge of nuclear physics and particle detectors, require a more detailed knowledge of the main methods of neutron detection.

Following an introductory chapter on the basic principles of nuclear physics and particle detection, the remaining chapters discuss reactions used in neutron detection, the chief instruments of neutron detection, applications of neutron detectors and neutron standards. A bibliography includes references as late as the end of 1959.

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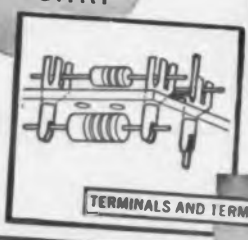

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BOOKS

Electronic Circuit Analysis—Volume I, Passive Networks

Philip Cutler, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y., 454 pp, $8.00

The purpose of this book, the first of two volumes, is to build a foundation in the basic concepts and techniques of analysis, design, and maintenance of electronic equipment. An undergraduate text, the book tries to narrow the gap between the technician's and engineer's viewpoints. Theoretical concepts are continuously woven with the problems of practical application.

Specifically, Chapter I introduces the concept of notation for voltages and currents. Network theorems and numerous practical illustrations are next investigated. Methods of loop and nodal analysis are developed, with a brief review of determinants also included. Other chapters discuss ac circuit fundamentals, transient analysis, transformers and transformer equivalent circuits, and finally, graphical analysis applicable to such nonlinear elements as vacuum tubes and transistors. To master the text the reader needs to know only basic electronics and high-school algebra.

Analog Computation in Engineering Design

A. E. Rogers and T. W. Connolly, McGraw Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y., 250 pp, $16.00.

This book is intended to show how the general-purpose analog computer can be profitably applied to the solution of a great variety of industrial problems. The emphasis is on applications, rather than on computer design and operation. Introductory material has been included on computing machine capabilities and computing techniques to support the presentation of applications and to permit the book to be used without reference to outside sources.

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puter and to its principles, capabilities, and limitations; a review of pertinent topics from engineering mathematics, and a full treatment of the computer methods of solution; an analysis of real problems, taken from a variety of industries and which illustrate efficient problem preparation and computer solution. The use of computers in the analysis of industrial processes and process control, nuclear reactors, and problems involving statistical phenomena is presented.

The book can be used as a reference or textbook by anyone associated with the problems of industrial design. It is also suitable for graduate courses in machine computation.

The Story of Stereo: 1881—

John Sunier, Gernsback Library, Inc., 154 W. 14 St., New York 11, N.Y., 160 pp, $2.95.

The history and development of stereo is discussed, from its earliest beginnings in the last century up to the present. The book provides a background in the principles of stereo so that the reader may better understand the subject. Covered are the applications of stereo on film, tapes and discs, and in broadcasting as well as descriptions of stereo techniques in the home, in business and industry, and in medicine.

Statistical Processes and Reliability Engineering

Dimitris N. Chorafas, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 438 pp, $12.75.

For the engineer with an interest in reliability who needs to be familiarized with statistical concepts that can be applied in this area. After a presentation of statistical techniques and stochastic processes, the author introduces cybernetics and information theory. Included are discussions of systems, sub-systems, transmission and regulation, information transfer, the noise problem, and the use of information theory in industrial processing. The last two parts of the book deal with statistical quality control, that is, estimating the product quality in the input and the output of an industrial process, and with reliability engineering.

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RUSSIAN TRANSLATIONS

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Frequency-Phase Characteristics of Selective Feedback Amplifiers

SELECTIVE amplifiers with RC or LC filters in the feedback loop are used extensively at low frequencies as substitutes for tuned amplifiers. The frequency characteristics of the two types are almost the same near the resonant or quasi-resonant frequency but there is an essential difference between the two at large deviations from resonance. Although the gain of a tuned amplifier diminishes monotonically with increasing deviation from resonance, the gain of a selective feedback amplifier approaches unity. This adversely affects its operation and reduces its immunity to interference.

The difference in the amplitude characteristics also brings about a difference in the phase characteristics. In tuned amplifiers the phase of the gain approaches 90 deg with increasing deviation from resonance, but approaches zero degrees in feedback amplifiers.

The gain of a feedback amplifier is given by:

$$\frac{U_2}{U_1} = K = \frac{K_0}{1 + \beta K_0} \qquad (1)$$

where β is the transfer function of the filter in the feedback loop and K is the open-loop amplifier gain (assumed to be real and independent of the frequency).

Many of the minimal RC and LC circuits used in feedback loops satisfy the relation

$$\beta = \frac{p + iy}{s + iy} \qquad (2)$$

where $y = \frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}$ (ω_0 is the resonant frequency)

This value for β is substituted into Eq. 1 and the following transformation is made:

$$K = \frac{K_0}{1 + \frac{p + iy}{s + iy} K_0} = \frac{K_0 (s + iy)}{s + pK_0 + iy (K_0 + 1)}$$

$$= \frac{K_0}{K_0+1} + \frac{K_0^2}{K_0+1} \cdot \frac{s-p}{s+pK_0+iy (K_0+1)}, \qquad (3)$$

$$K = \frac{K_0}{K_0+1} + \frac{K_0^2 (s-p)}{(K_0+1) (s+pK_0)} \cdot \frac{1}{1+iy\frac{K_0+1}{s+pK_0}}$$

The second term of Eq. 3 is identical to that for the gain of a tuned amplifier with $Q_e = (K_0 + 1) / (s + pK_0)$, while the first term

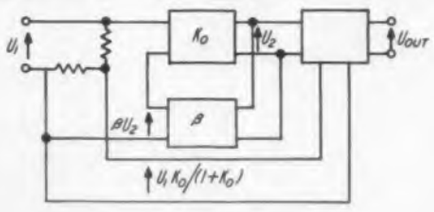

Fig. 1. Block diagram of a circuit which alters frequency-phase characteristic by subtracting $U_1K_0/(K_0+1)$ from amplifier output U_2.

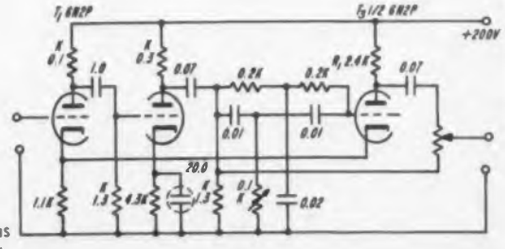

Fig. 2. Operating principle of the circuit of Fig. 1 was tested using this amplifier, which has a subtraction network at the input, in the feedback loop.

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causes the difference between the frequency characteristics of the two types of amplifiers.

Circuit Alters Frequency-Phase Characteristic

The simplicity of the form of Eq. 3 suggests a way to eliminate these differences, that is, to subtract from the output U_2 of the amplifier a voltage $U_1K_0/(K_0 + 1)$. This causes the first term of Eq. 3 to disappear. A block diagram of a circuit that accomplishes this is shown in Fig. 1.

The operation of the circuit is self-evident. The output of the bucking network is:

$$U_{out} = U_2 - \frac{K_0}{K_0 + 1} U_1 = U_1 \left(K - \frac{K_0}{K_0 + 1} \right)$$

Substituting into Eq. 3 the ratio U_{out}/U_1 we obtain:

$$\frac{U_{out}}{U_1} = K_c = \frac{K_0^2 (s - p)}{(K_0 + 1)(s + pK_0)} \cdot \frac{1}{1 + iy \frac{K_0 + 1}{s + pK_0}} \quad (4)$$

This is identical with the expression for the transfer function of a tuned amplifier with resonant gain:

$$K_c = \frac{K_0^2 (s - p)}{(K_0 + 1)(s + pK_0)} \approx \frac{1 - \frac{p}{s} - \frac{1}{K_0}}{1 + \frac{p}{s} K_0} K_0 \quad (5)$$

and equivalent gain:

$$Q_c = \frac{K_0 + 1}{s + pK_0} \quad (6)$$

This method of improving the frequency-phase characteristic of a feedback amplifier is not unique, nor is it the best method. Let us write down the difference between the voltages U_2 and βU_2:

$$U_{out} = U_2 - \beta U_2 = U_2 (1 - \beta) = U_1 \frac{K_0}{1 + K_0} (1 - \beta)$$

where the voltage βU_2 is taken from the output of the filter, Fig. 1. Inserting Eq. 2, we obtain:

$$\frac{U_{out}}{U_1} = K_c = \frac{K_0 (1 - \beta)}{1 + \beta K_0} \quad (7)$$

$$K_c = \frac{K_0 \left(1 - \frac{p + iy}{s + iy} \right)}{1 + \frac{p + iy}{s + iy} K_0}$$

$$= K_0 \frac{1 - \frac{p}{s}}{1 + \frac{p}{s} K_0} \cdot \frac{1}{1 + iy \frac{K_0 + 1}{s + pK_0}} \quad (8)$$

$$K_c = K_0 \frac{1 - \frac{p}{s}}{1 + \frac{p}{s} K_0} \quad (9)$$

$$Q_c = \frac{K_0 + 1}{s + pK_0} \quad (10)$$

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Table of Contents

Chapter

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obtain a somewhat greater gain and a simpler circuit. The amplitude-frequency and phase-frequency characteristics of the two circuits are identical with those of a tuned amplifier having a figure of merit Q_e.

The operating principle of the circuit of Fig. 1 was experimentally tested, using the amplifier shown in Fig. 2. A simplified bucking circuit was used. The plate circuit of the cathode follower T_3 (which serves no purpose in the conventional circuit) was used to reverse the phase of the voltage βU_2 on the grid of T_3. The resistor R_1 was chosen to make the transfer function equal to unity. The voltages U_2 and βU_2 are then summed at the center tap of R_2, with an over-all attenuation by approximately a factor of two. This shortcoming is offset by the fact that an additional tube was not necessary. A symmetrical double-T RC filter is used in the feedback loop. The amplitude-frequency characteristics for the compensated and uncompensated amplifiers are shown in Fig. 3. A comparison of the curves shows that, with the R_1R_2 compensating network, selectivity improves by at least 20 db. The curves could not be plotted over a wider dynamic range because the signal became masked by noise from the audio oscillator.

The circuit of Fig. 1 is more suitable for single-tube circuits in which the input and output voltages are out of phase. The subtraction network can therefore be replaced by an addition circuit,

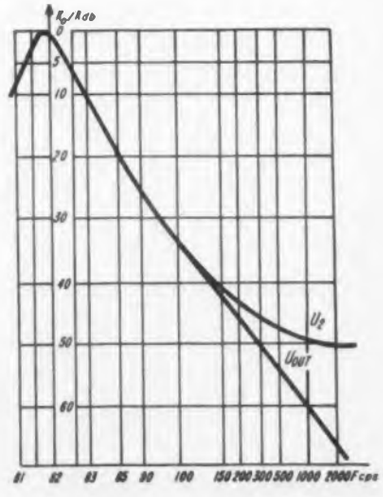

Fig. 3. Amplitude-frequency characteristics of compensated, U_{out}, and uncompensated, U_2, amplifiers.

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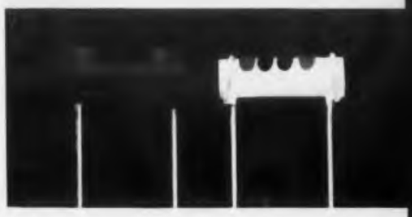

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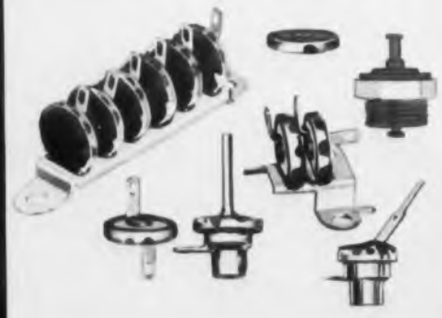

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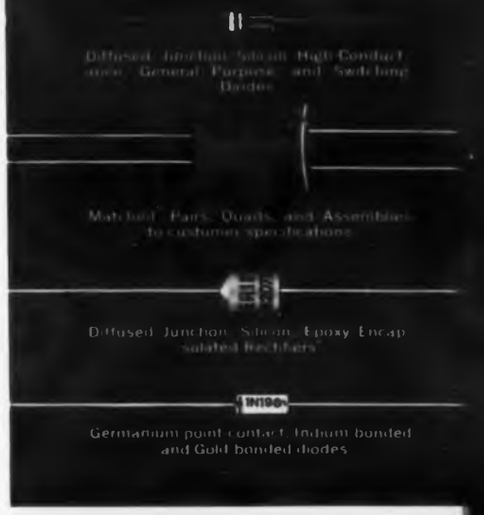

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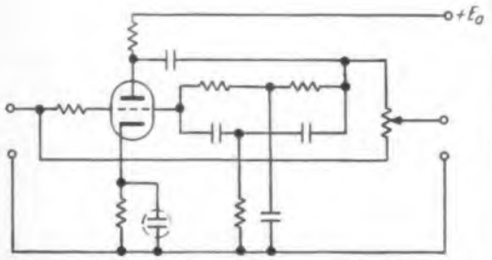

Fig. 4. Subtraction network in Fig. 1. can be eliminated if an addition circuit, such as shown here, is used for the feedback amplifier.

analogous to that of Fig. 2. An example of such a circuit is shown in Fig. 4.

Equivalent Q Holds Only For Compensated Circuits

It must be noted that the concept of equivalent Q can be defined uniquely only for compensated circuits, as indicated above. In ordinary uncompensated circuits, the equivalent Q, computed from the slope of the phase-frequency characteristic or from the bandwidth, is found to be different at different levels. This is because the frequency dependence of tuned-amplifier phase and gain is, in general, not the same as that of feedback amplifiers. For a complete estimate of the shape of the frequency curve of ordinary feedback amplifiers it is, therefore, necessary to specify two parameters: the equivalent Q, calculated with allowance for the second frequency-dependent term of Eq. 3 only,

$$Q_e = \frac{K_0 + 1}{s + pK_0} \tag{11}$$

and the ratio of the residual gain (at large degrees of detuning) to the resonant gain:

$$n = \frac{1 + \frac{p}{s}K_0}{K_0 + 1} \tag{12}$$

This would permit a full estimate of the selective properties of amplifiers, without resorting in each specific case to cumbersome derivations or to unjustified approximations.[2]

Translated from V. L. Zmudikov, How To Improve The Frequency-Phase Characteristics Of A Selective Feedback Amplifier At Large Deviations From The Tuning Frequency, Radiotekhnika, *Aug. 1960, pp 53-56.*

References

1. L. S. Gutkin, Jour. Tech. Phys. (U.S.S.R.), Vol. 15, No. 10, 1945.
2. A. A. Rizkin, Principles of Theory of Amplifier Circuits, Gosenergoizdat, 1958.

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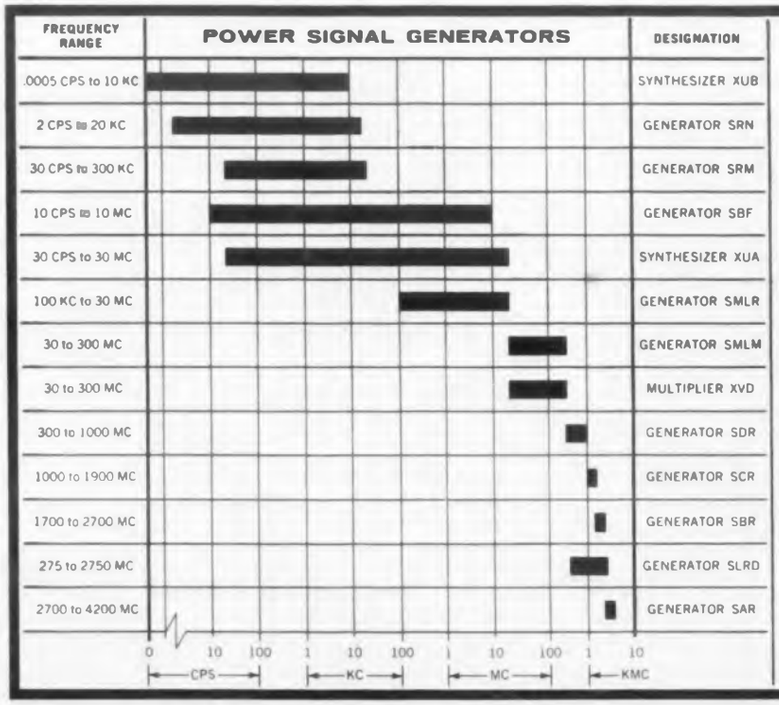

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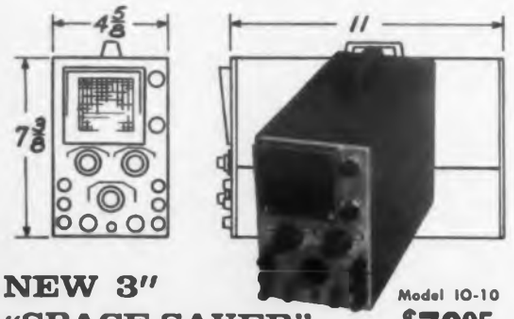

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GERMAN ABSTRACTS

E. Brenner

Active Filter Provides Hi-Q At Low Frequencies

AT LOW frequencies, RLC circuits with high Q's cannot be built. However, a high-Q active filter, suitable for performing spectral analysis, can be used instead. The response to a current pulse of this circuit, shown in the figure, and of a parallel RLC circuit are similar. This can be seen from the following.

When a current pulse, $i(t)$, with duration T is impressed on a parallel RLC circuit, the voltage response is given by:

$$v(t) = \frac{\omega_0}{\omega_d C} e^{-\alpha t} \cdot \sqrt{A^2 + B^2} \sin(\omega_d t + \phi - \beta); t > T$$

where

$$\omega_0^2 = 1/LC \quad \omega_d^2 = \omega_0^2 (1 - 1/4Q^2) \quad \alpha = \omega_0/2Q$$
$$\beta = \tan^{-1} \alpha/\omega_d \quad \phi = \tan^{-1} A/B$$

and

$$A = \int_0^T i(t)\, e^{\alpha t} \cos \omega_d t \, dt$$

$$B = \int_0^T i(t)\, e^{\alpha t} \sin \omega_d t \, dt$$

The amplitude of the pulse spectrum at $\omega = \omega_d$, except for the exponential factor, is proportional to the "amplitude," $\sqrt{A^2 + B^2}$. In general, the errors due to approximation can be analyzed and the pulse spectrum can be inferred from the tuned circuit response.

Let us now consider the active filter circuit shown in the figure. For the feedback network:

$$R_3 = R_1 R_2/(R_1 + R_2) \qquad a = R_2/(R_1 + R_2)$$
$$\omega_0^2 = 1/R_n C_n \qquad n = 1, 2, 3.$$

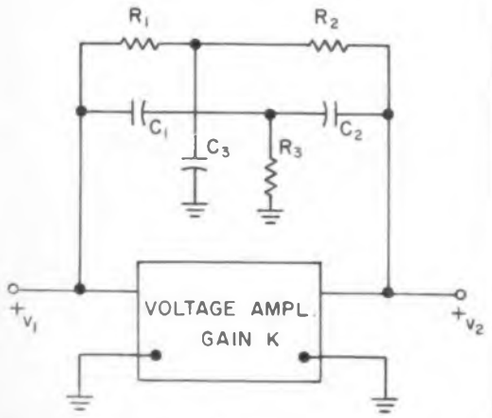

Fig. 1. High-Q active filter can be used in low frequency spectrum analyzer.

Denoting by K the gain of the amplifier without feedback, the relevant parameters are:

$$\alpha\,\alpha_1 = \omega_0/(K+1),\ 2Q = \omega_0/\alpha_1$$

$$\omega_0^2\,(1 - 1/4\,Q^2) = \omega_d^2 \qquad \beta_1 = \tan^{-1}\alpha_1/\omega_d$$

The voltage output, with the input voltage a pulse of duration T is:

$$v_2 = Fe^{-\alpha_1 t}\,\omega_0\sqrt{A_1^2+B_1^2}\,\sin(\omega_d t+\phi_1+\beta_1);\ t > T$$

where

$$A_1 = \int_0^T v_1(t)\ e^{\alpha_1 t}\cos\omega_d t\ dt$$

$$B_1 = \int_0^T v_1(t)\ e^{\alpha_1 t}\sin\omega_d t\ dt$$

$$\phi_1 = \tan^{-1}(A_1/B_1)$$

$$F = \frac{2K^2}{(K+1)\,[a^2\,(K+1)^2 - 1]^{\frac{1}{2}}}$$

If a transformer, with turns ratio r such that $\omega_d r$ equals a constant, is cascaded with the output, then the response is analogous to that of the RLC circuit and can be used similarly for spectral analysis. It is noted incidentally that, for high gain, F becomes independent of K and equal to $2/a$.

Abstracted from an article by H. G. Jungmeister Archiv der Elektrischen Uebertragung, *Vol. 14, No. 10, October 1960, pp 432-434.*

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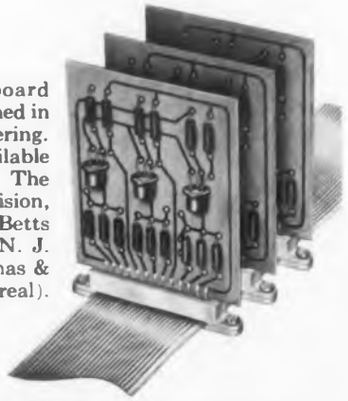

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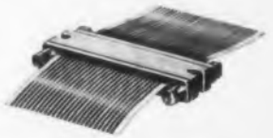

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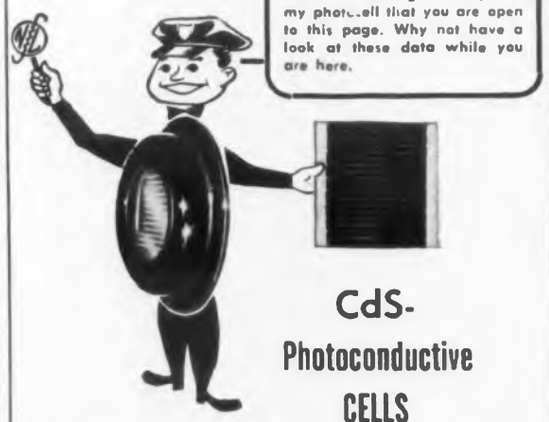

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Electronic Equipment Reliability

FOR ELECTRONIC equipment the failure rate per unit time, when plotted as a function of time, has the shape of the solid-line curve, Fig. 1. It is assumed here that high-quality components are used. The dotted line curve of Fig. 1 applies when the device consists of inferior quality components.

Users of reliable equipment are interested in the failure rate, λ, during the interval of normal operation. If λ is, for example, 0.004 per hr, there is an average of four failures in 1,000 hr and the mean time between failures, $T_m = 1/\lambda$, is 250 hr. Although these values only have statistical significance, the probability that a time T will elapse before failure occurs is of interest. Denoting this survival probability by P_T, it can be shown that:

$$P_T = e^{-T\lambda} = e^{-T/T_m}$$

so that if λ does equal 0.004, the probability that 10 hr will elapse before failure is $e^{-0.04}$ or 0.96.

For equipment in cascade, the over-all survival probability is the product of the individual prob-

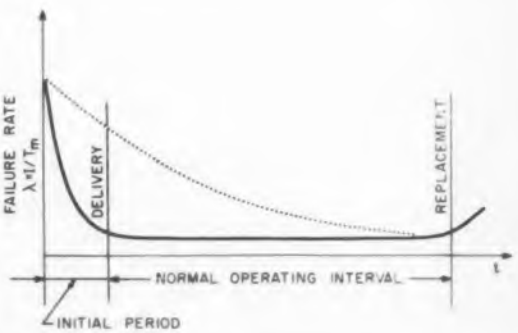

Fig. 1. Failure rate as a function of time for electronic equipment.

Table I. Failure rates, λ, of U.S. and German components. (Germ. Ind. Standards, Class I). Values of λ are per million hours.

Type of Equipment	T - hrs.	P_T - %	T_m - hrs.	λ	N	λ_{comp} hr.
Radio Receiver	1 000	37	1,000	10^{-3}	200	5×10^{-6}
Portable Radio	200	80	1,000	10^{-3}	500	2×10^{-6}
Mobile Radio	200	80	1,000	10^{-3}	1,000	1×10^{-6}
Underwater Amplifier	80,000	90	8×10^{5}	1.25×10^{-6}	50	2.5×10^{-8}
Large Computer	10	98	500	2×10^{-3}	10^{5}	2×10^{-8}

Table II. Proposed Reliability Standards

Component	U.S. 1950	U.S. 1955	German (est.)
Resistors	3.8	0.41	1.5
Capacitors	3.7	0.81	1.5
Relays	6.7	5.6	6
Transformer and Coils	2.9	0.47	1
Connectors	19.0	3.6	9
Switches	6.0	12.0	12
Tubes	160	55	100
Mean, excl. tubes	4.3	1.1	2

abilities. When identical devices, each with a probability P are in parallel, the over-all probability is, for n redundant items:

$$P_p = 1 - (1 - P)^n$$

To realize the improved probability of such "parallel" equipment, the switching apparatus must have high reliability. This is necessary because it appears in series with the parallel combination and its probability is multiplied by P_p.

While the failure rates of U.S. equipment is known with some precision, only estimates are available for German apparatus. Table I illustrates the great progress which the U.S. has made in reliability.* If the values from this table are applied to a radio receiver, it is found that the mean operating time, T_m, for the U.S. equipment was 140 hr in 1950, 460 hr in 1955. A corresponding piece of German equipment had an estimated T_m of 250 hr.

Table II lists the reliability standards proposed for a variety of equipment. In each case the operating time T, with the desired survival probability P_T, are shown. The mean trouble-free operating time T_m and the equipment failure rate are found from these values. Dividing λ by the estimated number of components, N, yields an estimated failure rate per component, λ_{comp}.

Abstracted from an article by H. J. Frundt, Nachrichtentechnische Zeitschrift, Vol. 13, No. 11, Nov. 1960, pp 524-528.

Note: A conference on reliability was held in Stuttgart on May 5 and 6, 1960 under the auspices of the "Nachrichtentechnischen Gesellschaft (VDE)." While "proceedings" are not available, four papers were published in the Nov. 1960 issue of *Nachrichtentechnische Zeitschrift*. These papers are entitled: "Technological Measures for the Improvement of Reliability," "Life Time Investigations on Capacitors," "Effect of Humidity on the Electrical Characteristics of Capacitors" and "Poor Reliability of Electronic Equipment and its Causes" (Abstracted above).

*C. M. Ryerson: Proc. of the Conf. on the Reliability of Military Electronic Equipment, Aug. 1953, pp 91-109.

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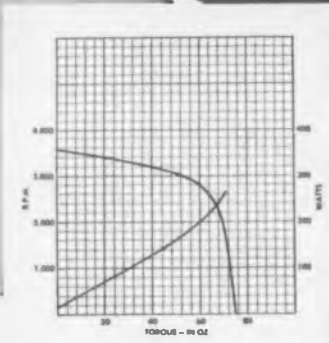

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Indirect Methods For Checking Analog Computer Accuracy

OPERATIONAL amplifier accuracy depends on resistor and capacitor tolerances, as well as on such amplifier characteristics as zero output balance. The measuring equipment needed to check these factors directly is generally unavailable to users of desk and other types of small analog instruments. Indirect methods for quantitatively checking various sources of error can be devised by solving certain problems using simple "standard" circuits.

Two nominally identical circuits are used for checking the static accuracy of components. Each circuit, Fig. 1, solves the equation:

$$\frac{d^2v}{dt^2} + \omega^2 v = 0; v(0^+) = v_0 \qquad (1)$$

so that:

$$v = v_0 \cos \omega t \qquad (2)$$

The radian frequency is determined by the time constants of the integrators and the multiplying factor of the sign changer, that is:

$$\omega^2 = k_1 k_2 \alpha; k_{1,2} = 1/(R_{1,2}C); \alpha = R_0/R_1$$

If the reciprocal time constants and the scale factor are subject to small errors:

$$k_1 = k_{10}(1 \pm \epsilon_1); k_2 = k_{20}(1 \pm \epsilon_2); \alpha = \alpha_0(1 \pm \epsilon_3)$$

then the maximum difference in frequency between the two circuits is approximately:

$$\Delta f = f_0(|\epsilon_1| + |\epsilon_2| + |\epsilon_3|) \qquad (3)$$

This small difference can be measured, by using the two outputs as the X and Y voltages on an oscilloscope. The time interval between straight lines indicates an "in-phase" condition. For example, a time interval of 104 sec results for a nominal radian frequency of 10 with each ϵ equal to 0.1 per cent.

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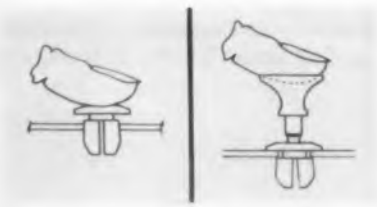

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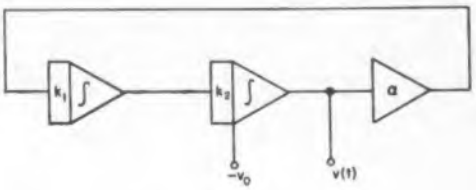

Fig. 1. Circuit for determining the static accuracy of analog computer components.

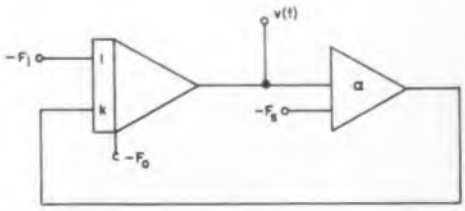

Fig. 2. A circuit for determining null errors.

Errors in integration due to capacitor losses and finite amplifier gain, as well as errors in adders, can also be detected by the circuit of Fig. 1. With identical integrators such errors lead to the damped response:

$$v = v_0 e^{-\alpha t} \cos \omega t \qquad (4)$$

Measurement of the logarithmic decrement can be used to judge the factors influencing dynamic accuracy.

To test the zero input error as well as the error caused by grid current, the (unstable) circuit of Fig. 2 is used. With e denoting the null voltage of an amplifier referred to the input terminals, i_g the grid current, R_i the input impedance, R_c the feedback resistance of the sign changer and R_c the feedback resistance of the integrator in the initial condition position, the null errors are:

For N sign changers

$$F_s = e(1 + \sum_1^N \alpha_i + R_0/R_i) - i_g R_0$$

For N integrators

$$F_s = e\,(\sum_1^N k_i + 1/R_i C) - i_g/C \text{ and } F_0 = 2e - i_g R_c$$

In the circuit of Fig. 2 with $\alpha = 1$ the approximate solution is

$$v(t) = e^{kt}\ [F_0 - F_s + F_i/k] \qquad (5)$$

The quantities in the brackets of Eq. 5 can be evaluated by permitting $v(t)$ to reach a predetermined value and measuring the corresponding time.

Abstracted from an article by A. Kley, Elektronische Rundschau, *Vol. 14, No. 10, October 1960, pp 403-404.*

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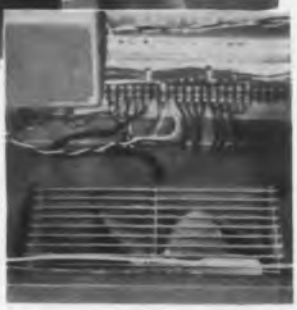

McLean Model IRB100 blower used in the HAM System. One blower is mounted at the base of each of the six racks.

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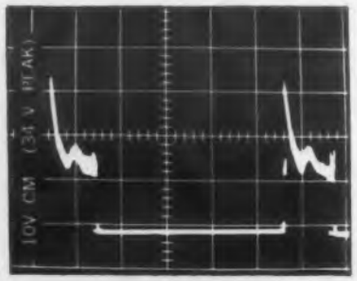
Electronic Products NEWS
by CARBORUNDUM®

Arc suppression in CLARE Stepping Switches Improved with GLOBAR® Varistors

Laboratory report shows up to 4 to 1 reduction in peak voltage compared with standard condenser-resistor networks

C. P. Clare & Co., Chicago, Ill., manufacture a line of precision stepping switches, offering as many as 480 contact points in a single unit. Arc suppression at the relay contact in these switches is vital to long life and dependable operation.

An extensive series of laboratory tests by Clare has established the superior arc suppression capabilities of GLOBAR varistors. Tests were made in comparison with standard resistor-capacitor networks, using various stepping switches having coil ratings of 6 volts up to 110 volts. Results were based on visual observation of arc suppression, peak voltage and speed as shown on 'scope, and heating of the body of the varistor, as recorded by a pyrometer. In some cases, tests with the varistor showed a 4 to 1 reduction in peak voltage. Temperature readings revealed more than adequate safety factors under all anticipated voltages and duty cycles.



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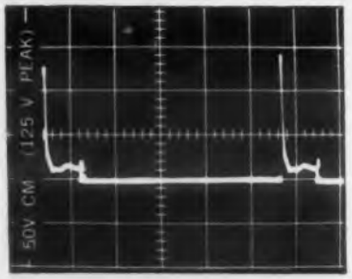

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Reduction of peak voltage is shown in these comparative oscilloscope traces. Upper trace, showing 34 v. peak, was obtained with varistor across coil. Lower trace shows 125 v. peak with .5 mfd capacitor and 10 ohm resistor across contacts.

Disc and rod type GLOBAR varistors are shown above. Wide variation in voltage coefficients may be obtained through changes in length-diameter ratios.

GLOBAR Type BNR varistors are non-linear, voltage-sensitive resistors made from electrical grade silicon carbide. Their negative voltage coefficient of resistance (resistance decreasing with an increase of voltage) offers wide possibilities for application in contact arc suppression, protection against voltage surges and similar problems. Response to short duration impulses is instantaneous.

Typical CLARE stepping switch, Type 20, is shown above. This switch offers up to 480 contact points in twelve 40-point levels, or 320 in sixteen 20-point levels.

All GLOBAR varistors are made to individual customer specifications. Inquiries concerning specific applications are welcomed. If your interest is in experimenting with possible uses, it is suggested that you investigate the GLOBAR Varistor Test Kit. Write to Globar Plant, Refractories Division, Dept. ED-31, The Carborundum Company, Niagara Falls, New York.

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BOOKLET AVAILABLE ON GLOBAR Type BNR VARISTORS

Full information on the physical and electrical characteristics of GLOBAR Type BNR varistors is contained in Technical Bulletin GR-2, which will be mailed on request. For your copy, write Globar Plant, Refractories Div., Dept. ED-31, The Carborundum Co., Niagara Falls, N. Y.

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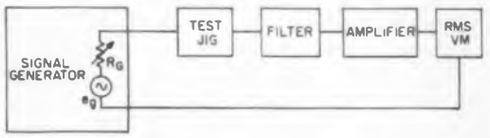

Fig. 1. Noise factor test circuit.

Designing Transistor

LOW-NOISE transistor amplifiers can be designed more easily if certain noise data are available to the designer. For a given transistor, these data include:

1. The relationship between generator resistance, R_G, emitter current, I_e, collector-to-emitter voltage, V_{ce}, and noise factor, F.
2. F as a function of frequency,
3. F as a function of temperature,
4. Minimum and maximum limits on F, and
5. Gain and bandwidth versus current level.

The noise factor F is defined as the ratio of the total noise power per unit bandwidth (at a specified frequency) appearing at the output terminals to the power per unit bandwidth at the output if the network were noiseless. A test circuit for measuring F is shown in Fig. 1. Here, F is defined as

$$F = \frac{e_o^2}{e_n^2 G^2} \qquad (1)$$

where e_o^2 = square of the total true-rms noise voltage indicated by the meter with $e_g = 0$,

e_n^2 = square of the rms thermal noise voltage (open circuit) generated by R_g, and

G = over-all voltage amplification between the signal generator, e_g, and the rms voltmeter.

For low noise applications, the selected transistor should have a high $f\alpha$, a high h_{fe}, and a low I_{CBO} to maximize its performance in the shot noise region. Data is then gathered for the transistor parameters listed (1 to 4) above. Figs. 2 and 3 plot the relations between the transistor's

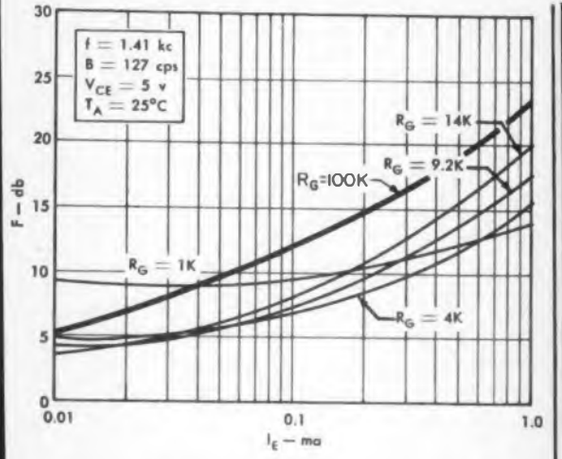

Fig. 2. Noise factor F vs emitter current I_E.

Low-Noise Audio Amplifiers

noise factor, emitter current, and generator resistance. Average values for several 2N338 transistors are used.

How To Design A Low-Noise Amplifier

The three-stage low-noise amplifier of Fig. 4 can be designed with the aid of the data given above and an additional equation relating the transistor's noise factor and the noise factor of the amplifier. Known as Friis' formula, this equation is:

$$F_A = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} \qquad (2)$$

where F_A = noise factor of the amplifier,

F_1, F_2, F_3 = noise factors of each transistor measured at their actual operating bias and impedance levels.

G_1, G_2 = available power gains of the first and second stages.

All noise factors must be of the same type and measured at the same frequency and bandwidth conditions. In most low-noise applications, the contribution of noise from the third stage can be neglected, thus simplifying the above equation to:

$$F_A = F_1 + \frac{F_2 - 1}{G_1} \qquad (3)$$

The amplifier of Fig. 4 was driven with R_G = 5.6 K. The data in Fig. 2 shows that a first-

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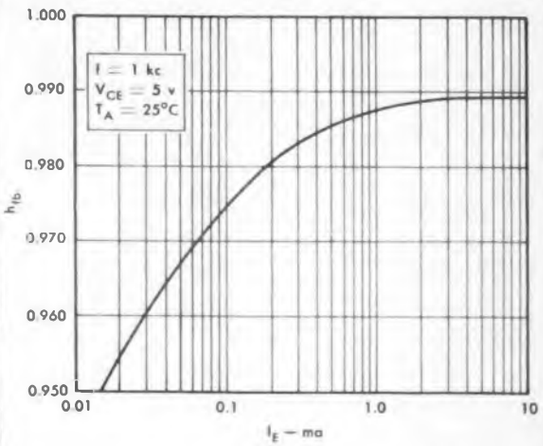

Fig. 3. Hybrid parameter h_{fb} vs emitter current I_E.

stage noise figure of 5 db ($f = 1.41$ kc) can be achieved if the transistor is biased at $I_E = 20$ μa and $V_{CE} = 5$ v. Fig. 3 shows that an approximate $h_{fb} = 0.955$ can be expected. Resistor values chosen for the bias network are determined by bias stability factors, where:

$$S_1 = \frac{\delta I_C}{\delta I_{CBO}} = \frac{R_B + R_E}{R_B (1 + h_{FB}) + R_E} \quad (4)$$

$$S_2 = \frac{\delta I_C}{\delta V_{BE}} = \frac{h_{FB}}{R_B (1 + h_{FB}) + R_E} \quad (5)$$

$$S_3 = \frac{\delta I_C}{\delta h_{FB}} = S_1 I_{E4} \quad (6)$$

where: R_B = Thevenin's equivalent resistance of base bias supply, and
R_E = external dc emitter resistance.

The total collector current change is equal to the sum of the individual changes. The effect of the base divider network and any unbypassed emitter resistance will always increase the minimum transistor noise factor for a given bias condition, F_{min}, and will increase or decrease the value of R_G required to give this minimum, R_{Gopt}. If the following conditions are satisfied, however, this effect will be negligible. These conditions are:

a) $R_B/R_G > 10$
b) $R_e/R_G < 0.1$ (R_e is the unbypassed emitter resistance)

The second stage is operated at $I_E = 100$ μa and $V_{CE} = 5$. The generator resistance seen by this stage is equal to the parallel combination of the base-bias network and dc collector load

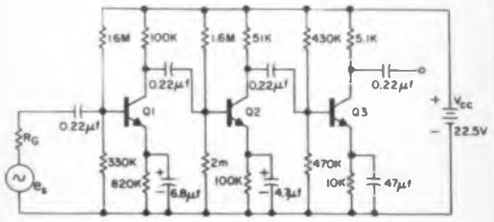

Fig. 4. Low-noise three-stage amplifier.

resistance of the first stage. This results in $R_G = 100$ K for the second stage. Fig. 2 gives an approximate F equal to 12.34 db. Referring to Eq. 3:

$$F_A = F_1 \tag{7}$$

$$\text{if } \frac{F_2 - 1}{F_1} \ll F_1 \tag{8}$$

In this application: $\dfrac{F_2 - 1}{G_1} = 0.1\ F_1$ (9)

This was considered a great enough difference for the noise of the second stage to be neglected. The gain of the first stage necessary to satisfy this condition is $G_1 = (F_2 - 1)/0.1\ F_1$. Inserting the known values of F_1 and F_2 gives:

$$G_1 = \frac{17.2 - 1}{0.1\ (3.16)} = \frac{16.2}{0.316} = 51.3 = 17.1 \text{ db}$$

The first-stage gain requirement can be reduced if the generator resistance seen by the second stage is nearer optimum. The obvious method is to use transformer coupling. If RC coupling is used, a small dc voltage drop across R_1 will help. Another method is to bypass part of R_1 to ground.

The remaining amplifier design is straightforward unless some type of feedback is employed for ac stability. The effect of feedback on the noise factor and its optimization depend on the particular application. This topic is covered in various references.

Digested from "Silicon Transistor Low-Noise Audio-Frequency Amplifiers," Texas Instruments Application Note, *Aug. 1960.*

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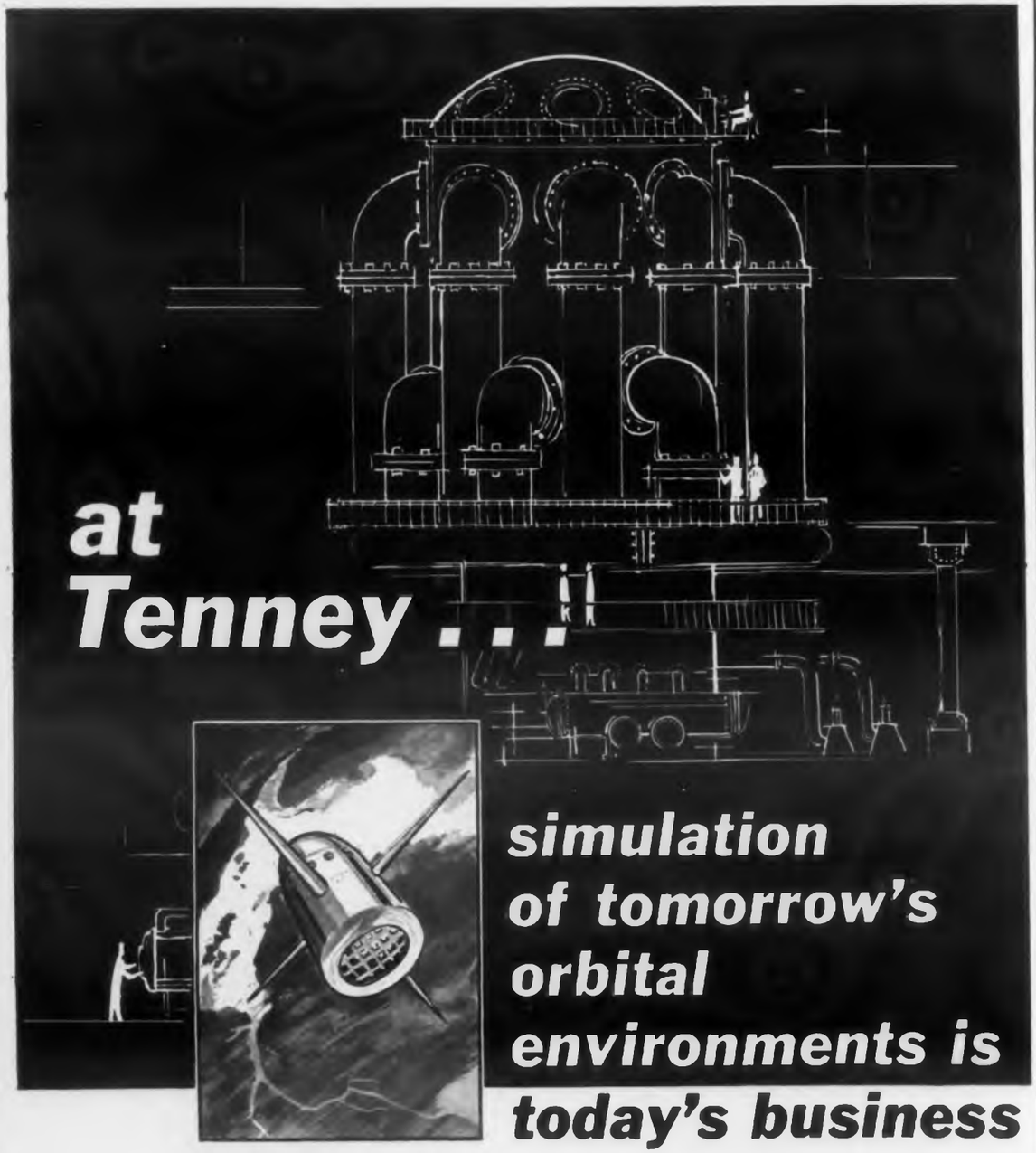

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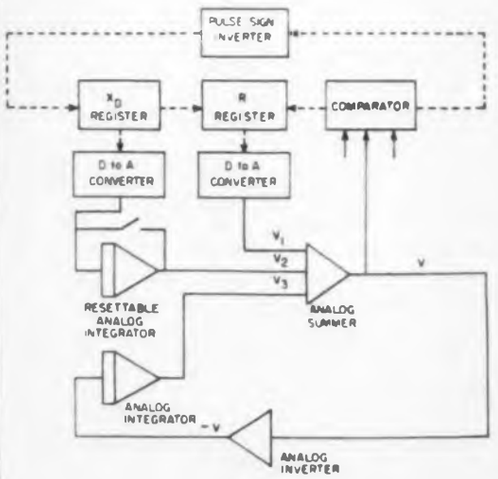
Analog-Digital Unit Proposed by NBS

COMBINING analog and digital operation yields the advantages of both—high speed and continuous representation of the variable with the analog system, and high precision and dynamic range with the digital system.

The National Bureau of Standards has been investigating a differential analyzer that uses both systems.

Developed by H. K. Skramstad, of the Bureau's data-processing systems laboratory, the proposed



Block diagram shows how proposed analog-digital system could be used to solve the differential equation $dx/dt\ \Delta\ x$.

analyzer appears to be naturally applicable to simulating dynamic problems in missile or aircraft design studies.

So far, an integrator and a multiplier have been designed. In general, they consist of one or more of the following units: an input digital register, a register for accumulating digital results, a digital-to-analog converter, a conventional analog integrator, a resettable analog integrator, an analog summer, and a comparator.

These basic units can be constructed from electronic digital and analog circuits commonly used at present. Analog-to-digital converters are not required for this system.

The analyzer is designed so the time period Δt in which numbers in the digital registers do not change is as small as possible and consistent with component limitations. This yields the maximum number of such periods. The greatest speed and presicion are realized, of course, with smallest Δt.

However, Δt must be long enough, not only to permit full-scale excursions of the various analog voltages, but also to fit within the bandwidth limitations of the operational amplifiers. Improving the amplifier characteristics will help reduce Δt. Even with present components, however, the precision in solving problems can be increased by a factor of 10 to 100 over conventional analog methods.

Work has begun recently on breadboard models to evaluate the system. These circuits will contain 2 integrator and 2 multiplier units that can receive voltages from other units.

Digital registers and digital-to-analog converters will be constructed from transistorized digital packages. The analog components will have 8-bit plus sign input and accumulating registers, and an analog reference of 10 v. They will operate with a Δt of 1 msec or less.

Digested from "A proposed Analog-Digital Differential Analyzer," from the National Bureau of Standards Office of Technical Information.

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Should You Register at a "Career Center"?

Steps of a Career Center: (1) When you arrive at the Career Center you will be given one of its standard registration forms. (2) An advantage claimed for the Centers is that an engineer has to fill out only one form to contact all the participating firms. (27 will be at the IRE.) (3) When you turn in your registration, which indicates your experience and the job desired, you are given your code number. (4) Your registration form is retyped by the Center's clerical staff with your code number substituted for your name. Mimeographed copies of this "objective and anonymous" form are then circulated to each of the participating firms. (5) While you wait to see if your number will be called by one of the firms, you can look over their employment literature displays. (6) You check the blackboard to see if your number has been called for. Actually most of the engineers leave as soon as they have handed in their registrations and then call in by phone to see if their numbers have been called. (7) When your number is called, you go to the appointment desk to find out which firm wants you. At this point you are in the position of knowing who the firm is but they still don't know who you are, according to the Center. You don't have to go any further if you don't care to. (8) The company learns who you are for the first time when you announce yourself at its room. The company interview rooms are in a different part of the center (often different floors of the hotel) from the registration area. (9) The pay-off: After the screening by the professional recruiter, you sit down and talk with one of the company engineers. In evaluating a Career Center, the question you must ask yourself is: could you have arrived at this final meeting by any more efficient path?

A new form of trade-show recruiting has taken its place among the smoke-filled company hotel suites. The "Career Center," which will be one year old when it is held during this year's IRE show, is an attempt to organize the engineer-employer scramble into a by-the-numbers "clearing house" operation. Engineers report that it works best for the man out fishing but less well for the man who knows what he wants.

Robert H. Cushman
Technical Editor

TWO-THOUSAND of the engineers attending this year's March IRE show in New York are expected to register at the Career Center, operated by Careers, Inc.

The pictures and descriptions elsewhere on this page explain what the center is. But for the engineer attending the show the questions are: Should I register? Why?

A survey of the pros and cons of this recruiting phenomenon produces three categories of engineers: the man who "yes," by all means should register; the man who "maybe" should register; and the man who "no," should not register.

'Yes': If You Want to Explore

If you have come to the end of opportunity in your present job classification but don't know where the next step is, you should register at the center. Registering will cost you nothing, and your talents, recorded on a simplified resume form, will be shown to the companies paying for the center (27 are expected to do so at this year's IRE show). You will remain anonymous during this selection process, for Careers, Inc., has a clerical staff that retypes your resume and substitutes a code number for your name.

Two benefits will accrue to you: you will find out what companies are interested in your qualifications, and you can arrange interviews with those that have posted your number.

'Maybe': If You Want To Check Your Status

If you like your present job but have been working for one firm so long that you don't have any idea of what other companies would think of you, then you should at least consider taking

advantage of the Career Center. In that case it's mainly a matter of finding the time during the show week.

William Douglass, head of Careers, Inc., says he has no objection to engineers using his service for personal job-status surveys. He admits there is nothing to prevent the ultra-cautious engineer from putting a fictitious name on his resume and then have his wife carry it over to the center. The engineer could phone in to see if any company had posted his number.

'No': If You Know What You Want

If you are one of those fortunate engineers who know just where they are going, particularly if you have achieved some professional stature in your field, you probably should not bother with the Career Center. You will be better off using more direct channels. If you have not developed such channels already, a show is an excellent place to start. This is not to suggest that the show should be misused simply for job-seeking purposes. But use the technical sessions, the exhibitions, and the private hotel suites to learn more about the technical work that companies in your field are doing and how the management of those companies thinks.

'Yes' and 'Maybe' Tend to Predominate

Most of the engineers who have registered at the Career Center at past shows have been in the "yes" and "maybe" categories—men with four to seven years' experience, earning $8-12,000 yearly. However, there have been some notable exceptions. There were the two $25,000-a-year men who registered at the center last fall during the American Rocket Society show in Washington, D.C. One of these men was a vice president with a large, well-known electronics company.

Interestingly enough, engineers who have used past Career Centers appear more enthusiastic about them than the companies. Most of the firms don't like being "regimented" into the same mold, according to Mr. Douglass. The engineers on the other hand—at least those in the "yes" category—like the systematized approach. ■ ■

The photographs were taken by *ED* at the recent center held in New York at the time of the AIEE and American Physical Society meetings. That center was in the top two floors of the Hotel New Yorker. The center for the IRE show in New York will be larger and will be held in the Henry Hudson Hotel across the street from the meeting exhibition at the Coliseum. H. F. Anderson, a recruiter for a West Coast company participating in the center was the "engineer."

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Engineering "Card Trick": Cut Random-Access Time in Computer Memories from 3 Minutes to 1/5 Second!

Pick a card from this magnetic deck, and you have NCR's ingenious answer to the need for a fast, moderately priced exterior random-access memory. Because each of the cards above stores as much information as seven feet of magnetic tape, you can record the equivalent of 1800 feet of tape-stored information on the 256 cards that comprise the full memory.

No two cards in the memory are alike. The top of each one is die-cut according to a binary identification code. All 256 cards hang from eight trunions, each of which rotates to the right or left depending upon the signal. Only the card whose die-cut top corresponds to the alignment of all eight trunions is then free to fall. A pneumatic system pulls the card past the readout head and shoots it back to the magazine. Maximum access-time—as compared with about three minutes for the 1800-foot tape reel—less than 1/5 second!

Perhaps you would enjoy seeing some of your own bright ideas become a reality. If so, NCR may be the place for you. At the Electronics Division, original thought earns many unusual rewards, both professional and personal, for its creators.

CIRCLE 903 ON CAREER INQUIRY FORM

DIGITAL COMPUTER ENGINEERS—

EXPANSION AT NCR CREATES OPENINGS IN LOS ANGELES FOR:

SENIOR SOLID STATE DEVICE ENGINEER

An important position entailing investigation of semiconductor devices for purpose of establishing mathematical models and design parameters used in circuit design. Requires minimum of three years' experience and some background in computer circuitry, transistors, diodes, resistors, and transient phenomena. Should be familiar with characteristics, analysis, and mathematical models of various semiconductors, such as alloy transistors, diffused-base transistors, mesa transistors, and diodes.

SENIOR PRODUCT DESIGN ENGINEER

Expanding commercial program offers excellent opportunity to apply advanced techniques in miniaturization. Applicant should have ME degree and substantial experience in packaging techniques for core-type memories and complex digital systems. Should also be capable of product design analysis and technical liaison to develop a producible product.

COMPUTER ENGINEERS

Seniors & Intermediates

Experienced graduate E.E.'s with 3 to 5 years in logic design and transistorized circuit design of digital equipment. Assignments will entail logic and circuit design of buffer storage units and digital peripheral equipment.

TRANSISTOR CIRCUIT ENGINEERS

Seniors & Intermediates

Highly creative positions are available in circuit analysis and design. Duties include: advanced mathematical studies in transistor circuitry, evaluation of transistor circuitry, component studies and keeping abreast of computer circuit advances. Circuit analysis ability and solid understanding of transistor theory essential. E.E. degree required.

TRANSISTOR POWER SUPPLY ENGINEER

For assignment in specifying power supplies for both large and small digital systems, supervising the design of supplies internally or by vendors, and evaluating supplies to determine conformance to specifications. Requires knowledge and design experience in solid state computer power supplies, their specification, and associated transistor circuitry. Requires experienced graduate E.E. or man with formal training and appreciable practical transistor power supply experience.

SYSTEMS ENGINEER

Experience required in formulating functional design specifications for digital computer systems (buffer storage, punch card, paper tape, magnetic tape, random access devices, system organizations, command structures). Training in logical design, data-handling methods and programming techniques desirable. Assignments entail formulating functional specifications for business computers.

Confidential interviews can be arranged at your convenience. Telephone or submit resume to N. E. Powell, Personnel Manager.

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A Diversity of Current Projects

Continuing an outstanding record of achievements that includes *the first recovery of a space vehicle from orbit*, and *the first flight demonstration of effective space vehicle stabilization control and navigation*, MSVD electronics engineers are currently working in such areas as:

Quick-launching Support Systems • Inertial Navigation Equipment • High Density Packaging • Stabilization Controls • Space-to-ground Communications Systems • Orbit Ejection Controls • Instrumentation for Nose Cones • Space Power Supplies • Satellite Telemetry Tracking & Command • Digital Computers • Circuit Design for Space Application • Electronic Navigation Techniques

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Today, engineers with TV and radio experience are working on missile and space vehicle payload problems at GE's *Missile & Space Vehicle Department*... others are applying their knowledge of radar to space communications... men with aircraft navigation experience are concentrating on advanced guidance and control systems for interplanetary space vehicles... In fact, engineers with experience in practically every area of electronics have transferred their technical knowledge directly to space problems.

Whether or not you've had specific experience in space electronics, you may be able to go right to work at MSVD on some of the most sophisticated and technologically exciting projects in the entire space field—from ICBM re-entry vehicles to operational space craft.

The work here is at the very edge of the state of the art, transforming the latest research discoveries into workable engineering solutions. You'll be concerned with new advances in plasma physics, thermoelectric phenomena, telemetry... with radical new requirements in micro-miniaturization, space to weight reductions, performance efficiency... with an entirely new order of reliability specifications to assure systems' operation in space for a year or longer.

Excellent positions are currently open in four major areas at MSVD: Navigation and Control Engineering • Instrumentation and Communications Engineering • Ground Support Engineering • Advanced Systems Engineering

These positions will place you on the ground floor of the move of a large segment of the Department to the new Space Technology Center—located at Valley Forge Park, just 17 miles from Philadelphia.

Inquiries are invited from electronics engineers who are technically advanced in their own discipline, and are deeply interested in the related fields of space vehicle development. Write informally, or forward your resume to: D. G. Curley, Div 76-SMO.

MISSILE & SPACE VEHICLE DEPARTMENT

GENERAL ELECTRIC

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CIRCLE 904 ON CAREER INQUIRY FORM

YOUR CAREER

NEWS AND NOTES

Stock options are better than year-end bonuses for holding key personnel, according to Fred How of Cadillac Associates Inc., Chicago. Mr. How said his employment firm had found that lack of stock options are the most frequently stated reason for executives leaving a firm and one of the best lures to attract executives to other firms.

Of interest to engineers is the news that some firms are also using stock options for their key engineers. One senior engineer told ELECTRONIC DESIGN that the availability of a stock-option plan was the deciding factor in his recent job change.

• • •

The professional attitude towards engineering is encouraged at Newark College of Engineering, Newark, N.J. In a recent issue of the college publication, "NCE Today," the growth of the professional outlook was described in terms of the trends in student dress as he approached graduation.

"An occasional freshman will come to school wearing a sports shirt overprinted with palm trees or sea horses; some sophomores and juniors may keep a necktie handy in their briefcases for classroom use only; but seniors, almost to a man, will dress and act like professional men."

• • •

The American Institute of Electrical Engineers has developed a new procedure to encourage the formation of technical specialty groups. A new group can be formed by the following steps:

- When any 50 members petition that they would like a new ITG (Institute Technical Group), the ITG will be considered officially "proposed."
- When the ITG has 250 paid-up members, it becomes a permanent AIEE entity. It is permitted to establish its own bylaws and elect its own officers.

The AIEE believes the new groups will be particularly popular with younger engineers in fields constantly being created by technological advances.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

Advancement Your Goal?

Use CONFIDENTIAL Action Form

ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—as *confidentially and discreetly as they would do in person.* The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—*the same day the resume is received.*

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN.*
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at *ELECTRONIC DESIGN,* and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

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USE BEFORE APR. 12, 1961

(5)

After completing, mail career form to *ELECTRONIC DESIGN,* 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

(Please print with a soft pencil or type.)

Name _____ *Telephone* _____

Home Address _____ *City* _____ *Zone* _____ *State* _____

Date of Birth _____ *Place of Birth* _____ *Citizenship* _____

Position Desired _____

Educational History

College	*Dates*	*Degree*	*Major*	*Honors*

Recent Special Training _____

Employment History

Company	*City and State*	*Dates*	*Title*	*Engineering Specialty*

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924
925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949

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unusual opportunities
in

microelectronics

A new group of scientists and engineers has been formed at the Applied Physics Laboratory of the Johns Hopkins University to perform highly advanced research and development work in solid state microelectronics. The objective: to explore new techniques and methods to produce reliable microelectronic functions for wide application in missiles, satellites, radar, adaptive computers, etc.

■ **Solid State Theory** The position requires a Ph.D. with two or more years of experience in solid state theory. You will apply the principles of dielectrics, conducting materials, and semi-conductors to the analysis of integrated electronic circuits. This is a new area of activity with unusual opportunities for rapid personal and professional advancement.

■ **Semi-Conductor Devices, Prototype Production** An opening with exciting possibilities. You will establish a semi-conductor laboratory and work freely within broad policy directives. Funds have been allocated for the laboratory. Duties include making integrated semi-conductor electronic circuits on a laboratory basis. B.S. plus three years of experience in this field desirable.

■ **Circuit-Systems Analysis** Position involves microelectronic system and circuit analysis and design, as well as maintaining close working relationship with prototype fabricator and user groups. Applicant must have a B.S. in electronics or physics and approximately five years of experience in system and/or circuit analysis.

**For details about these positions,
direct your inquiry to:
Professional Staff Appointments**

The Applied Physics Laboratory
The Johns Hopkins University

8635 Georgia Avenue, Silver Spring, Md.
(Suburb of Washington, D.C.)

CIRCLE 905 ON CAREER INQUIRY FORM

ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographical areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.

National Courses

Electron Beam Symposium Due in Boston March 23-24

Alloyd Electronics Corp. will present its Third Annual Symposium on Electron Beam Technology in Boston on March 23 and 24.

There will be four sessions. One on March 23 will cover electron beam physics, and welding and refining. The sessions on March 24 will cover present and future applications of electron beams to micro-electronics and the use of beams for advanced polymerization and food processing.

For details, write to R. Bakish, Chairman, Third Alloyd Symposium, 37 Cambridge Parkway, Cambridge 42, Mass.

Technical Publishing Forum Set In San Francisco April 13-14

The problems of the technical writer, illustrator and publications manager will be discussed April 13 and 14 at a convention of the Society of Technical Writers and Publishers in the Mark Hopkins Hotel, San Francisco. For more information, write to Sid Swirsky, 645 Castle Hills Road, Redwood City, Calif.

Strain Gage Course Slated At San Antonio in April

A one-week course in strain gage techniques will be held April 17-21 in San Antonio, Tex.

The course is sponsored by the Southwest Research Institute and the Society for Experimental Stress Analysis.

Lecturers include W. T. Bean Jr., consulting engineer, Detroit; W. M. Murray, professor of mechanical engineering, Massachusetts Institute of Technology; P. K. Stein, associate professor of engineering, Arizona State University; C. O. Vogt, Century Electronics and Instruments, Inc., Tulsa, Okla., and L. J. Weymouth, Baldwin-

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Thanks to recent medical progress, most cases of high blood pressure can be controlled. The danger of heart damage and "stroke" can be reduced with the help of new drugs and surgery.

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For more information, *ask your Heart Association.*

For greater advances against heart disease,

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In the Remington Rand Univac physics laboratory, 5 mil. diameter holes are ultrasonically drilled in ferrite cores, then threaded with fine wire in the examination of domain structure. Such experiments prove that a series of alternate-polarity pulses of diminishing amplitude result in concentric rings of alternately directed magnetization. Much smaller cores (80 mil. o.d.) were then studied by means of residual magnetization curves for flux distribution under various modes of partial switching.

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Attractive positions are now available for Research Engineers. These permanent assignments include circuit development work and the logical design of high speed computer elements.

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- **SERVO-ENGINEERS**
- **ELECTROMECHANICAL ENGINEERS**
- **QUALITY CONTROL ENGINEERS**
- **PRODUCTION ENGINEERS**
- **RELIABILITY ENGINEERS**
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Send resume of education and experience to:

R. K. PATTERSON, DEPT. C-3

Remington Rand Univac

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There are also immediate openings in all areas of digital computer development at our other laboratories. Inquiries should be addressed to:

F. E. NAGLE, Dept. C-3
REMINGTON RAND UNIVAC
1900 West Allegheny
Philadelphia 29, Pa

D. CLAVELOUX, Dept. C-3
REMINGTON RAND UNIVAC
Wilson Avenue
South Norwalk, Conn.

Lima-Hamilton Corp., Waltham, Mass.

The lecture portion of the course will cost $175, and there is an optional laboratory program costing $100.

Applications and tuition must be in by April 10. Address Dr. M. M. Lemcoe, Southwest Research Institute, Box 2296, San Antonio 6, Tex.

PAPER DEADLINES

Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

April 1: Deadline for papers for the **1961 Annual Conference of the Society of Photographic Scientists and Engineers** to be held **May 22 to May 26, 1961,** at the Arlington Hotel in Binghamton, N.Y. Subjects include: scientific engineering aspects of color and black-and-white photography, photographic image structure, cameras, and printing and processing equipment. Send papers to: F. H. Gerhardt, Papers Chairman, 771 River Road, M. R. 97, Binghamton, N.Y.

April 1: Deadline for 300-word abstracts and 50-word summaries for the **Fourth International Conference on Medical Electronics** to be held **July 16-21, 1961,** at the **Waldorf-Astoria Hotel,** New York. The conference, combined with the 14th Annual Conference on Electrical Techniques in Medicine and Biology, is sponsored by the Joint Executive Committee on Medicine and Biology (IRE, AIEE, and Instrument Society of America), under the auspices of the International Federation for Medical Electronics. Address submissions to: Dr. Herman P. Schwan, program chairman, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia 4, Pa.

May 1: Deadline for 100 to 200-word abstracts and 500 to 1,000-word detailed summaries for the **1961 WESCON** to be held Aug. 22-25 at **San Francisco's Cow Palace.** Authors will be notified by June 1 of acceptance or rejection of their papers. Submissions should be sent to the attention of Mr. E. W. Herold, chairman of the technical program, WESCON Northern California office, 701 Welch Road, Palo Alto, Calif.

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ENGINEERS

You can bring new meaning to your career in engineering by investigating opportunities in state-of-the-art developments at ACF. Experienced engineers at all levels are cordially invited to inquire about challenging positions in the following fields:

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SOLID STATE CIRCUITRY
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During the IRE SHOW visit the ACF Suite in the convention hotel MARCH 20-23

These openings involve assignments at our laboratories located in suburban Washington, D.C. and the New York metropolitan area at Paramus, New Jersey. Pleasant residential neighborhoods provide readily available housing. Advanced study under tuition refund may be conducted at nearby universities.

Send resume to: **Mr. Robert J. Reid**
Professional Employment Supervisor
at our Riverdale facility, Dept. 412

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- Microwave field engineers
- Transistor switching circuit design
- Logic circuit design
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- Home radio design
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- Auto radio design
- Mechanical engineering
- Semi-conductor device development
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CIRCLE 907 ON CAREER INQUIRY FORM

ADVERTISERS' INDEX

March 1, 1961

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Inquiries should be addressed to:
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NASA Flight Research Center
P. O. Box 273
Edwards, California

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA

CIRCLE 908 ON CAREER INQUIRY FORM

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Just as you take measures to achieve precision in your work, ELECTRONIC DESIGN also works to bring you accuracy. The magazine maintains a policy which demands truth in every word printed in its pages. The result is editorial data that you can rely on, and factual advertising to help you select products. ELECTRONIC DESIGN's Accuracy Policy is contained in every issue.

Strongly supporting its policy, ELECTRONIC DESIGN takes exacting care to verify all editorial material. Articles are checked repeatedly before they go to press. If an error does appear, steps are taken to correct it in the very next issue. Concerning advertising, the manufacturer must prove any product claim questioned by a reader. If the claim is not proved, the magazine reserves the right to reject the advertising from future issues.

ELECTRONIC DESIGN assumes full responsibility for accuracy. But you can help, too, by reporting any misstatement you find. You're encouraged to do so. It is through such a dual guardianship—readers and editors—that ELECTRONIC DESIGN can guarantee you highest reliability . . . from cover to cover.

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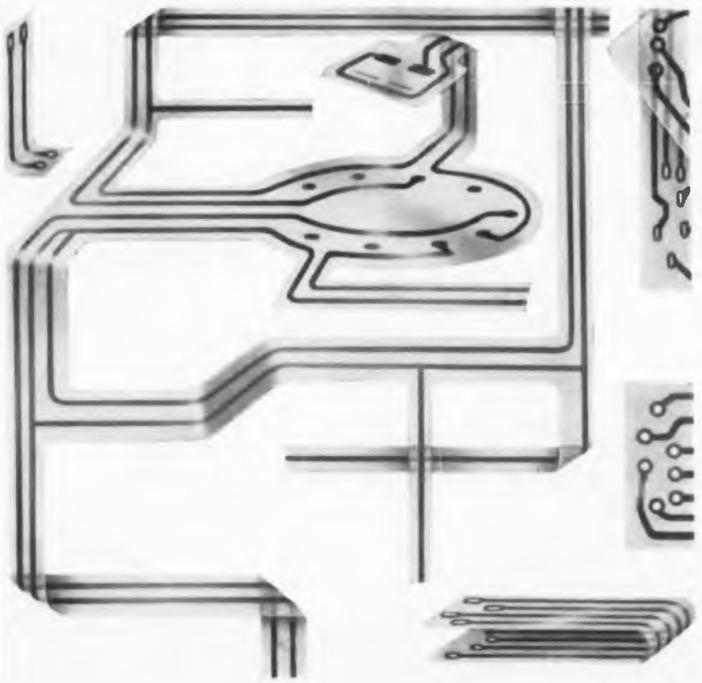
American Cancer Society

*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG

NEW FLEXIBLE PRINTED CIRCUITRY

from Garlock



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Maximum reliability. Garlock Flexible Printed Circuitry is made of etched copper completely encapsulated between two layers of Teflon FEP. Permanently bonded under pressure, this encapsulation affords both line-to-line and line-to-ground protection, and will resist penetration of harmful moisture and gases. No adhesive is used to effect the bond, eliminating any possibility of breakdown through aging.

Reduced size and weight. Garlock Flexible Printed Circuitry can often cut overall package dimensions by as much as 50%. Being extremely flexible, it will hug curves, go around corners, conform to the most eccentric layout. And, because of excellent electrical properties a thinner gauge of Teflon FEP can handle the same job that requires thick gauges of other insulating materials. This, combined with the use of less copper, greatly reduces package weight.

For more information, call your nearest Garlock Electronic Products representative for more data, or write Garlock Electronic Products, Garlock Inc., Camden 1, New Jersey.

GARLOCK

Visit our Booth No. 2814-2816 at the IRE Show for the complete story of Garlock Flexible Printed Circuitry.

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Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

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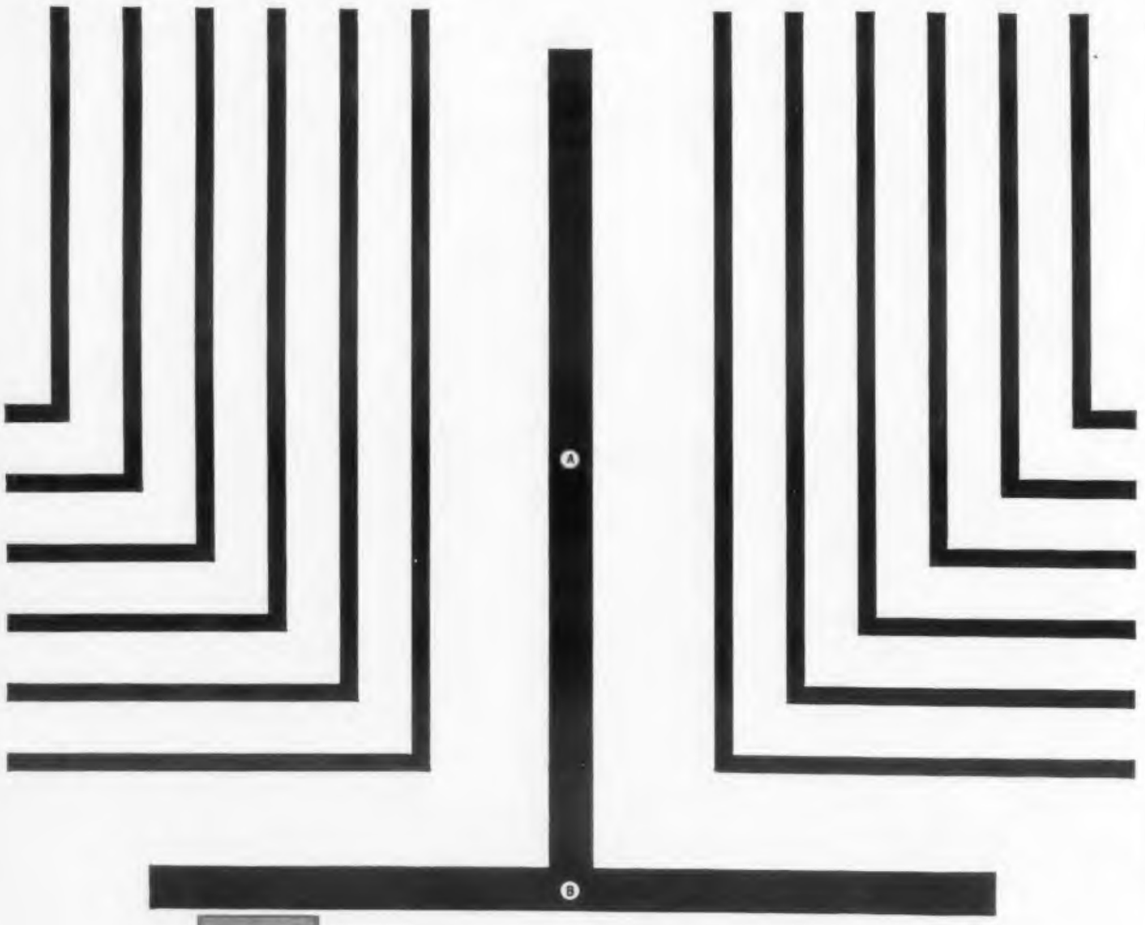
CIRCLE 828 ON READER-SERVICE CARD



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USE BEFORE APRIL 12th, 1961

C

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
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 _____ City _____ Zone _____ State _____

Home Address _____

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

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B

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