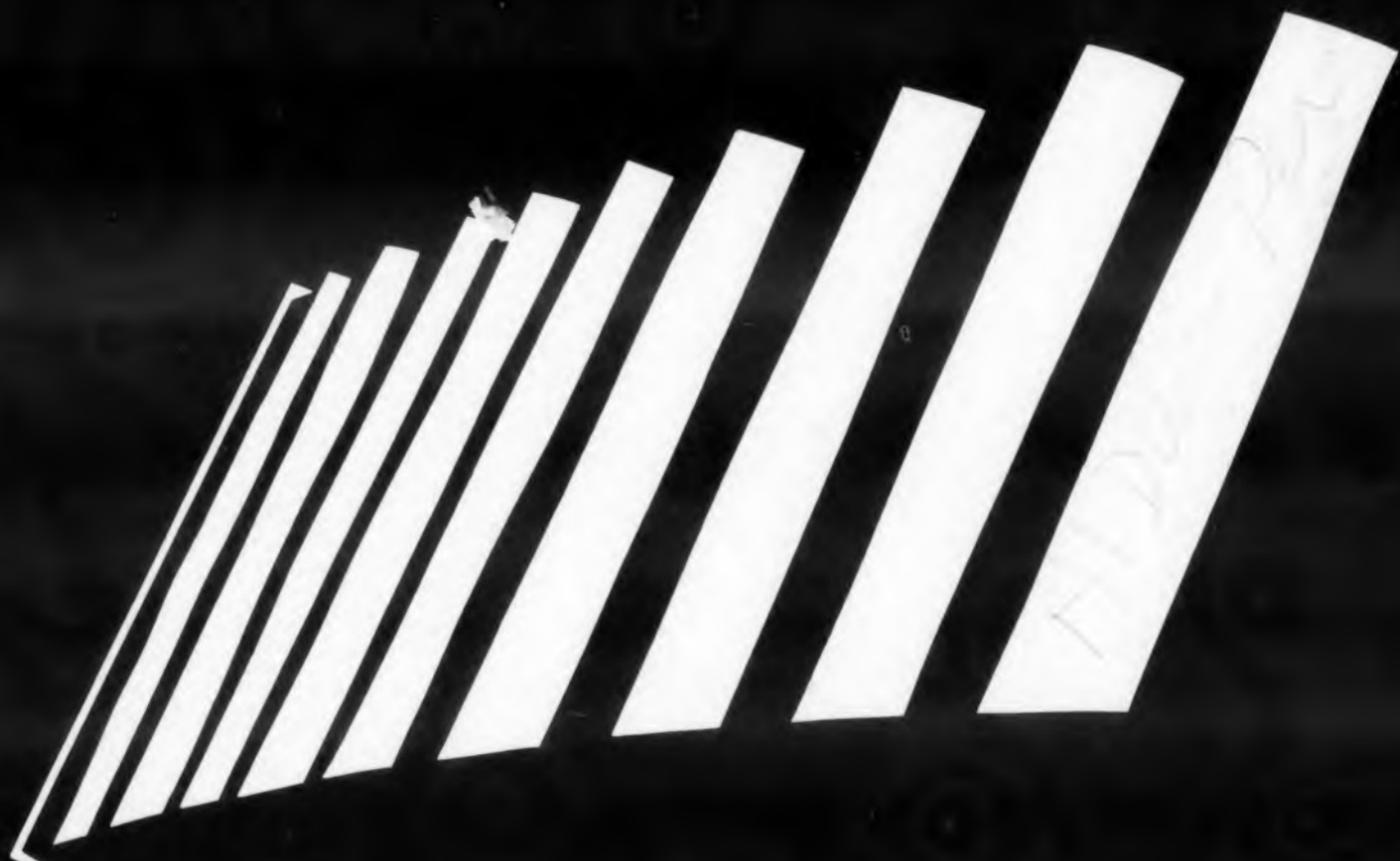


ELECTRONIC DESIGN



Glass-Ambient
Diode
p 98



Highly-Regulated
Supply
p 102



Binistor Switch
p 100



Switching Time
Meter
p 96

WEBSOON

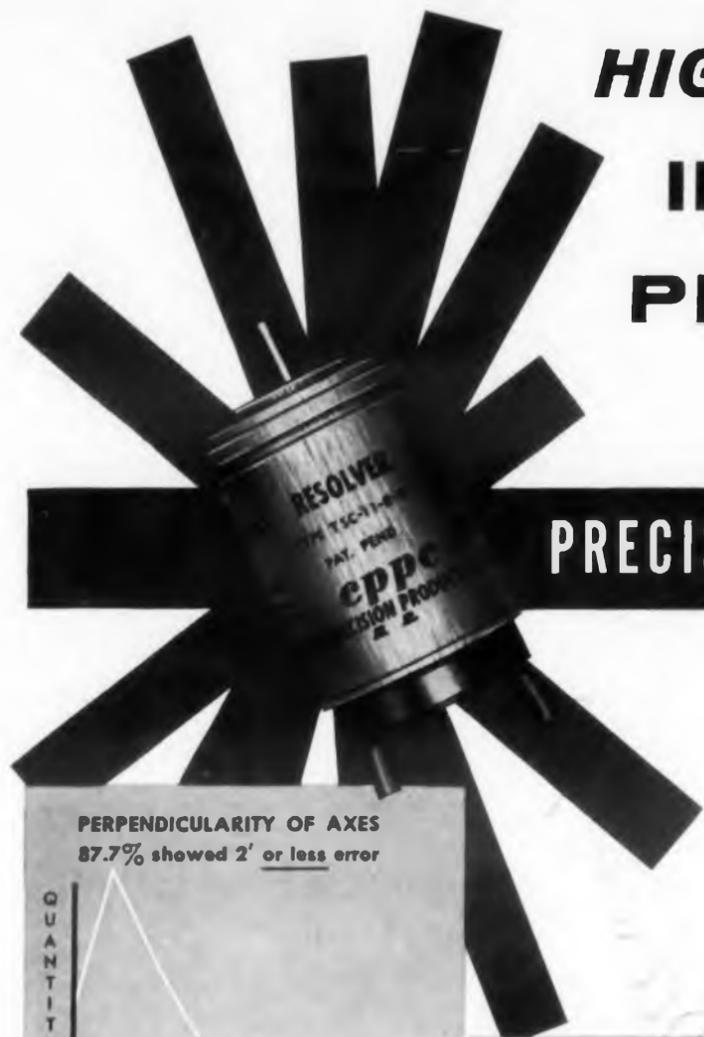
HIGHEST ACCURACY

IN

PRODUCTION

QUANTITIES

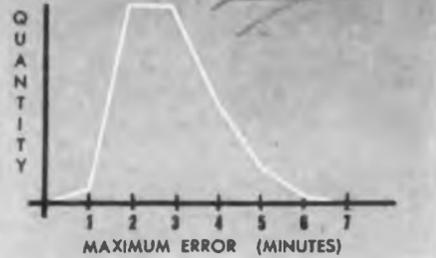
PRECISION COMPUTING RESOLVERS



PERPENDICULARITY OF AXES
87.7% showed 2' or less error



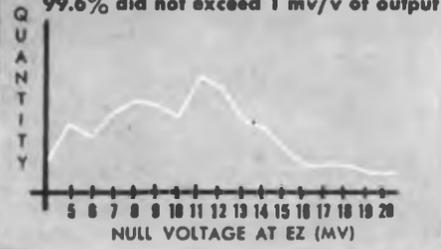
MAXIMUM ERROR
93.4% showed 4' or less error



MAXIMUM ERROR SPREAD
91.4% showed 6' or less error spread



NULL VOLTAGE
99.1% did not exceed 1 mv/v of input
99.6% did not exceed 1 mv/v of output



TRANSFORMATION RATIO

96.9% did not exceed 1% tolerance

Occasionally we see advertised rotating components of fantastic accuracy. Sure, we make these *hand built* units too. But they are usually very expensive, of a large size, and you get delivery a few units at a time.

CPPC will sell you 1000 (or 10,000) of these Size 11 Precision Computing Resolvers, holding the very high accuracies shown on this page, and at a price which will surprise you. If you know the rotary components market, you know that we have been able to substantially lower traditional prices in the past.

Two modern rotary components facilities (Clifton Heights, Pa. and Colorado Springs, Colo.) assure deliveries in 45 days on quantity orders. Samples from the shelf immediately. Telephone Hilltop 9-1200 or our representatives.

ENGINEERS—Pioneer with a leader in the field.
Write David D. Brown, Director of Personnel.

CLIFTON PRECISION PRODUCTS CO., INC.

CLIFTON HEIGHTS, PA.

cppc

CIRCLE 1 ON READER-SERVICE CARD



COVER: The modern lines of Los Angeles' New Memorial Sports Arena inspired Art Director Ray Schultz to create this cover design (See photo on p 26). The arena will be the site of WESCON 1960. The four new products, glass ambient diode, p. 98, highly regulated supply, p. 102, binistor switch, p. 100 and switching meter, p. 96, are all described in detail in this issue, and will be on display at WESCON.

Selected Topics in This Issue

Circuit Design

- Design of a Long Time Constant Asymmetrical Transistor Multivibrator p 70
- Designing Low-Noise Transistor Circuits p 86
- Simple Equations for Rapid Pi-Network Design p 94

Components

- Microwave Rectifier Tube Designed at Raytheon p 58
- Silicon Diode Withstands 10 Times Power Overloads p 98
- Silicon Tetrode Suitable for Switching and Memory p 100

Instrumentation

- Record Antenna Patterns Using Off-The-Shelf Test Equipment p 78
- Direct-Reading Switching Time Tester Samples Nanosecond Waveforms p 96

Reliability

- Highly Reliable Resistors Result from Rigid Tests p 50
- A Reliability Quiz p 74

Westward, Ho!—To WESCON

Engineers will be making tracks westward to attend WESCON 1960. In this issue, New Products Editor, Leon Topko, has given you a bird's-eye view of preview evaluations of new products, that will be on display at the show. A detailed program of technical sessions (See p 28) is given, including a sessions index which will enable you to spot quickly the subject which is of particular interest to you. A detailed coverage of show affairs and events begins on p. 26. As usual we will be on the scene publishing *ELECTRONIC DAILY* and covering each day's happenings at the show. We will be located at Booth 2714-5 and will be glad to discuss your manuscripts or article ideas. If you should miss picking up a copy of *ELECTRONIC DAILY* at your hotel, please drop in and pick up one at the booth. We are looking forward to renewing old acquaintances and making new friends, and will be glad to listen to your comments and criticisms on *ELECTRONIC DESIGN*.

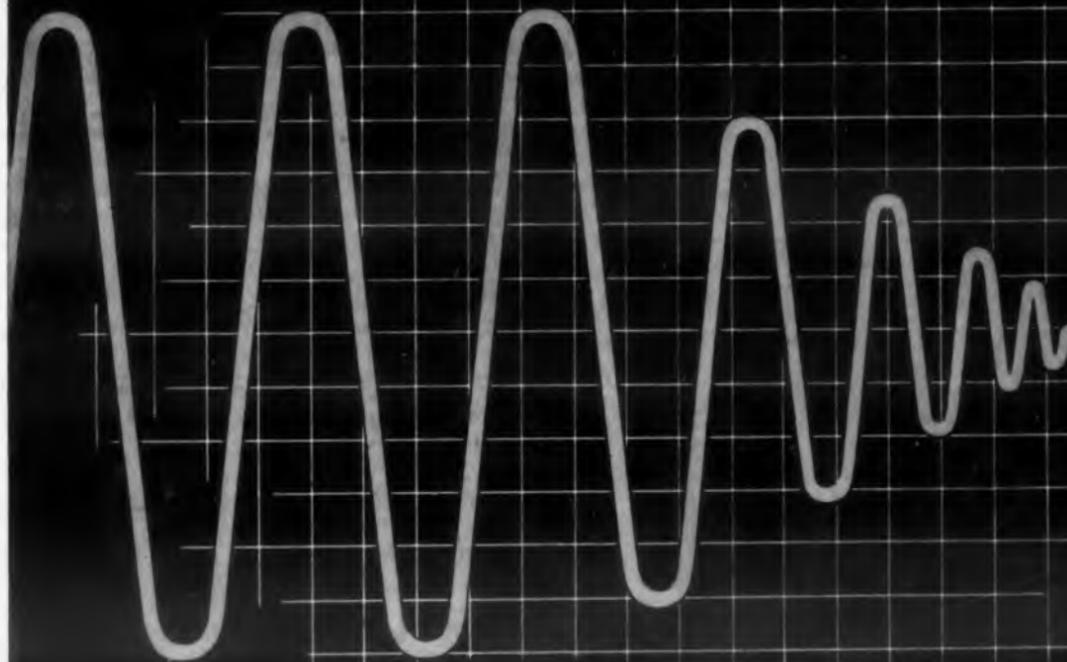
Western Electronics

The electronics industry in the west is expected to reach a total of \$2 billion sales this year. "West" in this instance refers to five principal areas: Portland-Seattle, San Francisco-Oakland, Los Angeles-Orange County, San Diego, and Phoenix-Tucson. West Coast Editor, Tom Mount, has covered the industries explosive growth with text, graphs and charts beginning on p 36. The nature of this explosive growth should be of significant interest to those planning to attend WESCON.

RFI

As the number of artificial earth satellites increases, projected plans for exploration beyond the earth's atmosphere may be hampered by natural interference levels encountered. Therefore careful consideration must be given to the problems stemming from radio noise of cosmic origin, the principal source of natural interference to be expected. On p 70 James F. Lee presents an interesting article on these problems.

CIRCLE 2 ON READER-SERVICE CARD



A Pair of Smoothies For Series Regulator Service

The Raytheon CK6336A and CK6528 are mechanically rugged, long-life twin power triodes. They are designed to handle large currents over a wide voltage range and at high temperatures in regulated power supplies. Zirconium coated graphite anodes, ceramic insulators, gold plated molybdenum grid wires, and hard glass envelopes are some of the advanced design features of both types.

Stringent power supply regulation requirements are no problem for these "smoothies." Get full technical data on the CK6336A and CK6528 as well as Raytheon's expanding line of high voltage rectifiers, pulse modulators, and transmitting types. Please write to: Raytheon, Industrial Components Division, 55 Chapel St., Newton 58, Mass.

For Small Order or Prototype Requirements See Your Local Franchised Raytheon Distributor.

RATINGS

	Max. Plate Voltage	Max. Plate Dissipation Watts	Max. Plate Current (per plate)	Amplification Factor
CK6336A	400	2 x 30	400 mAdc	2.7
CK6528	400	2 x 30	300 mAdc	9

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

**RAYTHEON
CK6336A
AND
CK6528**



KAY Ligna-Sweep®

MODEL SKV



ALL ELECTRONIC — AUDIO, VIDEO, VHF SWEEPING OCILLATOR COVERS W-I-D-E RANGE 200 CPS TO 220 MC.

FEATURES

From 10 mc
Down to 1 kc in
One Wide Video Sweep.

Highly Stable, Narrow-Band
Video Frequency Sweeps
(20 kc on Variable Bands,
200 cps on Fixed).

Logarithmic Sweep for
Low-End Expansion.
Linear Sweeps 0.2 cps to
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8 Fixed, Narrow-Band
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Center Freqs.
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High-Level RF Output—
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AGC'd to ± 0.5 db
Over Widest Sweep.

PRICE: \$995.00 F.O.B.
Factory. Includes variable
and audio bands. (Fixed-
frequency bands to customer
specified frequencies; add
\$17.00 per band. Pulse-type
frequency markers at \$17.00
each).

SEE US AT THE WESCON SHOW
BOOTHS 2062 - 2063

Write for Catalog Information, Dept. ED-8.

KAY ELECTRIC COMPANY
MAPLE AVENUE • PINE BROOK, N. J. • CAPITAL 6-4000

To provide this wide and continuous coverage, the SKV makes maximum use of both fundamental and beat-frequency oscillator techniques. Three beat-frequency bands are provided—each optimized for high stability consistent with sweep width required. These circuits are carefully shielded and filtered to prevent spurious output signals, and are carefully balanced to preserve pure wave-shapes. The beat-frequency system also provides effective frequency coverage in a single frequency sweep, permitting a continuous single display from 1 kc to 10 mc.

For high-frequency work, 9 sweep bands, operating at fundamental frequencies, provide wide, stable sweeps from 10 to 220 mc. At the low end of the spectrum, an audio-frequency sweep from 200 to 20,000 cps is provided.

For checking high-Q circuits and low-frequency response characteristics, variable rep-rates down to 0.2 cps are available. This wide choice of sweep rates (continuous to 30 cycles, and a fixed 60-cycle lock) makes it easy to select that highest rep-rate which gives both an accurate response display and easiest, brightest viewing on the scope screen. A nominally logarithmic 30-cycle sweep, most useful for studying audio and video low-pass circuits, provides an expanded view of the low-frequency end, while showing over-all frequency characteristic.

In addition to the variable-center-frequency sweep signals, a front-of-panel control permits selection of any one of 8 narrow, highly stable, fixed sweep bands at frequencies between 20 kc and 12 mc (as specified by the customer). These bands are extremely useful for repetitive alignment of a variety of narrow-band, tuned circuits.

WESCON 1960

- WESCON 1960: The Big Show Takes on a New Look** 26
New Los Angeles Sports Arena to welcome engineers; technical sessions geared to workshop meetings
- Electronics in the West: The 1960 Look** 36
Little boom shot up to big boom but still suffers growth pains
- Most Products at WESCON to be Displayed for First Time** 104
Touring engineers will be lured by hundreds of devices from cable connectors to computers

- High Hopes for WESCON** 69
An Editorial
- Design of a Long Time Constant Asymmetrical Transistor Multivibrator** .. 70
Design steps, plus their mathematical derivation, for an asymmetrical multivibrator which can directly drive a load. Included is a typical design example—M. I. Marks
- A Reliability Quiz** 74
A good reliability engineer should be able to answer these questions in 12 minutes. Can you?—B. E. Phillips

- Record Antenna Patterns Using Off-The-Shelf Test Equipment** 78
Eliminate need for elaborate recording devices—R. L. Thomas
- Probe Design for Capacitive Level Measurements** 82
A basic analysis of level-gaging probes—G. Revesz
- Designing Low-Noise Transistor Circuits** 86
Types of noise and their origin in transistors, plus factors affecting design of low-noise circuits are discussed. A typical design example is included—P. J. Beneteau

RFI Series

- Natural Interference in Space Systems** 90
During initial phases of satellite communication design, cosmic radio emission must be considered in terms of interference effects; radio noise of cosmic origin internal and external to our solar system are discussed—J. F. Lee

- Simple Equations for Rapid Pi-Network Design** 94
Impedance-transforming pi-networks can be quickly designed with the aid of these three simple equations—W. M. Bauer
- Direct-Reading Switching-Time Tester Samples Nanosecond Waveforms** 96
Reported five times faster and ten times more accurate than earlier units
- Silicon Diode Withstands 10 Times Power Overloads, Tolerates Red-Hot Operation** 98
Glass-enclosed structure sustains high peak inverse voltage and overload
- Silicon Tetrode Suitable for Switching and Memory** 100
Bistable, negative resistance binistor is essentially a four-layer npn switch
- Ultra-High Regulation Featured in All-Transistor Supply** 102
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Series-Connected Transistors Increase Voltage Switched to Load
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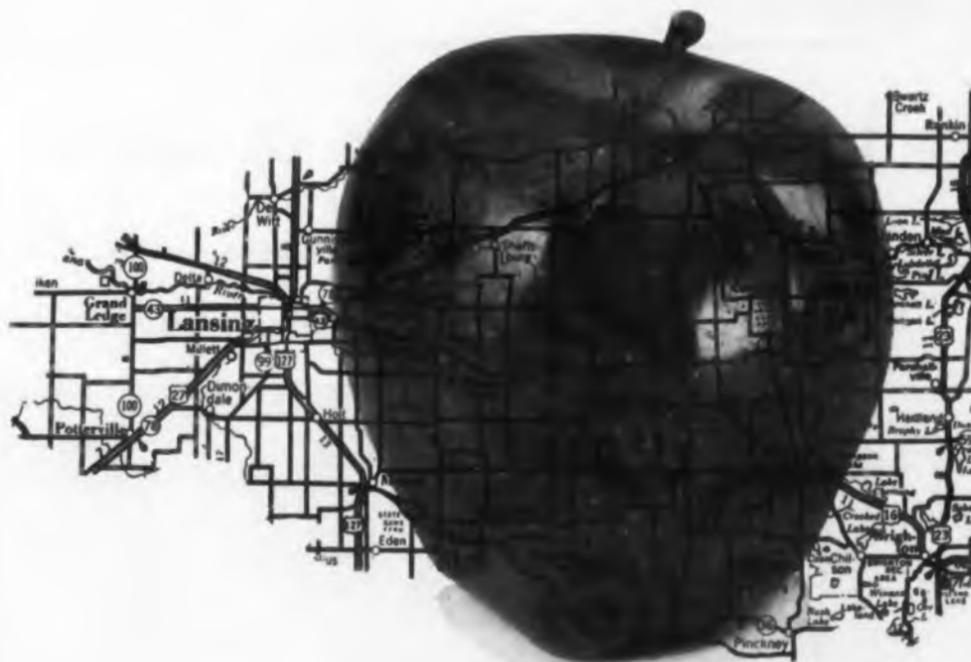


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Accepted as controlled circulation at Bristol, Conn. Additional entry, New York, N. Y. Copyright 1960 Hayden Publishing Company, Inc. 36,602 copies this issue.

if you have
one apple and
Johnny gives you
two apples...
how long will
it take you to get
to East Lansing,
Michigan?*

Knotty, we know,
but Canoga engineers
solve problems
of this and greater
magnitude every day
They also excel
in the solution of
problems involving
more exotic products
than the apple...
such as research,
design and development
of radar, command,
communications and
telemetry antennas,
missile range
instrumentation,
digital data handling
and processing,
electronic and
electromechanical
devices, test equipment
and mangoes.

CANOGA



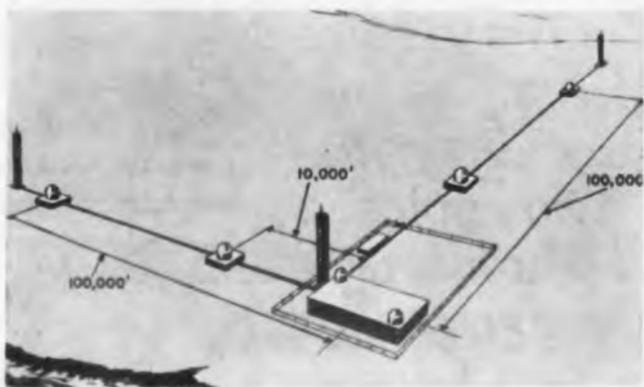
*Solution to the problem: First of all, determine where you are (if you are already in East Lansing, no fair). Take three apples of equal size and give them to your wife (if you have no wife, this is fair enough). Suggest baked apples. Some people prefer them with raisins, which add a delectable flavor, a new dimension, so to speak, especially when covered with thick cream. Have Johnny over for a drink and thank him for the apples. Call an airline and ask them how long it will take you to get to East Lansing, Michigan.

Canoga/a division of the Underwood Corporation Van Nuys, California Fort Walton Beach, Florida

CIRCLE 4 ON READER-SERVICE CARD

Plan High Accuracy Trajectory System

*Range, Range Difference Measurements
To Give Point Missile Positions in Mistram*



L-shaped receiving station network planned for missile trajectory measurements over the Atlantic Missile Range. The central station along with either the pair of receiving stations 10,000 feet away or the pair 100,000 feet away provides a point position for a missile. Errors are expected to be small in relation to missile size.

A HIGHLY precise missile trajectory measurement system will be constructed near Cape Canaveral by General Electric Co.'s Defense Systems Dept., Syracuse, N. Y.

An initial \$15.5 million Air Force contract has been awarded to GE for design and construction of the system, called Mistram for Missile Trajectory Measurement system. Operational status is scheduled for January, 1962, with total costs estimated by GE at \$25 or \$26 million.

Measurement errors expected with the new system will be small compared to a missile's size, so that a transponder on the top of the vehicle will be tracked. This order of accuracy exceeds that accomplished by any presently existing or planned trajectory measurement systems, according to GE.

The total system will consist of a central trans-

mitting and receiving station, and four outlying receiving stations arranged in an L-shaped pattern. One pair of receiving stations will be located 10,000 feet from the central station, and the second pair will be 100,000 feet distant.

Mistram is designed to position a missile at the intersection of a hemisphere and two hyperboloids. These surfaces are determined by measurement of transit time of a continuous wave signal between the ground transmitter in the central station and the various receivers. The hemisphere of possible position is provided by the transit time from the central station to the missile and back. The difference in signal transit times between the central station in a pair provide the two hyperboloids of possible position.

The receiving stations located on the 10,000 foot

Interference Key to Space Frequency Controversy

*AT&T Requests New Space Frequency Allocations;
EIA, Private Users Favor Sharing of 1-10 Kmc Band*



Project Echo control panels are handled by W. C. Jakes, Jr., Bell Labs project director, at Holmdel, N. J., site (*ED*, April 13, p. 4), as horn reflector antenna, inset, picks up transmission bounced off an inflated plastic satellite. Active repeater satellites are more likely to be used commercially EIA spokesmen told the FCC during recent hearings. Because of horn reflectors and other techniques to lower noise to the receiver, both ground and space systems might operate compatibly on the same frequencies, the EIA said. AT&T asked that at least 2 kmc be allotted solely for commercial space uses.

FUTURE commercial space system design is bound to be affected by recent requests that the Federal Communications Commission reassign large portions of the 1-10 kmc band for potential space uses (*ED*, June 8, p. 4).

American Telephone and Telegraph Corp. asked the FCC at recent hearings to reconsider allocations already made in the 1 to 10 kmc region to include at least four and preferably more 500-mc bands for satellite communications links. The relative costs per channel of satellite versus undersea cable links already are beginning to make space communications attractive, according to AT&T. The techniques for accomplishing these systems are already here or in advanced development.

The Electronic Industries Association and some

(continued on page 10)

Subcontractors for Mistram System

Subcontractor	Subsystem
GE Heavy Military Electronics Div. Lenkurt Electric Co., Inc.	Precision Measuring Data Transmission/ Recording Analog Computer
Electronic Associates, Inc. GE Communications Products Dept. Milgo Electronics Corp. GE Light Military Electronics Div. General Bronze Corp.	Rf Communication Link Data Multiplex Airborne Transponders Transponder Test Set Acquisition and Tracking

baselines will be used initially for missile positioning, with the 100,000 foot baselines used for redundant data. Theoretically the longer baseline receivers should give more precise missile positions, but since baselines of this length have not been attempted before the accuracy that can be attained is not yet firmly established.

This technique provides direct measurement of range, azimuth, and elevation angle. Velocity will be obtained from doppler shift data.

Frequency modulation will be used to determine the number of cycles which occur between transmission of a carrier and return of the missile transponder carrier to the ground receivers. The phase difference between the transmitted and received signals is measured by interferometer techniques to determine a fraction of the last cycle being counted. The ultimate accuracy of the system depends on the precision of this phase measurement.

Two techniques are credited with the accuracy GE expects to get with the new system. One of these is the use of a high modulation frequency. The central station on the ground will continuously transmit two carrier frequencies—one at 8,148 mc and the other at 7,792 mc—so that when they are beat together a 256 mc intermediate frequency is obtained. The 7,792-mc signal is swept down 8 mc to 7,784 mc over a 1.5-sec interval.

The transponder in the missile is synchronized and phase-locked to the ground transmitter. It returns signals continuously offset by 68 mc from the ground transmitter frequencies. Thus the transponder smoothly follows the frequency sweep.

The transit time between the ground station and the missile causes the frequency sweep received from the transponder to be offset—usually by a few milliseconds—from the ground transmitter sweep. Matching of the transmitter and transponder sweeps permits the determination of the number of cycles which have elapsed in the ground transmitter during the signal transit time. An 8 mc sweep back up to the 256 mc if is used so that phase-lock is not lost although no measurement depend on this return sweep.



The KIN TEL Model 501 4-digit, over-ranging digital voltmeter measures DC from ± 0.0001 to ± 1000.0 volts with $0.01\% \pm 1$ digit (of reading) accuracy. An extra fifth digit in the left decade indicates "0" or "1" to provide ten times greater resolution at decade (1, 10, 100) voltage points than standard 4-digit voltmeters. Ranging and polarity indication are entirely automatic. The measured voltage, decimal point and polarity symbol are displayed on an in-line readout in a single plane—no superimposed outlines of "off" digits.

An adjustable sensitivity control permits decreasing sensitivity to allow measurement of noisy signals. Ten-line, parallel input printers can be driven directly, and converters are available for driving other types of printers, typewriters, and card or tape punches. The input may be floated up to 25 volts DC above or below chassis ground with no degradation in performance, and up to 250 volts DC with slight decrease in accuracy. Stepping-switch drive coils are energized with DC as in telephone-type service to provide long, trouble-free operation.

The 501 is one of a complete line of KIN TEL digital instruments. Others include AC converters, AC and DC preamplifiers, ratiometers, and multi-channel input scanners.

KIN TEL manufactures electronic instruments for measurement and control, and closed circuit TV Representatives in all major cities. Write for detailed literature or demonstration.

5725 Kearny Villa Road, San Diego 11, California, Phone: BRowning 7-6700

CIRCLE 5 ON READER-SERVICE CARD

IMPORTANT SPECIFICATIONS

Display... Six decades display 5 digits (Left digit "0" or "1" only), decimal point, polarity symbol. Ranging and polarity indication are automatic. Projection system readout employs bayonet-base lamps with 3000-hour minimum life rating. Readout contains no electronic circuitry and can be remotely mounted.

Automatic Ranges... ± 0.0001 to ± 1000.0 volts DC in four ranges: 0.0001 to 1.9999; 02.000 to 19.999; 020.00 to 199.99; 0200.0 to 1000.0

Accuracy... $0.01\% \pm 1$ digit (of reading).

Input Impedance... 10 megohms on all ranges at null.

Reference Voltage... Chopper-stabilized supply, continuously and automatically referenced to standard cell.

Stepping-Switch Drive... DC voltage within stepping-switch manufacturers rating applied by transistor drive circuit at rate of approximately 20 steps per second.

Controls... Three: on-off; sensitivity; and mode of operation (standby, normal, print auto, print remote).

Printer Drive... Built-in for parallel input printers. Automatic or remote.

Dimensions and Net Weights... Control unit: 45 lbs, 5 1/4" H x 19" W x 16" D. Readout: 10 lbs, 3 1/2" H x 19" W x 9" D.

Price: \$2995

KIN TEL
A DIVISION OF
COHU
ELECTRONICS, INC.

A PROVEN INSTRUMENT



PROVEN:

0.05% DC Accuracy

0.2% AC Accuracy



The Model 803 is the end result of more than six years of concentrated engineering effort in the Differential Voltmeter field. Excellent customer acceptance plus service records which reflect extreme reliability are evidence that this Voltmeter is truly a proven instrument.

FEATURES

**DIRECT IN-LINE READOUT
STANDARD CELL REFERENCE
AUTOMATIC LIGHTED DECIMAL**

DC

- Accuracy 0.05% of input voltage
- Four search ranges and four null sensitivities
- Infinite input resistance at null

AC

- Accuracy 0.2% of input voltage
- Converter frequency response 30 CPS to 5KC
- Measures RMS value of true sine wave

GENERAL SPECIFICATIONS

Voltage Ranges:	AC—5, 50, and 500V DC—0.5, 5, 50, and 500V
Accuracy:	AC—±0.2% from 0.5 to 500 VAC, 30 CPS to 5 KC DC—±0.05% from 0.1 to 500VDC ±0.1% or 50uv, whichever is greater, below 0.1V
Null Sensitivity Ranges:	AC—100V, 10V, 1V, 0.1V, and 0.01V DC—10V, 1V, 0.1V, and 0.01V
Max. Meter Resolution:	50uv
Input Impedance:	AC—1 Megohm, 25uufd DC—Infinite at null
Dimensions:	Cabinet—9¼"Wx13"Hx16"D Rack—19"Wx8¾"Hx17-5/16"D
Weight:	Cabinet—30 lbs., Rack—33 lbs.
Price:	Cabinet—\$875.00, Rack—\$895.00

MODEL 80A VOLT BOXES

Model No.	Division Ratio	Maximum Input	Total Resistance	Price
80A-1	2:1	1 KV	1 Megohm	\$ 60.00
80A-2	4:1	2 KV	2 Megohms	\$ 70.00
80A-3	6:1	3 KV	3 Megohms	\$ 80.00
80A-4	8:1	4 KV	4 Megohms	\$ 90.00
80A-5	10:1	5 KV	5 Megohms	\$100.00
80A-6	2:1	1 KV	10 Megohms	\$120.00

The jf 800 series differential voltmeters may be used to measure DC voltages in excess of 500 volts by utilizing an appropriate voltage divider (Volt Box). The division ratio of all models is accurate to 0.01% and long term stability is better than 0.01% per year. The approximate magnitude and the polarity of the unknown high voltage may be easily observed with the newly incorporated center zero panel meter.

Prices and technical data subject to change without notice.

JOHN FLUKE MANUFACTURING CO., INC.

P. O. BOX 7161
SEATTLE 33, WASHINGTON



CIRCLE 6 ON READER-SERVICE CARD

NEWS

Mistram

(continued from page 5)

Use of a high modulating frequency means that only a small portion of the range measurement is provided by the difficult phase measurement on the last cycle.

The second important feature of the GE system is the development of equipment to provide an electrical baseline for use in making interferometer measurements.

In past systems of this type it has been difficult to get an accurate measurement of transit time differences between two receiving stations. Propagation anomalies in the atmosphere introduce a spurious phase shift into a signal which is sent from one station to another for phase comparison. Since these anomalies vary with temperature, pressure, and other conditions it is difficult to make proper corrections for them. In the past temperature controlled waveguide has been used for this interstation transmission, with precalculated corrections made for propagation anomalies. Small variations in the length of this path, caused by equipment expansion with temperature, shifting of the ground, or other factors sometimes caused serious errors.

In the planned GE system the phase shift error introduced by propagation anomalies will actually be electrically determined at the time of interstation transmission. A phase stabilization technique developed by Dr. Lewis J. Neelands, specialist, systems development engineering in GE's Defense Systems Dept., is credited with making this electrical baseline feasible.

The possibility of such an electrical correction has been known theoretically for some time, according to Dr. Neelands, however it has been difficult to instrument the theory. According to this theory if two signals of different phase, $\cos(\omega t + \alpha)$ and $\cos(\omega t + \beta)$ for example, are received at separate stations and it is desired to measure the phase difference between them, $\alpha - \beta$, then each of the signals can be transmitted to the opposite station. Since both signals travel over the same path the propagation anomalies introduce a phase shift Δ into each of them. At one of the stations the phase angle difference between $\cos(\omega t + \alpha)$ and $\cos(\omega t + \beta + \Delta)$ is $(\alpha - \beta - \Delta)$. At the other station the phase difference between $\cos(\omega t + \beta)$ and $\cos(\omega t + \alpha + \Delta)$ is $(\beta - \alpha - \Delta)$.

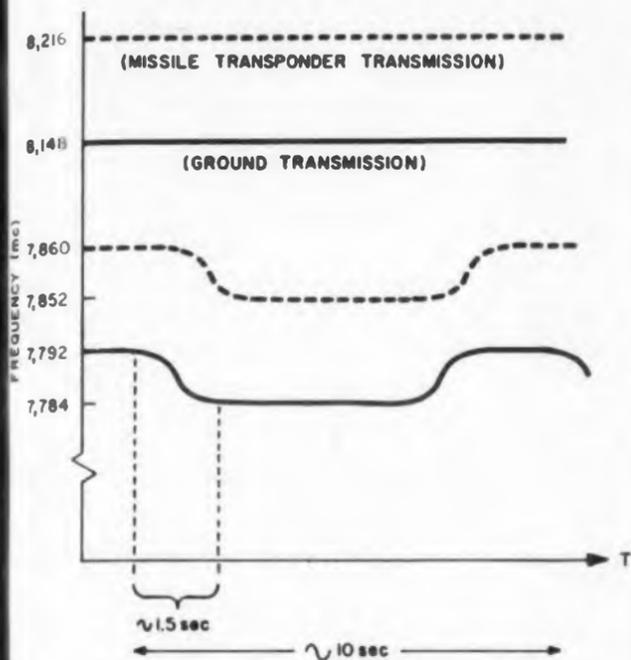
Since these measurements give discrete values they can be subtracted and divided by two:

$$(\alpha - \beta - \Delta) - (\beta - \alpha - \Delta)/2 = (\alpha - \beta)$$

A variation on this technique for cancelling the Δ factor will be used in the GE system, according to Dr. Neelands. The signal received at the central station will be sent out to each outlying re-

ELECTRONIC DESIGN • August 3, 1960

8,216
8,148
7,860
7,852
7,792
7,784
Ground
a transp
offset. Be
a 256 mc
sec inter
offset in
sweep b
signal tra
8 mc up
the syste
ceiving
station d
all phase
quired t
that onl
points.
form of
foot base
is plann
Since
Mistram
be requ
will be s
differenc
antenna
outlying
sile trac
The s
erage fo
and acc
Range
missile
Neeland
with mir
Accura
is critica
and Geo
of 1/4 in
receivers
the grou
source o
curacy o
minimize
ELECTR



Ground transmitter frequencies are returned by a transponder on the missile with a continuous 68-mc offset. Beating the high and low carriers together gives a 256 mc if which is swept down to 264 mc over a 1.5-sec interval. The sweep returned from the missile is offset in time from the ground transmitter frequency sweep by a few milliseconds—corresponding to the signal transit time. No measurements are made on the 8 mc upsweep, used to maintain phase-lock throughout the system.

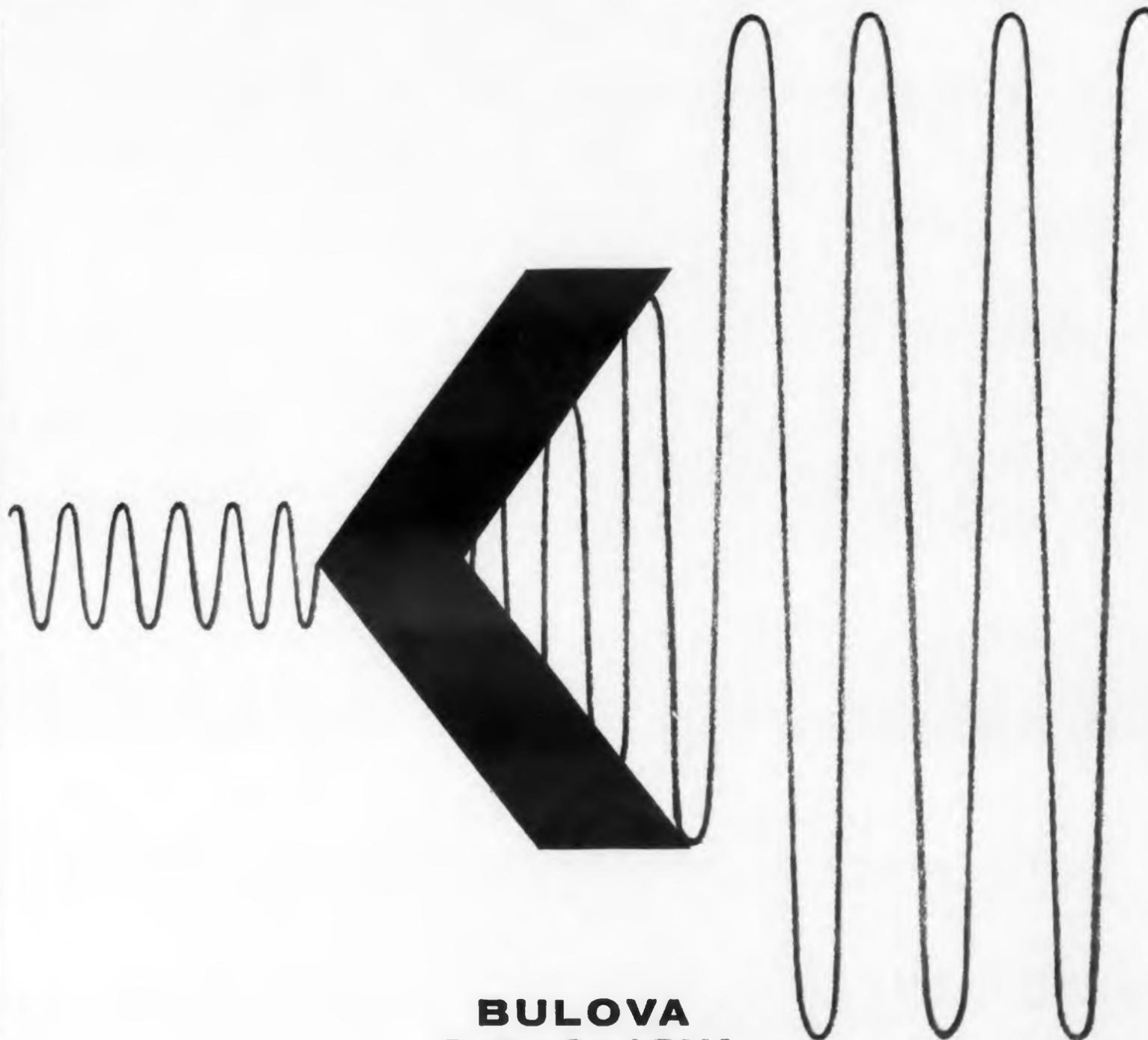
ceiving station and back again, with all computation done at the central station. This permits all phase measurements and other calculations required to be performed at the central station, so that only receivers must be located at outlying points. To minimize propagation effects some form of waveguide will still be used for the 10,000 foot baseline, Dr. Neelands explained. An air link is planned for the 100,000 foot baseline.

Since no angular measurements are involved in Mistram high precision tracking antennas will not be required. Standard radar tracking antennas will be sufficient to get accurate range and range difference measurements. An auxiliary tracking antenna will be used to guide the central and outlying stations to the proper position for missile tracking.

The system will be designed to provide coverage for 1,000 miles at velocities of 50,000 ft/sec and accelerations up to 750 ft/sec².

Range of the system is essentially limited to missile transponder power, according to Dr. Neelands, so that space tracking uses are feasible with minor additions to the equipment.

Accuracy of positioning of the receiving stations is critical in accuracy of the system. The Coast and Geodetic Survey expects to attain accuracies of 1/4 in. in surveying for the 10,000 foot baseline receivers, according to a GE spokesman. Shift of the ground under receiver locations may prove a source of some error. The inherently greater accuracy of a longer baseline system is expected to minimize this source of error. ■ ■



BULOVA 3.5, 6, 12W SERVO AMPLIFIERS



In addition to their "greater-than" conversions at high temperatures, the new Bulova Servo Amplifiers promise maximum flexibility in systems design with a minimum of ounces and inches.

The all-silicon transistors potted in these amplifiers assure continuous operation from -50°C. to +125°C. and provide maximum wattage output per unit volume and weight. Under varied unit suited to your needs and budget. For additional data write and severe environmental and operating conditions, Bulova Department 1671, Bulova Electronics, Woodside 77, New York.

Servo Amplifiers exhibit outstanding performance, portray the following characteristics: shock and vibration resistance, thermal and electrical stability.

If your requirement for a 3.5, 6 or 12w servo amplifier is a little more sophisticated, a bit more demanding than the average, take it to Bulova. There's a stock

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MODEL B-5-A



This unit features an electronic pulse delay that can be set to zero or is continuously variable from .030 microseconds to 500 microseconds in five ranges. Pulse width is continuously variable from .02 to 12.5 microseconds in four ranges.

SPECIFICATIONS: **Amplitude:** 40 volts positive, 45 volts negative • **Attenuator:** 60 db in 1/2 steps • **Polarity:** Both positive and negative pulses simultaneously available • **Output Impedance:** 185 ohms • **Output Decay Constant:** 750 microseconds when terminated in 185 ohms • **Synchronizing Pulse Out:** 10 volts, positive • **Rise Time:** Less than .02 microsecond • **Width:** .03 microsecond • **External Trigger:** Pulse required: 10 volts minimum with rise time less than .05 microsecond • **Pulse Repetition Rate:** Continuously variable from 1 cycle/sec to 10 mc/sec in seven ranges • **Delay:** A fixed delay of .1 microsecond occurs between the synchronizing pulse out and the main pulse.
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CIRCLE 8 ON READER-SERVICE CARD

NEWS

Photoelectric Oscilloscope Tracer Developed

A PHOTOELECTRIC device to follow a trace on an oscilloscope face, providing signals suitable for operating a recorder, has been developed by Elcon Laboratory, Inc., Cambridge, Mass.

The device, known as a Scopograph, is expected to find applications where photography is now used to record signals at too high a frequency to be traced by a recorder. Since Elcon is a research organization without manufacturing facilities, production of the Scopograph will not begin until licensing or other arrangements have been completed, according to Dr. Edwin Langberg, president.

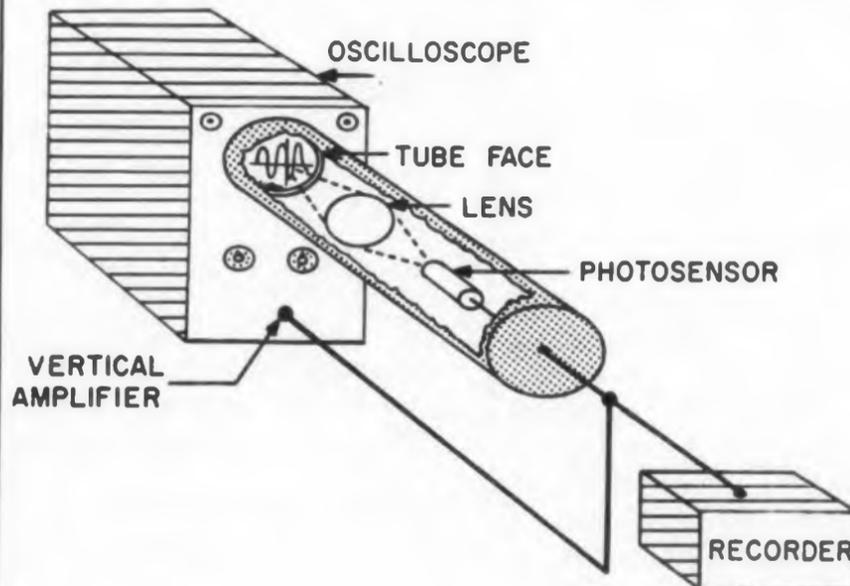
The Scopograph is a small electronic package which can be fitted over the face of an oscilloscope, sealing out ambient light. A photo-

detector is directed at the center of the scope face. This detector is designed so that it can sense whether the trace on the CRT face is above or below the center point.

In operation a trace to be recorded is first synchronized on the scope face, and then the Scopograph is fitted over the face and a plug-in connection is made to the oscilloscope.

A small ramp bias voltage is summed with the horizontal sweep voltage, so that the trace moves slowly across the scope face. The speed of motion can be synchronized with paper or tape recorder speed if desired.

A slowly varying dc bias voltage is added to the vertical amplifier to continuously position the trace at the center point of the oscilloscope



Artist's representation of an operating Scopograph shows how error signals generated by the photo-detector bids the vertical amplifier of the oscilloscope, continuously moving the trace to the center-point of the scope face. The bias signals required, proportional to the amplitude of the trace, drive the recorder. Not shown is a small ramp summed with the sweep voltage so the trace moves slowly across the scope face.

face. This bias voltage is supplied by the photosensor as an error signal with polarity depending on whether the trace starts to move above or below the center point.

The magnitude of the photodetector signal thus provides a continuous measurement of the amplitude of the oscilloscope trace.

When sharp rises in a curve must be measured, the horizontal sweep bias can be reduced to slow up horizontal motion and provide more accurate amplitude measurements.

Electromechanical System for Transients

An electromechanical model of the Scopograph has been designed for use with either repetitive or transient signals.

Storage on the tube face is required for this system. A high persistence crt is sufficient for simple waveforms but complex waves require a storage tube.

The photodetector in this second model is carried by a moving carriage. As the carriage moves horizontally across the face of the tube the photodetector moves vertically to follow the trace.

The carriage can be linked directly to an ink tracer, or potentiometers can generate signals proportional to trace amplitude. Output signals might be fed to a digital encoder to feed magnetic or punched tape or punched cards.

Another system providing direct digital output for use in a computer is also being developed by Elcon, according to Dr. Langberg.

This system will be capable of following photographs or other visual presentations as well as oscilloscope traces, providing a direct digital output. It should be capable of supplying x vs y values for about 100 data points per sec, and should be useful for transients of very short duration.

Similar experiments with short set-up times will probably be the major application for this latter system. Analyzing bubble or cloud chamber data, or nuclear reaction information, are some possible uses, Dr. Langberg feels. ■ ■

CIRCLE 9 ON READER-SERVICE CARD

Philco
announces
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MICRO-ENERGY SWITCH

the industry's first
LOW ENERGY, HIGH SPEED
switching transistor

T-1930 . . . MICRO-ENERGY SWITCH . . . TO-18 CASE

MAXIMUM RATINGS

Storage Temperature 100° C
Total Device Dissipation at 25° C . . 35 mw

CHARACTERISTICS

	MIN.	TYP.	MAX.
DC Current Amplification Factor, h_{FE} ($V_{CE} = -0.20$ v, $I_C = -2$ ma)	25	40	
Collector Voltage, V_{CE} ($I_C = -2$ ma, $I_B = -0.2$ ma)		.095	.13 V
Gain-bandwidth Product, f_T ($V_{CE} = 1$ v, $I_C = 1$ ma)	125	175	mc/s

The Philco T-1930 is a new concept in the design of switching transistors for high speed computer logic circuits! All internal device capacities are exceedingly small . . . and its static characteristics are optimized for operation at low collector voltages and collector currents. *It permits the design of high-speed logic circuits with an overall power consumption only 1/3rd to 1/10th that of circuits with conventional transistors. It will operate at pulse rates in excess of 10 mc with collector currents as small as 1 ma from collector supply voltages as small as 1 V.*

This new micro-energy switch is of great importance in the design of ultra-reliable, high density, high speed equipment. In micro-energy circuits, the total device dissipation is reduced to an absolute minimum . . . 250 microwatts . . . a prime consideration in achieving maximum reliability. The T-1930 is an important step toward microminiaturization . . . permitting high packing densities without excessive internal heat generation. For complete information write Dept. ED-81760.

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* At CW noise is more than 100 db below carrier in any 100 channel wide than 1 kHz centered from the carrier.

Varian is delivering many high-power low-noise CW klystrons for CW radar and illuminators; eight types are unclassified and are listed below. A 20 kilowatt X band type, soon to be added, will be another extension of the state-of-the-art by Varian.

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May we send full specifications or discuss development of special types for your requirements?



CURRENTLY AVAILABLE	C BAND	X BAND
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2 kW	VA-804, VA-805	VA-856, VA-848, VA-851
5 kW	VA-846	VA-823
UNDER DEVELOPMENT		
20 kW		VA-849

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CIRCLE 10 ON READER-SERVICE CARD

News

Space *(continued from page 4)*

private microwave user groups opposed the re-allocation request. The present allocations in the 1 to 10 kmc region already give 1.77 kmc to common carrier and operational fixed services, they said. Where is the additional 2 or more kmc now requested by the telephone companies going to come from, queried Samuel G. Lutz, senior staff scientist, Hughes Aircraft Co. Research Laboratories.

The answer, according to Mr. Lutz and several other industry speakers, will have to be sharing of frequency between ground and space users.

Mr. Lutz and others presented many possible engineering considerations which could permit such interference-free sharing to be accomplished. He recommended that stationary active satellites be chosen for communication and TV links.

Possible interference with the satellite receiver by horizontal transmission on the ground would only be a problem around a narrow band of the earth, and if care was taken interference could be avoided. Fewer earth terminals and satellites would be required with this system in comparison to random low-orbit active repeater satellites, and continuous service would be assured.

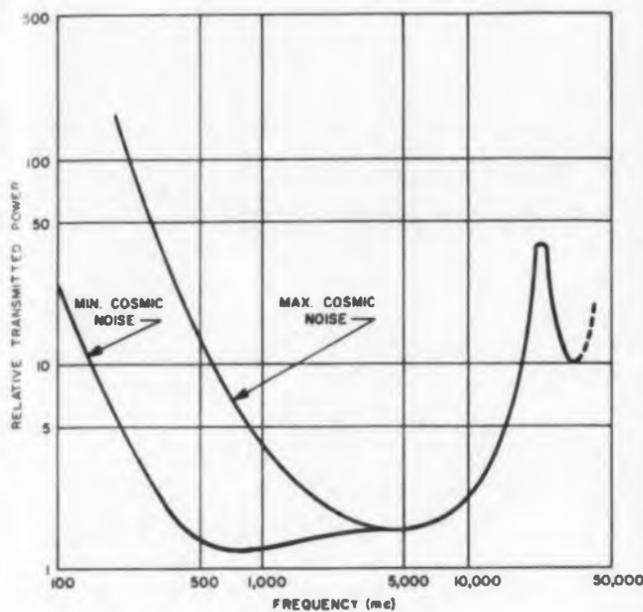
Recommends Isolated Station Sites

Another consideration pointed out by William L. Firestone, director of engineering, Communications Div., Motorola, Inc., is that isolated sites rather than near-city locations would probably be best for non-interference reasons. A passing airplane, for example, might cut off or disturb communications such as TV reception is presently affected by aircraft.

The interference problem which does exist was illustrated by a Project Echo incident related by John R. Pierce, director of research, communications principles for Bell Telephone Laboratories.

Nine receivers of the New Jersey Turnpike Authority operate in the 953-960 mc band, with a receiver at New Brunswick, 15 miles from the Crawford Hill Project Echo site, operating at 959.7 mc with nominal 0.5-mc band. The Echo transmitter operates at 960.05 mc, which theoretically should have been compatible. If more than 3 kw was transmitted in any direction, however, the New Brunswick receiver was knocked out.

To cooperate with the Echo work, the Turnpike operators switched the New Brunswick transmitter and two others in the area down to 953 mc. Then it was found that interference at New Brunswick could be considered negligible.



Plot of relative radiated power of a transmitter in space required to produce a received signal having a fixed proportion to thermal ground-receiver noise. A no-noise receiver is assumed with a fixed-area antenna looking 10 deg above the horizon. A window of frequencies between about 500 and 20,000 mc, is apparent. The lower end is limited by cosmic noise, and the higher end by atmospheric attenuation. Power requirements are absolute, so that even new developments can not extend the window very much because of the steep slopes at each end.

The EIA cited this example as an indication of how interference problems could be worked out in the future. Common carrier spokesmen, however, indicated that with the expected growth of overseas use of telephone, TV, data, and other transmission, the interference problems would become too severe.

Even more specific in its demands for new allocations, Radio Corp. of America and RCA Communications, Inc. asked for four 50-mc bands between 1,000-2,300 mc; four 100-mc bands between 2,300-3,500 mc; four 200-mc bands between 3,500-6,575 mc; and four 300-mc bands between 6,575-10,000 mc, just for record communications usage. Other specific channels should be allocated for point-to-point TV transmission, RCA said.

Because of heavy assignments already made to the government and such important services as radio navigational aids in the 1-10 kmc region, the FCC faces thorny problems in attempting re-allocation. The technical complications of the filings with the Commission further complicate the decision. Because of the important public considerations, however, a decision will probably be reached soon according to an FCC spokesman. ■ ■



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(see above photo)

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Logipak series includes:

1100Z1	Inverter	2100Z5	Delay
1100Z2	Diode	3100Z1	Clock
1100Z3	Complementary Trigger	3100Z2	Pulse Generator
2100Z1	Flip-Flop	3100Z3	Pulse Amplifier
2100Z2	Trigger Network	3100Z4	Indicator Driver
2100Z4	Shift Register Flip-Flop		

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LOGILINE* CIRCUITRY

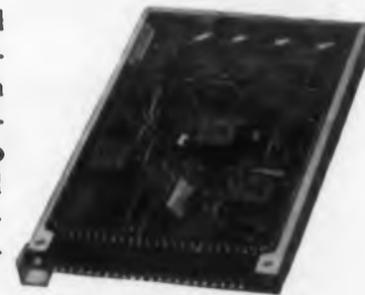
for digital system design

LOGILINE circuitry features a series of 5 mc/s transistor switching circuits in building block form. Basically a pulse-level system, LOGILINE circuitry performs all of the digital functions required by computer designers, including combinational logic, temporary storage, pulse source, and pulse amplification.

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LOGICARD* wiring board cards

• Epoxy glass etched wiring board and twenty-two pin connector in aluminum frame • Designed for insertion into pre-wired rack mounted panel • Completely interchangeable with comparable units.



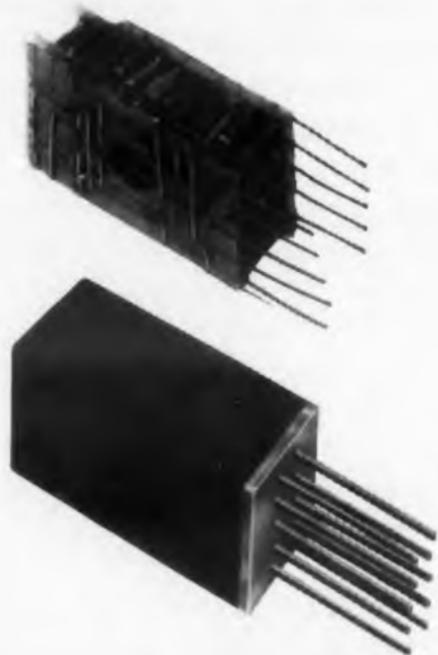
Logicard series includes:

1000Z1	Inverter	2000Z4	3-Digit Shift Register
1000Z2	Diode	3000Z1	Clock
2000Z1	Flip-Flop	3000Z2	Pulse Amplifier
2000Z2	Dual Flip-Flop	3000Z3	Pulse Generator
2000Z3	Delay	3000Z4	Indicator Driver

SPRAGUE®

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CIRCLE 11 ON READER-SERVICE CARD



how do you play the numbers game?

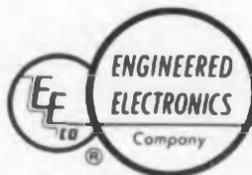
The current numbers game consists of seeing how many components you can wedge into a small space. But there's a catch to it.

Some circuit modules may seem small until you string them together and find that interconnections and supporting structure take more space than the modules themselves. That's why it's important, in evaluating miniaturization, not to consider the module size alone, but to be concerned with the over-all size, including module, interconnections, and supporting structure.

New EECO MINIWELD circuit modules are designed with over-all system size in mind. They offer optimum miniaturization not only of modules, but also of interconnections and supporting structure. Add to this the reliability of proven circuits incorporating readily available standard catalog components rather than hard-to-get specials, the superior strength of welded rather than soldered connections, and you have an unbeatable combination of advantages.

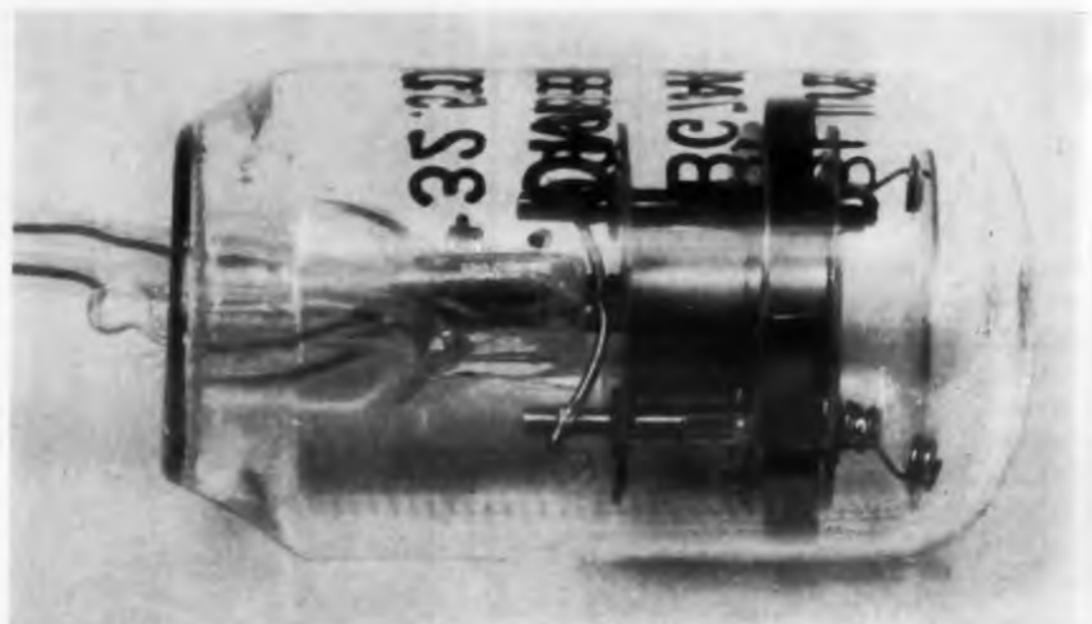
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Rugged 3-mc quartz crystal produced by Bliley Electric Co., Erie, Pa., for Transit satellite. Crystal is designed for minimum temperature coefficient.

NEWS

Shipboard Success Speeds Transit Project

PRECISION navigation results currently being obtained from the orbiting Transit II-A satellite aboard a Navy experimental ship are speeding the Transit system toward operational status.

The planned doppler navigation system, set for 1962, will consist of four satellites. Design aim for the system is 1/10-mile accuracy, considered necessary for precision positioning of Polaris-firing submarines. This accuracy will require a full computer system on shipboard, consisting of a dual frequency receiver, a mixer which can apply ionospheric refractive corrections, a digitizer and a computer.

Regular Navy vessels will probably use a simpler version of this system, which takes into account first order errors, but skips corrections for second or higher order errors. The electronics required for this system would be comparable in complexity to a home TV receiver, according to a system designer at Johns Hopkins University's Applied Research Laboratory, Baltimore. ARL is designing the system for the Navy.

This shipboard installation might consist of a dual frequency receiver and a

mixer which applies an ionospheric refraction correction, along with some form of readout. Navy sources indicate that the exact configuration of this simpler navigation system is still being debated. The navigator would calculate his position from equipment data using a Weems-type circular calculator or some other manual technique.

A key point in achieving accuracy with either system is the ionospheric refraction correction. Some estimates of the effect of this error on doppler measurements place navigational inaccuracies at tens of miles. Corrections planned for this effect are based on the assumption that doppler shift ionospheric refraction errors are dependent on the inverse square, and higher powers, of the frequency.

Confirmation of this theory is being provided by the present Transit II-A, which is transmitting at four frequencies — 54, 162, 216, and 324 for doppler measurements. Pulse width modulation telemetry is being provided on a separate 108 mc carrier.

Design of stable oscillator circuits is a major requirement in this experiment,



This Dewar flask is used to maintain a stable temperature for the stable oscillators in the Transit program. The quartz crystal is mounted in the flask, and the oscillator circuitry is mounted on a circular plastic board fitted inside the top of the flask.

as it will be in the operational system. Thermal stability is the key to packaging of the 3-mc AT cut quartz crystals and the oscillator circuitry in double Dewar flasks (*ED*, April 27, p 14).

Requirements set up for the stable oscillator designed for Transit were short term stability of 1 part in 10^8 for any 30-min period during the life of the satellite, and long term stability of 25 parts in 16^8 for three months. Tests indicated that the circuits designed considerably exceeded these goals under the most extreme environments expected.

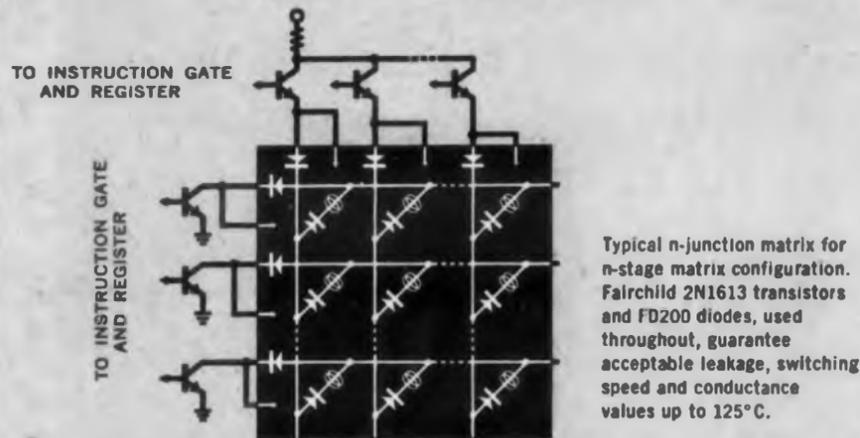
A Colpitts-type circuit using a transistor has been used. The crystal is operated in a fundamental mode at series resonance in the feedback loop between the emitter and the tank circuit. Low phase slope of the transistor at 3 mc contributes to the frequency stability.

A silicon diode is used across the tank circuit to limit crystal drive level and thereby help stabilize the frequency against power supply fluctuations. Base voltage is held constant by a two-stage avalanche diode regulator.

The oscillator is isolated from the following stages by a resistor. A common emitter amplifier following the buffer resistor raises the output voltage to a usable level. Gain control is provided by a variable emitter degeneration resistor. Drive level at the input to frequency multipliers is kept constant by an emitter-follower output stage.

Two frequency multipliers apply doublers and triplers to the 3-mc stable oscillator outputs to provide the proper frequencies to two power amplifiers. Multiplier circuitry is mounted on a plastic board which is potted in plastic foam for vibration resistance. ■ ■

NEW



Typical n-junction matrix for n-stage matrix configuration. Fairchild 2N1613 transistors and FD200 diodes, used throughout, guarantee acceptable leakage, switching speed and conduction values up to 125°C.

ANSWER

TO COMPUTER MATRIX PROBLEMS

LOW LEAKAGE TRANSISTORS AND FAST RECOVERY, LOW CAPACITANCE DIODES FROM FAIRCHILD

Approach to the ideal matrix. 2N1613 silicon transistors and FD200 silicon diodes from Fairchild are unique in making feasible the ideal matrix. They give you low leakage and low capacitance with high conduction and high speed, even at high ambient temperatures. These characteristics are combined only in Fairchild Planar devices. With them you can now largely ignore stray leakage or capacitance build-up across the matrix. Temperature effects and long-term performance decay are no longer critical. You can eliminate complex circuitry previously necessary in designing around these losses.

Fairchild's Planar structure for transistors and diodes features the industry's most advanced diffusion and surface passivation techniques. Current leakage is reduced to 10 μA maximum (2N1613) and 0.1 μA maximum (FD200) at 25°C. Maximum values at 150°C are 10 μA and 100 μA .

Surface passivation also prevents significant degeneration of parameters during circuit life which could introduce error or failure in the matrix. This technique also lends itself to precisely controlled manufacture, assuring excellent product uniformity.

2N1613 ELECTRICAL CHARACTERISTICS (25°C except as noted)

Symbol	Characteristic	Min.	Typical	Max.	Test Conditions
h_{FE}	D.C. Current Gain	40		120	$I_C = 150 \text{ mA}$ $V_{CE} = 10 \text{ V}$
$V_{BE(sat)}$	Base Saturation Voltage			1.3V	$I_C = 150 \text{ mA}$ $I_B = 15 \text{ mA}$
$V_{CE(sat)}$	Collector Saturation Voltage			1.5V	$I_C = 150 \text{ mA}$ $I_B = 15 \text{ mA}$
C_{ob}	Collector Capacitance	18		25 μf	$I_E = 0$ $V_{CB} = 10 \text{ V}$
I_{CBO}	Collector Cutoff Current	0.8 μA 1.0 μA		10 μA 10 μA	$V_{CB} = 60$ $T = 25^\circ\text{C}$ $V_{CB} = 60$ $T = 150^\circ\text{C}$

FD200 ELECTRICAL SPECIFICATIONS (25°C except as noted)

Symbol	Characteristic	Min.	Typical	Max.	Test Conditions
V_F	Forward Voltage			1.0V	$I_F = 100 \text{ mA}$
I_R	Reverse Current			0.1 μA	$V_R = -150 \text{ V}$
I_R	Reverse Current (150°C)			100 μA	$V_R = -150 \text{ V}$
B_V	Breakdown Voltage	200 V			$I_R = 100 \mu\text{A}$
t_{rr}	Reverse Recovery Time			50.0 μsec	$I_F = 30 \text{ mA}$ $R_L = 150 \Omega$ $I_F = 30 \text{ mA}$
C_D	Capacitance			5.0 μf	$V_R = 0 \text{ V}$ $f = 1 \text{ mc}$
RE	Rectification Efficiency	35%			100 mc
	Forward Voltage Temperature Coefficient		-1.8 mV/oC		



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CIRCLE 12 ON READER-SERVICE CARD

Optical Maser Research Programs Nearing Success

*Development Speeded on Crystal, Gas and Semiconductor Types;
Hughes Laser Announcement Stirs Industry, Triggers Controversy*

Manfred W. Meisels

Assistant Editor

AFTER long and patient laboratory development, optical and infrared masers may soon evolve to the point of useful application in system and equipment design. An indication of things to come is the recent Hughes Laboratories' announcement of a successful ruby laser. Spurred by this news, many organizations are stepping up

the pace of their work in this field. Other groups are dusting off old plans and planning an active role in laser and iraser development.

Industry and government planners are meanwhile establishing design requirements for space communications, light radar and weapons systems predicated on the successful development of lasers and irasers. Such applications are suggested by the highly coherent and extremely nar-

row, intense beams to be radiated by these devices.

Crystalline solids, gases, and semiconductors in almost bewildering variety are being investigated for application in lasers and irasers. Oscillators and amplifiers at power levels ranging from milliwatts to thousands of watts are in the works and each class of material will undoubtedly find its proper niche in this array of devices.

Principal Laser and Iraser Research Programs

Organization	Maser Type	Frequency Generated	Maser Characteristics
Hughes Research Laboratories, Malibu, Calif.	Ruby: Pumped by pulsed mercury arc. Output due to energy decay from R level to ground level.	Red (6,943A)	Inherently high output power. Output band width and coherence require considerable improvement. Interferometer resonator being designed to eliminate unwanted oscillation modes. Traveling-wave type considered feasible. Operates at room temperature, but much narrower band widths possible at liquid nitrogen temperature. CW operation difficult.
*Technical Research Group, Syosset, N.Y.	Ruby: Pumped by continuous mercury arc. Output due to energy decay to satellite level.	Red (7,009A)	Operates at cryogenic temperatures. Considerably lower power output than Hughes laser. CW operation believed possible.
	Krypton-mercury vapor: Pumped by self discharge.	Infrared (6 microns)	Intermediate power output (several watts). CW operation possible.
	Cesium vapor: Pumped by continuous helium arc.	Infrared (7 microns)	Low power output (milliwatts). Alkali vapors attack maser cell. CW operation possible.
Bell Telephone Laboratories, Murray Hill, N.J.	Ruby: Pumped by continuous mercury arc. Output due to energy decay to satellite level.	Red (7,009A)	Operates at cryogenic temperatures. Considerably lower power output than Hughes laser. CW operation believed possible.
	Helium-neon mixture: Pumped by self discharge.	Infrared (1 micron)	Energy transfer from helium to neon by collisions. CW operation possible.
*Columbia University, New York City.	Cesium vapor: Pumped by continuous helium arc.	Infrared (7 microns)	Low power output (milliwatts). Alkali vapors attack maser cell. CW operation possible.
	Potassium vapor: Pumped by continuous mercury arc.	Infrared (3.14 microns)	Characteristics and problems similar to those of cesium vapor iraser.
American Optical Co., Southbridge, Mass.	Helium-neon mixture in hollow glass filaments: Pumped by self discharge.	Infrared (1 micron)	Filaments act as mode selectors to reduce incoherent oscillations. Many filaments can be paralleled to increase power output. Feasibility study now in progress.
	Inert gases in hollow glass filaments: Mercury arc pumping.	Infrared	Above comments on helium-neon filament iraser apply here.
R.C.A. (David Sarnoff Research Center), Princeton, N.J.	Ruby: Output due to energy decay to ground level.	Red (6,943A)	Device would be similar to Hughes laser. Feasibility study now in progress. Development proposal submitted to Air Force.
General Electric Co. (Electronic Laboratories), Syracuse, N.Y.	Ruby: Xenon arc pumping: Output due to energy decay between R levels.	Far Infrared	Operates at cryogenic temperatures. Feasibility study now in progress.
Varian Associates, Palo Alto, Calif.	Ruby: Pumped by pulsed mercury arc. Output due to energy decay from R levels to ground level.	Red (6,943A)	Comments on Hughes laser apply here.
*M.I.T. (Lincoln Laboratories), Lexington, Mass.	Thin germanium sheet sandwiches: Pumped by mercury arc. Output due to energy decay to deep valence level in germanium.	Infrared (10 microns)	Operates at cryogenic temperatures and in intense magnetic field. Coherent operation results from cyclotron resonance principle. CW operation believed possible. Believed tuneable over two octaves from infrared to millimeter range.
*I.T.T. Laboratories, Nutley, N.J.	Silicon-indium antimonide Junction: Non-optical pumping method employed.	Infrared	Coherent operation results from spin resonance principle. CW operation believed possible.
	Cesium vapor: Pumped by continuous helium arc.	Infrared (7 microns)	Previous comments on cesium vapor irasers apply here.

*Research in lasers and irasers supported by Air Force

Wide Variety of Optical Masers Predicted

"I foresee a complete family of optical and infrared masers, each designed for a particular application, power level and frequency," is the prediction of Dr. Arthur L. Schawlow of the Bell Telephone Laboratories who, together with Dr. Charles H. Townes of Columbia University, first suggested the development of optical masers.

The use of ruby in a laser, proposed by Dr. Schawlow and others has been demonstrated by Dr. Theodore H. Maiman of the Hughes Research Laboratories, Malibu, Calif., but in a manner unlike that envisioned by most scientists. The Schawlow proposal suggested the use of the so-called "satellite" line in ruby. In this approach, chromium ions in the ruby crystal are pumped to a higher energy level by optical excitation. They

Other Maser Types Under Study

Solids other than ruby under study but not disclosed.

Solid chlorides doped with rare earths also being studied.

Lanthanum chloride crystals doped with samarium or europium. Other rare earth chlorides. Other gases, mixtures and vapors.

None reported.

Crystals capable of being grown in micron-size filaments. Ruby not feasible as minimum possible diam. is 200 microns.

Various gases and alkali vapors reportedly under study.

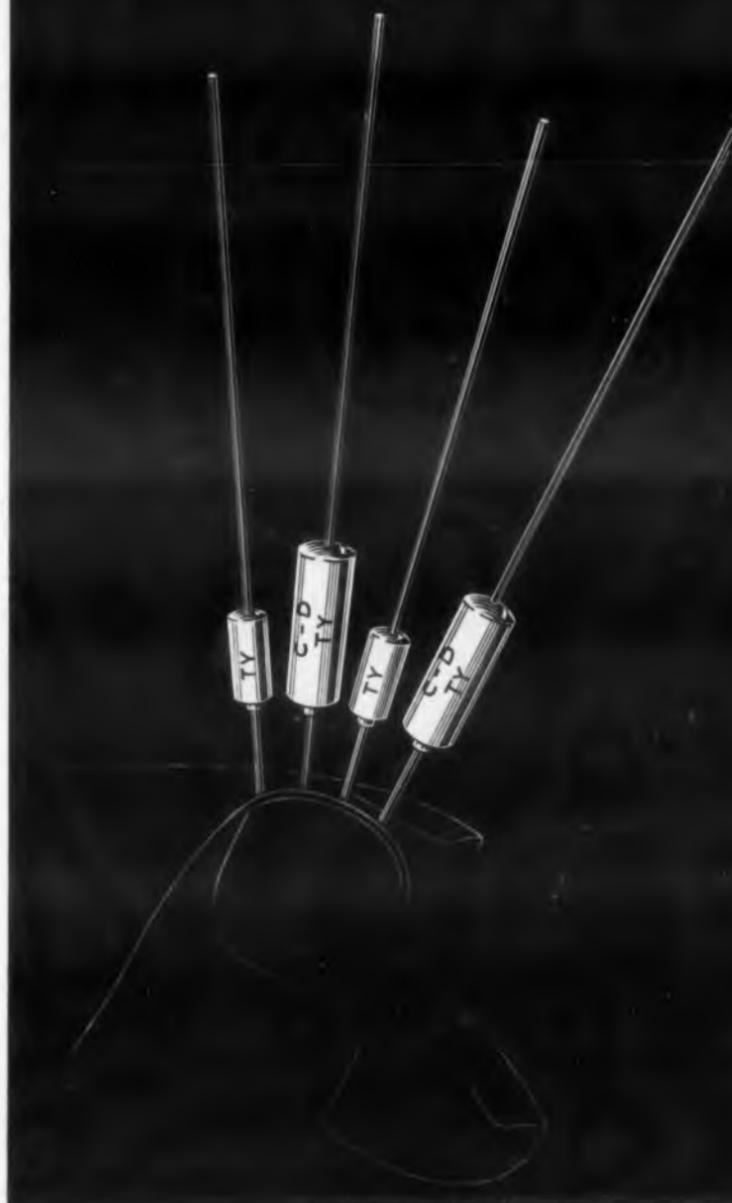
Alkali halide crystals under study. Gases, vapors and mixtures also being investigated.

None reported.

None reported.

None reported.

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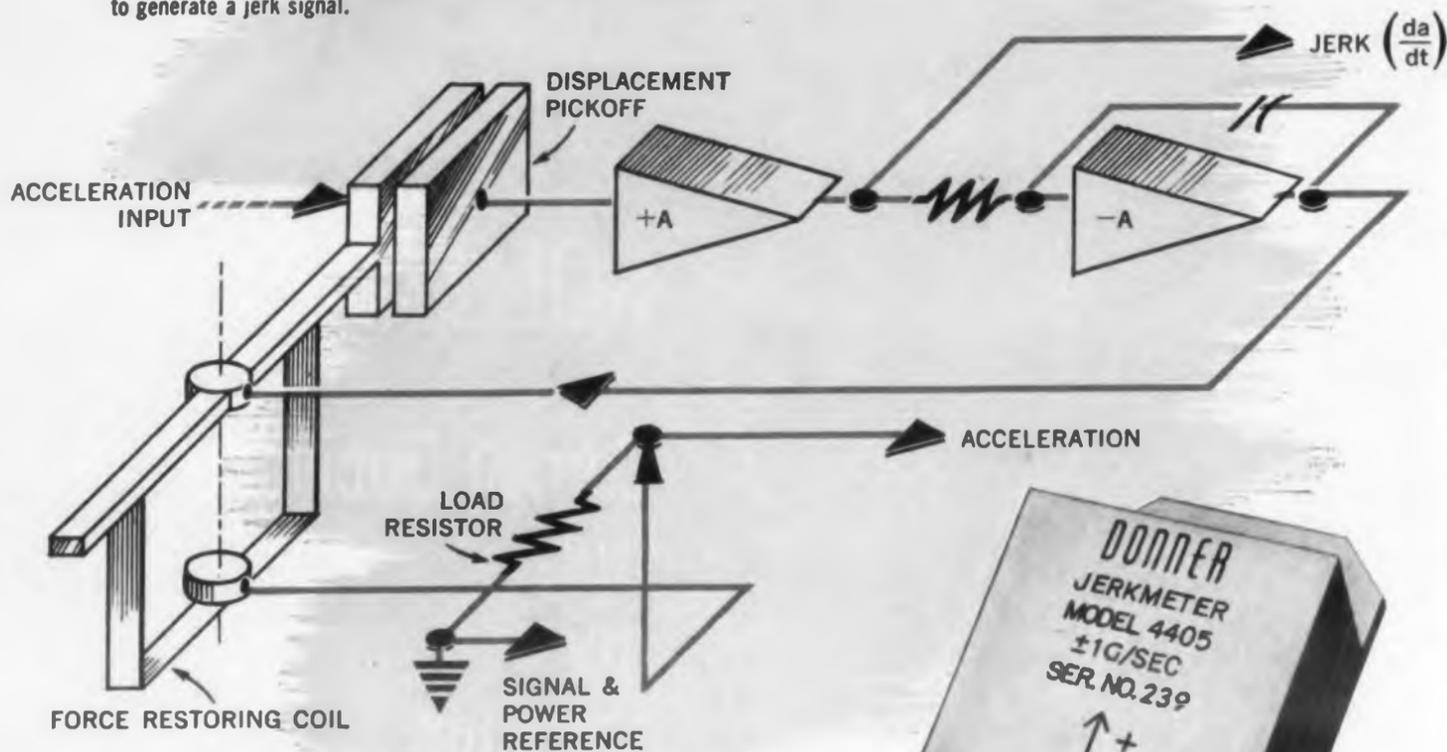


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● Functional diagram of Donner Linear Jerkmeter. This unique instrument operates as a subminiature servo-system of the force-balance type which is responsive to jerk along the sensitivity axis of the linear unit and about the sensitive axis of the angular unit. Basically, the system consists of a transistorized accelerometer with an integrator inserted into the servo-loop to generate a jerk signal.



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instigate compensatory control forces or other actions. An acceleration analog output voltage is also available.

Typically, a jerkmeter installed in a jet aircraft will provide an instantaneous output proportional to the rate of change of g's. This signal can be used to predict impending disaster conditions.

Other applications include use wherever constant acceleration is required. Here, the Donner jerkmeter provides a "velocity-damping" term. The jerkmeter also provides a third order term for stabilizing displacement devices. It can also be used as an inertial indicator of first motion.

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Acceleration: ± 1 g full range to ± 30 g full range
Jerk: ± 0.5 g/sec full range to ± 20 g/sec full range

OUTPUT FULL SCALE

Accelerometer: ± 7.5 v dc
Jerk: ± 7.5 v dc

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LINEARITY

0.1% full scale or better

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NEWS



Laser operation is described by Dr. Theodore H. Maiman at the New York announcement of the Hughes Laboratories device. Chart illustrates coherent oscillation of chromium ions in a fluorescent ruby crystal achievable by placing crystal in an interferometer.

then emit 7009 Å red light by dropping into a lower energy level normally empty at liquid helium temperatures. Pumping power is reasonably

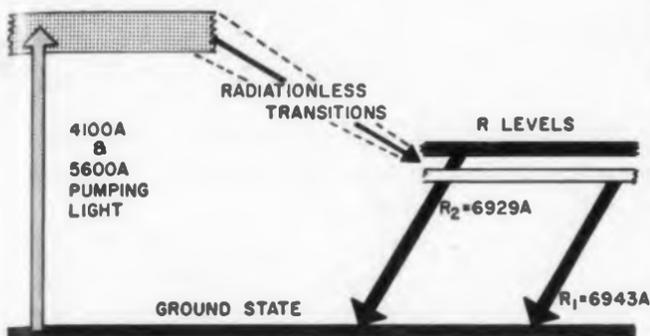
Systems Designers Preparing to Use Lasers in Space Radio and Weapons

Serious consideration is already being given to the design of weapons and communications systems employing optical and infrared masers. When these devices finally emerge from the laboratory, hardware design for their utilization will likely be well along.

Technical Research Group, for one, is performing in-house and government-supported studies on "High-energy radiation weapons" employing lasers.

According to TRG president Lawrence Goldmuntz, two proposals submitted along these lines have been "well received" by Defense Dept. officials. An intense, high energy light beam could conceivably be employed as an anti-ICBM weapon. Government efforts to classify company-supported laser work and the security restrictions applied to government-sponsored work in this field indicate serious military consideration of "death rays."

In communications, General Electric (Ithaca) is studying design requirements and performance of tight-beam space communications systems on a theoretical level. A 1-mw cw laser system would have a range of 61,000 nautical miles, according to GE studies. This is based on a 2-cm diam beam, receiver sensitivity of 10^{-12} w, and signal to noise ratio of 4 to 1 at the receiver. Laser amplifiers designed on paper do not, however, meet the sensitivity requirement, and GE believes that photomultipliers may have to be used at the receiving end of the system.



Energy levels involved in the natural red fluorescence of ruby. Pumping light excites chromium ions to higher energy bands as shown for 5600 A (green) and 4100 A (blue) light. Ions then pass from both bands to R levels via radiationless transitions, and return to ground level by emitting 6929 A and 6943 A red light. By brute force optical pumping of the ruby with a 10 megawatt mercury lamp, Dr. Maiman claims to have inverted the normal chromium ion population between the R and ground levels thereby inducing stimulated rather than natural fluorescence of the ruby.

low as the level into which the chromium ions drop is not densely populated. Bell Laboratories and Technical Research Group, Syosset, N. Y., are among those attempting to develop a laser utilizing this principle.

Hughes Laser Requires Intense Pumping

Dr. Maiman, however, obtained laser action by employing the "main" fluorescence line of ruby, where chromium ions radiate 6929 A and 6943 A red light by dropping from a higher energy state directly to the ground energy level. This is considerably more difficult, as the ground level must first be depopulated by highly intense optical pumping. The present Hughes device is limited to pulsed operation at about 60 sec. intervals primarily because of the intense heat generated by the discharge lamp used for pumping. During the one msec/operating interval, however, output is 10 kw.

Present operation is at room temperature and coherence is rather poor; operation at liquid nitrogen temperatures should improve coherence by a factor of about 25, and a further improvement of several orders of magnitude will be obtained by mounting the ruby in an interferometer resonator of appropriate design.

Ruby Laser Believed Possible

Another approach to the use of ruby is being developed by Dr. Gunter Wessel at the General Electric Electronics Laboratory in Syracuse. Dr. Wessel hopes to generate infrared radiation through chromium ion transitions from the $2\bar{A}$ to the $2\bar{E}$ energy levels. These are the levels from which energy transitions to the ground level generate red light in the Hughes laser. Dr. Wessel calculates that energy transition between these levels will emit far infrared radiation. Operation at liquid helium temperatures is required.

(continued on page 18)

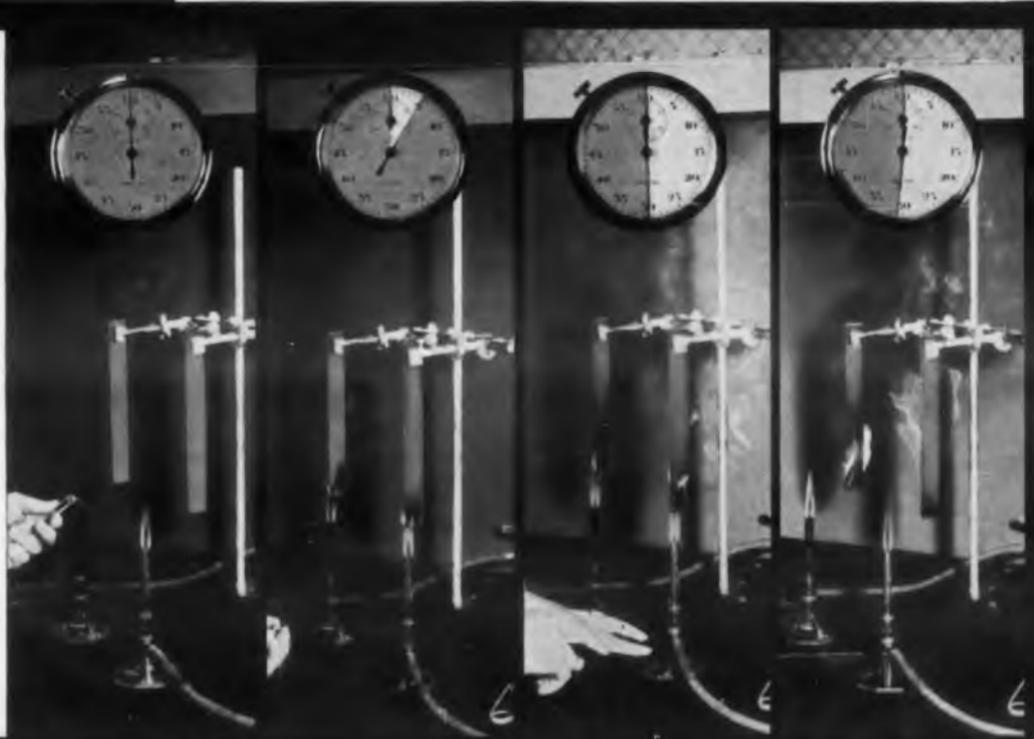


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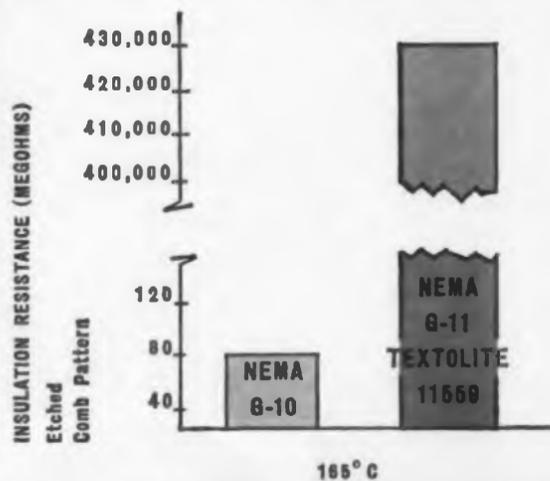
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Actual flame test of a non self-extinguishing glass-epoxy laminate and Textolite G-11 (11559) glass-epoxy laminate. Less than two seconds after removal of burners, flame on 11559 dies, the other glass-epoxy laminate continues to burn.

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For more information on 11559, consult Sweet's Product Design File, Cat 2b/Gen., or write: Laminated Products Department, Section ED-80, General Electric Company, Coshocton, Ohio.



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Participation in military projects and special work with prime contractors is a strong point at Crosby-Teletronics. Shown here is a facsimile memory storage recorder developed as part of the AIRCOM Project Quick-Fix.

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Ground testing plays a great part in the nation's missile development, and Crosby-Teletronics is playing its part with a full line of test equipment. Shown here is a telemetering test oscillator (model TO-258) which has become a standard in many U. S. missile programs.

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and diversity transmission and reception equipment is a forte of Crosby-Teletronics. Extensive research in long range communications has made the company the foremost name in this area. Shown here is a single sideband signal generator—model SG-262.

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Fax Storage Recorder



Model TO-258



Model SG-262



NEWS

Gas devices, while of inherently lower power than solids, are reportedly close to development by a number of research groups.

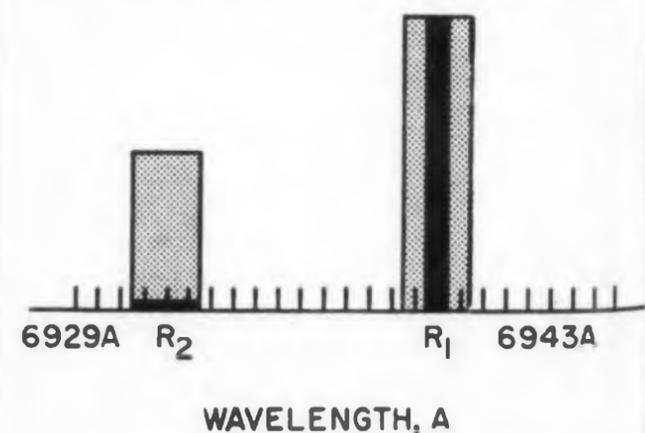
Cesium vapor experiments are in progress at Columbia University, ITT Laboratories, TRG, Martin-Denver, Laboratory for Electronics, Boston, and American Optical Co. Pumping is by a helium lamp, whose spectrum contains a 3888 Å line capable of exciting cesium atoms to a higher energy level. The decay of these atoms to a lower level emits 7-micron infrared radiation. A similar scheme using potassium vapor excited by a mer-

**"If he has what he thinks he has,
he most certainly has a laser,"**

... is the comment of a pioneer in maser development to Dr. Maiman's claim of a successful laser. All workers in the field agree that Dr. Maiman has performed a remarkable experiment—one that many of them had not even considered possible, but there is some controversy as to whether the success of this experiment warrants the announcement of an operating device.

Through the development of an extremely high-intensity light source (10 megawatts), Dr. Maiman was able to invert the chromium ion population in ruby between the ground and metastable R levels. As a result, he has reduced the time of fluorescence from its natural exponential decay curve to a sharp pulse. Also, the natural fluorescence, instead of being distributed within two bands, is concentrated into one comparatively narrow band covering only 1 Å.

Scientists object that the band width must be further narrowed by several orders of magnitude before the Hughes device can be considered as a truly coherent light source. This involves the de-



High intensity optical pumping of ruby results in concentrated fluorescence at 6943 Å (black bars). Dotted areas show natural fluorescence spectrum of ruby.

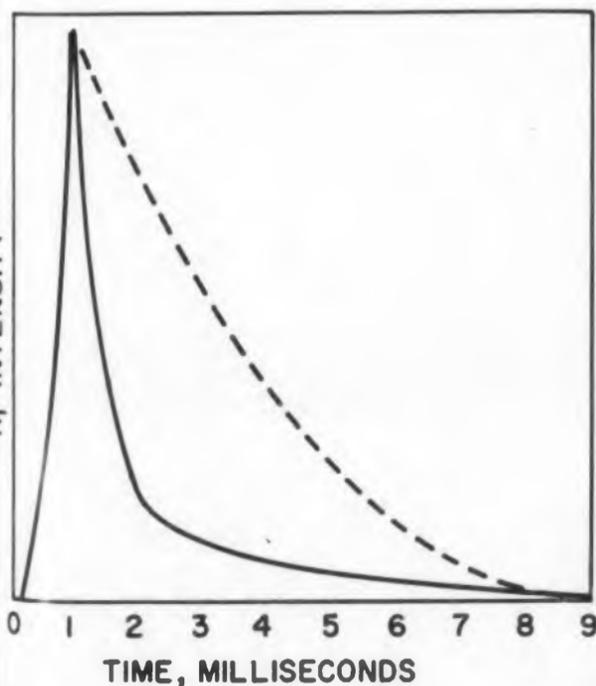
cury arc and emitting 3-micron radiation is also in development at Columbia. Both methods suffer from the corrosive effect of the alkali gases upon their containers.

Gas irasers can also be pumped by self discharge which is more efficient than external pumping. A gaseous mixture is employed. One gas provides the discharge path and the other operates as the iraser. Examples include a krypton-mercury device at TRG and a helium-neon unit at Bell Laboratories. In the Bell iraser, collisions between the helium and neon atoms provide the mechanism by which the neon atoms are excited to a suitable state.

At the American Optical Co., Southbridge,

sign of a suitable interferometer cavity which will reject non-coherent modes of oscillation. Dr. Maiman is now working on this problem and is confident of early success. Others point out however, that the interferometer mirrors must be plane and parallel to less than a wave length of light and that optical inhomogenities in the ruby present another difficult problem.

In one method to be tried at Hughes, the ruby will be immersed in a liquid of high refractive index. This will reduce internal reflections in the ruby which propagate some of the non-coherent modes and cool the laser so as to permit continuous operation and minimize thermally-induced distortion of the interferometer mirrors. Dr. Maiman also suggests that other approaches to obtaining coherent operation are being studied, but is reluctant to describe them at this time.



Natural fluorescence time in ruby is reduced from exponential decay curve to sharp peak.

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Hughes laser shown without housing consists of ruby cylinder surrounded by high intensity mercury discharge lamp. Interferometer necessary for operation can be achieved by mirroring ends of the cylinder or by mirroring the end plates of the laser housing.

Mass., Dr. Elias Snitzer is studying gas irasers consisting of extremely thin optical waveguides. A hollow, 4-micron thin glass filament coated with several microns of higher index of refraction glass is used. This may prove to be a more efficient mode selector than the larger cylinders used elsewhere. Self discharge pumped and externally pumped types are both in development. Solid filaments are also a possibility. Ruby crystals of the required fineness cannot be grown, but other materials may prove useable.

Two Approaches to a Semiconductor Irlaser

Semiconductors are also in the running for iraser materials. At the Lincoln Laboratories, Lexington, Mass., Dr. Benjamin Lax is experimenting with thin germanium sheet sandwiches, separated by dielectric layers which combine to form an interferometer. Electrons in the germanium are pumped by a mercury arc from a deep valence band to the normal conducting band. Electrons drop from an intermediate energy level into the deep valence band emitting infrared radiation in the process. The device requires cryogenic temperatures and an extremely intense magnetic field. Germanium sheets 1 cm square and 10 microns thick would be stacked in a 10-layer sandwich.

At ITT laboratories, an iraser employing silicon-indium antimonide junctions is reportedly in advanced development. The device does not employ optical pumping and will operate cw at relatively low power. ■ ■

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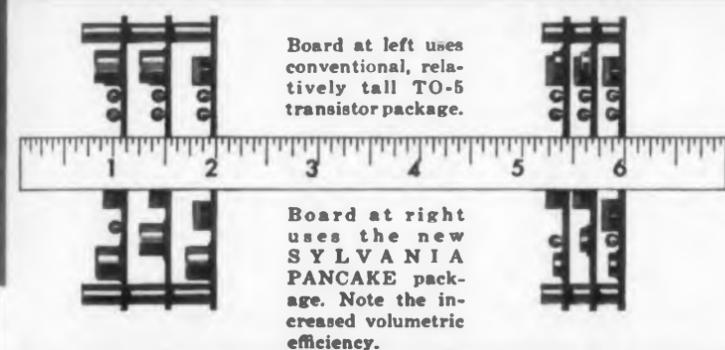
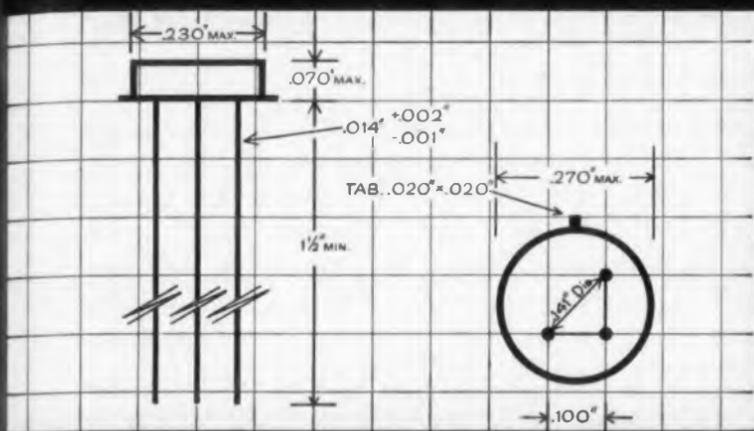
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SYL-1986 and SYL-1987 shown actual size*





Tentative data

MAXIMUM RATINGS AT 25°C	SYL-1986	SYL-1987
Collector to Base Voltage	-25V	25V
Collector Current	100mA	200mA
Power Dissipation	100mW	100mW
Temperature Range	-55°C to +100°C	-55°C to +100°C
Alpha Cutoff Frequency (min.)*	4Mc	5Mc

* $(V_{cb} = 6V, I_e = 1.0mA)$ ($V_{cc} = 6V, I_c = 1.0mA$)

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School Audio-Visual Methods Under Study by SMPTE

Plans for a conference devoted to the evaluation and suitability of audio-visual equipment and devices for educational needs are under way.

A \$24,000 contract, awarded to the Society of Motion Picture and Television Engineers by the U. S. Office of Education, will also cover the formulation of engineering principles that will serve as guideposts in the development of audio-visual devices for use in education.

The two-year study contract, granted under the National Defense Education Act of 1958, will allow for the latest advances in engineering techniques to be made available immediately to both the designers and the users of educational communications media and equipment.

The group will include educators thoroughly familiar with the problems of methods, materials, media, curricula, building facilities, teacher training, and administration. Engineers having the required competency and engineering background to make evaluations and significant recommendations will also participate. They will cover such areas as motion pictures, TV, filmstrips, slides and transparencies, recordings, teaching devices and machines, graphics, and textbook publishing.

The study will be conducted under the direction of John Flory of Eastman Kodak Co. of Rochester, N. Y.

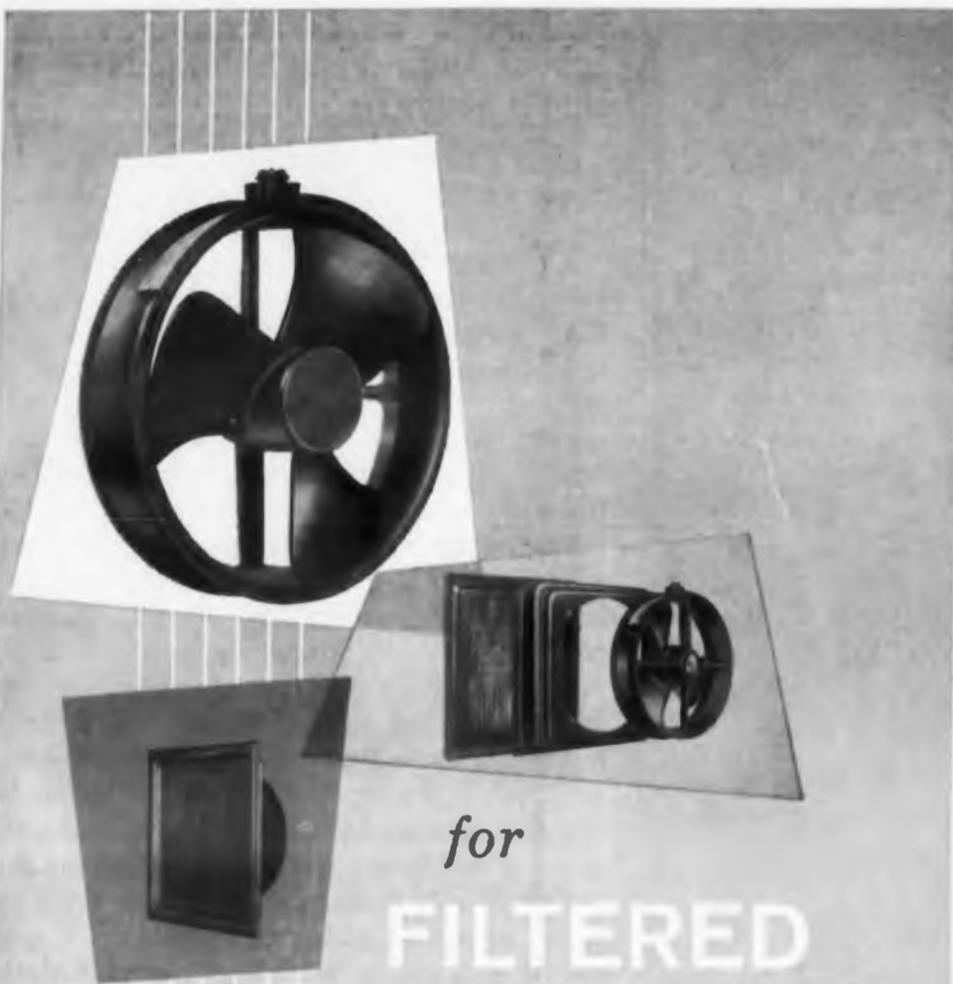
Rocket-Relay Transmission System Being Developed by Air Force

Project Tattle-Tale, an Air Force program to develop an emergency long-range communications system based on rocket-relayed transmissions, is proceeding with limited success at Wright Air Development Div., Dayton, Ohio, and at Eglin AFB, Fla.

In its initial form, the system makes use of an Aerobee-300 rocket to carry aloft a transmitter and a tape deck that contains a prerecorded message. The 100-w transmitter, which operates in one of the regular Air Force uhf telemetry bands, transmits the message over a line-of-sight path for the duration of the rocket's flight, about 800 sec, according to the Air Research and Development Command.

Eventually, the ARDC designers hope to install a receiver in the rocket so that true relay operation would be possible.

Experimental shoots have established that the rocket-borne equipment has to be modified to withstand higher-than-expected temperatures. The equipment is also being redesigned to resist the high-g stresses of the 800-sec flights. So far the system has not been made to work.



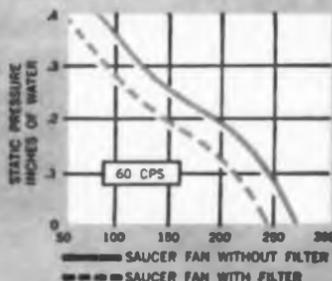
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WASHINGTON REPORT



Ephraim Kahn

ELECTRONICS RELIABILITY requires "radical improvements" for military adequacy, reports a joint industry-military study group that has been working on improving reliability checks. The advisers suggest that development of electronic parts specifications be centralized, that new levels of parts failure rates be set, and that all specifications be brought up to design demand for current uses. Reliability should be monitored during production, though tests would be made by the manufacturers themselves "under the surveillance of the appropriate government inspection service." In order to minimize the test load in establishing failure rates, the number of types and styles of standard reliable parts would be reduced "to a considerably greater degree than is currently true of military standards."

PAYOFFS FROM BASIC RESEARCH for the Air Force have been handsome, states Brig. Gen. B. G. Holzman, chief of its Research Division. Indications are that practical applications will be many; Gen. Holzman thinks that "there is no conceivable discovery of natural law that would not be of interest to the Air Force." Work is going on, for example, on a new concept in computers which may lead "not only to really practical computers but also to such distinctly Air Force purposes as new, automatic guidance and control systems for missiles and spacecraft." The Air Force will support research projects which hold promise of a payoff. "In many cases the decision as to whether a given project is basic or applied research is an arbitrary one," says Gen. Holzman, observing that it is best policy "not to worry about a line which is so indistinct."

COMPETING BIDS BY AFFILIATES will be allowed on government contracts in certain circumstances. The General Accounting Office has dropped its long-standing ban on such submissions, which in the past has been carried to the extreme of denying an award to a low bidder simply because another bid was made by a related firm. Taking into account the proliferation of affiliated companies, the Accounting Office observes that each may well be answering a separate invitation, and that the two may well be unaware of each others participation. From now on, contracting officers are supposed to turn down such bids automatically only if there is reason to think, "it was resorted to for the purpose of circumventing the requirements of a statute . . . ; where an unfair advantage may be gained in cases of an award through the drawing of lots; or in any other instance where multiple bidding is prejudicial either to the United States or to other bidders."

OCEANOGRAPHIC RESEARCH should be stepped up four-fold, states the House Committee on Science and Astronautics. Taking issue with the Navy's performance in this field, the group asserted that "the Navy, until recently, has not pursued a broad program in oceanography, despite its relevance to the Navy's antisubmarine mission, and this has been true even though the Navy now is the largest single supporter of such research. To remove the disparity between the current level of effort and the needs for national security, federal management of an oceanographic program is necessary. This should include identification of goals, budgeting of funds for a balanced research program embracing both military and peaceful studies; and carrying out the program "by both in-house and contract research."

BESETTING PROBLEMS IN R&D for the military deal with needless "layers of decision making" and the large number of reviews given to each project and proposal, according to Dr. Herbert F. York, Director of Defense Research and Engineering. His comments, made after a private 3-day meeting of the Defense Department's R&D managers, indicated that "a climate for progress" was created, though the problems themselves were not solved.

DESIGN STANDARDS and requirements levels for the weapons checkout systems that may be in use as much as 15 years in the future are being studied under Air Research and Development Command contracts. By and large, the studies will cover the electronic (and other) devices which tell whether an aircraft or missile is ready to fly, with all components functioning. One objective of the studies will be to come up with design data that can be used to help standardize and integrate systems components in the interests of efficiency and economy.

PATENT POLICIES of the Treasury Department have been sharply scored by the Senate Subcommittee on Patents, Trademarks and Copyrights. The group's chairman, retiring Sen. Joseph C. O'Mahoney (D., Wyo.), says its inquiries clearly illustrate "the need for legislative standards to cover all research and development expenditures." As the Subcommittee sees it, "when an agency's patent policy is not controlled by legislative standards it may even expend government tax monies for research and development without retaining proprietary rights for the government. Such contractual action grants to the favored contractor all inventions developed as a result of the contract. This gives him a legal monopoly controlling use of the inventions in the commercial market and a claim against the government if they are used for governmental purposes."

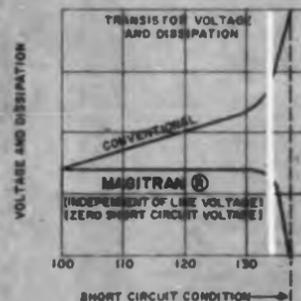
NAVAL AVIONICS FACILITY at Indianapolis should be retained as an active unit, according to an advisory group of businessmen who checked seven Navy weapons plants. It urged that three be dropped or consolidated. The Avionics Facility drew approval as the Navy's only wholly-owned plant for high-precision avionic equipment. In addition, its foreseeable workload will enable it to be operated on an economic basis.

NEW

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Typical Transpac illustrated. Dust cover removed to show accessibility of components.



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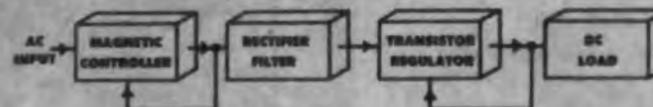
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The new *Transpac* Miniaturized Power Packs utilize ERA's exclusive Magitran principle which combines the properties of a special magnetic controller with the fast response characteristics and advantages of the transistor regulator. Pre-regulation and line transient protection is achieved by the magnetic controller. This controller is also designed in a manner so as to provide zero output in the event excessive current flows due to overload or short in the external circuit. The transistor regulator accommodates all fast line or load variations and provides for ripple reduction.

Combines The Advantages Of Transistor and Magnetic Regulators



STANDARD MODELS

Input 105-125 VAC, 60 or 400 cps. Input regulation better than $\pm 0.05\%$. Load regulation better than 0.05%. Ripple less than 0.01% RMS. Variable voltage types adjustable by means of external screwdriver adjustment.

MODEL NO.	VOLTAGE VDC	CURRENT MA	CASE SIZES (b)		NET PRICE (c)	
			60 CPS	400 CPS	60 CPS	400 CPS
TR150M	150	0-100	ME	ME	\$120	\$130
TR150MA	150-160	0-100	ME	ME	130	140
TR200M	200	0-100	MF	ME	130	140
TR200MA	200-210	0-100	MF	ME	140	150
TR250M	250	0-100	MG	MF	150	160
TR250MA	250-260	0-100	MG	MF	160	170
TR300M	300	0-100	MG	MF	155	165
TR300MA	300-310	0-100	MG	MF	165	175

(a) Nominal Voltage Specified Within 2%
 (b) 400 cps units designated by prefix "F" (ie, TR150MF, etc.)
 (c) Prices FOB Factory, Subject To Change Without Prior Notice

CASE SIZES (WxDxH) Inches Approx.
 ME — 3 1/2 x 3 1/2 x 6 1/2
 MF — 3 1/2 x 3 1/2 x 6 1/2
 MG — 4 x 4 1/2 x 6 1/2

Special or modified units supplied to customer's specifications. Also designs for commercial and military applications. Write for comments and quotations. ®Reg. U.S. Pat. Off.

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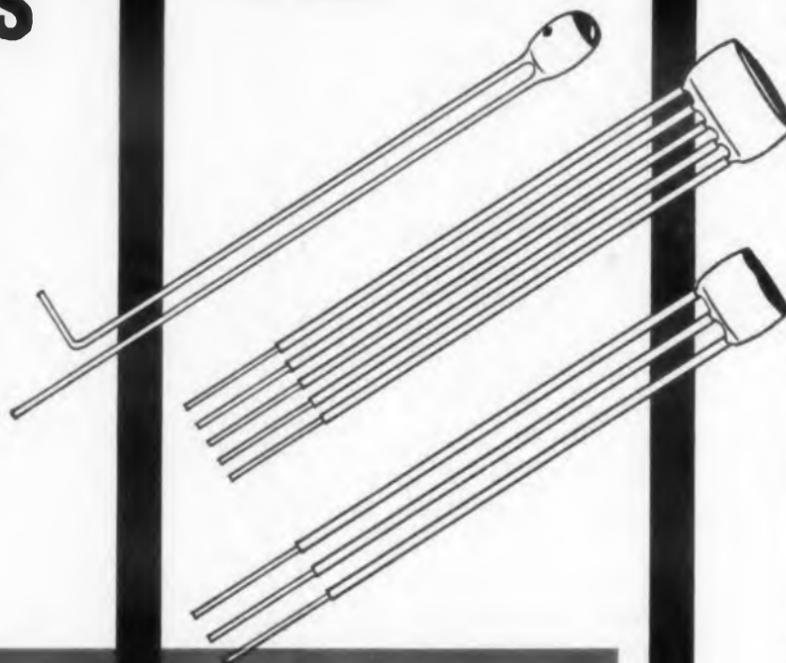
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for
reliability
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as low as
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which interest you. We simply
ask that you specify in your
request the application you
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course.

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NEWS

**Solderless Connectors Specified
In Many Devices at Huntsville**

Solderless connection methods, including crimp-type, poke-home, tapered, and other compression connectors are being specified in an increasingly larger share of ground-support and airborne equipment being designed at the Marshall Space Flight Center, Huntsville, Ala.

Relay sockets and pygmy connectors employed in Saturn ground-support equipment are almost entirely wired in with crimp-type connectors. Huntsville engineers are meanwhile stepping up a recently instituted test program to extend the use of solderless connectors to a larger share of the NASA ground and flight equipment being designed at the space center.

The technical groups headed by Dr. Wernher von Braun were accustomed to working with the soldered connections primarily used in German industry. Since being introduced to solderless connectors they have subjected them to a rigorous series of tests including vibration, pull-out humidity and corrosion, as well as cost analyses and time studies. Results have been favorable and specifications are being drafted to foster the trend away from soldered connectors. The Guidance and Control Laboratory, the Systems Support Electrical Laboratory, and the Fabrication Laboratory are among the Huntsville groups involved.

**CHANGES IN PRICES
AND AVAILABILITY**

TUNNEL DIODES have been drastically reduced in price by General Electric Semiconductor Div. of Syracuse, N.Y. Typical examples are as follows: gallium arsenide type 1N3118, previously priced at \$85 each, has been reduced to \$6; type 1N3120 has been decreased from \$55 to \$4.50.

MESA SWITCHING TRANSISTOR, type 2N1300, has been reduced 36 per cent in price by RCA's Semiconductor Products Div. of Somerville, N.J. The cut will drop the unit price of the 2N1300 from \$2.75 to \$1.76 in quantities of 100-999 and from \$2.50 to \$1.60 each, for lot purchases of 1,000 or more units.

TRANSISTORS have been reduced in price ranging from 13 per cent to 48 per cent by Philco Corp.'s Landsdale Div. of Landsdale, Pa. Price reductions chiefly affect silicon transistors, 16 types in all, and include a drop in price of the 2N1663 SADT from \$12.90 to \$8.50 in lots of 1,000.

NEWS BRIEFS . . .

HYPERPURE SILICON for electronic semiconductors will be manufactured by a new process at the E. I. du Pont de Nemour & Co.'s new facility in Newport, Del. The new process is based on the thermal decomposition of silane, a silicon hydride. Du Pont has exclusive rights to make the material in the U.S., Canada and the British Commonwealth. It has the right to sell in all world markets.

FIRST ALL-TRANSISTORIZED electronic data-processing center, a Radio Corporation of America project, is being used in Washington to serve both Government and business.

RECEIVING ANTENNA, 1,000 ft long, 500 ft wide, 250 ft high, was described to a German technical audience in Munich by its inventor, Boynton G. Hagaman of the Developmental Engineering Corp. of Washington, D.C. The Tapered Aperture Horn Antenna, reportedly the world's largest receiving antenna, is currently under service test at La Plata, Md. Evaluation is scheduled to be completed this month.

TV PLAYS IMPORTANT ROLE in medical education and research, a survey by the Council on Medical TV confirms. The Council looked into TV's use in 85 medical schools in the country. Nineteen schools are now employing TV for laboratory instruction and research and 15 plan installations within two years.

ENGINEERING SERVICES and operation analysis in support of a \$2-billion Post Office modernization program will be undertaken by Aerolab Development Co. of Pasadena, Calif., under an initial \$500,000 contract. Many other companies are participating in the nation-wide project.

UNDERGROUND LAUNCHING SYSTEM for Atlas ICBM will be designed and developed by American Machine and Foundry Co. of New York under a \$3,800,000 contract from the Convair Div. of General Dynamics Corp.

INERTIAL GUIDANCE SYSTEM, including ground operating equipment, will be designed and developed by AC Spark Plug of Milwaukee, Wis., under a \$84-million Air Force contract.

CERTIFICATE OF APPRECIATION for Patriotic Civilian Service has been presented to the City of Huntsville, Ala. The certificate honors the 70,000 residents for their support of Army activities and personnel from 1941 through 1960.

◀ CIRCLE 850 THRU 865 ON READER-SERVICE CARD
ELECTRONIC DESIGN • August 3, 1960



The Sanborn "650" is the first *complete* multi-channel high-speed optical recording system with medium gain general purpose amplification for each channel. Either the 8-channel amplifier or the recorder may be used separately. Together they provide a max. sensitivity of 2.5 *mv/in* and a frequency response of *DC to 5000 cps* (within 3 db at 4 in peak-to-peak) in a multi-channel "direct writing" system.

MODEL 658-3400 GENERAL PURPOSE AMPLIFIER. Here is the first sensitive multi-channel amplifier designed specifically for use with high frequency optical galvanometers — those in the Sanborn "650" and any similar recorder. The single chassis has 8 separate channels, each one complete from floating and guarded signal input to galvanometer output. They include front-end modulator and input transformer, medium gain carrier amplifier, demodulator, filter and driver amplifier. An internal pre-emphasis circuit increases galvanometer frequency range from 2000 cps to 5000 cps in the "650" recorder. The all transistorized circuitry is mounted on easily serviced printed plug-in cards. The Amplifier chassis has an output transfer chassis on the rear which simplifies coupling to optical recorders of other manufacturers. External damping resistors are easily added when required.

Specifications: Sensitivity: 7.2 *ma/mv* input, max. . . . Attenuation: X2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000 . . . Common Mode Performance: tolerance — 500 volts max; rejection — 140 db for DC . . . Input Resistance: 100,000 ohms all ranges floating and guarded.

MODEL 650 1- TO 24-CHANNEL OPTICAL RECORDER. The Model 650 Recorder provides high frequency direct writing recording, flexible housing and wide application possibilities. It may be used separately with from 1 to 24 plug-in type galvanometers of various natural frequencies. When used with the 658-3400 Amplifier, the recorder is equipped with eight 2000 cps galvanometers — extended to 5000 cps by the amplifier pre-emphasis circuit — for wide range, high speed, wide deflection recording. The recorder has nine electrically controlled (local or remote) chart speeds, beam interrupters for trace identification, timing lines at 0.01 or 0.1 sec intervals; amplitude lines with manual washout from 1/4, 1/2, 3/4 or all of the record; full chart width deflection for each trace and trace overlap.

Specifications: Input Sensitivity: 17.5 *ma/inch* (with 2000 cps galvanometers) . . . Chart Speeds: 0.25, 0.5, 1.0, 2.5, 5.0, 10, 25, 50 and 100 inches/second . . . Dimensions: 19" wide by 17 1/2" by 16 1/2" deep . . . Weight: approx. 120 lbs. (Data subject to change without notice)



= a new
0 to 5000 cps
direct writing
system

SANBORN "650" SERIES

Complete data is available from Sanborn Sales-Engineering Representatives located in principal cities throughout the United States, Canada and foreign countries.


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NEWS

WESCON 1960: The Big Show Takes on a New Look

*New Los Angeles Sports Arena to Welcome Engineers;
Tech. Sessions Geared to Workshop Meetings*

LOS ANGELES, the fastest-growing electronic area in the U.S., is again host city for WESCON—which this year has a “Soaring Sixties” theme. Hopefully, the industry (and the convention) will soar like the many missiles produced in the area.

With a brand-new showplace for its exhibits and pioneering treatment of its technical sessions and by-product activities, WESCON’s increase in quality is expected to keep pace with its increase in quantity.

More than 200 authors and panelists are scheduled to speak to an audience of about 35,000 engineers. One site, Los Angeles’ Memorial Sports Arena, just past its first birthday, will house 987 exhibit booths and 44 carefully planned technical sessions. At some previous WESCONs, the two activities were housed separately.

Headquarters hotel, the Ambassador, will serve as nucleus for other activities like the Distributor-Rep Conference, the All-Industry Cocktail Party, and other WESCON-related activities.

Technical Soup to Nuts

The technical program runs the gamut of the electronic art, including such heretofore fringe sessions as “What are the Communication Values of the Technical Symposium?” (Session 6), “Stereo-Multiplex Broadcasting” (Session 12), “Analysis of Man-Machine Systems” (Session 14), “Working with Engineers” (Session 19), and a special women’s session called “Engineering: The Woman’s Role.”

Chairman Richard G. Leitner and his Technical Program Committee have tried to balance the

proportion of theoretical, practical, management and marketing papers. The committee established session formats only after it had received and evaluated all technical papers. In this way sessions were matched to the quality and kind of material received. Session formats include panel discussions, debates, tutorial papers, workshop sessions and paper-plus-panel sessions. Although most sessions will be made up of contributed papers, seven sessions will be conducted by invited authors and panelists. These sessions are: “Stereo-Multiplexing Methods,” “Information Theory and Modulation Methods,” “Microminiaturization,” “Air Traffic Control” (two sessions), “Seeking a Logical Bio-Instrumentation System,” and a session on space sciences.

In session 3, new solutions are promised to some old problems in communications: Machi and Hoffman of System Development Corp. in Lodi, N.J., will describe the effect of link elimination in data-transmission systems; Sandia Corp.’s Paul Lux and the University of Washington’s Swarm and McNelis will talk about the optimum antenna pattern for a signal-burst communication system, and Elie Baghdady from MIT’s Research Laboratory of Electronics will present a linear-cancellation technique for suppressing impulse noise.

In the session on microminiaturization, Session 25, Motorola and Fairchild Semiconductor Corp. will present first-time papers on their microelectronics techniques. Motorola’s J. R. Black will talk about the “Design and Fabrication of a Microelectronic IF Amplifier;” and Kattner, Last and Nall, from Fairchild Semiconductor, will speak on Fairchild’s new “Solid-State Micrologic

Elements.” Fairchild’s element will be shown at the company’s booth.

Pacific Semiconductor’s T. C. Hall will report on PSI’s successful surface passivation of micro-components, the promising technique that enables the company to get along without sealing semiconductor microcomponents in a glass or metal container.

In the same session, J. Alegreti of Merck, Sharp & Dohme will discuss a new concept in microcircuitry—“Laminar Junction Structures.” Rheem Semiconductor’s G. P. Walker will present “Semiconductor Packaging for High Component Density Applications.”

“What has happened since the Pioneer V beep opened the IRE Show in New York?” (Session 29) will be a symposium on the Pioneer V experiments. Speakers C. Y. Fan, P. Meyer and J. A. Simpson from the University of Chicago will reveal preliminary results from the space probe Pioneer V, which made history by communicating from 23 million miles in space. Measurements of the geomagnetic and interplanetary magnetic fields by the space probe will be reported by Space Technology Labs’ Coleman, Judge, Smith, and Sonett. Radiation measurements made by Pioneer V will be listed and described by the University of Minnesota’s Arnoldy, Hoffman and Winckler; and J. D. McGuire, D. D. Morrison and L. Wong of STL will show how an astronomical unit is determined from the least square foot to the orbit of Pioneer V.

A promising session is the preplanned “Seeking a Logical Bio-Instrumentation System” panel discussion (Session 31). Four panelists will discuss:

"The Anesthetized Individual in a Normal Environment," J. B. Dillon, M.D., University of Calif.; "The Unhealthy, Conscious Individual in a Normal Environment," T. Freedman, M.D., North American Aviation; and "The Healthy, Conscious Individual in an Abnormal Environment," P. Meehan, M.D., University of Southern Calif. An apparent non-sequitur in the session is "Computers and Programming in a Bio-Instrumentation System" by Paul Tiffany of System Development Corp.

Workshops Keyed to Technical Sessions

Workshop sessions will be an unusual feature of WESCON this year. Keyed to four technical sessions, the 3-hour afternoon workshops will review the subjects that were discussed by the morning speakers. According to Technical Program Chairman Richard G. Leitner, inputs for the workshop discussions, which will be open to the audience, will be largely from written questions received during the morning sessions. The moderators will pick the most controversial questions for review.

Panelists in the workshop will not be the speakers during the technical session, but will be encouraged to attend the paper presentations during the morning.

The workshops and presiding moderators are "Management of Man-Machine Systems," R. L. Clark, Department of Defense; "Analysis of Man-Machine Systems," Lt. Col. Anthony Debbons, Rome Air Development Div.; "Synthesis and Design of Man-Machine Systems," D. T. McRuer, Systems Technology, Inc.; "Operation and Training of Man-Machine Systems," J. Lyman, UCLA.

Some controversies are anticipated during the sessions. One may be the working relationship between engineers and psychologists. Who should work for whom? Should the psychologist be a consultant or should a company building man-machine systems maintain an elaborate staff of psychologists in the organization? The issue of the systems management approach versus complete in-house capability may arise during the workshop on Management of Man-Machine Systems.

Panelists from the Department of Defense, Stromberg-Carlson Co., Radio Corp. of America, Space Technology Labs and Sylvania Electric Products, will discuss whether it is better to have a prime contractor and team members who are legally subcontractors but have participated in the proposal writing, or to maintain a complete in-house capability and subcontract out discreet portions of a system. Team bidding advocates insist that a better job can be done having a systems manager who knows the field and can form a team of small specialists. In-house proponents maintain that better control of the project is pos-

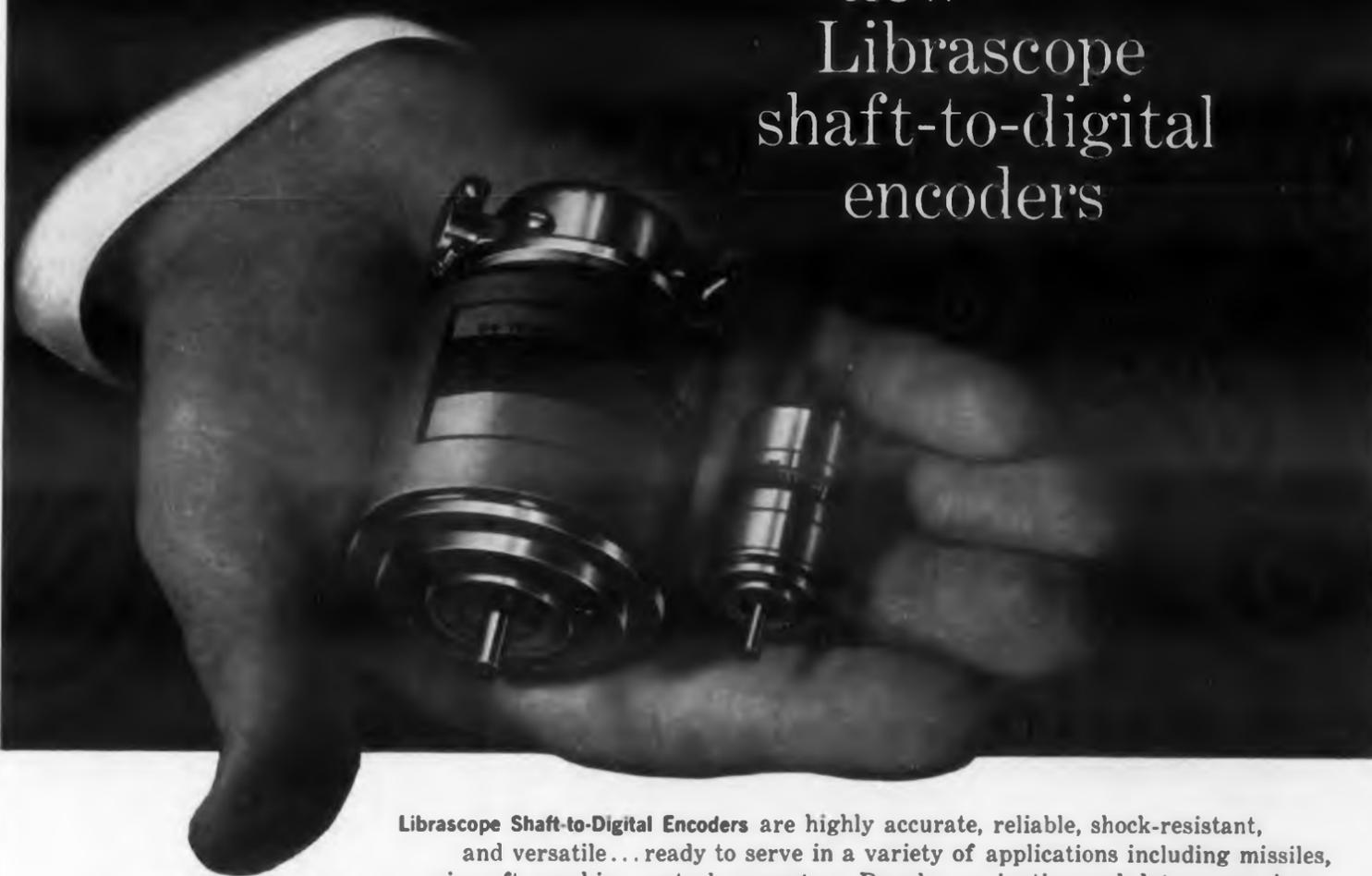
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MAGNETIC

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SIZE 8

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new noncontact magnetic encoder

MODEL NO. 807

FEATURES:

Long life, high reliability, high speed, natural binary V-Scan readout.

SPECIFICATIONS:

Output Code: natural binary
Resolution: (per input shaft turn) 128 counts
Full Scale Capacity: 7 bits*
Speed: operating from 0 to 10,000 rpm
Life Expectancy: 20,000 hours at 4,000 rpm; 4 x 10⁹ revolutions
Starting Torque: 0.1 in-oz. max.
Diameter: 2"
Length: 1 13/16"
Weight: 5 ounces

*ALSO AVAILABLE IN 13, 17, AND 19 BIT CAPACITIES.

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AVAILABLE
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for your copy



new subminiature size 8 encoder

MODEL NOS. 787 & 793

FEATURES:

Low torque, low inertia, long life, high reliability, withstands severe environments.

SPECIFICATIONS:

Output Code: natural binary
Resolution: (per input shaft turn) 128 counts
Full Scale Capacity: 7 bits, 13 bits
Speed: operating 200 rpm, slew 600 rpm
Life Expectancy: 2 x 10⁶ revolutions at 200 rpm
Starting Torque: 0.5 oz-in. maximum
Diameter: .750"
Weight: 3 ounces

other popular Librascope encoders

Code	Model no.	Full scale capacity	Resolution per input shaft turn
Binary	773	13 bits	128 counts
	0-773	oil-filled unit for increased life	
Binary	710	10 bits	1024 counts
	707 (707D*)	7 bits	128 "
Binary	713 (713D*)	13 bits	128 "
	717 (717D*)	17 bits	128 "
	719 (719D*)	19 bits	128 "
	0-713	oil-filled unit for increased life	
Self-Decoding Binary	740	10 bits	1024 counts
	723 (723D*)	2,000 counts	200 "
B/C/D	724 (724D*)	20,000 "	200 "
	733 (733D*)	3,600 "	200 "
	734 (734D*)	36,000 "	200 "
	735	360,000 "	200 "
Sine/Cosine	757-S**	4 quadrants per turn	7 bits per quadrant + limit 1
	758-S**	4 quadrants per turn	8 bits per quadrant + limit 1
Gray	708	8 bits	256 counts

*Contain isolation diodes for multiplexing

**Servo driven, hermetically sealed

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CIRCLE 24 ON READER-SERVICE CARD

NEWS

sible when the responsibility rests principally within one organization.

The Analysis, Design and Operation sessions will include several psychologists as well as engineers. Forrest Bethel of Stromberg-Carlson points out that the whole man-machine series has a strong "human factors" slant. The area of discussion mainly concerns how man can best get along with machines . . . or how machines can best be designed to get along with man.

No WESCON Recruiting . . . Quite

Recruiting on Show grounds this year will be minimal, according to Show Manager Don Larson. "Of course, there is no way to prevent individuals from talking to each other, but no organized re-

cruting will go on in the exhibit areas, headquarters hotel or technical sessions."

Response to the famed "gentlemen's agreement" letter sent to major electronic firms by WESCON Chairman Walter E. Peterson was "very favorable," says Mr. Larson. Hundreds of replies were received, unanimously supporting the WESCON no-recruiting policy. ". . . recruiting of engineering personnel has always been discouraged at WESCON," the letter read in part. "We feel it is to the benefit of all attending the trade show and convention to rule out such distracting influences in a high level technical meeting. . . . We wish to call upon your company to join in a 'gentlemen's agreement' to rule out recruiting at WESCON functions."

But plans for the California Southland Career Center are progressing full blast. To be located in the Shrine Auditorium a few miles from the

(text continued on page 30)

Condensed Schedule—Wescon Technical Program

*(Note: Sessions 1&2 are from 10:00—12:30)

August 23-26	Room A	Room B	Room C	Room D	Room E
Tuesday 10:30 — 12:30 am	1 Reliability	2 Pulse-Handling Techniques	3 Communications	4 Management of Man-Machine Systems	5 Semiconductor Devices & Tubes
Tuesday 2:00 — 5:00 pm	6 Communication Values of the Technical Symp.	7 Varactors & Tun- nel Diode Appli- cations	8 Instrumentation	9 Circuit Theory	10 Semiconductor Devices
Wednesday 10:30 — 12:30 am	11 Computer— General	12 Stereo Multiplex Broadcasting	13 Microwave Theory & Techniques I	14 Analysis of Man- Machine Systems	15 Microwave Tubes
Wednesday 2:00 — 5:00 pm	16 Computer Circuits & Devices	17 Magnetic Data Recording	18 Microwave Theory & Techniques II	19 Working With Engineers	20 Vehicular Communications I
Thursday 10:30 — 12:30 pm	21 Component & Systems Reliability	22 Air Traffic Control I	23 Antennas I	24 Synthesis & De- sign of Man- Machine Systems	25 Microminia- turization
Thursday 2:00 — 5:00 pm	26 Government & Industry	27 Air Traffic Control II	28 Antennas II	29 Pioneer V Experiments	30 Microminiaturiza- tion
Friday 10:30 — 12:30	31 Seeking a Logical Bio-Instrumenta- tion System	32 Military Electronics	33 Information The- ory & Modulation Methods	34 Operation & Training of Man- Machine Sys.	35 Vehicular Com- munications II
Friday 2:00 — 5:00 pm	36 Continuation of Session 31	37 Coding Methods & Telemetry	38 Continuation of Session 33	39 Effects of Nuclear Radiation on Elec- tronic Equipment	40 Vehicular Com- munications III

Technical Papers—Subject Index

AM sessions begin at 10:30; pm sessions at 2:00. *Note: Sessions 1 and 2 begin at 10:00.

Air Traffic Control

- Operational Considerations in ATC Design (22)
Thur am—Room B
- Pilot Looks at ATC (22) Thur am—Room B
- ATC From Aircraft Owners' Viewpoint (22)
Thur am—Room B
- Airlines & Air Traffic Control (22)
Thur am—Room B
- Central Data Processing of ATC Systems (27)
Thur pm—Room B
- Data-Processing Requirements of ATC Systems (27)
Thur pm—Room B
- Need for Automatic ATC (27)
Thur pm—Room B
- Future Trends in ATC (27)
Thur pm—Room B

Antennas

- Optimum Antenna Pattern-Signal Burst System (3)
Tues am—Room C
- Tower and Guy Effects on Side Mounted Vertical Antennas (20)
Wed pm—Room E
- Broad-Band 160-Mc Colinear Array (20)
Wed pm—Room E
- Vehicular Center-Fed Whip Antenna (20)
Wed pm—Room E
- Continuous Bistatic-Echo Area Range (28)
Thur pm—Room C
- Region Boresight Methods (28)
Thur pm—Room C
- Zone-Plate Focusing Element (28)
Thur pm—Room C
- Beacon Antennas for Project Mercury (28)
Thur pm—Room C
- Cavity-Fed Slot Antennas (28)
Thur pm—Room C
- "Coke-Bottle" Antenna (23) Thur am—Room C
- Circular-Array Frequency Scan (23)
Thur am—Room C
- Low-Sidelobe Interferometer Antenna Patterns (23)
Thur am—Room C
- Design Techniques—Spiral Antenna (23)
Thur am—Room C
- Phase Distribution of Spiral Antennas (23)
Thur am—Room C

Automation & Sound Control Systems

- Automation in ATC (27) Thur pm—Room B
- Need for Automatic ATC (27)
Thur pm—Room B
(continued on page 30)

INTRODUCING THE ONLY SELF TUNING ULTRASONIC CLEANERS

Powertron's new line of self tuning ultrasonic cleaners **CUT CLEANING TIME 300% over outmoded ultrasonic systems.** Case histories on file show up to 900% faster cleaning consistently, and savings of \$3,000 a month in labor costs — details on request.



POWERTRON'S COMPLETE LINE OF AUTOSONIC CLEANERS INCLUDES TANK MODELS, CABINET MODELS, IMMERSIBLE TRANSDUCERS, DEGREASERS AND COMPLETE PROCESS SYSTEMS.



The Autosonic by Powertron is the world's only full line of ultrasonic cleaners with the self tuning feature that assures you of consistent peak performance cleaning regardless of load changes, solution level, liquid temperature, solvent contamination, or operator inattention.

Powertron's unique feedback transducer senses the energy level in the cleaning tank and automatically tunes itself for maximum cleaning efficiency. Every change in operating conditions is sensed by the Autosonic transducer and is immediately compensated for to keep cleaning performance at its peak continuously without operator attention.

Powertron Autosonic cleaning systems are high power, heavy duty units, ruggedly constructed for continuous operation on any cleaning job—even those that other ultrasonic systems can't handle.

A single switch is the Autosonic's only control, so careless operation can't affect the rate or degree of cleaning. Because Powertron's advanced design has eliminated knobs, meters and moving parts, even mishandling, such as no-load operation, won't damage the Autosonic. Every Autosonic cleaner is unconditionally guaranteed.

Powertron's complete line of Autosonic cleaners includes tank models from 2 gals. to 100 gals., cabinet models, immersible transducers, degreasers and accessories, competitively priced and available from stock. Whatever you want to clean can be cleaned better in an Autosonic.

Powertron will be glad to show you how your cleaning problem can be solved Autosonically. Simply describe your application, or send a sample of the item you want to clean, and Powertron will send you proof that the Autosonic can increase your output, cut production time, and increase your profits. If you prefer, send for details on Powertron's free trial offer.

WRITE FOR FREE BULLETIN 60-1
"HOW TO CLEAN ULTRASONICALLY
WITH SELF TUNING"



POWERTRON ULTRASONICS CORP.

DEPT. ED-8, PATTERSON PLACE • ROOSEVELT FIELD • GARDEN CITY, L.I., NEW YORK • PIONEER 1-3220

CIRCLE 25 ON READER-SERVICE CARD

DAPON SERVES COMMUNICATION



DAPON (diallyl phthalate) RESIN GIVES A LIFETIME SHRINKAGE VALUE OF .001 IN THIS AMPHENOL CONNECTOR

This connector routes many circuits in the Bell System's multi-line "Call Director" at a great saving of space and weight.

About the size of a cigarette lighter, an Amphenol-Borg Electronic Corporation connector is used in the Bell System's "Call Director." This versatile telephone can handle as many as 29 outside lines or extensions. The working members of this connector are fifty gold plated bronze contacts held firmly in a body molded from DAPON (diallyl phthalate) Resin.

Chosen by Amphenol for this application because of its dimensional stability and insulating properties, DAPON's superior moldability accommodates the thick and very thin sections and lateral cavities of the connector's body. DAPON molds easily around metal inserts; there is no cracking and little or no after-shrinkage of DAPON molded parts after years of service, even under elevated temperatures.

Specify DAPON (diallyl phthalate) Resin when you need:

- Low dielectric loss
- High dielectric strength
- Superior dimensional stability
- Excellent arc resistance
- High volume and surface resistance after high humidity-high temperature conditioning

Write to the address below for FMC's data sheet containing technical information about DAPON, suggested uses for this resin, and the name of the DAPON compounder nearest you.



FOOD MACHINERY AND CHEMICAL CORPORATION
Dapon Department

161 East 42nd Street, New York 17, New York

CIRCLE 26 ON READER-SERVICE CARD

NEWS

Sports Arena, the Career Center will hopefully be visited by 3,000 engineers looking for a change, says William Douglass, president of Career Publications, Inc.

"When an industry needs engineers it has to recruit," he pointed out. "Even with the best intentions a company that must fulfill a contract may resort to technical seminars which are little more than recruiting devices to tell the company's story to invited engineers.

Most engineers recruited during the Show, according to Mr. Douglass, will be from the West. "To recruit engineers locally cuts costs. This year scientists and mathematicians as well as engineers will be in demand." ■ ■

Broadcasting

- FM Stereophonic Radio Transmission (12)
Wed am—Room B
- FM Stereophonic Broadcast Systems (12)
Wed am—Room B

Circuit Theory

- Feedback Systems—Gain and Time Constant Variations (9) Tues pm—Room D
- Sensitivity of Linear Systems (9) Tues pm—Room D
- Sampled-Data Technique for Network Transfer Functions (9) Tues pm—Room D
- Delay Distortion Correction for Networks and Filters (9) Tues pm—Room D

Communications

- Link Elimination in Data Systems (3) Tues am—Room C
- Optimum Antenna Pattern Signal Burst System (3) Tues am—Room C
- Suppressing Impulse Noise (3) Tues am—Room C
- Vehicular Center-Fed Whip Antenna (20) Wed pm—Room E
- Broad-Band 160-mc Colinear Array (20) Wed pm—Room E
- Tower and Guy Effects on Vertical Antennas (20) Wed pm—Room E
- Foamflex Coaxial Cable (20) Wed pm—Room E
- Electronic Ancestor Worship (32) Fri am—Room B
- National and Global Systems (32) Fri am—Room B
- Computer Techniques—Ground Support (32) Fri am—Room B

ELECTRONIC DESIGN • August 3, 1960

- Performance Compatibility and Standards (35) Fri am—Room E
 Modular Construction (35) Fri am—Room E
 Paging in the VHF Band (35) Fri am—Room E
 Control Console and Related Facilities (35) Fri am—Room E
 Fail-Safe Binary Communication (37) Fri pm—Room B
 Multichannel Telephone Service (40) Fri pm—Room E
 Address Communication Systems (40) Fri pm—Room E
 Pushbutton Dial Radiotelephone (40) Fri pm—Room E
 Three-Channel SSB Multiplexed FM Radio (40) Fri pm—Room E
 Guarded Tone Signalling (40) Fri pm—Room E

Computers

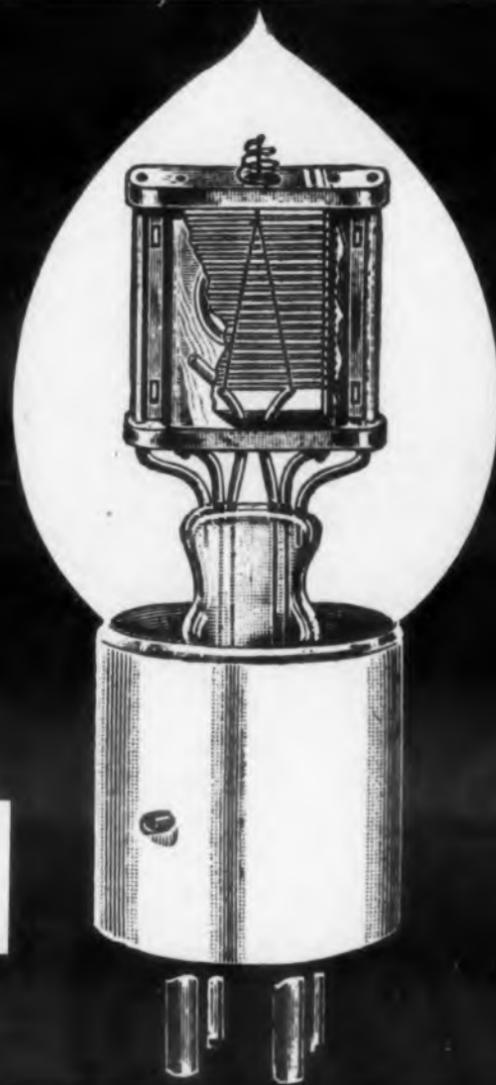
- Microsecond Clock Synchronization (8) Tues pm—Room C
 Digital Control in Space (11) Wed am—Room A
 Polymorphic Data Processing (11) Wed am—Room A
 Adaptive Character Reader (11) Wed am—Room A
 Random Access File (16) Wed pm—Room A
 Visual Display Encoding (14) Wed pm—Room D
 Magnetic Core Logic (16) Wed pm—Room A
 Adaptive Switching Circuits (16) Wed pm—Room A
 25-Mc-Clock Rate Circuits (16) Wed pm—Room A
 Logic For a 16-Mc Clock Rate (16) Wed pm—Room A
 ATC Data Processing (27) Thur pm—Room B
 ATC Data Processing Requirements (27) Thur pm—Room B
 Optimized Data Systems (37) Fri pm—Room B

Instrumentation

- Microsecond Clock Synchronization (8) Tues pm—Room C
 Compensating Networks (8) Tues pm—Room C
 Servo Response Plotter (8) Tues pm—Room C
 Determining Instantaneous Speed Error Data (8) Tues pm—Room C
 Extending Recording System Bandwidth Wed pm—Room B
 CM-100 Recorder—Mechanical Design (17) Wed pm—Room B
 CM-100 Recorder—Electrical Design and Performance (17) Wed pm—Room B

Magnetic Data Recording

- Extending Recording System Bandwidth (17) Wed pm—Room B
 Wideband Magnetic Recording (17) Wed pm—Room B



THEN

NOW

AT WESCON—BOOTH 728

"Then," as it refers to the electronics industry, means . . . "just a very few years ago." The radically swift advances made in those few years have changed the whole concept of component design and performance.

Capacitor users will find the new capacitors which modern circuitry demands at Pyramid Electric Company, where miniaturization with highest reliability are among our proven engineering and production accomplishments. A few of the modern capacitor products are shown here.



type TAD . . . solid tantalum high reliability capacitors. They are available in a wide range of sizes and values, are hermetically sealed, and have a long shelf and operating life.

temperature range: -80°C to $+85^{\circ}\text{C}$
 $+125^{\circ}\text{C}$ (with derating)

Write for bulletin ET-7



type MLE . . . true miniature electrolytic capacitors. They are metal clad of all-welded construction, made to last ten years or longer.

temperature range: -40°C to $+85^{\circ}\text{C}$

Write for bulletin EL-6



type TAK-H . . . wet electrolyte tantalum capacitors with built-in rugged construction, seep and vibration proof, and made to meet specifications MIL-C-3965.

Write for bulletin ET-8



type 107 . . . Mylar[®] dielectric capacitors—the smallest film capacitors made. Non-hydroscopic polyester dielectric and wrapper with thermosetting resin end seals.

temperature range: -55°C to $+125^{\circ}\text{C}$

Write for bulletin MY-2

For full details write or call: Sales Department S-100

PYRAMID ELECTRIC COMPANY

ORANGE STREET, DARLINGTON, SOUTH CAROLINA • In Canada: Wm. Cohen, Ltd., 8900 Tanguay Street, Montreal • Export: Morhan Exporting Company, 485 Broadway, New York 13, N. Y.

CIRCLE 27 ON READER-SERVICE CARD



over a 180° C range with Centralab's temperature stable Ceramic Capacitors

These low-cost Type CE ceramic disc Hi-Kaps® have been extensively tested over an 18 month period by prime contractors in the missile and radar fields. Their findings: *the excellence of the CENTRALAB design parameters for standard commercial units permits the identical capacitors to be used in military applications.*

In radio-TV as well as military usage, these units operate from -55° C to +125° C without derating. They last longer than paper or mica capacitors, and their small size makes them economical to work with. Semi-stable Type CF CENTRALAB Hi-Kaps® offer similar advantages.

SPECIFICATIONS

CAPACITIES: 150-6200 mmf

SIZE: .290"-.920" diameter, .156" thick

WORKING VOLTAGE: 500 VDC

LEAKAGE RESISTANCE: Initial, 10,000 Megohms minimum; after humidity test, over 1000 Megohms

POWER FACTOR: 2% Max. at 1KC

TOLERANCES: GMV, ±20%, ±10%, +80-20%

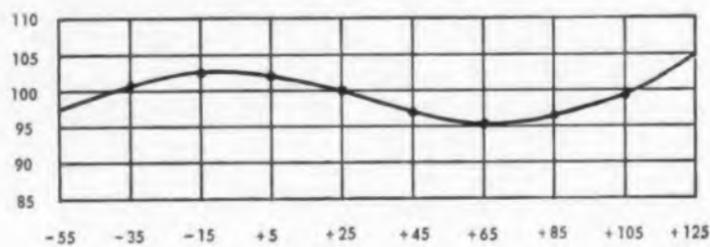
Detailed information on these and many other CENTRALAB ceramic capacitors can be found in Catalog 42-857. Write for your free copy.

Centralab

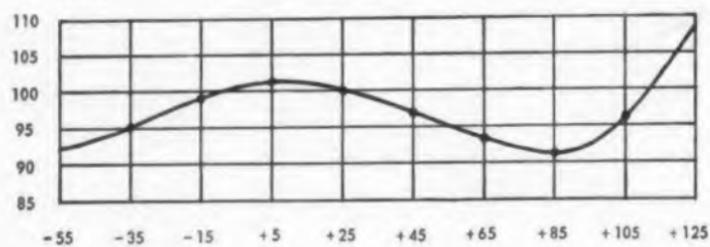
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ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS
SEE US AT WESCON, BOOTH 664
CIRCLE 28 ON READER-SERVICE CARD

TYPE CE—% of 25° C Capacity vs. Temperature in °C



TYPE CF—% of 25° C Capacity vs. Temperature in °C



The Electronics Division of Globe-Union Inc.
960H E. Keefe Ave., Milwaukee 1, Wisconsin
Centralab Canada Limited • Ajax, Ontario

NEWS

Merit, Excellence, Designs Shown

WESCON's second Industrial Design Awards program, which has nothing to do with the value of the electronic circuitry or techniques within a package, will exhibit 22 award-winning entries. Five awards of excellence and 17 awards of merit will be announced. Award-winning products this year listed alphabetically:

- Ampex FR600 Magnetic Tape Recorder/Reproducer; Designers: Frank T. Walsh and F. Arden Farey, Ampex Data Products Co., Redwood City, Calif.
- Ampex TM-1 Digital Tape Handler, designers: Frank T. Walsh and F. Arden Farey
- Amphenol Micromodule Connector, designer: Connector Div., Amphenol-Borg Electronics Corp., Chicago, Ill.
- Beckman Laboratories Potentiometric Recorder, designers: Tor Petterson and Melvin Best, Beckman Instruments, Fullerton, Calif.
- Beckman Model 210 High-Speed Data-Processing System, designer: Zierhut/Vedder/Shimano Associates, Los Angeles.
- Bendix G-20 Data Processing System, designers: Emerson/Johnson/Mackay
- Corning NF Fusion Sealed Resistor, designer: Corning Electronic Components Div., Corning Glass Works, Bradford, Pa.
- Decker Corp., group of four measuring instruments: Model 905 Delta Unit Controller, Model 410 True Differential Voltmeter, Model 904 Delta Unit, Model 306 Differential Pressure Meter. Chosen as group because of design resemblance. Designer: E. Rolin Nichols, Decker Corp., Bala Cynwyd, Pa.
- DeMornay-Bonardi Precision Standing Wave Detector, designer: Richard E. DeMornay, DeMornay-Bonardi, Pasadena, Calif.
- Eitel-McCullough X7626 Power Triode
- Eitel-McCullough Model X778 Traveling Wave Tube
- Electro-Instruments Model 300 X-Y Plotter, designer: Robert D. Mason, IDI
- General Electric Model GE312 Digital Control Computer, designer: Henry H. Bluhm
- Hewlett-Packard Variable Attenuator, designers: Carl Clement, Allen Inhelder, Phil Hand, Lawrence LaBarre, Ed Phillips
- Huggins Traveling Wave Tube
- Librascope RPC 4000 Electronic Computer System, designers: George H. Kress Associates, ASID, Los Angeles.
- Librascope X-Y Plotter Model 210, designer: Zierhut/Vedder/Shimano Associates, Los Angeles.
- P. R. Mallory Voltage Reference Battery.
- Mincom Div. Minnesota Mining & Mfg. CM-100 Video Band Recorder/Reproducer
- Ramo-Wooldrige Standard Cabinet, designer: Joseph Pollice, Thompson-Ramo-Wooldrige
- Southwest Industrial Electronics Model N-2 Signal Generator.
- Voltron Products Precision Electronic Motor, designer: Tor Petterson, ASID

Sensitive Reproducing Head (17)

Wed pm—Room B

CM-100 Recorder—Mechanical Design (17)

Wed pm—Room B

ELECTRONIC DESIGN • August 3, 1960

CM-100 Recorder—Electrical Design and Performance (17) Wed pm—Room B
 FM and Carrier Erase Techniques Wed pm—Room B

Management

Communications Values of Technical Symposium (6) Tues pm—Room A
 Marketing (19) Wed pm—Room D
 Patent Law (19) Wed pm—Room D
 Accounting and Finance (19) Wed pm—Room D

Man-Machine Systems

Management Appraisal of Human Engineering (4) Tues am—Room D
 Human Factors in Management Control (4) Tues am—Room D
 Human Pilot Dynamics (14) Wed am—Room D
 Air Defense Center Decisions (14) Wed am—Room D
 Linear Dynamics of Human Systems (14) Wed am—Room D
 Systems Analysis Methodology (14) Wed am—Room D
 Visual Display Encoding (14) Wed am—Room D
 Systems Design Requirements (24) Thur am—Room D
 Human Factors Laboratory (24) Thur am—Room D
 Detection Threshold (24) Thur am—Room D
 Color Display Unit (24) Thur am—Room D
 Teaching Systems (24) Thur am—Room D
 Unit Repair (34) Fri am—Room D
 Human Factors in ADP Systems Performance Fri am—Room D
 Maintenance Functions (34) Fri am—Room D
 Human Factors in Systems Operations and Training (34) Fri am—Room D
 Human Interactions in Systems (34) Fri am—Room D

Microwave Theory and Techniques

Periodic Structures—Equivalent Circuits (13) Wed am—Room C
 X-Band Circulator (13) Wed am—Room C
 Broadband Filters (13) Wed am—Room C
 Waveguide Attenuation (13) Wed am—Room C
 Broadband Rotary Joint (13) Wed am—Room C
 Parametric Diode Equivalent Circuit (5) Tues am—Room E
 Multiple Reflectors in Semiconductors (10) Tues pm—Room E
 Masers for Systems Applications (18) Wed pm—Room C
 Parametric Amplifiers Noise Figure (18) Wed pm—Room C
 TEM Diode Switching (18) Wed pm—Room C

Take a closer look at contacts

They're the most important part of a low-power switch . . .



Oak contacts are the main reason why builders of MILITARY and quality INDUSTRIAL equipment prefer Oak switches.

7X Magnification Shows the Unique Precision and Intricacy of Typical Oak Contacts



Test and Compare Oak Contacts Yourself

Compare them with any other switch made for low-power switching. In many cases, the results will be dramatic. First, you will note that *all* Oak contacts are double wiping (to stay clean and eliminate maintenance) and that each has the longest possible spring length for extra life. Then you will discover that extra contact pressure holds circuit resistance and noise to lower levels over a longer span of life.

Because of unique design and manufacturing subtleties, Oak switch contacts will test out superior in practically every characteristic. They are the finest contacts produced today for low-power, dry circuit switching.

In Oak contacts, you also get the widest selection of forms and materials (many of them exclusive) which are custom engineered to the exact requirements of your application.

Write for New STOCK CATALOG 399

Prices and specifications on 124 stock rotary switches for Military and other applications.



ONLY THE FINEST IN LOW-POWER SWITCHES

OAK

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SWITCHES CHOPPERS VIBRATORS
 ROTARY SOLENOIDS TUNERS
 SUBASSEMBLIES VARIABLE CAPACITORS

CIRCLE 29 ON READER-SERVICE CARD

NEWS

Tunnel Diode Oscillators (18) Wed pm—Room C
S-Band Parametric Amplifier Wed pm—Room C

Microwave Tubes

Low Noise TWT Amplifiers (15)
Wed am—Room E
High Convergence Electron Guns (15)
Wed am—Room E
Slow Space-Change Waves (15)
Wed am—Room E
ARC Discharge (15) Wed am—Room E
Backward-Wave Oscillators (15)
Wed am—Room E
Ku-Band Klystron Amplifiers (15)
Wed am—Room E

Military Electronics

Electronic Ancestor Worship (32)
Fri am—Room B
National and Global Systems (32)
Fri am—Room B
Ground Support Computer Techniques (32)
Fri am—Room B

Pulse-Handling Techniques

Enhancement Filters (2) Tues am—Room B
Pulsed RF Storage (2) Tues am—Room B
Video Processing and Distribution (2)
Tues am—Room B
Solid-State Video Processor (2)
Tues am—Room B

Reliability

Electronic Equipment Maintenance (1)
Tues am—Room A
Models for System Design Engineers (1)
Tues am—Room A
Precision Film Potentiometers (1)
Tues am—Room A
Product Quality (1) Tues am—Room A
Wiring Failure-Rate Data for Component
Part Derating (21) Thur am—Room A

Semiconductor Devices

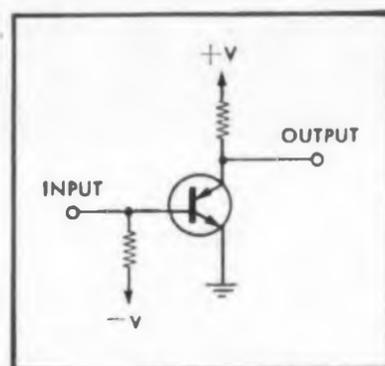
Thermionic Converters (5) Tues am—Room E
High Power at 1 Kmc (5) Tues am—Room E
Parametric Diode Equivalent Circuit (5)
Tues am—Room E
Power Transistor Reliability (5)
Tues am—Room E
Electrostatic Storage Memory Element (10)
Tues pm—Room E
Multiple Microwave Reflections (10)
Tues pm—Room E
PN-PN Switches (10) Tues pm—Room E
Transistor Scaling Theory (10) Tues pm—Room E
Tunnel-Diode Adder-Subtractor (10)
Tues pm—Room E

A NEW DESIGN APPROACH TO SIMPLIFY

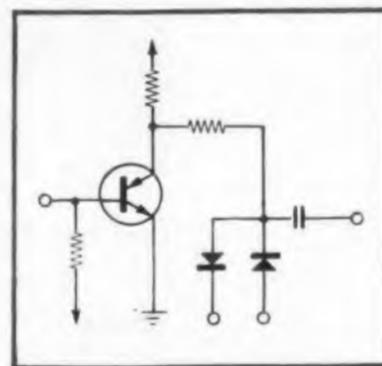
with advanced PNP semiconductors
available NOW — from **SSPI**

... already finding wide use in

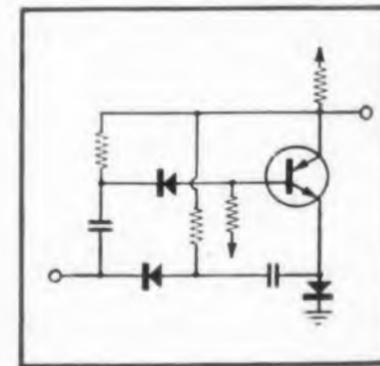
- Shift registers
- Ring counters
- Binary counters
- Gating
- Nixie drivers
- Programming
- Squib firing
- Relay drivers
- Replacing relays
- Replacing mag-amps
- Indicator lamp drivers
- Electronic circuit breakers
- Voltage sensing
- Current sensing
- Static switching
- Pulse generators
- Time delay



Trigistor Flip-Flop



Shift Register Stage



Binary Counter

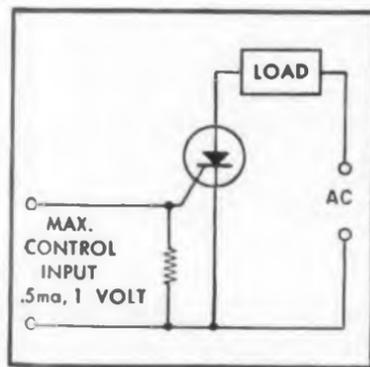
Write for Applications Bulletin D410-02

SSPI

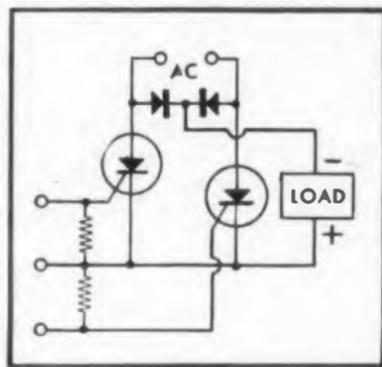
SSPI

CONTROL CIRCUITS

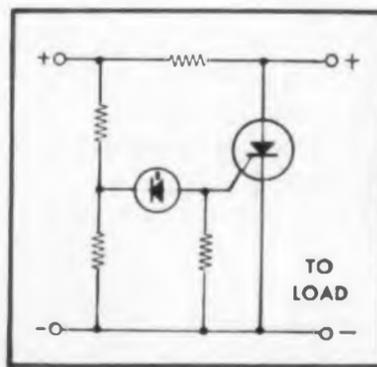
- . . . Major advances in circuit simplicity, component reduction, and reliability are possible through the use of proven PNP Semiconductors --- from SSPI.
- . . . New PNP logic possibilities with SSPI Trigtors --- full on-off control with pulsed input at a single terminal --- operation down to 1 ma allows significant current conservation.
- . . . SSPI Miniature SCR's and Controlled Switches allow precise firing control (.52 ± .08 volt) with high gain --- 20 μa will control 10-1250 ma D.C. and peak pulses up to 30 amperes with efficiencies to 99%.
- . . . Miniature packaging --- all leads isolated from case --- MIL-S-19500 environmental capabilities --- Operation -65°C to +150°C.
- . . . Investigate these devices in terms of your design.



Relay or Lamp Driver



Power Control



Overvoltage Protection

Write for Applications Bulletin D420-02

SOLID STATE Products, Inc.

CIRCLE 30 ON READER-SERVICE CARD

- High Component Density (25) Thur am—Room E
- S-Band Parametric Amplifier (18) Wed pm—Room C
- Solid State Micrologic (25) Thur am—Room E
- Parametric RF Amplifier (7) Tues pm—Room B
- LF Reactance Up-Converter Tues pm—Room B

Space Electronics

- Pioneer V—Preliminary Results (29) Thur pm—Room D
- Pioneer V—Radiation Measurements (29) Thur pm—Room D
- Pioneer V—Magnetic Field Measurements (29) Thur pm—Room D
- Pioneer V—Astronomical Unit Determination (29) Thur pm—Room D
- Nuclear Radiation on Electronic Equipment (39) Fri pm—Room D

Telemetry

- FM Discriminator Detector (37) Fri pm—Room B
- Improved Dopap Transponder (37) Fri pm—Room B
- Optimized Data Systems (37) Fri pm—Room B
- Fail-Safe Binary Communication (37) Fri pm—Room B
- Data Compression (37) Fri pm—Room B
- Three-Channel SSB Multiplexed FM Radio (40) Fri pm—Room E

Tunnel Diodes & Varactors

- Capacitor Harmonic Generator (7) Tues pm—Room B
- Parametric RF Amplifier (7) Tues pm—Room B
- LF Reactance Up-Converter (7) Tues pm—Room B
- UHF Tunnel Diode Amplifier (7) Tues pm—Room B
- Twin-Tunnel-Diode Logic (7) Tues pm—Room B

Distributor-Reps Meet All Day

Facilities for an expected 600 participants in the Sixth Annual Distributor-Representative Conference will be set up in the Ambassador Hotel. Chairman W. Bert Knight predicts that many distributors, factory sales managers and sales representatives from throughout the West will spend all day Monday, Aug. 22, exchanging views at the Ambassador Hotel. Even before the event Mr. Knight is anticipating a greater program in future years. "The popularity of the program is responsible for the suggestion that it be made a two-day affair in future years with its own program of speakers. We will ask for a vote on this proposal at this year's conference," Mr. Knight says.

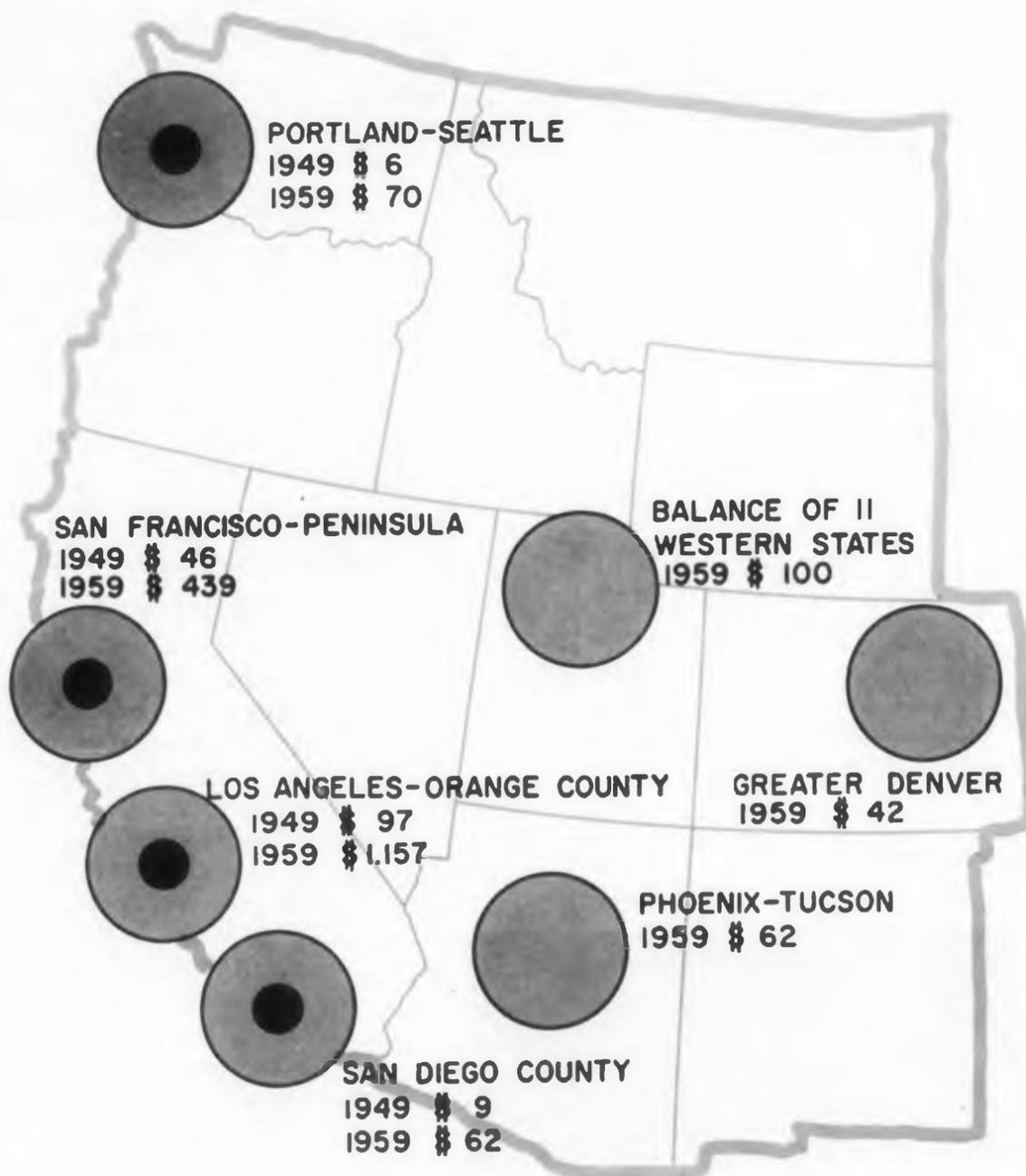


NEWS

Hughes modern installation contrasts with old Cal Tech

Electronics in the West: The 1960 Look

*Little Boom Shot Up to Big Boom
But Still Suffers Growth Pains*



CONCENTRATED in five principal areas—Portland-Seattle, San Francisco-Oakland, Los Angeles-Orange County, San Diego, and Phoenix-Tucson—the western electronics industry this year will reach a total of \$2 billion sales. To those accustomed to the relative density of medium-sized and large companies in the Midwest and East, this figure may be misleading. There are more firms than might be supposed—about 800. Nu-

Ten-year growth figures from 1949 to 1959 compiled by the Western Electronic Manufacturers Association last year show the explosive growth of the western electronics industry. In 1949 there were a total of 85 electronics firms in the 11 western states; in 1959 there were 770. Employment in 1949 was 11,000; in 1959, 146,000. Sales were multiplied a dozen times from \$158 million in 1949 to \$1.932 billion in 1959. The breakdown is shown in the table.

City	Ten-Year Growth (Statistics from Western)		
	1949	1949	1949
	No. of Firms	Employees	Sales
Seattle-Portland	5	400	\$ 6 million
San Francisco-Peninsula	34	3,300	\$46 million
Los Angeles	43	6,700	\$97 million
San Diego County	3	600	\$ 9 million
Phoenix-Tucson	—	—	—
Greater Denver	—	—	—
Balance of 11 western states	—	—	—
Total	85	11,000	\$158 million



merically, most of the western electronic companies are small firms employing fewer than 100 people.

In Los Angeles, with 485 firms, some 80 per cent have fewer than 100 employes, according to the Los Angeles Chamber of Commerce. About 63,000 workers are employed by 20 per cent of Los Angeles firms—including, of course, Hughes Aircraft Co., with 32,168 employes of its own in electronics. Hughes accounts for \$385 million of the Los Angeles-Orange County estimated total gross of \$1.7 billion sales in 1960.

Western electronics has a predominance of systems, building blocks, and study and test equipment. It is not fundamentally a components area, according to sources at the Western Electronics Manufacturers Association. This is in some sense a result of the proximity of large aircraft companies such as Lockheed, Hughes Aircraft, Douglas, Boeing, and Convair; and to the location, in Los Angeles, of the Air Force Ballistic Missile Div. Research and development programs proliferate partially because of the small size of the majority of western electronics firms and the encouragement provided by Stanford University, the California Institute of Technology, and the University of California at Berkeley. It is easier for a

of Western Electronics

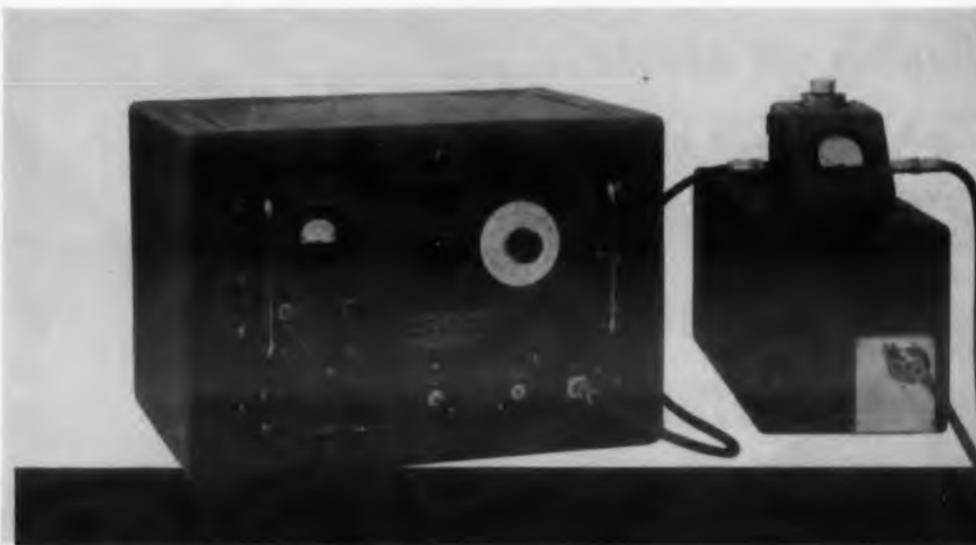
(Electronic Manufacturers Assn.)

1959

No. of Firms	Employees	Sales
35	6,000	\$70 million
144	35,000	\$439 million
461	84,000	\$1,157,000,000
31	4,000	\$62 million
21	5,000	\$62 million
18	3,100	\$42 million
60	9,000	\$100 million
770	146,000	\$1,832,000,000

Ready for you now!

Primary standard accuracy for power measurements to 1,000 watts!



Frequency coverage dc through 12.4 KMC.

Guaranteed power measuring accuracy of 1%. Probable accuracy better than 0.5%. Precise ac wattmeter, calorimeter and heat exchanger in one neat, rack unit. Separate dual loads for dc to 4 KMC, also C, XB, X bands. Direct reading linear scale.

Above are highlights of the new Sierra 290B Calorimetric Wattmeter Test Set—the industry's closest approach to absolute power measurements in this range.

Model 290B measures power in three distinct modes.

1. For power levels 30 to 1,000 watts, a null-balance mode provides measurement accuracies of 1% or better, with probable error as low as 0.5%.
2. For wider range power levels from 10 to 1,500 watts, a direct-reading mode provides excellent linearity in thermal readout and 2% to 3% accuracy. Readout is fast—60 seconds or less.
3. For expanded scale readings of highest resolution, the above two modes may be combined in a third mode to obtain the order of accuracy of the null-balance mode, together with the time-saving convenience of the direct readout mode.

Model 290B, \$4,500.00. (Water loads, extra.)

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

SIERRA ELECTRONIC CORPORATION

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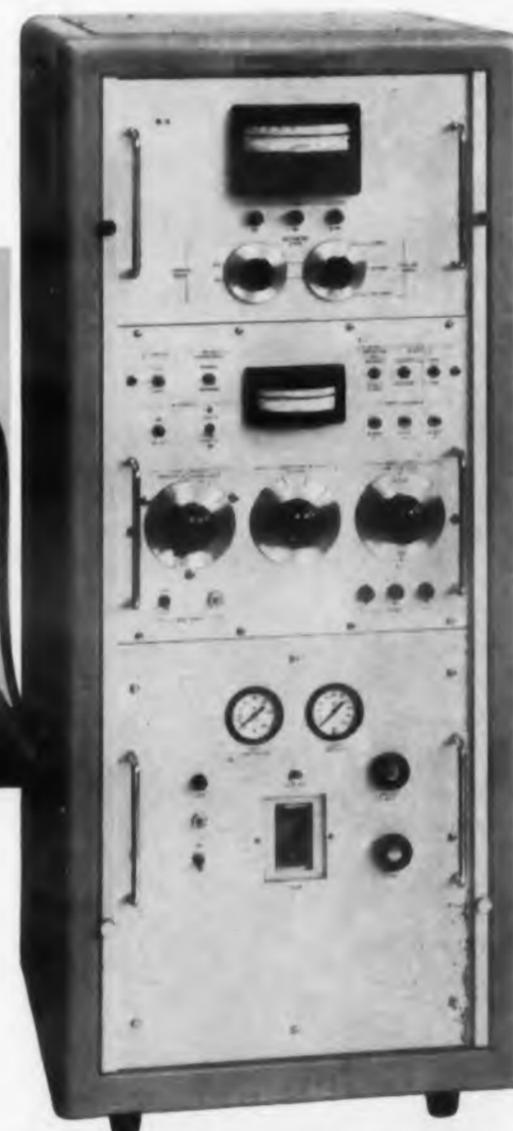
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Sierra 290B Test Set

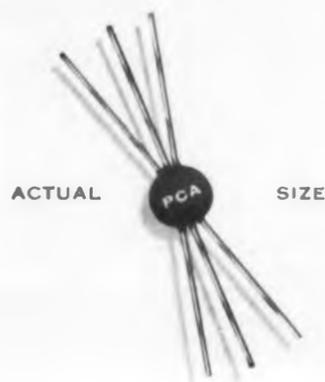
Laboratory setup above shows Sierra Model 215 Power Source being used in conjunction with Model 290B Calorimeter to calibrate Sierra Bi-Directional Power Monitor. Designed specifically for calibration purposes, 215 series Sources include four 50 watt models covering, collectively, 25 to 1,000 MC. Model 215A, 25 to 50 MC; Model 215B, 50 to 150 MC; Model 215C, 150 to 470 MC; Model 215D, 470 to 1,000 MC. Price (any model) \$3,300.00.

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NEWS

small company to go into an R&D program than to engage in mass production of hardware.

Despite the industry's still strong ties with the aircraft industry, much activity is taking place in third- and fourth-generation spin-offs. Companies like Thompson-Ramo-Wooldridge—then Ramo-Wooldridge—which were started by a group of engineers from a large aircraft firm, are now generating spin-offs of their own and, in some cases, the spin-offs have given birth to companies in turn. In the Portland-Seattle area where Boeing Airplane Co. encouraged the creation of a number of small electronics companies, these companies have so grown as to encourage several spin-offs of their own during 1959 and early 1960.

The development and perfection of the "team bid" concept in the West is largely due to the fierce competition given large companies by the numerous small ones. Pushed strongly by James D. McLean, then of Hoffman Electronics Corp., team bidding is now common and successful, and has the blessing of the Small Business Administration.

'Soaring '60s' Getting off the Ground

While western electronics sales have increased from 1959, industry sources indicate that the increase has not been up to expectations. Hardware and test equipment manufacturers have complained that first-quarter business was not as good as was hoped for. Research and development groups grumble that the Western area has not kept pace with areas like Boston, New York, and New Jersey, in study-program contracts. At the moment, however, industry spokesmen are looking for an increase in military and industrial contract negotiation. One manufacturer feels the disappointment in rate of growth has purely political origins. According to another manufacturer, the Skybolt program and revitalization of the B-70 program will help.

Electronic Exurbanites

As with much of the nation, electronics is moving outward from the large cities into suburban areas. Except for Convair Electronics, almost all of San Diego's electronics is concentrated several miles out of town on Kearny Mesa. In Los Angeles the recent exodus of TRW, Litton Industries, and Packard-Bell Electronics point up the movement from the center of town to the countryside some 40 miles away. Most of San Francisco electronics is concentrated on the Peninsula—a lovely, resort-like finger of land which stretches 45 miles south to join the mainland at San Jose.

ELECTRONIC DESIGN • August 3, 1960

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Small Business Enterprises
300 Montgomery Street
San Francisco 4, Calif.

Western SBIC
1005 A Street
San Rafael, Calif.

Capital for Small Business, Inc.
1314 Westwood Boulevard
Los Angeles 24, Calif.

Electronics Capital Corp.
1400 Fifth Avenue
San Diego 1, Calif.

First California SBIC
215 West Sixth Street
Los Angeles 14, Calif.

South East SBIC
3350 Tweedy Boulevard
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Columbia SBIC
2035 SW 58th Avenue
Portland 1, Oregon

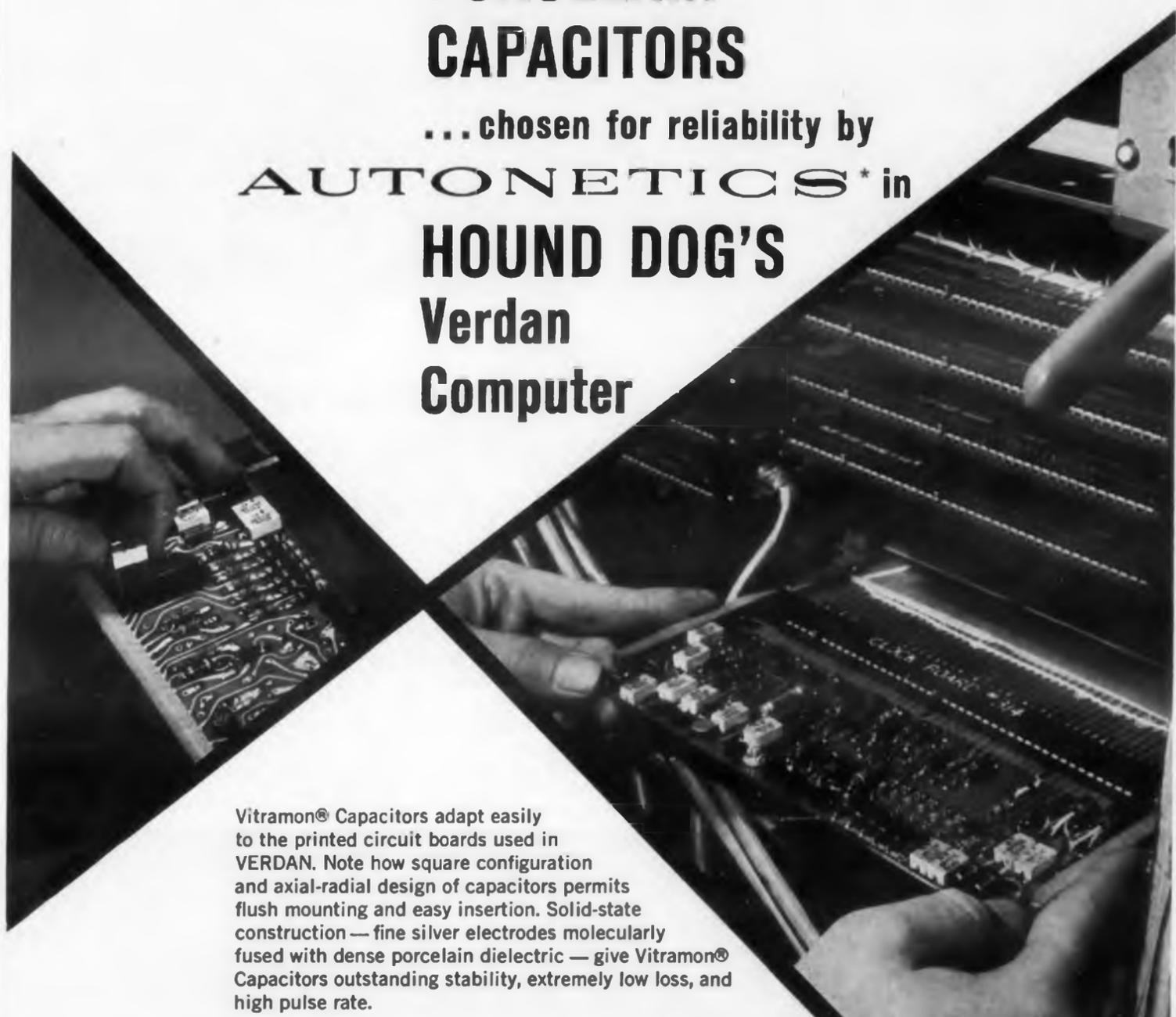
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The prime reason for the development of electronics in the suburbs, industry sources say, is to attract engineers to good living conditions, to take advantage of cheaper land, and reduce the cost of semi-skilled labor. But labor costs, even in the suburbs, are on the rise. Several firms on the San Francisco Peninsula are looking outside the area for expansion, due to increasing labor costs. One company has indicated they get twice the productivity in their Salt Lake City plant than in their California facility.

More Money Available

Ever since the Small Business Investment Act was passed by Congress in 1958, Longterm equity financing has been more readily available to small electronics companies. The Act provided tax incentives for establishing small-business investment companies geared to provide new firms with funds for working capital, growth and eventual expansion or modernization.

With such a large numerical percentage of small firms in the West, it might be expected that small-business investment companies would flourish—and so they have. There are a round dozen major SBIC's between Portland to San Diego. Of these the largest is Electronic Capital Corp. with offices in San Diego and Los Angeles, which specializes entirely in the electronics industry. The company is staffed by successful former electronics executives and engineers and says its prime

Vitramon® Capacitors adapt easily to the printed circuit boards used in VERDAN. Note how square configuration and axial-radial design of capacitors permits flush mounting and easy insertion. Solid-state construction — fine silver electrodes molecularly fused with dense porcelain dielectric — give Vitramon® Capacitors outstanding stability, extremely low loss, and high pulse rate.

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NEWS

objective is to provide continuing financial strength to its client companies during "fair and foul weather."

While most SBIC's are mainly interested in already-established companies with promising products or services, chances are good that an engineer with a good idea and sound technical background can obtain capital to start a new business.

At ECC, President Charles Salik says the corporation tries to find out from the engineer just how good his idea is. Is the product soundly designed? Is there a market for it? And, most important, is there a good chance that the market can be expanded? The next step is to investigate the applicant. ECC wants to know something about the engineer's technical background and his record in business, "In particular," Vice President Richard Silberman says, "we want people who have some experience in business, who have made some mistakes, so to speak, and consequently have learned their lesson." ECC requires a projection from the engineer or firm as to what the contemplated organization, sales and marketing operations will be, who the management people will be, and how much money the engineer thinks he needs. If this checks with what ECC thinks is reasonable and proper, after analysis negotiations begin.

One of the brightest examples of the rising interest in electronics investment is Electro-Logic Corp. in Venice, Calif. Two working engineers obtained financing early this year on the strength of their technical and sales abilities and several solid product ideas. Result: a new digital volt-



The Space Technology Laboratories shown here has been leased to Aerospace Corp., demonstrating the interplay of Western electronics. The building is in Los Angeles.

ELECTRONIC DESIGN • August 3, 1960

meter currently stirring interest in the industry and a digital transponder system with an extremely high market potential for use in telemetering.

In the Los Angeles basin alone new capital investment estimated for 1960 amounts to \$28,070,000—spent for the construction of six new plant buildings and the expansion of 46 others.

The western population increase that has made boom towns of Phoenix and Tucson and boosted Los Angeles to No. 3 City in the nation, barely trailing Chicago in population, has included large numbers of engineers and scientists. Universal fair weather in the "Southland" (as Southern Californians call their country) and the Southwest, the equable climes of Northern California and the gorgeous, though damp, scenery of Portland and Seattle are largely responsible. Companies needing high-level personnel for research and development operations that do not require extensive marketing and logistic accommodations are likely to set up shop in a spot which offers a pleasant environment. Once established in the West, these engineers and scientists are not likely to return East. "It would have to be a darn good offer to make me go back to Detroit," one contented engineer said recently.

About 20 per cent of the 35,000 engineers looked for at WESCON will be Easterners. Some, having lived through a week of Los Angeles sunshine and casual atmosphere, will stay.

WEMA Is a Prime Mover

Spokesman for the western electronics industry is the Western Electronics Manufacturers' Association. A non-profit organization comprising more than 100 electronics firms, WEMA compiles statistics, co-sponsors WESCON and supports a scholarship program to cultivate more students in the engineering and scientific fields. Last year WEMA made scholarship awards to 17 western universities. According to S. H. Bellue, President of WEMA, chairman of its Los Angeles Council and vice president of marketing at Osborn Electronics Corp., WEMA was founded in 1943 with the objective of encouraging the recognition and development of the electronics industry in the western states.

"Consumer electronics, the older and smallest segment of the industry, accounted for \$1.6 billion last year, reflecting a 21 per cent gain in sales over 1958. We forecast about a 5 per cent gain in this part of our industry for this year. Industrial electronics," Mr. Bellue continued, "a sleeping giant—has begun to stir during the past year. In 1959, industrial electronics sales were estimated to be \$1.65 billion. It is entirely possible that in the first year of 'The Soaring '60s' industrial sales may be increased another 14 per cent to \$2.31 billion."



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The problem was a natural for AMP's Capatron personnel and facilities. New transformer design standards were developed, new high temperature insulations tested, new components created. The unit was packaged and tested in record time. Capatron is now in volume production of this unit . . . the AMP #855053.

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Exotic design at left is representative of the exotic circuits that may be possible using the epitaxial-growth process—position of vaporized silicon so that it continues the single crystal structure of the seed crystal. This is an example of silicon deposition on a crystal oriented along the 100 plane.

At right is a matrix of four resist transistor-logic gates deposited in 11 layers on a glass substrate by IBM for the Signal Corps. This group is part of a 9-circuit matrix.

NEWS

Services Spelling Out Micromin Plans

AF, Signal Corps Programs Jelling; Current Plans and Problems Outlined

AS THE FOCUS on electronics moves West for the industry's number two show of the year, much attention will be directed toward microminiaturization as hardware begins to make an appearance.

Comments of troubled components manufacturers at New York's IRE Show in March showed the many doubts that existed about the proper approach to the coming micromin era (*ED*, April 13, p 16). Since the military is the primary potential user of micromin, parts producers have looked to statements from the services to clarify the future.

In convention statements, and during interviews with *ELECTRONIC DESIGN*, some military leaders have spelled out as fully as they can at this juncture the direction of their intentions.

Col. Leon J. D. Rouge, components research director, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J., summed up a view that appears to be prevalent:

"As any improved circuitry technique demonstrates reliability equivalent to other techniques," he commented, "we will replace the old circuits with the new ones."

Lt. Col. Jeremy K. Schloss, chief of Wright Air Development Div.'s Electronics Technology Laboratory, backed up this view by indicating that various Air Force agencies are currently investigating micromodules, and if they are found reliable enough they will be used in Air Force equipment.

A second vital requirement was stressed in a recent speech by Vice Adm. Rawson Bennett, Chief of Naval Research, when he explained that

if a choice had to be made between two transceivers, one of wrist-watch size and 1-oz weight, and the other of billfold size and weighing 5 oz—the Navy would buy the smaller one only if it cost less.

A timetable for development of various microminiaturization concepts has been one of foggy issues in the program. Although solid circuits are now off-the-shelf items at Texas Instruments, Inc., and Westinghouse Electric Corp. has built operating functional blocks, the Air Force still considers the molecular electronics program to be in an "applied research" status, Colonel Schloss said.

He explained that current efforts can be considered a form study aimed at developing techniques for combining functional blocks. Westinghouse plans to produce blocks suitable for making a radio receiver by mid-1962, and Texas Instruments is building a small computer using blocks measuring 4 x 4 x 1 in.

Actual form will depend on requirements for particular equipment, Colonel Schloss commented. For example, if radiation will be a severe problem, encapsulation may be specified. This is necessary because unshielded semiconductor material could serve as a target for fast neutrons.

Heat dissipation is a problem receiving much attention now. Several approaches are being investigated including making use of the peltier effect.

New Problems With Functional Circuits

New design problems will arise with functional circuits, Colonel Schloss said. Interstage transformation effects must be considered, and

very low impedance levels may be required to avoid impedance matching problems.

The next two to five years will be spent in proving feasibility of the molecular electronics concept for usable equipment, according to Colonel Schloss. About \$2.4 million has been spent specifically on development of functional electronic blocks, he said, although developments



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HB-6	0-325	0-600 ma.	
SR12-50	5-13	0-50	0.1%
SR28-50	24-32	0-50	
SR48-30	44-52	0-30	
SM14-30	0-14	0-30	0.1%*
SM36-15	0-36	0-15	
SM75-8	0-75	0-8	
SM160-4	0-160	0-4	
SM325-2	0-325	0-2	

*0.01% models available on special order

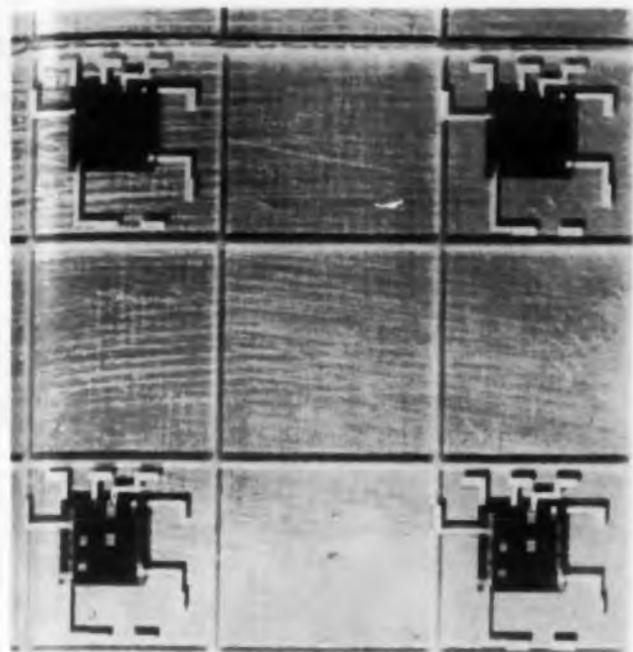
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in many other projects are also making contributions to this program.

The Army Signal Corps micromodule program, which has advanced to the prototype equipment stage, has a more detailed timetable. A front line combat radio, either for use in helmets or in the pocket, will be ready in prototype form by early fall of 1961, with final models scheduled for the



Technician removes micromodule flip-flop from the navigation computer used with the RCA micromodularized inertial-guidance system, upper and lower left. Pencil at lower left points out some of the preamplifier micromodules, which have been mounted on the inner gimbal of the guidance system to cut down on the number of slip-rings required. Size of encapsulated modules is illustrated above. This spoonful is equivalent to six transistor commercial receiver.

3 1/2"



MODEL HB-6M

8 3/4"



MODEL SR28-50

8 3/4"



MODEL SM36-15M

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NEWS

end of next year. Deliveries are set for 1962. A final prototype of a micromodule field computer is also scheduled for 1962.

Radio Corp. of America, prime contractor to the Signal Corps on this program, has already built an operating inertial guidance system using micromodules (*ED*, July 6, p 18). RCA is now working on a micromodulized digital differential analyzer to use with the guidance system.

Colonel Rouge feels that enough automation equipment will be installed by 1965 to make micromodules competitive pricewise with conventional components of comparable quality. Some sources at RCA are estimating a much more optimistic cross-over point of 1962.

First MICRAM Equipment Delivered

Progress is also being made by seven firms which are cooperating under a program known as MICRAM, for Microminiature Individual Component Reliable Assembled Modules. (*ED*, March 16, p 8.)

The first equipment produced under this program has just been delivered to the Army by Cleveland Metal Specialties Co., the coordinating firm in the program. Infrared devices and an electronic timing and fusing system are being produced using conventional microcomponents mounted on wafers.

Wafer size is not being standardized for this program according to Al Gross, chief engineer

What Happens To Designers In The Molecular Era

There will be a shift in design requirements rather than a replacement of circuit-design engineers when the functional block comes into use some years from now, according to Col. Leon J. D. Rouge, components research director, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J. Currently, Colonel Rouge pointed out, there are three basic types of designers—for components, circuits, and equipment. As technology moves into the functional block era, he predicted, there will be a progression to designers for functional networks, equipment, and systems. This amounts to one step up the ladder for each type, and will require just as many designers as are available now.



Flip-flop in a nutshell was shown at the recent National Convention on Military Electronics in Washington along with several other circuits produced under the MICRAM program. Cooperating firms are Cleveland Metal Specialties Co.; Aerovox Corp.; Formica Corp.; Pacific Semiconductors, Inc.; Raytheon Co.; Sylvania Electric Products, Inc.; and Wilrite Products, Inc.

for the Cleveland company. Although it has been suggested that MICRAM wafers be standardized at 1/3-in., to conform with the micromodule wafer size, Mr. Gross told *ELECTRONIC DESIGN* that present plans are to vary sizes to meet particular applications.

Greater Flexibility and Packing Density

This will permit much greater flexibility, and also allow much greater packing densities than can be accomplished with micromodules. Currently, Mr. Gross said, MICRAM wafers are being assembled with tweezers, soldering irons, and binocular microscopes. Automation of some of the procedures is possible, but this is not yet a prime requirement since only small lots are being produced.

Another technique which has great promise is the thin film deposition of circuit layers. Recent developments in the epitaxial vapor growth of semiconductors could permit complete circuits to be deposited in the form of a layered thin film. (ED, July 6, p 4.)

The current practice in the Army Signal Corps program limits each wafer to one manufacturing process. If the thin-film-deposition techniques demonstrate reliability, however, they might be used where small size is very vital.

IBM has developed automation equipment for alternate layer deposition on a circuit substrate using masks in sequence under vacuum. ■ ■

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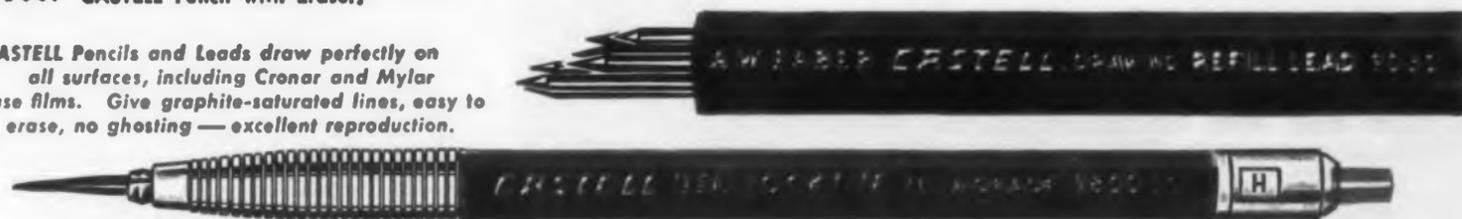
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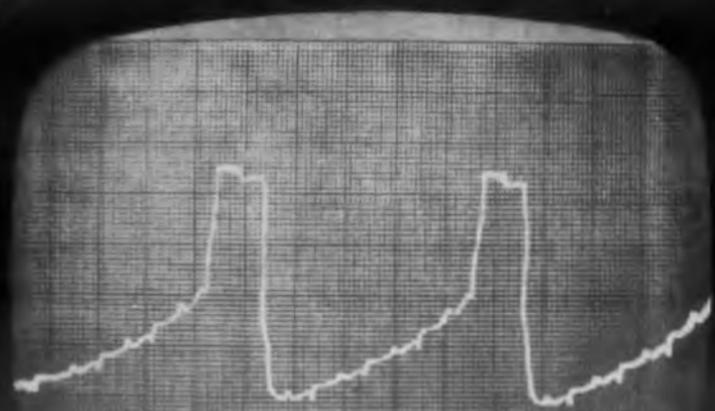
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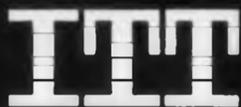
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CIRCLE 39 ON READER-SERVICE CARD

NEWS

Post Office Installing Electronic Handlers

*First Fully Automated Facility at Providence,
Electronically Controlled Equipment Throughout*

ELECTRO-MECHANICAL mail-handling equipment is now being installed at Providence, R.I., for the fall opening of Project Turnkey, the world's first fully automated post office. The electronically controlled equipment going into the automatic mail system includes:

- Facer-canceller
- Mail sorter
- Package sorter

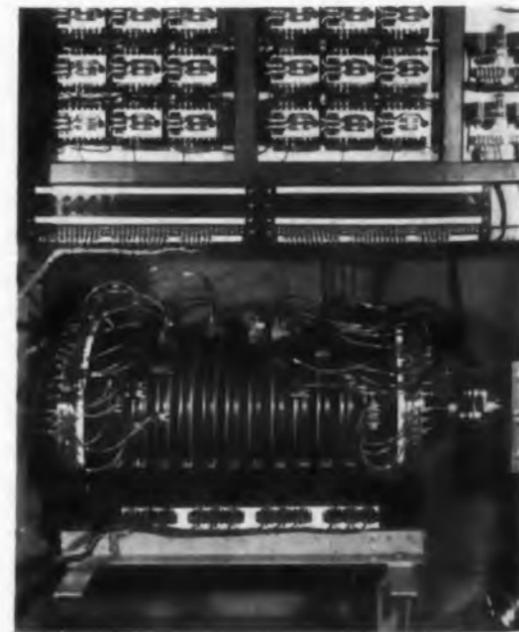
The facer-canceller examines each letter through a system of photocells to

determine the position of the stamp. A series of belts then turns the letter into either of two positions for canceling. The machine recognizes metered and unstamped mail and deflects it out of the canceling line. Colored stamps on colored envelopes do not confuse the machine; nor do picture postcards. Capacity is approximately 24,000 letters per hour. Six cancelling machines, manufactured by Standard Elektrik Lorenz of Germany, an International Telephone and Telegraph associate, will be installed.

The letter sorter is operated by six workers, each of whom punches a destination code into the machine as the letter moves past his work station. The code is stored in mechanical "combs" which travel along an endless belt. A separate comb is coded for each letter and travels on the belt in synchronism with the letter, which is meanwhile deposited into a box moving past a series of bins. When the comb reaches a position correspond-



Rube Goldberg appearance of facer-canceller belies its 24,000-letter-per-hour capacity. System of photocells controls belt drives moving letters through the machine to cancelling heads in foreground. Metered and unstamped mail is deflected into tray which is shown at the right of machine.



Magnetic drum memory of package sorter. Destination of packages traveling on pallets is written on drum by operators. When package is above its destination bin, command is given for the pallet to tip the package into the bin.



Electromechanical memory of letter sorter. Each "comb" is punched according to destination of a particular letter and travels along endless belt. Letter travels in a box on another belt in synchronism with the memory belt. Teeth on combs signal the box to open and to deposit letter into its proper destination bin. Two of the six encoding mechanisms controlled by the operators are visible at the bottom of the photo.

ing to the position of the box above its destination bin, the box is automatically opened and the letter falls into its proper bin.

The machine can sort up to 18,000 letters per hour in this manner into 300 destination bins. The Bell Telephone Manufacturing Co. of Belgium, another ITT associate, is providing 11 letter sorters for the Providence installation.

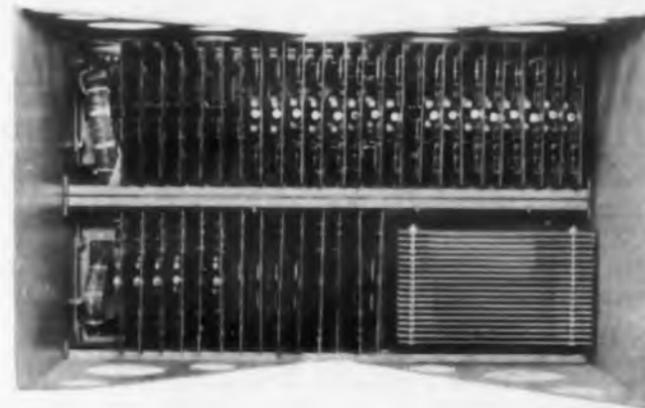
The package sorter, built by the J. B. Webb Conveyor Engineering Co. of Detroit, employs a magnetic storage drum as its memory. Packages are placed on tiltable pallets and destination coded by a keyboard operator. This code is stored on the drum and causes the pallet to dump the package when it passes above the correct destination bin. The machine can sort up to 14,400 parcels per hour to 32 destinations. Two package sorters will be installed initially, with two more to be added later.

In addition to these machines, a control center equipped with indicators, controls, and a communications system will direct traffic flow on the work floor. Automatic conveyors and chutes will be controlled from the center to move the mail from one machine to the next. ■ ■

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Designed for use in data systems requiring small, fast memories compatible with logical control at rates to 200 kc.

Capacity — 128 to 1024 words — 4 to 24 bits per word — larger capacities with multiple units. 5-microsecond load or unload — 8-microsecond complete memory cycle.

Operating Modes — Sequential load and unload — random access load and unload — clear/write and read/restore memory cycles. Operations may be intermixed in any manner desired.

Input and Output Signals — input may be either polarity and may be levels or pulses; output signals are levels.



TELEMETER MAGNETICS Inc

P. O. Box 329, Culver City, California

offices and plant: 9937 Jefferson Blvd., Culver City, California

PIONEERS IN DEVELOPMENT AND MANUFACTURE OF CORE MEMORY PRODUCTS

CIRCLE 40 ON READER-SERVICE CARD

WHY

PERMANENT MAGNETS ARE PERMANENT!

Study of Remanence by Indiana Steel indicates 100% stability can be achieved

Truly permanent permanent magnets are now possible, according to scientists of Indiana Steel Products Division, Indiana General Corporation. Proof of 100% stability of remanence was gained during a special research project conducted by Indiana and supported by funds of the United States Air Force.*

Natural Stability

Materials having a high coercive force displayed the greatest natural stability. For example, a sample of non-oriented barium ferrite (INDOX I) with an H_{ci} of 4,000 oersteds was measured for natural stability over a period of more than 5,000 hours. Relative remanence was 100% $\pm 0.1\%$. An oriented sample of the same material (INDOX V) with an H_{ci} of 2,030 oersteds measured 99.5% $\pm 0.1\%$. The material having the lowest coercive force—ALNICO III—also exhibited the least natural stability, 97.04% $\pm 0.05\%$.

A second important factor affecting natural stability was length-to-diameter ratio (L/D). It was found that rods of ALNICO V, having a greater L/D ratio, proved more stable. For example,

rods with a ratio of 8.7:1 showed no detectable loss in remanence during a year. Rods with an L/D of 2.1:1 logged only 97.6% for the same period.

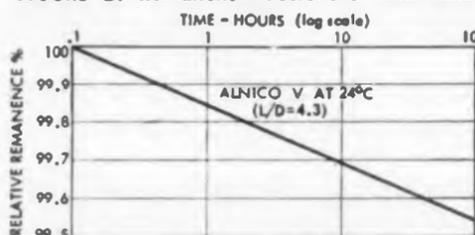
Where change in remanence was perceptible, it was found that it decreases linearly with the logarithm of time (see figure 2). This relation is expected to hold for all permanent magnets when they are undisturbed at room temperature and made of a material which does not change with time.

Test Conditions

During the study, sample magnets were kept in a special room where they were relatively free from such external demagnetizing influence as temperature variations, stray magnetic fields, short circuiting by iron contact and excessive movement or handling. Temperature was held virtually constant at 24° $\pm 2.5^\circ$ C.

The sensitive measuring apparatus was also located in the test room. Developed in 1948 by Dr. Rudolph Tenzer of Indiana Steel, this equipment permits measurements to an over-all tolerance of better than 1 in 10,000.

FIGURE 2. Remanence decreases with time



Artificial Stabilization

Critical space-age applications often require that a magnet be completely stabilized. Many methods for achieving this were surveyed. For critical applications, methods based on repetitive processes were found superior to those based on any sudden, one-time action. Two of these proved successful, both involving artificial reduction of remanence.

- 1. Temperature Knockdown.** ALNICO V magnets were repeatedly exposed to temperatures above and below the temperature of magnetization. Several cycles improved magnetic stability, while remanence was reduced somewhat as a result. Low temperature exposures, to -65° C, produced the greatest improvement in stability, as well as the greatest reduction in remanence.
- 2. Knockdown by Applied AC Field.** ALNICO V magnets were subjected to a cycling diminishing field, which also caused a reduction in remanence. Depending upon the material and its use, magnets were knocked down a predetermined amount between 5 and 15% to achieve complete stability. Variations in remanence were less than $\pm 0.03\%$, which is the limit of measuring accuracy for this size sample.

Conclusions

This study indicates that permanent magnets can be completely stabilized. A magnet, however, that is perfectly stable under these conditions can still be affected by larger temperature variations, stray magnetic fields, vibrations or many other factors. In the case of selected magnets, stability can be guaranteed for a flux change no greater than 0.01% per year.

For complete information on the practical aspects of "Stability," ask for a copy of *Applied Magnetism*, First Quarter, 1959. Write Dept. M-8.

FIGURE 1. Summary of Experimental Results

Material	L/D	Remanence Bd kilogauss	Stability Relative Remanence at 24° C 5 log cycles (10,000 hr) after magnetization	Measuring Accuracy
INDOX I	0.9	1.4	100.0%	$\pm .1\%$
INDOX V	0.8	2.5	99.6	$\pm .1$
ALNICO III	3.5	4.5	98.10	$\pm .04$
	2.2	3.2	97.04	$\pm .05$
ALNICO VII	3.5	4.9	99.32	$\pm .04$
	2.2	3.9	98.96	$\pm .06$
ALNICO V (long)	8.0+	12.3	99.95	$\pm .01$
(medium)	5.8	11.9	99.81	$\pm .02$
(short)	4.3	10.4	99.23	$\pm .02$
	3.5	8.2	98.84	$\pm .04$
	2.9	6.7	98.50	$\pm .05$
	2.1	4.1	97.6*	$\pm .07$

*Extrapolated 1 to 2 log cycles beyond last measurement.



INDIANA STEEL PRODUCTS

VALPARAISO, INDIANA

In Canada: The Indiana Steel Products Co. of Canada Limited, Kitchener, Ontario

INDIANA PERMANENT MAGNETS

CIRCLE 41 ON READER-SERVICE CARD

NEWS

Air Force To Test Eighteen Automatic Tutoring Machines

Eighteen automatic teaching machines, designed to increase speed and accuracy of learning, will be tested by the U.S. Air Force for training personnel in basic electronics.

Western Design, a division of U.S. Industries Inc. of New York City, has received an Air Force contract to produce the machines, known as the AutoTutor. The contract calls for both machines and training material to be service-trained at Keesler Air Force Base.

The AutoTutor is basically an automatic, random-access film projector. It presents either microfilmed or motion picture material to the student, examines him on each point presented, and requires him to demonstrate understanding before it will pass on the next point. At the same time, the AutoTutor keeps a detailed record of his progress.

The machine's functional specifications are:

- Selects and projects any one of 10,000 stored images when the number of the desired image is entered into the selector keyboard.
- Standard 35 mm motion picture film is used.
- The image is presented on a back projection screen with an image area of 8.2 in. x 11.2 in.
- Search speed is 24 images per second.
- The sequence of images viewed and the time spent viewing each are recorded numerically on tape.
- The search control unit is bi-directional; it searches forward or backward from any given position without resetting.

In addition to increasing the precision of the educational process, the AutoTutor speeds training by permitting each student to progress at his own maximum speed.

Ehrlicke Sees Manned Probes To Mars and Venus in Decade

Manned, nuclear-powered space ships may be blasting off for Mars and Venus within the next 10 or 11 years, Krafft Ehrlicke, rocket pioneer and program director for Convair Astronautics, has predicted.

At the Semi-Annual Meeting and Aviation Conference of the American Society of Mechanical Engineers, Mr. Ehrlicke said the scientific payload of instruments, probes and other equipment should be about 57,000 lbs for the flight to Mars and about 320,000 lbs for Venus.

The crew for Mars would take radiation coun-

CIRCLE 42 ON READER SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

ters, meteor-search radar and instrumented satellites to go into various orbits from the main ship, he said. Both recoverable and non-recoverable landing probes would be made to sample soil, air temperature, humidity, and sound.

He described the manned radar reconnaissance satellite for Venus as being able to eject a smaller satellite carrying part of the crew from the spaceship's regular orbit into the outer fringes of Venus' atmosphere.

For more detailed reconnaissance, several smaller instrumented satellites, atmospheric entry probes and a power plant and radar equipment for high-altitude reconnaissance would be ejected from the main vehicle.

Projection System Is Called Aid to Intelligence Briefings

A projection system, said to combine real-time display with large-screen performance, has been developed for use during military intelligence briefings. Called the Light Valve projection system, the device gives high brightness to TV images and other data projected on large screens, according to developer, General Electric Co.

In Light Valve projection, a special control layer modulates the light from a high intensity Xenon lamp. The optical characteristics of the control layer are changed by a beam from an electron gun which is controlled by the input signal.

The system is self-contained except for power supplies. A typical cabinet measures 63-1/4 x 41-1/4 x 25 in.

In addition to military uses, the company says the system opens new projection possibilities in the medical, educational, and commercial fields.

Computers Used To Simulate Blast Furnace Operations

Electronic computers are being used to simulate the operation of blast furnaces in studies aimed at increasing productive capacity at low cost.

Comparison of the computer predictions with former methods has shown computer predictions to be more reliable.

New steelmaking methods and rising costs have made it imperative that the production of iron and ferro-alloys be increased with as little investment as possible.

The results of the computer studies point to production increases of as much as 25 to 30 per cent in blast furnaces as well as other important gains in thermal efficiency and control.

◀ CIRCLE 42 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

10-inch high-quality Storatrons are available. Choice of electrostatically or magnetically deflected writing guns. The popularity of these tubes has been proved—a result of their overall quality of display plus excellent resolution and brightness.

Electrostatic tubes feature two identical writing guns—mounted along with a view gun on a single, sturdy, centrally located

mount for ease of control and operation.

Magnetic tubes feature a viewing gun axially located for uniformity of display and a writing gun placed for use with standard yokes. Both guns have standard miniature bases. These Storatrons are just two examples from the largest line of immediately available quality direct view storage tubes (2 3/4" to 21")—DU MONT STORATRONS.

Send for complete specifications including circuit information.

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See Us At WESCON Booths 1023 to 1026.

CIRCLE 43 ON READER-SERVICE CARD

Precision
**FREQUENCY
STANDARDS**
AND
**FORK OSCILLATOR
UNITS**

OUR NEW HOME, DOUBLING OUR FORMER CAPACITY

Watch Master
ELECTRONICS



Our instruments, 40 to 30,000 cycles, are used extensively by industry and on government projects where enduring accuracy and maximum durability are required. Your inquiries on related products are invited.

PRECISION FORK OSCILLATOR UNITS

TYPE 2003



Size 1½" dia. x 4½" H. Wght. 8 oz.
Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at -65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at -65° to 85°C)
Double triode and 5 pigtail parts required.
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

TYPE 2007-6



TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 360 to 1000 cycles
Accuracies:
2007-6 (±.02% at -50° to +85°C)
R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at -65° to +85°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

TYPE 2001-2



Size 3¼" x 4½" x 6" H., Wght. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3-12-28
B voltage, 100 to 300 V., at 5 to 10 ma.

ACCESSORY UNITS FOR 2001-2



L—For low frequencies multi-vibrator type, 40-200 cy.
D—For low frequencies counter type, 40-200 cy.
H—For high freqs, up to 30 KC.
M—Power Amplifier, 2W output.
P—Power supply.

PRECISION FREQUENCY STANDARDS

TYPE 2005A

Size 8" x 8" x 7¼" High
Weight, 14 lbs.

Frequencies:
50 to 400 cycles (Specify)
Accuracy:
±.001% from 20° to 30°C
Output, 10 Watts at 115V
Input, 115V. (50 to 400 cy.)



TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% 20° to 30°C
Input,
115V (50 to 400 cy.)



TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.

Frequencies: 50 to 1000 cy.
Accuracy:
(±.002% at 15° to 35°C)
Output: 115V, 75W.
Input: 115V, 50 to 75 cy.



WHEN REQUESTING INFORMATION, PLEASE SPECIFY TYPE NUMBER

ATA
**American Time Products
Inc.**
61-20 Woodside Avenue
Woodside 77, N. Y.

NEWS

Highly Reliable Resistors

METAL-FILM resistors with a reliability objective of 0.004 per cent per 1,000 hr at 25°C and at 0.5 rated load—reportedly an order of magnitude better than that of the best commercial resistors—will soon be available to designers.

The resistors are graded at 1/8 w at 125°C and are said to meet MIL-R-10509C. Key to their reliability, according to the manufacturer—International Resistance Co., Philadelphia—is the careful testing each resistor undergoes.

Tests are said to be made of: film adhesion to ceramic, temperature coefficient of film, solderability of the resistors' gold-plated terminals, pull qualities of leads, resistance from lead to edge of termination, absence of chips, and quality of the glass-to-glass hermetic seal.

A gas-leak test, in which the units are filled with helium, is also made, as well as a short overload test, during which the resistors are subjected to a 2.5-v overload. The resistors are also checked for resistance after two weeks under rated load.

Each resistor has a code number and its own individual IBM card. The card records the complete history of the resistor and is used to analyze the resistor's characteristics. Purchasers receive a card with each resistor.

The resistors, called "XLT" by their manufacturer, were developed for the Minuteman ICBM program under a contract from North American Aviation Co.

According to IRC, the XLT reliability ratings are supported by tests of 4,000 hr each on 65,000 units. In describing the reliability of the XLT resistors, the company defines failure statistically. That is, defects are not related to the specification but to the deviation from the statistical distribution established by the various tests. In this system, defects can be caused by departures from homogeneity in favorable as well as in unfavorable directions.

Tests made and tolerances required are:

- **Resistance**—Within 1 per cent of normal resistance.
- **Temperature cycling**—Change in resistance not to exceed ±0.2 per cent plus 0.05 ohm.
- **Low temperature operation**—Change in resistance not to exceed ±0.2 per cent plus 0.05 ohm.
- **Short-time overload**—Change in resistance not to exceed ±0.2 per cent plus 0.05 ohm.
- **Terminal strength**—Resistance will not change in excess of ±0.2 per cent plus 0.05 ohm.
- **Dielectric-withstanding voltage**—Change in resistance not to be greater than ±0.2 per cent plus 0.05 ohm.

Result from Rigid Tests

- **Insulation resistance**—Not less than 10,000 megohms.
- **Effect of soldering**—No change in resistance in excess of ± 0.1 per cent plus 0.05 ohm.
- **Moisture resistance**—Change in resistance between initial and final measurements not to exceed ± 0.5 per cent plus 0.05 ohm, and insulation resistance to be minimum of 100 megohm.
- **Resistance temperature characteristic**—Not to exceed 25 ppm at each of the required temperatures.
- **Load life**—Change in resistance between initial measurement and any succeeding measurement not in excess of ± 0.5 per cent plus 0.05 ohm.
- **Acceleration**—No change in resistance in excess of ± 0.2 per cent plus 0.05 ohm.
- **High-frequency vibration**—No change in resistance in excess of ± 0.2 per cent plus 0.05 ohm.
- **High-temperature exposure**—Change in resistance not to exceed ± 0.2 per cent plus 0.05 ohm.

Electrostatic Glass Shielding Shown At Design Show

Electrostatic glass shielding to prevent electromagnetic interference near computers, in laboratories, or similar uses was displayed by Corning Glass Works, Corning, N.Y., at the 1960 Design Engineering Show in New York.

The shields are borosilicate glass panels coated on one side with a 1/16-millionth-in. transparent metallic film. The coating, which intercepts radio frequency interference, can be grounded by conductive tape, a carbon button, or clamp-on spring. About 70 per cent of visible light is transmitted.

Applications include windows in computers to prevent buildup of spurious charges, shielding for low-level medical measurements, radio and TV studios, and other places where interference is an important problem.

The panels are available on special order in sizes up to 2 x 6 ft.

Minus Sneaks Into Plus Spot

A minus crept in where a plus should have been in the description of the character recognition machine being developed by Baird-Atomic, Inc., in *ED*, July 6, p 14.

The third paragraph on p 14 should have begun with $(P_i + N_i)$ rather than $(P_i - N_i)$.



Another Tinnerman Original...

Tinnerman Push-On SPEED NUTS® fasten with a "bite" that can't shake loose

In a split-second, this low-cost Tinnerman Push-On SPEED NUT arches its spring-stec! back, then bites hard to make a positive attachment on unthreaded studs, rivets, tubing, nails, jewels, small housings.

Application is easy—finger pressure starts it; a push with a simple hand tool locks it under live spring tension. No threads to worry about, no spot welding, no riveting, no special inserts, bushings or washers necessary. Elimination of extra parts and assembly operations may save you up to 50% or more in fastening costs.

Push-On SPEED NUTS lock on everything from thermoplastics to die-cast, chrome-plated steel. Hundreds of variations to fit any shape or size stud—from very small diameters to larger rectangular shapes. Some Push-Ons have "caps" that cover exposed shaft, axle or stud ends.

Check Sweet's Product Design File, section 8-T. Or look under "Fasteners" in the Yellow Pages and call your Tinnerman representative for complete information and samples. Or write to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®



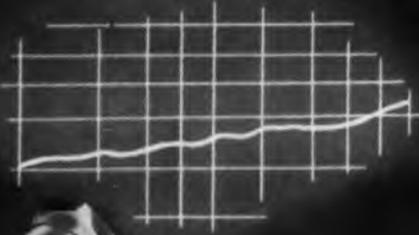
FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerospace Ltd., Treforest, Wales. FRANCE: Simmonds S.A., 3 rue Salomon de Rothschild, Sarcelles (Seine). GERMANY: Mecano-Brady GmbH, Heidelberg.

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NOW...

Miniature RF
Connectors
Match Electrical Specs...



of Standards!

NEW
GREMAR
Red Line
CONNECTORS
BRING RELIABLE
MINIATURIZATION
TO COAXIAL CABLE
ASSEMBLIES!

REPLACE STANDARDS WITH MINIATURES! Now, because of GREMAR CONNECTORICS (T), it is possible to miniaturize your RF cable assemblies and still maintain rigid electrical specs.

Red Line Miniatures, identified by their red Teflon insulation, are half the size and weight of the reliability-proved GREMAR TNC Connectors.

DESIGNED FOR USE WITH MIL-TYPE SUBMINIATURE COAXIAL CABLES, *Red Line* Miniature Connectors, and adapters feature:

- A new patented metal-to-metal cable clamping method which saves up to 80% of your cable assembly time while assuring a lower, more constant VSWR.
- Nominal 50 ohm characteristic impedance, 500 volts rms peak and 10,000 megacycles practical frequency limit.
- Operating temperature range: -65F to +350F.
- Meets or exceeds all applicable requirements of MIL-STD-202A and MIL-E-5272B.
- Configurations for all typical applications including adapters to BNC and TNC connectors.
- Metal parts are heavily silver plated for maximum corrosion-resistance... protected with Iridite to retard tarnishing. All contacts are gold-plated.
- Standard *Red Line* adapters and connectors are stocked for immediate delivery.



WRITE FOR BULLETIN 9 containing complete data on Greomar *Red Line* Miniatures. Literature on all other RF connectors is available for the asking.



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RELIABILITY THROUGH QUALITY CONTROL

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CIRCLE 46 ON READER-SERVICE CARD

NEWS

Superconductive Transitions Revealed by New Technique

A NEW TECHNIQUE enabling direct visual observation of metals in transition between the superconductive and normal states has been developed at the General Electric Research Laboratory, Schenectady, N.Y. The shift of metallic domains into and out of superconduction is clearly seen. The high resolution and fast response of this method suggest its application in the design of cryotrons, superconducting gyros, and other low-temperature electronic devices.

A combination of magnetic and optical effects is used. Since metals in their superconductive state are essentially perfect magnetic insulators, the flux distribution within a specimen in a magnetic field corresponds exactly to the arrangement of superconductive domains in the metal. This flux pattern is rendered visible by its effect on the polarizing action of certain kinds of glass (the Faraday effect).

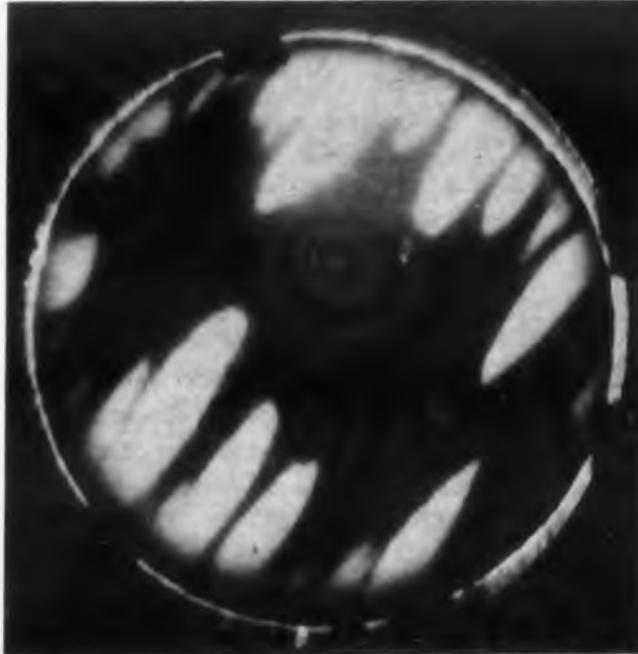
A sample disk of the metal under study is covered with a 0.01-in.-thick sheet of cerium metaphosphate glass which polarizes reflected light according to the intensity of the magnetic field present. Monochromatic, polarized light from

a mercury arc is beamed at the glass. The light reflected from the glass, now repolarized in certain areas due to non-superconductive domains in the sample at those areas, is observed or photographed through an analyzer.

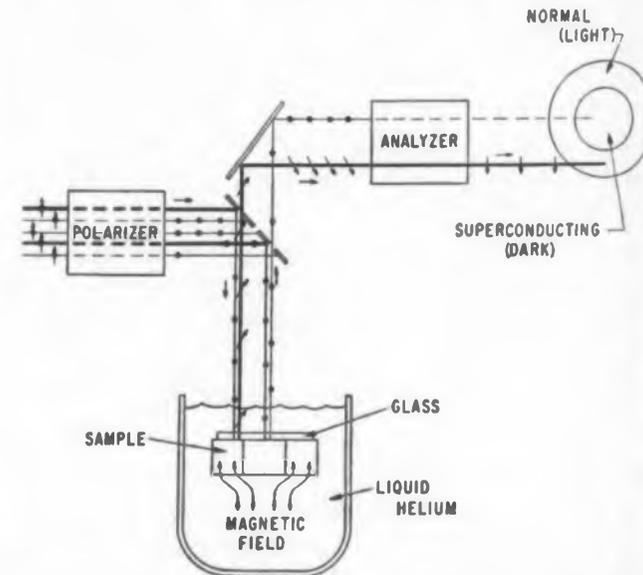
The sample and glass are housed in a vacuum chamber which is immersed in a 1.5 K liquid helium bath. A magnetic field on the order of 250 oersted is applied transversely to the sample by a solenoid. The glass, available from Bausch and Lomb, rotates polarized light approximately 5 deg/100 oersted/mm at 1.5 K. This shift is sufficient to permit ready observation and photography of time-dependent superconductive domain transitions. Conventional methods employ ferromagnetic powder which gathers in non-superconductive regions. This is, however, slow-acting and offers poor resolution in that the powder tends to adhere at small surface imperfections.

Movies Showing Method Available

Dr. Warren DeSorbo and W. A. Healy developed the magneto-optical technique from an approach originally used at the Naval Research Laboratory by Dr. Perry Alers. Dr. Alers applied



Superconductive domains in a thin tantalum sheet appear as dark areas. Magneto-optical technique developed by Dr. Warren DeSorbo at GE Research Laboratory permits direct visual observation of intermediate superconductive state. Normal areas shown in white, are elongated in the direction in which the sheet was rolled.



Polarized light is the key to observation of superconductive and normal areas of a sample. As shown in this schematic diagram of the new method, polarized light is shifted by the glass at areas where the sample is normal, but remains unaffected where the sample is superconductive. Resultant light and dark pattern is observed through an analyzer.

a cerous nitrate glycerol solution to his samples and obtained similar though less effective results. During the last three months Dr. DeSorbo has analyzed several dozen samples of various metals using the new technique. Motion pictures of his findings are available on request. A second film which also describes the laboratory apparatus and technique will be available in about two months.

Computer Diagnosis of Ills Envisioned in 10 to 50 Years

Medical diagnosis of human ills may be performed with the aid of computers in "ten or twenty or fifty years," two physiologists told a session of the Semi-Annual Meeting of the American Society of Mechanical Engineers.

Mechanical simulation of the living human body is already a valuable aid, the session heard. Attendants at the Dallas meeting agreed that medical science would be in a poor state without the contributions of mechanical processes, mathematics and computers.

As an example of simulation of human functions, the session was told of experiments in which arteries had been equated with a rubber tube filled with water. Studies made of these rubber-tube systems yielded information on the behavior of arterial pulses. The simulated systems were adjusted until their pulses matched that of a human.

Doctors can now feed data on a patient's arterial system into a computer and, by determining the difference between that data and information for a normal artery, can determine whether the patient's system is normal.

According to R. W. Stacy, associate professor of physiology and biophysics, and N. A. Coulter Jr., assistant professor of physiology and biophysics, both of Ohio State University, the future for simulation of bodily processes by formulas on a computer is bright.

"It is conceivable," the two reported, "that after ten or twenty or fifty years of development . . . a physician can collect his data on a patient whose diagnosis is not obvious . . . then transmit these data to a central medical computing agency. The computer then . . . returns to the physician an analysis stating the most probable diagnosis, the probability function associated with this diagnosis, a second most probable diagnosis with similar information and perhaps even a recommendation for further data collection or for treatment."

The physiologists concluded: "Perhaps at this point, we may be permitted to speculate even further. The ultimate step in the process of simulation would be the design of an artificial brain."



WESTON "CROWN" METERS OFFER HIGH PERFORMANCE AT LOW COST

*New AC instrument now available in
economy line of matched panel meters*

A newly-designed AC moving iron instrument with improved ballistic characteristics joins the Weston line of "Crown" meters. Instruments in this matched group combine economy with dependable accuracy, and incorporate many time-proven Weston features.

Exclusive Weston CORMAG[®] self-shielded mechanisms, for example, permit mounting on magnetic or non-magnetic panels without special adjustment. Instruments with this important feature may be closely grouped without intereffects, and are immune to stray field errors.

Exceptional readability is another advantage of "Crown" meters. Models 1721 and 1724 have 2.5" long scales, Model 1741 has a 4.9" scale. Clear plastic covers provide excellent, shadow-free illumination. Black lance pointers and black markings on white dial further enhance readability.

Accuracies within $\pm 2\%$ full scale are available in DC and moving iron AC meters, and $\pm 3\%$ in rectifier types.

Call your Weston representative for specifications on "Crown" instruments, or write for Catalog 01-112.

Daystrom, Incorporated, Weston Instruments Division,
Newark 12, New Jersey. *International Sales Division,*
100 Empire St., Newark 12, N. J. *In Canada: Daystrom Ltd.,*
840 Caledonia Rd., Toronto 19, Ontario.

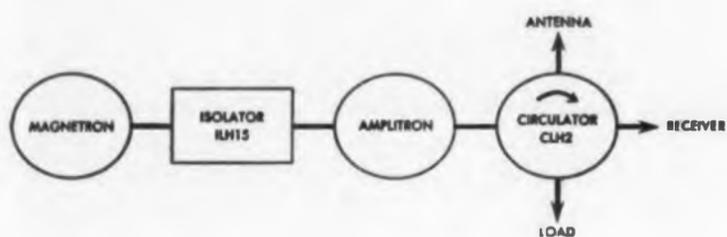


New Model 1724 AC instrument with moving iron mechanism has a 2.25" long scale. Supplied as: voltmeters, ammeters, milliammeters. Model 1721 (2.5" scale) and Model 1741 (4.9" scale) are supplied as: DC voltmeters, ammeters, milli- and microammeters. Rectifier-type AC Model 1722 (2.5" scale) is supplied as: Voltmeters (1,000 ohms/volt), milli- and microammeters.

DAYSTROM, INCORPORATED
WESTON INSTRUMENTS DIVISION
Weston for Dependable Accuracy.

CIRCLE 47 ON READER-SERVICE CARD

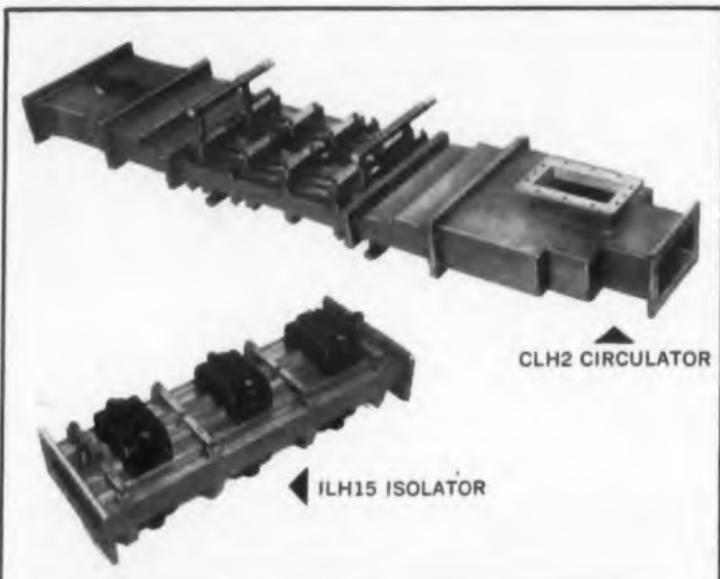
FERRITE DEVICES FOR HIGH-POWER RADAR



RAYTHEON ISOLATORS AND CIRCULATORS IN IMPROVED L-BAND "FLIGHT TRACKER" SYSTEM THAT BOOSTS OUTPUT TO MORE THAN 5 MEGAWATTS

With an output of more than 5 megawatts at 1,280 to 1,350 mc., the improved FAA "Flight Tracker" radar system has *ten times* the power of its predecessor. In the microwave generator and amplifier circuits, Raytheon isolators and circulators help achieve this power level by providing the required broadband match between magnetron and Amplitron®...and between Amplitron and antenna. The isolator also aids in maintaining frequency stability during the 5 megawatt pulse peaks by acting as a buffer between magnetron and Amplitron.

The L-band ILH15 isolator and CLH2 circulator in the "Flight Tracker" are part of Raytheon's line of L-band devices with ratings from 1.5 to 10 kilowatts average and peak power capabilities as high as 6.5 megawatts.



TYPICAL SPECIFICATIONS

	ILH15 ISOLATOR	CLH2 CIRCULATOR
Frequency range (mc)	1250-1350	1280-1350
Power, average	2.5 KW	5 KW
Power, peak	2 MW	6.5 MW
Isolation, min.	22db	26db
Isolation, max.	24db	32db
Insertion loss, min.	.7db	.65db
Insertion loss, max.	.9db	.8db
VSWR, min.	1.28	1.04
VSWR, max.	1.30	1.12
Weight, lbs.	60	140
Length, in.	22	69½
Flanges	½ ht. L-band	mates with UG418/U
Waveguide (liq. cooled)	½ ht. L-band	WR 650

See our newest devices at Wescon, Booths 2052-3
CIRCLE 48 ON READER-SERVICE CARD



On Massachusetts' Route 128 in the Waltham Industrial Park, Raytheon has recently opened the most modern facility devoted exclusively to microwave ferrite device and materials development, testing and production. To learn more about the work now underway at these new facilities, or for information on your particular microwave ferrite problem, please write to the address below.

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SPECIAL MICROWAVE DEVICE OPERATIONS
WALTHAM INDUSTRIAL PARK
WALTHAM 54, MASSACHUSETTS

In Canada, contact Raytheon Canada, Ltd.,
P. O. Box 153, Waterloo, Ontario



Excellence in Electronics

NEWS

Japanese Television Is Seen No Threat to U.S. Market

Tokyo shoppers in the market for a TV receiver must pay \$150 for a 14-in. portable and as high as \$320 for a 21-in. table model. When shipping charges plus import duty are added to these figures, it becomes obvious that the threat of Japanese TV flooding the U.S. market is relatively unlikely. However, Dr. Milton Goldstein, Dean and Director of Research, cautioned that a price cut-back could take place in the event the Japanese home market becomes saturated and other markets are needed.

Addressing radio and TV design engineers attending the Chicago Spring Conference on Broadcast and TV Receivers, Dr. Goldstein outlined the growth of the seven-year old Japanese TV industry. Over 40 per cent of the Japanese electronic production, or \$350 million, was directed toward TV. As an example of the rapid growth still in progress, about 50 TV stations were broadcasting in early 1960, 90 are on the air now and 27 more are scheduled for operation before the end of the year. Surveys indicate that one of every five homes in Japan boasts a TV set. Considering the fact that a 14-in. set costs \$150 and the average electronic worker's salary (including fringe benefits, not take-home pay) is \$125 to \$150, the percentage of TV owners is quite high.

The 14-in. size represents about 80 per cent of the total TV market with the 8-in. "small screen" and 21-in. expensive models finding little interest. Japanese receivers are sold with a one-year labor and parts guarantee compared to 90 days for U.S. merchandise, Dr. Goldstein stated. It is customary, he added, for the repair agency to supply a substitute set for the time during which repair work is needed.

Japanese Electronic Exports To U.S. Rise 350% in Year

Japanese electronic exports to the U.S. climbed to \$75.6 million in 1959, according to figures released by the U.S. Dept. of Commerce. This was an increase of 350 per cent over 1958.

Most of this increase was accounted for by radios, of which more than 6 million were imported in 1959, compared with 2.5 million in 1958. The bulk of these radios contained three or more transistors each.

Heavy imports in other types of electronic gear during 1959 included:

Capacitors—8.9 million.

Vacuum tubes—7.9 million.

Loose transistors—2.4 million.

Earphones—2.7 million.

The average prices at which these components were imported were given as: radios, \$14.30; capacitors, 6 cents; vacuum tubes, 27 cents; transistors, 66 cents, and earphones, 44 cents.

Electronics is now Japan's second largest export industry. The U.S. is the largest customer for the exports accounting for 56 per cent of Japan's foreign electronic equipment sales.

The rise in exports of Japanese electronic products accomplished record production by the Japanese electronics industry, the Dept. of Commerce reports.

Electronics production in Japan in 1959 was valued at \$936 million, according to the department. This compares with \$498 million in 1958. The record level is attributed chiefly to the accelerated production of consumer electronics products, which rose to \$531 million in 1959, more than the output of all electronic products in 1958.

Japanese Electronics Production, 1959, 1958 (Value in millions of dollars)

	1958	1959
Consumer electronic products	266.2	531.4
Commercial, industrial and military electronic equipment	85.2	110.6
Electron tubes	76.5	141.1
Semiconductor devices	24.5	52.9
Other electronic components	45.6	99.7
	498.0	935.7

Vibration Tester Installed at GE



A new vibration-test facility for the precision testing of flight and fire-control components has been developed at General Electric Light Military Electronics Dept., Johnson City, N.Y. The 15,000 lb force, electronically driven, oscillator-controlled machine, called the C-200, performs sinusoidal vibration testing at temperature ranges of -65 to +200 F and is specially equipped with an oil-film table for difficult testing in the horizontal mode. A technician tests a sight amplifier, the F-104.

DEAD

END

for

high

power
problems



SPERRY E42C1 RADAR SYSTEM WATER LOAD

The problems of handling high peak and average powers in ground based radar systems are ended completely by the new Sperry Water Load. Small and rugged, where previous units have been both large and delicate, this termination can handle extremes of power easily, and with relatively low water flow. Most other liquid coolants may also be used.

The Water Load is one integral unit with standard flanges, and input and output water ports with standard pipe fittings. The unit may be easily adapted to existing systems, and can replace antennas of every type for test and other purposes.

Used with thermocouples to measure incoming vs. outgoing water temperatures—plus a flow meter—the Water Load becomes a calorimeter to compute average system power.

Many other high power lab, test and research uses will suggest themselves. Address inquiries to Clearwater, outlining your projected application. *Sample quantities available for evaluation.* Please write us stating your requirements and frequency band.



Typical Specifications:

Model	Peak Power	Average Power	Height	Length	Weight
E42C1 (illustrated)	3.0 mw	4.5 kw	3 3/8"	6 3/4"	3 lbs.

SPERRY MICROWAVE ELECTRONICS COMPANY, CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION
CIRCLE 49 ON READER-SERVICE CARD



ELECTRONIC DESIGN maintains a policy which demands accuracy . . . accuracy on which its 36,000 readers have

learned to rely in keeping themselves informed of the very latest electronic developments.

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Recognizing the power of the printed word to influence, it is *ELECTRONIC DESIGN'S* policy:

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To publish promptly corrections brought to our attention.

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It is through such dual guardianship—readers and editors—that *ELECTRONIC DESIGN* guarantees highest reliability and detailed coverage.

NEWS

Electromagnet Measures Blood

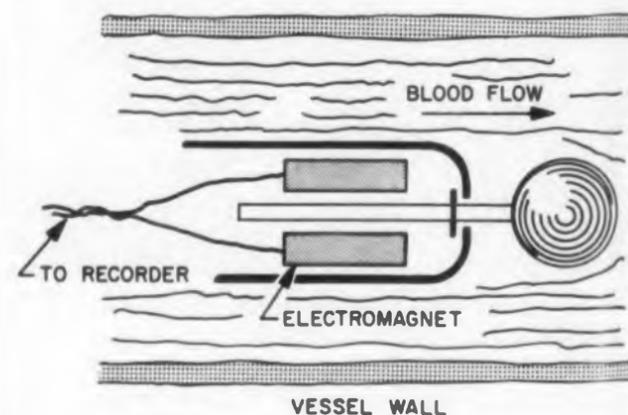
Instrument Under Development At Franklin Institute Labs

DIRECT measurement of blood flow within the heart is promised by a sub-miniature electromagnetic device now in development at the Franklin Institute, Philadelphia. The instrument consists of a tiny ball restrained by an electromagnet and is inserted directly into a blood vessel at the end of a long, flexible tube. Viscous drag exerted on the ball by the blood stream displaces an iron rod within the magnet thereby providing a readily measurable change in magnet current proportional to flow velocity.

Work to date has resulted in a 6-mm diam unit which has been tested only in conditions simulat-



Blood flow meter components shown here are too large for animal or human use. The 6-mm ball was used in simulated flow experiments. Both the magnet coil and its plastic bobbin are illustrated. The ball is machined of Teflon or other physiologically inert material.



Iron rod through electromagnet is displaced by the viscous drag exerted on the ball in the blood stream. Resulting change in magnet current gives accurate indication of flow velocity.

Blood Flow Within Heart

ing blood flow. A 3-mm device is being assembled for use with experimental animals and will be followed by a 1.6-mm device suitable for human patients. For best results, the meter should not be larger than 1/10th the diameter of the vessel in which it operates.

Accuracies to within 5 per cent are thought to be attainable, but a blood flow meter having even a 20 per cent error would be welcomed as a significant improvement over present methods. Even greater accuracies may be achieved by substituting a differential transformer for the electromagnet. This would maintain a fixed extension of the ball at all flow velocities and minimizing inaccuracies due to differing hydrodynamic conditions at various ball positions.

In use, the flows meter ball undergoes a maximum excursion of ± 0.075 in. Signal-to-noise ratio very good. Input to the magnet coil is about 10 vdc on which is superimposed a 1500-cycle signal at about 5 v rms. The alternating current imparts a slight vibration to the ball which prevents the accumulation of fibrous deposits on it during the hour or so that the ball remains in the blood stream.

The flow meter is being developed by John H. Busser, senior staff engineer at the Franklin Institute. The National Institutes of Health are supporting the program. ■ ■

Portable Checkout Receiver To Be Developed for JPL

Jet Propulsion Laboratory has awarded a contract for development of a tiny, all-transistorized portable telemetry checkout receiver to Leach Corp.'s Communications Div. at Compton, Calif.

The device will be an ultra-high frequency phase-lock receiver intended for demodulation of sub-carrier tones and used for calibration and confidence checks of telemetry and command systems in laboratory or field applications. It will be made to be hand-carried up into the gantry.

Specifications call for the unit to be approximately 160 cu in. Powered from a 28-v dc power supply, it is designed for detection of phase-modulated signals at either end of two fixed-carrier frequencies.

Sylvania announces a major breakthrough in

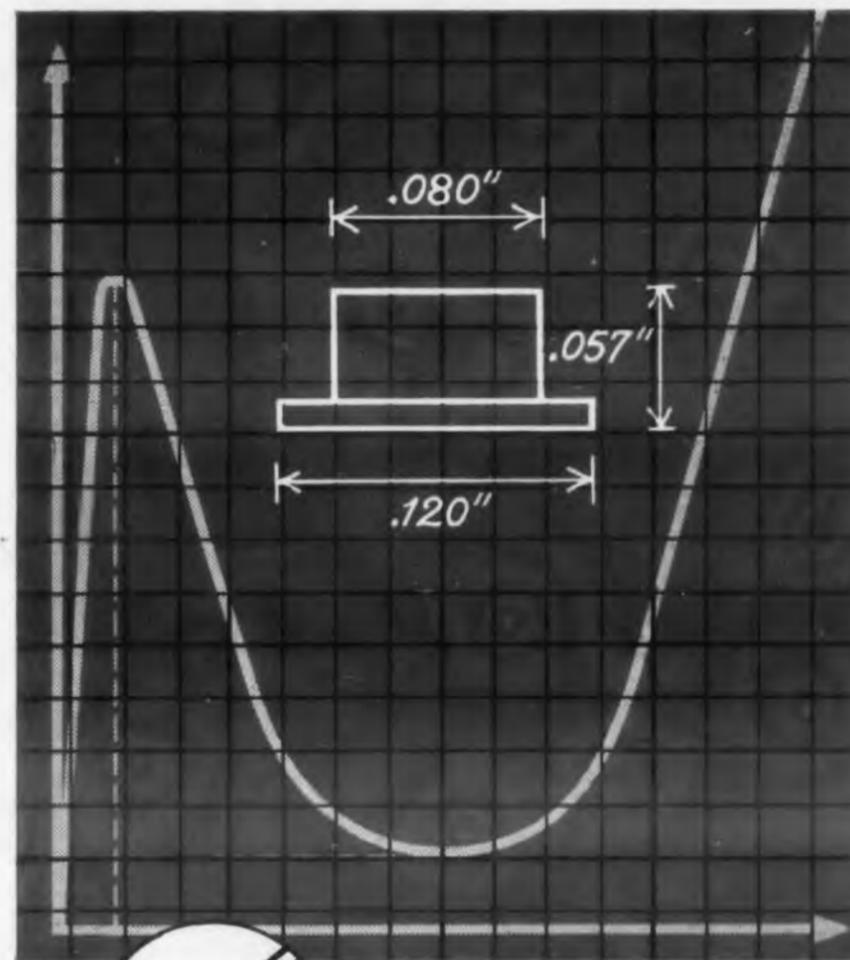
TUNNEL DIODES

...featuring oscillation capabilities at unusually high frequencies...

2 KMC MINIMUM
with type D4115

3 KMC MINIMUM
with type D4115A

4 KMC MINIMUM
with type D4115B



- basic package design offers potential of 10 KMC operation
- ruggedness proved—withstands 500G 1-millisecond shock test
- hermetic ceramic-to-metal seal—Sylvania tunnel units will pass MIL moisture tests

ELECTRICAL CHARACTERISTICS—SYLVANIA TUNNEL DIODES

	D4115	D4115A	D4115B
Measured Oscillation Freq.	2 KMC min.	3 KMC min.	4 KMC min.
I_D	1.8 mA typ.	1.7 mA typ.	1.6 mA typ.
$I_D : I_V$	5:1 min.	5:1 min.	5:1 min.
V_V	350 mV typ.	350 mV typ.	350 mV typ.
V_D	55 mV typ.	55 mV typ.	55 mV typ.
R_s	1 ohm typ.	2 ohm typ.	3 ohm typ.
C	8 μ f typ.	6 μ f typ.	4 μ f typ.

Sylvania Tunnel Diodes are now available in limited quantities for engineering evaluation. Start your investigations of the exciting tunnel phenomenon with advance-design Sylvania units. For details on price and delivery, contact the Field Engineer at your nearest Sylvania Field Office.

SYLVANIA FIELD OFFICES: BALTIMORE, MD., 6301 Harford Rd., Baltimore 14, Md., Clifton 4-7333 BOSTON, MASS., 100 Sylvan Rd., Woburn, Mass. Wells 3-3500 CHICAGO, ILL., 2001 N. Cornell Ave., Melrose Park, Ill., Fillmore 5-0100 CINCINNATI, OHIO, 411 Oak St., Cincinnati, Ohio, Plaza 1-8464 DALLAS, TEXAS, 100 Fordyce St., Dallas, Texas, Riverside 1-4836 DAYTON, OHIO, 333 West First St., Dayton, Ohio, Baldwin 3-6227 LOS ANGELES, CALIF., 6506 E. Gayhart St., Los Angeles, Calif., Raymond 3-6371 NEW YORK, N. Y., 1000 Huyler St., Teterboro, N. J., Atlas 2-9484 ORLANDO, FLA., P. O. Box 7248, Orlando, Fla., Cypress 3-4289 PHILADELPHIA, PA., 4700 Parkside Ave., Philadelphia 31, Pa., Greenwood 7-5000 SAN FRANCISCO, CALIF., 1811 Adrian Rd., Burlingame, Calif., Oxford 7-3600 SENECA FALLS, N. Y., Logan 8-6881 SYRACUSE, N. Y., 6700 W. Genesee St., Camillus, N. Y., Orange 2-3111 WASHINGTON, D. C., 1200-08 Walker Bldg., 734 16 St., N. W., Republic 7-7733

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Epsco COMPONENTS

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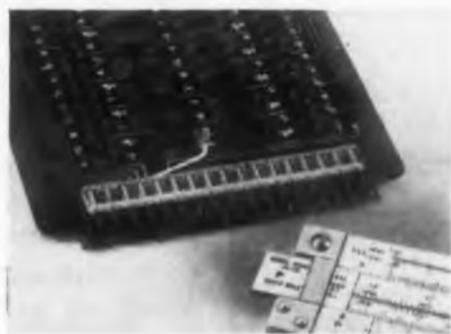
Digital circuitry and control instrumentation is easier, quicker, surer with Epsco Components. The line is the broadest in the industry, answering more of your circuitry needs. It includes Transistor Digital Circuits — plug-in modules or printed circuit cards — and Magnetic Components — logic elements, shift register assemblies, and buffers. All types are electronically

compatible, to simplify system design and construction. They are ideal as design tools in blocking out logic circuitry and prototype assembly. Epsco's quality control program assures their reliability. All TDC Modules and Cards are supplied with individual connectors. Their low cost and immediate availability from inventory are assured by Epsco's volume production.



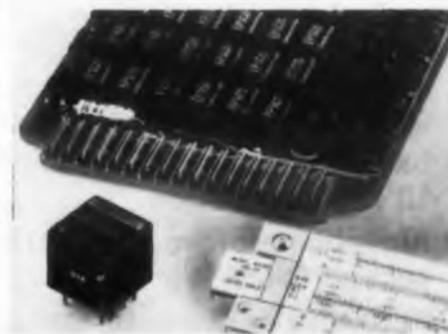
TDC Miniaturized Plug-in Modules

Clamped saturating logic circuitry, encapsulated for ruggedness and compactness, designed for wide tolerance, low noise. Temperature ranges -55°C . to $+71^{\circ}\text{C}$. Frequencies in excess of 1 MC. Most economical approach to small system design, military and industrial equipment. (Now available — new Module Cage for high density packaging in systems.)



TDC Printed Circuit Cards

Complementing plug-in line, with identical circuitry. System-designed with wide loading tolerances and high noise thresholds, providing high packing density and cooling efficiency. Test points and visual indicators speed testing and servicing. Proven in military, general purpose and commercial applications. (Now available — Card Cage for optimum utilization of this line.)



Magnetics

Logic elements and Shift Register Assemblies for high density, low cost, information storage, completely compatible with transistor logic circuitry. Ruggedized performance under the most adverse environmental conditions. Full range of frequencies to 250kc. (Complete line of transistor drivers complements these magnetic circuits.)

Magnetic Buffer Memory Units

Variable word and message length. Read-Write cycle speeds to 100 kc., programming for sequential or random access, destructive or non-destructive read-out. Compatibility with TDCs permits direct communication between system's logic and memory areas. Built to your specifications from standard modules for prompt delivery.

Seminars

To help you learn about digital applications and system design with Epsco Components, we offer a seminar program with an operating demonstrator.

A request on your letterhead will bring you additional information about these seminars.



CIRCLE 50 ON READER-SERVICE CARD

NEWS

Microwave Rectifier Tube Des

High-Vacuum Device Could Be Used In Sky-Station Communications Link

A NEW DEVICE for converting beamed microwave energy to any lower frequency or dc has been operated with 40 per cent efficiency at Raytheon Co.'s Spencer Laboratory, Burlington, Mass.

The microwave rectifier, designated Microfier, is a high-vacuum device which could be used in a sky-station relay link for communications, TV, or other transmission. The stationary sky platform would be powered from the ground by directed, narrow-beam microwave energy.

When the sky-platform idea was first recommended by Raytheon (*ED*, June 10, 1959, p 3) it was suggested that microwave energy could be converted to heat to drive the rotor blades used to keep the platform in the air. If electrical energy was required in the station an inefficient conversion from heat back to dc or a low frequency would probably be required.

The Microfier, however, should be capable of directly converting part of the beamed energy to the required low frequency or dc for electronic equipment at efficiencies in the 70 to 80 per cent range.

The Microfier is a high-vacuum, traveling-wave device, producible using standard vacuum-tube technology. Conversion is accomplished by crossed



Microfier experiment is conducted at Raytheon's Crossed Field Tube Lab by John Jensen, staff engineer. Electromagnets are at left, and a QK625 M-Type backward wave oscillator delivering 200 w of cw at S-band is at right. The converter, with a 2-in. metal band around it, is located between the pole pieces of the electromagnets.

Tube Designed at Raytheon

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field interaction of waves and an electron beam.

Using vacuum promises long life and little change in characteristics over long periods, which would be difficult to achieve with ionized-gas filled tubes.

Dc-bias voltages are necessary to operate the Microfier. These can be provided by using some of the converted microwave energy once the tube is in operation, however a small dc power source will be required for starting.

Initial laboratory tests were performed at "hundreds of watts," according to Edward Dench, manager of Raytheon's Crossed Field Tube Laboratory.

"We can foresee levels of tens of kilowatts at least with no difficulties," he said.

Mr. Dench estimated that a Microfier weighing about 20 pounds should be capable of handling power levels of 1 or 2 kw.

Initial Tests at S-Band

The initial Raytheon tests were conducted at S-band using modified rather than specially designed equipment for the experiment according to Dr. John M. Osepchuk, staff engineer, who is in charge of the project.

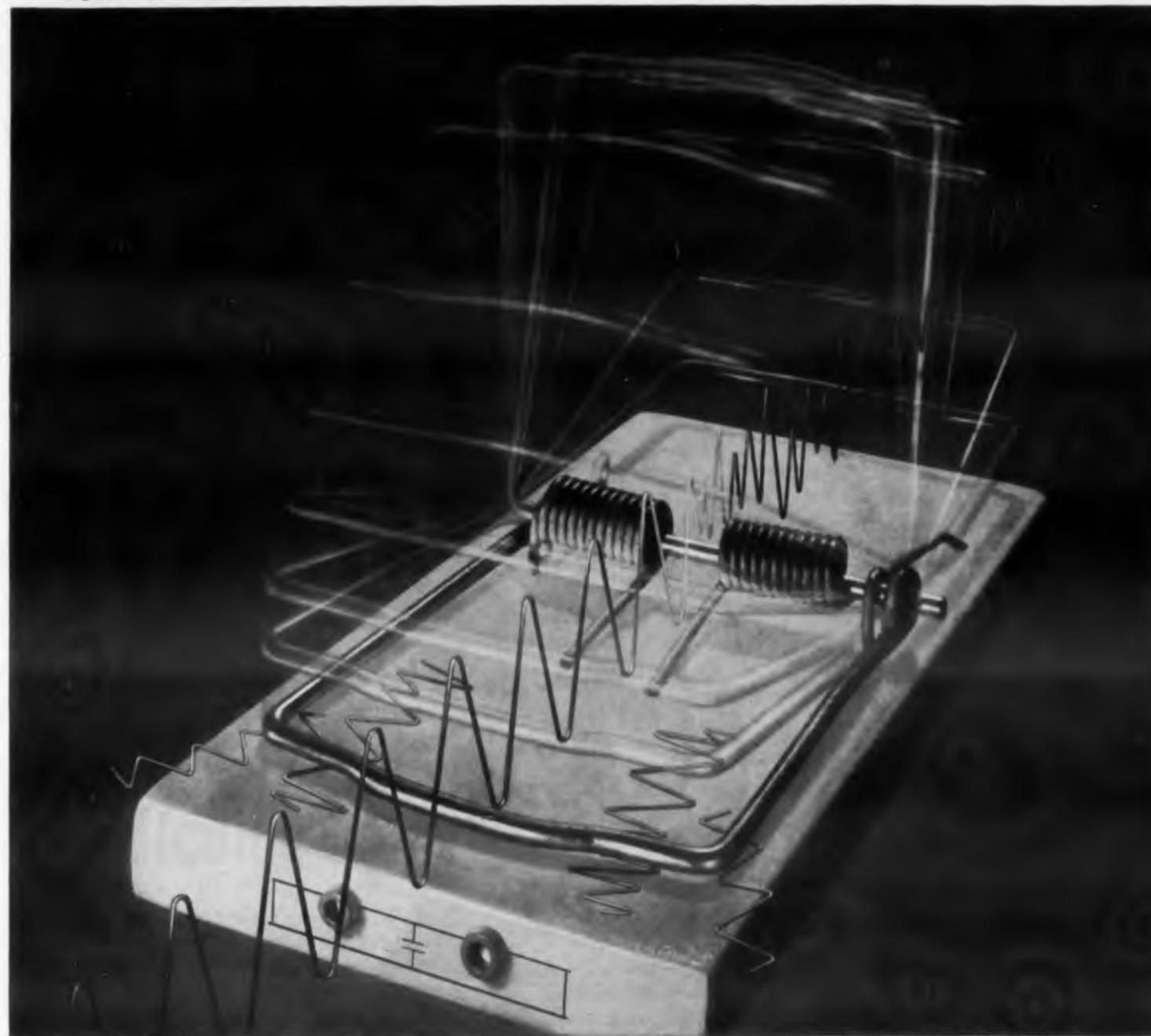
This laboratory model used about 1/3 of the dc produced for biasing, however with specially designed equipment it should require about 10 per cent of the converted energy to bias the Microfier.

The 40 per cent efficiency was determined by subtracting the dc biasing power from the dc output, and dividing this figure by received power minus a small amount of rf exhaust power which might be used for some application in the sky platform.

Although other applications for the device have not been fully explored, it might find use where it is difficult to install or maintain cables to remote transmitting or relay stations. Beamed microwave energy might be used instead of cables.

Interrogation of sonar buoys is another possible application of the beamed-power technique.

Now that feasibility of the Microfier has been proven, further development is being held up until its use is called for in a specific project, according to Mr. Dench. ■ ■



How to build a better (audio signal) trap!

Magnetics Inc. permalloy powder cores give filter designers new attenuation and stability standards—and miniaturization to boot!

The art of trapping unwanted frequencies has been advanced during the past year with a succession of improvements in molybdenum permalloy powder cores by Magnetics Inc. Most audio filter designers now work with smaller cores, more stable cores and cores whose attenuation characteristics are ultra-sharp. Do you?

Do you, for example, specify our 160-mu cores when space is a problem? With this higher inductance, you need at least 10 percent fewer turns for a given inductance than with the 125-mu core. What's more, you can use heavier wire, and thus cut down d-c resistance.

What about temperature stability? Our linear cores are used with polystyrene capacitors, cutting costs in half compared to temperature stabilized moly-permalloy cores with silvered mica capacitors. Yet frequency stability over a wide swing in ambient temperatures is increased!

And what do you specify when you must rigidly define channel cut-offs, with sharp, permanent attenuation at channel crossovers? Our moly-permalloy cores have virtually no resistive component, so there is almost no core loss. The resultant high Q means sharp attenuation of blocked frequencies in high and low band pass ranges.

Why not write for complete information? Like all of our components, molybdenum permalloy powder cores are performance-guaranteed to standards unsurpassed in the industry. Magnetics Inc., Dept. ED-82, Butler, Pa.

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WHICH JOB WOULD YOU TAKE?

If you're like most of us, you'd take the job with the more tempting salary and the brighter future.

Many college teachers are faced with this kind of decision year after year. In fact, many of them are virtually bombarded with tempting offers from business and industry. And each year many of them, dedicated but discouraged, leave the campus for jobs that pay fair, competitive salaries.

Can you blame them?

These men are not opportunists. Most of them would do anything in their power to continue to teach. But with families to feed and clothe and educate, they just can't make a go of it. They are virtually

forced into better paying fields.

In the face of this growing teacher shortage, college applications are expected to *double* within ten years.

At the rate we are going, we will soon have a very real crisis on our hands.

We *must* reverse this disastrous trend. You can help. Support the college of your choice today. Help it to expand its facilities and to pay teachers the salaries they deserve. Our whole future as a nation may depend on it.

It's important for you to know more about what the impending college crisis means to you. Write for a free booklet to: HIGHER EDUCATION, Box 36, Times Square Station, New York 36, N.Y.



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NEWS

Optical Tracker Designed For

Circular Scan Locks on Moon Rim Using Motor-Driven Telescope

AN OPTICAL tracking system for terminal guidance of an unmanned moon vehicle has been designed by Aerojet-General Corp., Downey, Calif.

The system is designed to be carried in a 650-lb terminal vehicle about 30-in. in diameter and 52-in. long. The main weight is a retro-rocket, with instrumentation contributing about 150 lb.

The optical tracker locks onto the rim of the moon with a circular scan, modulated to produce a gear-tooth pattern. The output of the optical system is a series of evenly spaced matched pulses over the portion of the circular scan where the moon's rim offers a light-dark contrast. A motor-driven telescope, with its optical axis offset from a stable platform axis, performs the scan.

The system provides automatic measurement of range to the center of the moon, range rate, and angular velocity of the scanning centerline. These measurements, beginning at about 70,000 miles from the moon, increase in accuracy as range decreases.

Several Moon Missions Possible

The present system is capable of several possible moon missions, Robert H. Grube, head of the detection systems analysis section at Aerojet's Avionics Div., told a session of the recent National Specialists Meeting on the Guidance of Aerospace Vehicles in Boston. These include a close approach with subsequent escape to space, circling or orbiting the moon, or making a free-fall or direct impact.

A soft landing would be difficult to achieve without additional instrumentation because the moon's jagged edge introduces important errors with close approaches.

A trajectory which carries the vehicle within 30,000 miles of the moon with a velocity below 7,000 ft/sec is accurate enough for the system.

Instrumentation consists of a tracking telescope, a stable platform, computing circuits, and three servo subsystems. The servos position the telescope, the stable platform, and the vehicle with respect to the stabilized axis.

The platform axis is aligned toward the moon prior to launch, and remains in an inertial mode throughout the launch. Alignment accuracy within

Designed For Guiding Moon Vehicle

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a few degrees is all that is required. The vehicle servo subsystem aligns the vehicle longitudinal axis with the stable axis soon after launching, and the vehicle remains in alignment with the platform through the rest of the trip.

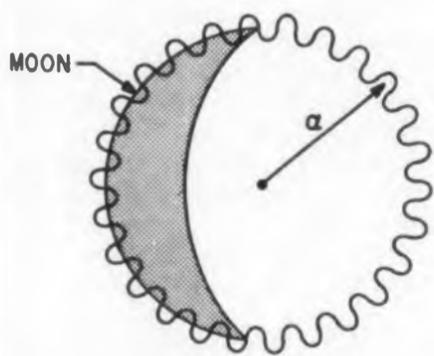
Digital Encoder Reads Moon Angle

The optical tracker in the terminal package consists of a folding parabolic telescope, a photoconductive detector, an oscillating reticle assembly, motors, and gearing for the conical scanning. Amplifiers and logic circuitry, along with a digital encoder for reading the angle across the radius of the lunar disc, are also required.

The distance to the center of the moon is computed by combining this half-angle of the scan with the known radius of the moon. The torque required to orient the scanning axis continuously toward the center of the moon is used to measure $d\theta/dt$, the angular velocity of the scanning axis in space. Radial velocity is obtained by differentiating the range measurement.

Trajectory correction is applied by firing the retro-rocket at the closest point of approach. A small guidance computer is preset to initiate the correction at the proper time.

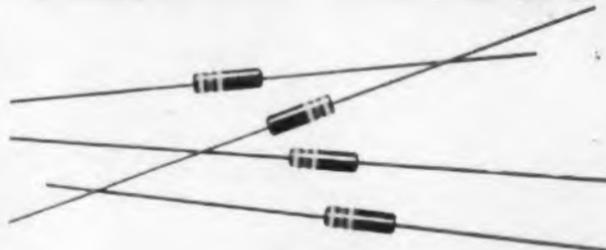
The signal for firing the rocket might be initiated at this point by either the radial range rate



SIGNAL

Circular gear-tooth type scan is used optically to lock onto the sharp discontinuity between the edge of the moon and space beyond. Equal-sized, equally spaced pulses result when system is properly locked on, as shown. Although only part of the scan gives signals with a non-full moon the system interpolates full circle.

NEW CBS DIFFUSED SILICON DIODES



featured in more efficient economical switching block

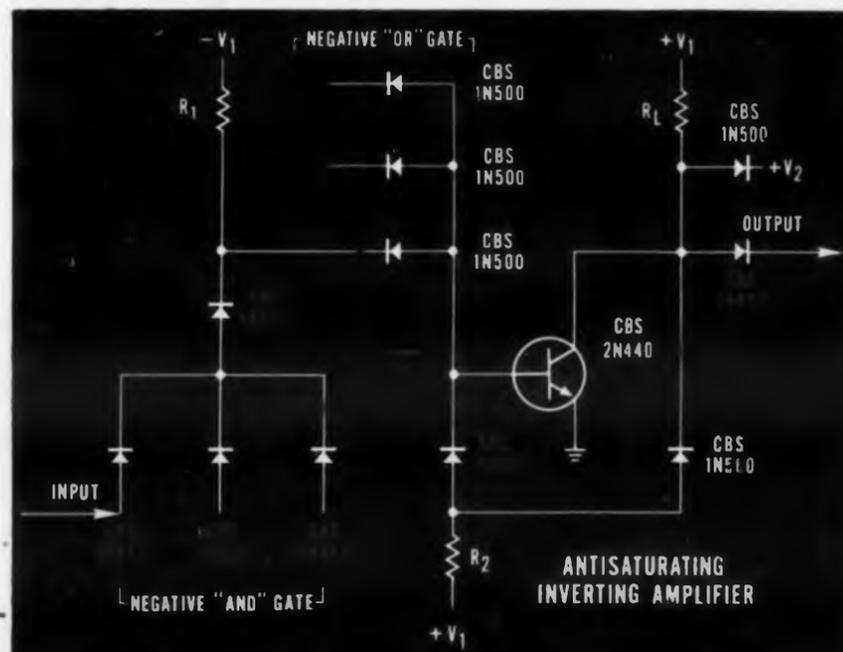
New CBS high back-resistance diffused silicon diodes for positive switching now join CBS high-conductance and fast-recovery types. Efficient and flexible switching is made possible (see circuit). CBS diffusion techniques offer three major advantages over the alloying method: Close process control of all parameters, great uniformity, and high reverse voltage through the graded junction.

The new CBS 1N456, 1N457, 1N458, 1N459 are particularly designed for efficient computer operation in missiles, rockets, airborne and industrial equipment. Typical applications include: switching, pulse, flip-flop, modulator, demodulator, discriminator, clamping, gating, and detector circuits. Write for data sheet E-387. Order direct, from your local sales office, or MWD distributor.

ADVANTAGES OF CBS 1N456, 1N457, 1N458 AND 1N459

- Efficient computer switching
- High back resistance
- Sharp back-voltage characteristic
- Excellent forward conductance
- Low current saturation
- Wide storage and operating temperature ranges

More Reliable Products
through Advanced Engineering



This single building block for computer switching achieves increased efficiency, flexible cascading, and simple maintenance. New CBS high back-resistance diffused silicon diodes used in the "And" gate assure positive switching. The relatively large voltage drop developed by these current switching devices drives the phase inverter transistor efficiently at high switching speeds, and minimizes cooling problems.

Check These Characteristics

Type	Min. Rev. Voltage @ 100 μ A (volts)	Min. Forward Current		Maximum Reverse Current				Avg. Rect. Fwd. Current (mA)
		I_F (mA)	E_F (volts)	@ 25°C		@ 150°C		
				I_R (μ A)	E_R (volts)	I_R (μ A)	E_R (volts)	
1N456	-30	40	1.0	0.025	-25	5	-25	90
1N457	-70	20	1.0	0.025	-60	5	-60	75
1N458	-150	7	1.0	0.025	-125	5	-125	55
1N459	-200	3	1.0	0.025	-175	5	-175	40

Other CBS Diffused Silicon Types

Type	Min. Reverse V @ 100 μ A	Min. Avg. Forward @ 1V mA @ 25°C	Bulletin
High Conductance Types			
1N482	-40	100	E-373
1N483	-80	100	E-373
1N484	-150	100	E-373
1N485	-200	100	E-373
Fast Recovery Types			
1N625	-35	20	E-374
1N626	-50	20	E-374
1N627	-100	20	E-374
1N628	-150	20	E-374
1N629	-200	20	E-374

CBS ELECTRONICS

Department of Electronics, General Electric

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semiconductors

NEWS

or scanning angle rate going to zero, or when the scanning angle rate first indicates a change in sign, Mr. Grube said. Range accuracy is optimum at this point.

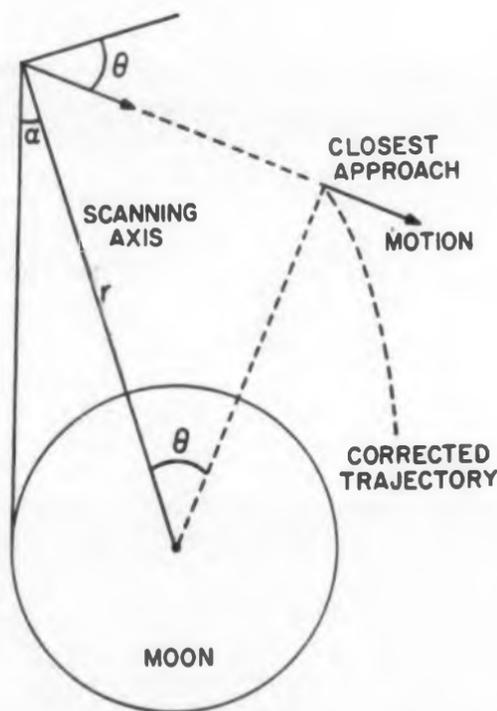
If the rocket impulse brings the horizontal velocity to zero, the vehicle will impact the moon in free-fall. This would give about 14 hours for photography, Mr. Grube estimated.

Since the radial velocity is zero, an impulse to slow the horizontal velocity by a pre-computed amount would result in an elliptical orbit coming as close to the moon as desired.

The closest point of approach is not the optimum point for trajectory correction from the fuel economy standpoint, Mr. Grube commented, however it offers the best combination of simple instrumentation, computation and rocket positioning.

Inward Spiral Scan Acquires Moon

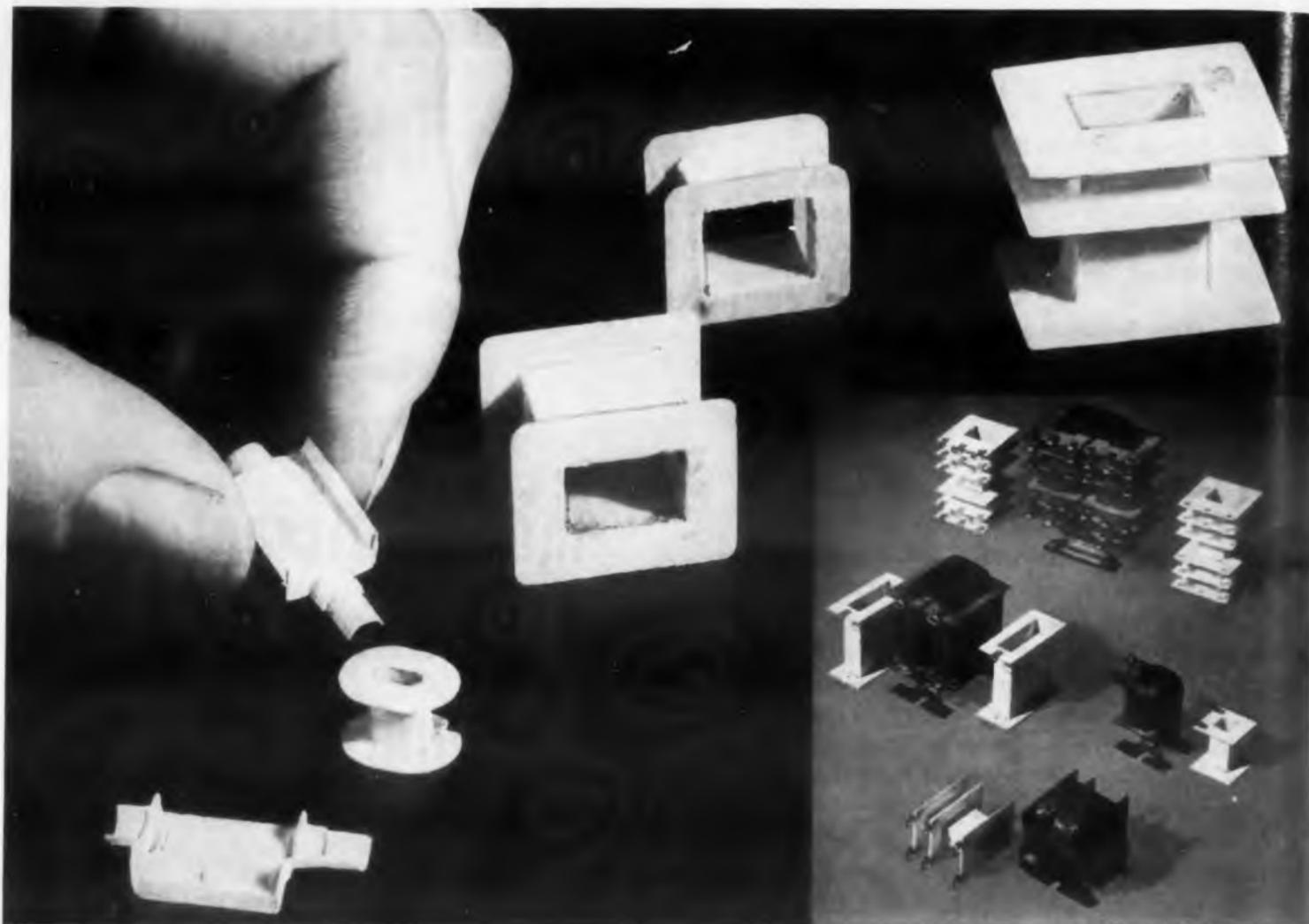
Initial acquisition of the moon is accomplished by presetting the scanning angle to a large value, perhaps 10 deg, so that the moon will be inside of the scan during the early phase of the trajectory. The case is set to continuously spiral inward until the moon's rim is acquired. The scan continues to spiral inward until the moon is encircled and the scanning axis is directed at the moon's center.



Retro-rocket applies impulse to give the desired corrected trajectory at the closest point of approach to the moon. The rocket is positioned so that its thrust is opposite to the motion at the correction point. Tracker measurements will indicate $dr/dt = 0$; $d\theta/dt = \text{maximum}$; and $da/dt = 0$ at the correction point. Known radius of the moon times $csc\alpha$ results in the r measurement.

SILICONE NEWS from Dow Corning

When Miniaturizing



Design Problems Are Simplified With Silicone-Glass Laminates

Miniaturization means heat. Heat that has to be dissipated from smaller surface areas. Temperatures go up — and materials like Dow Corning Silicones come into their own!

Take silicone-glass laminates, for example. At high temperatures they have dielectric properties that are superior to those of other laminated materials. In addition, silicone-glass laminates have excellent resistance to ozone, arcing, corona, and fungus attack . . . even the formidable 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. One-piece laminated coil bobbins, like those shown, are used in continuous operation at 250 C. have been tested at 400 C for 1,000 hours. This high temperature resistance means soldering heat doesn't loosen terminals.

These are reasons why the Foster Transformer Company, Cincinnati, Ohio, specifies coil bobbins of silicone-glass laminates for transformers they manufacture. Multi-flange coil bobbins simplify manufacture of computer power transformers. Used in airborne guidance control systems (top of insert), they weigh only .85 pounds each. This transformer, the filter chokes (center) and output transformer (bottom) all have coil bobbins made from silicone-glass laminates . . . are impregnated with Dow Corning silicone varnish to assure reliability of lightweight miniaturized designs.

Glass laminates made with Dow Corning Silicones are available from leading laminators. Write for a list!

CIRCLE 800 ON READER-SERVICE CARD

For "Silicones for the Electronic Engineer", Write Dept. 3308.



Dow Corning

... Specify Silicones

For Constant Capacitance

Dow Corning silicone fluids are, in themselves, excellent dielectrics. In capacitors and RF filters, silicone fluids boost the performance of the paper dielectric . . . substantially increase permissible operating temperatures, decrease electrical losses. Highly stable to changing environments, silicones show little drift in electrical or physical properties over a broad range of temperature and frequency conditions . . . often eliminate costly compensating circuit. To assure an almost constant capacitance vs. temperature relationship for their specialty capacitors . . . and the lowest possible power factor for their RF interference filters . . . The Filtron Co., Inc., of Flushing, N. Y., impregnates their RF interference filters and capacitors with Dow Corning silicone fluid.



CIRCLE 801 ON READER-SERVICE CARD

Silastic RTV Packages . . . Protects

Built by Vitro Laboratories, Silver Spring, Md., this pre-amplifier consists of a vacuum tube and three transistor stages containing a total of twenty-five parts. Design specifications called for a package no larger than 1-7/16" diameter by 5" . . . plus operating requirements of high insulation strength, heat stability, resistance to shock, vibration and moisture. These were met conveniently and easily by mounting the components on a printed circuit board, encapsulating the unit with Silastic® RTV, the Dow Corning room-temperature vulcanizing silicone rubber.

Silastic RTV is poured over the unit until the mold is completely filled. It exerts a firm grip on components, eliminating clamps and brackets . . . soaks up shock and vibration, dissipates heat, locks out moisture.



CIRCLE 802 ON READER-SERVICE CARD

To Save Space . . . Cut Weight

Airborne Accessories Corporation, Hillside, N. J., uses a variety of miniaturization techniques in designing power drives for actuators and other devices. One of their most important tools in making smaller, more reliable drive motors is silicone insulation, including Dow Corning Silicone Varnish impregnation. Its use on these high performance motors assures utmost reliability under almost continuous on-off-reverse operation . . . helped designers provide up to 50% more power per pound.

This 400-cycle silicone insulated actuator motor has a 4.25 inch frame, weighs only 13.2 pounds with brake, is rated 2.5 hp, 11,000 rpm continuous duty; to 6 hp, 9,000 rpm intermittent duty.



CIRCLE 803 ON READER-SERVICE CARD

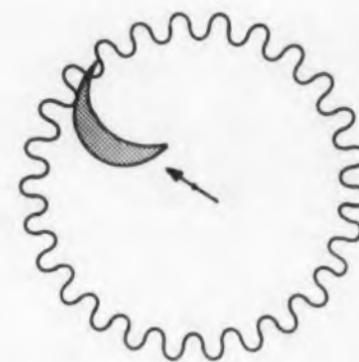
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CIRCLE 800, 801, 802, 803 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960



SIGNAL

In acquisition mode, scan spirals inward until it encircles the moon.

If the scanning radius becomes too large the pulses become too narrow because the telescope is directed at the bright portion of the moon during only a short portion of the scan. Conversely, pulses become too wide when the scanning radius becomes too small. If the scan shifts in X or Y directions, unequal pulse widths result.

Corrections are automatically generated to compensate for these errors.

If the scan is jarred off the moon's rim onto the inner edge of a crescent moon, the logic will cause the scan to spiral to zero. The scan will then be expanded and reacquisition follows.

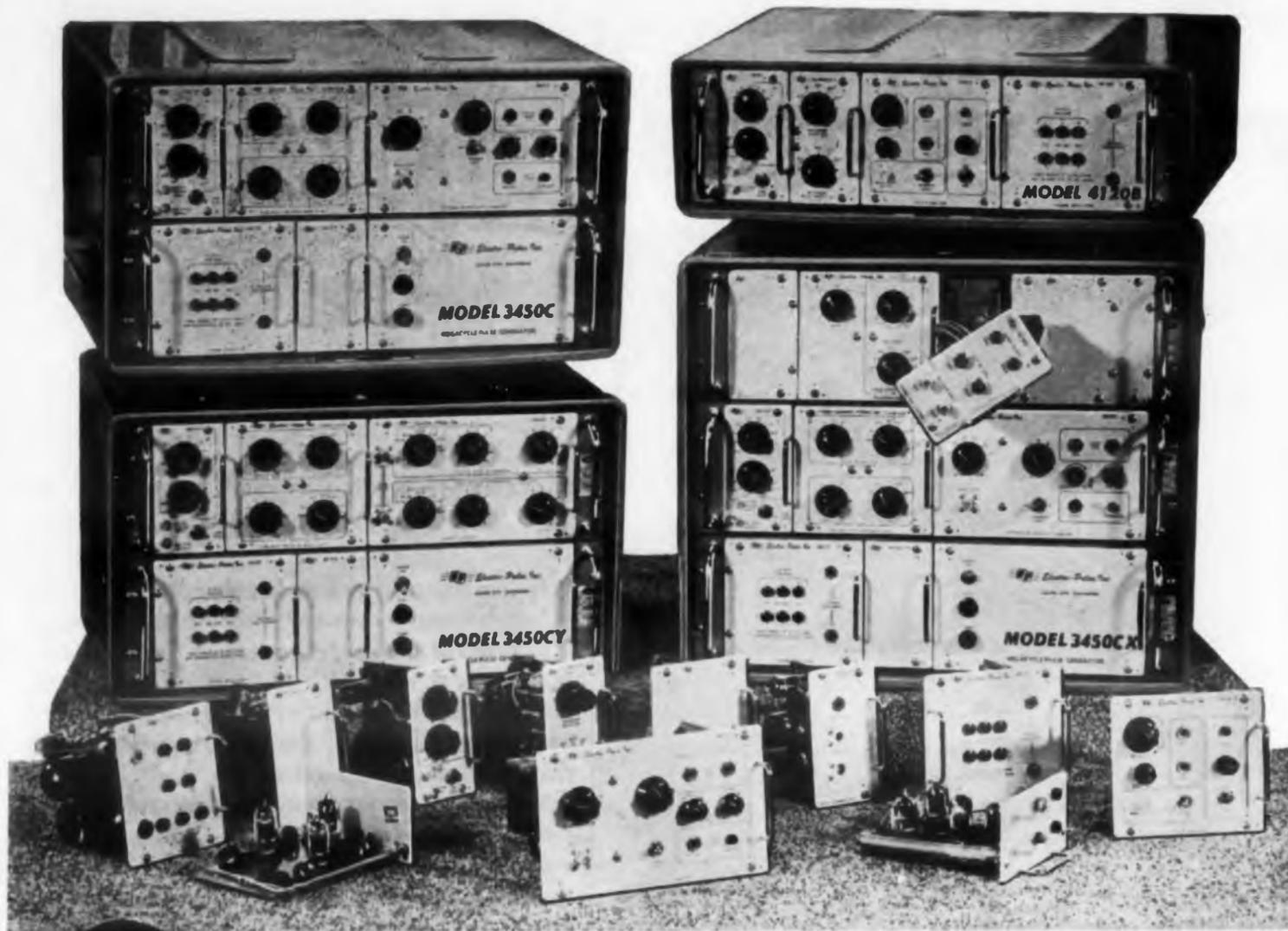
One of the most difficult conditions is a nearly-full moon. The system might lock on the junction between light and dark areas on the surface. The poor discontinuity between the light and dark areas of the moon's face compared to the sharp discontinuity between the moon's rim and space beyond might be used to correct this possible error, Mr. Grube commented.

Best accuracy can be obtained, he said, with a short wavelength optical system—perhaps an infrared one.

MIT Studies Aim Toward Improved 3-Color TV Stability

Studies of the two-color L and color television scheme in progress at Massachusetts Institute of Technology have confirmed the outstanding picture stability provided by the system, according to an MIT researcher.

Understanding of the reasons for this stability may lead to improvements in stability of the present red-blue-green system. The Land system, developed by Dr. Edwin H. Land, president of Polaroid Corp., Cambridge, Mass., uses only red and white.



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FULL coverage in Pulse Instrumentation through MODULAR CONSTRUCTION

Modular plug-in construction adds unparalleled versatility and serviceability to proven EP circuit quality, allows extension of standard instruments to special requirements, and provides the key to rapid, economical fabrication of simple or complex pulse and digital instrumentation systems.

See our Complete Display at WESCON BOOTH 412-413

Electro-Pulse currently manufactures 137 standard pulse and digital circuit modules (both tube and transistor types). Over 90 catalog instruments are offered to save you time and money in the generation of fast-rise pulses, pulse pairs, pulse trains, gates, time delays, digital words, programmed current pulses, PPM and PCM codes, etc. Our current comprehensive catalog is yours for the asking.

Various combinations of only eleven basic pulse circuit modules,* when plugged into wired rack frames, make up the four standard pulse generators shown above—

3450C—.015 μ s rise single pulses, 50v into 50 ohms to 2MC, variable durations, delay and waveform.

3450C/X—Adds pulse pair and pulse train capabilities to 3450C.

3450C/Y—Fast rise, power flip-flop (45v into 470 ohms, Pos. and Neg. outputs), duration to 1 sec., rep rate to 1.7MC.

4120B—Economical fast-rise pulses to 500KC, 35v into 100 ohms.

Write for complete data: Bulletins 3450 and 4120

Representatives in Major Cities



Electro-Pulse, Inc.

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CIRCLE 55 ON READER-SERVICE CARD

*Basic modules in photo above:

Time Base, Delay and Width Control, Pulse Forming, Flip-flop, Trigger Amplifier, 2 Output Amplifiers, 2 Power Regulators, Rectifier-Filter, and Gating Control, with variations. Also available: Counters, And/Or Gates, Crystal Oscillators, Precision Time Delays, Blocking Oscillators, Mixers, Inverters, Attenuators, Input Amplifiers.

Note, in above photo of 3450CX, the ease with which a single module may be extended on plug-in adapter for service.

Pulse and Digital Circuit Engineers:

Rapidly expanding Systems activity and New Product development at Electro-Pulse have created several attractive openings for qualified engineers. Please send resume to T. C. Ridgway, Personnel Manager.

NEWS

New Thermoelectric Devices

THE CAPABILITY of sudden, unsuspected attack represents the key weapon of a modern submarine; take away the element of surprise and the undersea craft is relatively unarmed. To avoid the ever-increasing submarine-detection systems, noise must be reduced to an absolute minimum, said Lt. Cmdr. Peter G. Beierl, U.S.N., in his keynote speech to more than 125 engineers attending New York Univ.'s course on Thermoelectric Materials and Devices, this spring.

The Navy is seeking thermoelectric power generators and cooling systems for use in nuclear-powered submarines, Commander Beierl explained, as a means for propulsion, food storage over long periods, and air conditioning. Since moving parts are reduced to a minimum (water-circulating pumps, for example, would still be required), quiet operation with inherently improved reliability are to be expected compared to existing equipment. Although space is at a premium inside a submarine, he said, thermoelectric devices could be stacked in small unused areas throughout the interior rather than the large central area now required for conventional generators. Finally, Commander Beierl indicated that the simplified maintenance anticipated could reduce the crew complement as a further saving in space and needed supplies. Efficiencies in the order of 12 per cent would be considered competitive with present power systems in submarines. To bring this goal closer to reality, the Navy is spearheading the quest for improved thermoelectric materials.

Following Commander Beierl's keynote talk, various phases of T-E research were outlined. Since the "figure of merit" of a thermoelectric material is inversely proportional to electrical resistivity and thermal conductivity, scientists are searching for new materials with low values for both quantities. Properties of bismuth telluride, lead telluride, ternary semiconductors, refractory and ionic materials, molten salts and liquids were discussed in terms of thermoelectric possibilities.

In addition, thermionic emission and plasma devices were outlined. The course in Thermoelectric Materials and Devices was presented by the Metallurgical Dept. of the NYU College of Engineering and the Office of Special Services to Business and Industry with Dr. Irving Cadoff course chairman.

USSR T-E Efforts Cited

Soviet advances in thermoelectric power generation and refrigeration were presented by

Engineers Scientists... **HELP EXPAND**

ELECTRONIC FRONTIERS at **COLLINS RADIO COMPANY**



There are many challenging projects now underway at Collins Radio Company, Cedar Rapids, Dallas and Burbank Divisions—managed and directed by some of America's foremost scientists and engineers.

You are invited to join them . . . share in their pioneering knowledge in electronic research and development . . . use their extensive facilities . . . and help to do what has never been done before in electronics.

Collins is one of the nation's leading electronic growth companies. Balanced government and commercial business assures stable employment. Present military and commercial backlogs are approximately \$200 million. Commercial sales are heavy in airline, business aircraft, amateur, broadcast and ground communication areas. And Collins is an engineer-minded company . . . with 20% of the more than 13,000 employees working in engineering.

Collins Radio Company is interviewing at the Wescon Show. Could you contribute new ideas to these fields?

CEDAR RAPIDS — E.E.'s and M.E.'s are needed for assignments in Airborne communication and navigation R&D. Communication design engineers, and field service men for Doppler installations are also needed. If unable to interview at the Wescon Show, send your resume to: Mr. L. R. Nuss, Manager of Professional Employment, Collins Radio Company, Cedar Rapids, Iowa.

DALLAS — Qualified E.E.'s and M.E.'s with 5-10 years experience are needed in Collins Texas Division for R&D work in Data System Engineering. If unable to interview at the Wescon Show, send your resume to: B. E. Jeffries, Manager of Technical Employment, Collins Radio Company, 1930 Hi-Line Drive, Dallas 7, Texas.

BURBANK — E.E.'s and M.E.'s with 2 to 8 years experience are needed for research and development work in the expanding field of high speed data transmission equipment and systems. If unable to interview at the Wescon Show, send your resume to: Al Peachey, Collins Radio Company, 2700 West Olive Avenue, Burbank, California.



COLLINS RADIO COMPANY
CEDAR RAPIDS • DALLAS • BURBANK

PLAN NOW TO TALK TO A COLLINS REPRESENTATIVE AT THE WESCON SHOW

L. R. Nuss, Al Peachey and F. I. Aiken will be located at the Career's Inc. area in the Shrine Exposition Hall during the show. For a personal, confidential interview phone Richmond 6-1211 between 9 am and 9 pm.

CIRCLE 914 ON CAREER INQUIRY FORM, PAGE 233

Sought for Navy Subs

Cmdr. C. G. Spoerer, Bureau of Ships. Russian efforts to apply the Peltier effect for refrigeration began in 1950, headed by Prof. A. F. Ioffe of the Leningrad Physico-Technical Institute of the Academy of Sciences. By 1953, a prototype of a 0.35 cu ft cooling capacity refrigerator was completed. The unit required 25 w to maintain a 4 C chamber temperature from a 27 C ambient; steady-state operation was reached four hours after startup. The figure of merit of the materials was about $1.23 \times 10^{-3}/C$ and the coefficient of performance was 20 per cent with a 40 C temperature difference across the elements.

In 1954, a 1.92-cu-ft unit was developed reportedly using n-type lead telluride-arsenide and p-type tellurium-antimony alloy. In 1956, the first semicommercial refrigeration was built in Leningrad; the capacity was 1.4 cu ft with insulation approximately 4.75 in. thick. The unit was designed to operate from 127-v ac house supply mains with rectification by means of germanium diodes. About 75 w were required during start-up with 55 w necessary after the steady-state temperature was reached. Latest efforts include commercial refrigeration units which have been tested in Soviet TU-104 passenger jet planes.

Soviet Active in Field

The famous Soviet TKG-3 kerosene-fueled thermoelectric generator was mass-produced in 1953. The heat from the kerosene lamp was applied to zinc antimonide and constantan thermoelements and 3-w output was obtained, sufficient to power a radio receiver. The temperature difference was reported to be 30 C. The TKG-3 provided 0.5 amp at 2 v for filament supply and 2 amp at 2 v for a vibrator to produce higher plate potential. By 1956, an improved version (TEGK-2-2) was made with 4-w output; enough couples were included in the plate supply to eliminate the vibrator; plate supply input was 9 ma at 100 v.

By 1958, a 15-w generator (TGU-1) was developed for transceiver applications to establish communication between central agricultural stations and field tractors. Other devices developed included 200-w and 500-w generators using wood or gasoline as fuel. A 40-w solar thermoelectric generator was built in 1956 and a 100-w unit is reported in operation.

Soviet goals for 1961 include the development of thermoelements with efficiency of 15 per cent and service life of 20,000 to 30,000 hrs. ■ ■

NEWS

Independent Inventor's Importance Cited in Statistical Research

The independent researcher has not been lost in the shadows of the giant corporations with their teams of skilled scientists and engineers.

This conclusion was reached by Dr. Daniel Hamberg, professor of economics at the University of Maryland, in the June issue of "Challenge" magazine, a New York University publication.

In his article, Dr. Hamberg pointed out that:

- Of 61 important inventions made since 1900, 33 were the products of independent inventors, six were the products of research conducted in laboratories of small to medium-size firms, and only 11 can be traced unqualifiedly to the laboratories of giant corporations.

- Manufacturing companies employing 5,000 or more persons account for some 70 per cent of R&D carried on in manufacturing industry.

- In contrast, manufacturing firms employing less than 500 people account for only 10 per cent.

Dr. Hamberg made it clear, however, that the statistics contain several important qualifications:

- The figures refer to performance, not to amounts of sources of research financing.

- The data also show that for any size group of firms, there is great variation in R&D expenditures from industry to industry. The bulk of unsubsidized research is concentrated in three or four industries.

Glass Disc Holds Dictionary In Russian-English Translator

A 10-in. glass disc holding coded Russian words, idioms, and phrases paired with English meanings serves as the memory unit in an experimental translator. The data are arranged in 700 concentric tracks in an annulus 0.36 in. wide.

According to the translator's developer, International Business Machines Corp., a Russian dictionary of about 55,000 word stems has been compiled so far. With the word endings also listed, this is said to correspond to about a half million words as they appear in text.

The data on the disc are read by a light source from a cathode-ray tube. As the disc rotates at 1400 rpm, the light beam scans each track searching for a match to the input Russian text. When a proper match is found, the corresponding English meaning is read out.

If at any time the transistor finds a word not in its dictionary, it signals the output printer to print this word in red for later addition to the disc

If you're at all concerned with electronics, here is the biggest circuit component story of the year. The seven AMP lines listed below will all be designed into tomorrow's electronic products.

AMP-MAD* SHIFT REGISTER

The first commercial all magnetic register/counter using only multiaperture ferrite cores and wire. Available with any serial/parallel input/output combination and featuring non-destructive dynamic and static readout.

AMP-MECA

(Maintainable Electronic Component Assembly) is a three-dimensional packaging concept that will change your thinking. Components, or functions are assembled and encapsulated, if necessary, in AMP-Cells then plugged between programmed AMP side rails.

AMPin-cert CONNECTORS

Series A, D, M and W meet or exceed all applicable mil-specs. Pins and sockets are crimp-type for uniform reliability.

AMP DOUBLE THROW SWITCH

From 80 to 1500 pole for instrumentation and related applications requiring a compact, rugged programming unit.

AMP PATCHCORD PROGRAMMING SYSTEMS

In universal and shielded types, this line offers more unusual features than any other system made including positive wiping action and unbeatable reliability.

AMP PINBOARDS

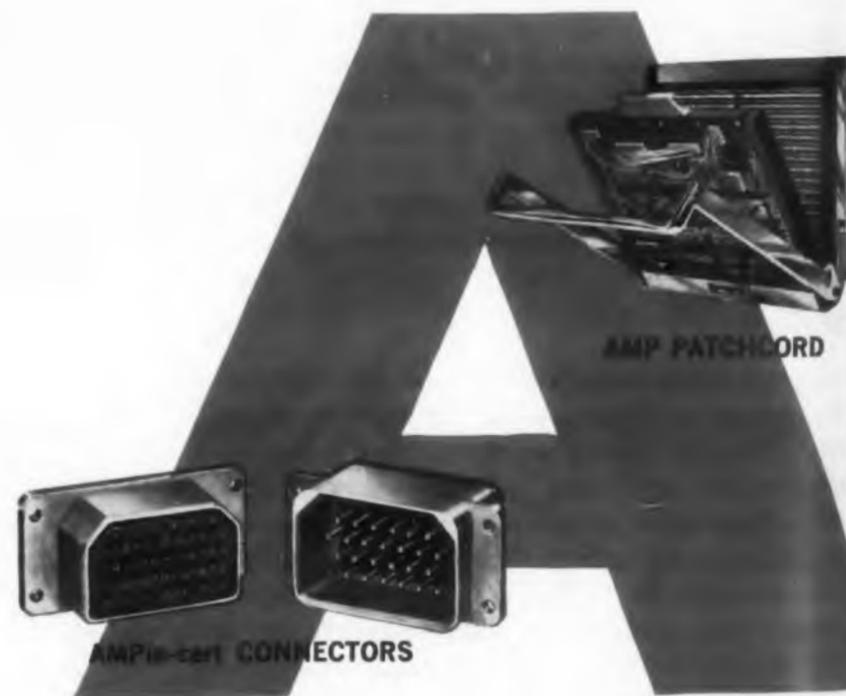
For matrix programming. No moving parts, top reliability and low cost, range of sizes.

AMP GENERAL LINE

One of the greatest continuing stories in modern industry, the AMP solderless crimp technique each year produces a host of new items and new applications.

* Trademark

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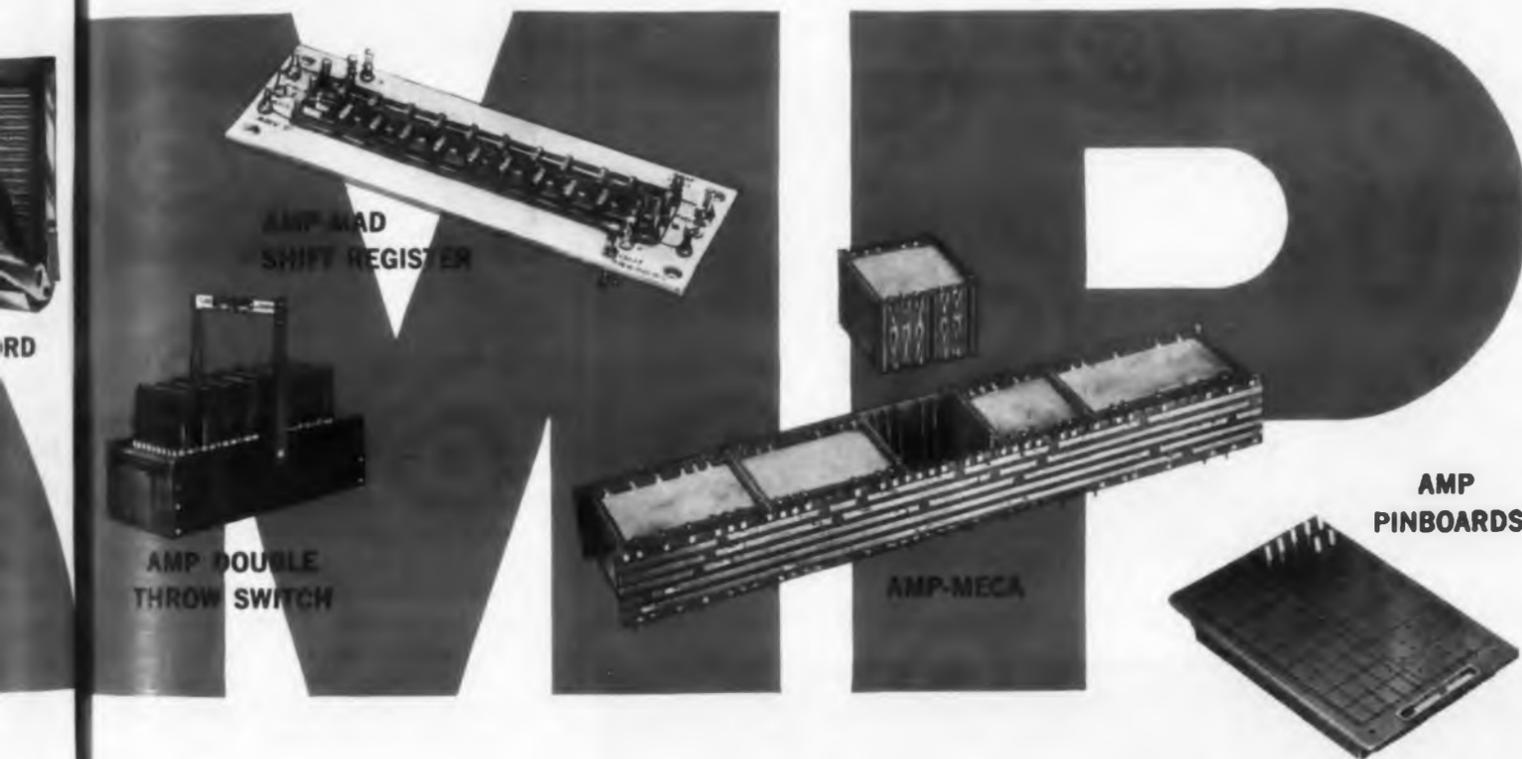


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1960

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Harrisburg, Pennsylvania

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1960 ELECTRONIC DESIGN • August 3, 1960

memory. Proper names and nouns are also printed in red.

Right now, the system is said to be capable of translating at a rate of 1,800 words a minute. The company is currently pursuing research in automatic print reading and is supporting a development program at Baird-Atomic Corp., Cambridge, Mass. By the end of the year, it is expected that high-speed equipment will read printed material and feed it to the system at a rate of 2,400 words a minute.

Also under development is a word analyzer that will improve the translator's grammar, the company says. The analyzer will be designed to scan entire sentences and determine the correct grammatical role of each word. This approach is similar to the process called predictive analysis now being used at the Harvard Computational Laboratories (*ED*, March 30, p 22).

The company's Russian translation program has been carried out mostly under contract to the Air Force's Air Research and Development Command. While the Air Force is mainly interested in Russian technical information, applications of the translator are seen in other areas of science, industry, and government.

Soundproofing Seen as New Use For Rigid Polyurethane Plastic

Rigid forms of Stafoam polyurethane plastic may provide superior soundproofing of terminal and junction boxes, telephone booths, consoles, and cabinets.

According to reports from Freedlander Research and Development Laboratory, American Latex Products Corp. of Hawthorne, Calif., cast urethanes not only provide exceptional acoustic damping, but the lightweight material can be made strong enough to form the entire protective box cover or cabinet wall. Console cases could be fabricated from urethane with the single material providing structure, thermal insulation, and soundproofing, the company says.

Stafoam urethane can also be sprayed or poured in liquid state on the interior walls of metal or fiber glass cabinets providing both soundproofing and increased structural strength, according to the maker. A chemical reaction causes the material to foam, completely filling all voids and cavities, bonding itself to the shells as it rapidly becomes rigid at room temperatures.

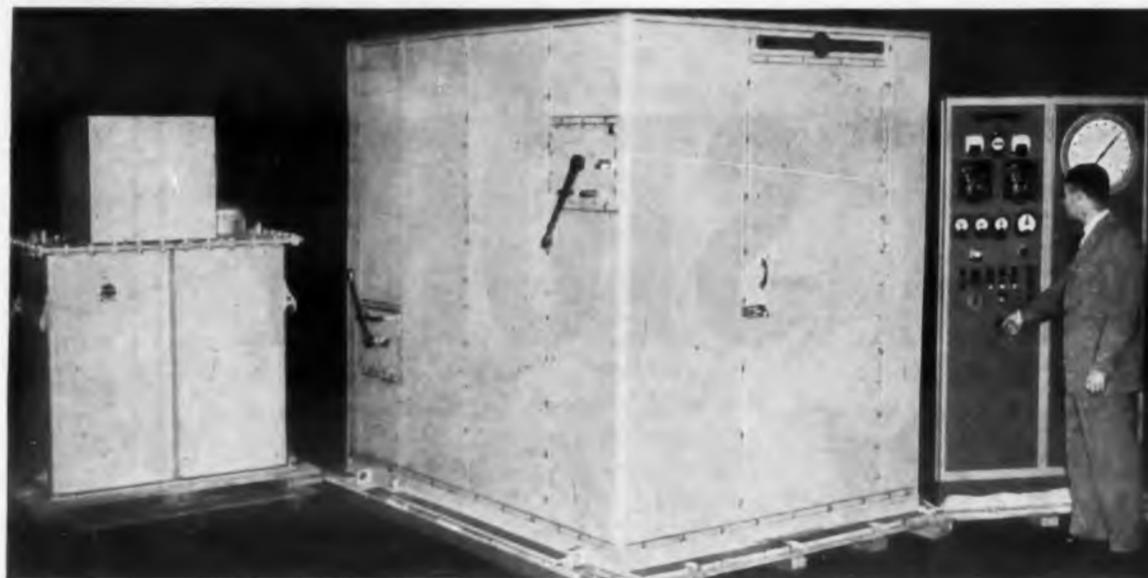
Stafoam urethane is also adaptable for insulating, cushioning, and potting transformers, and other electronic devices, because of ability to be poured through tiny openings, Freedlander reports. Dielectric constants and power factors also lend themselves to electrical applications.

PROJECT '60s: DESIGN NOW FOR THE GREAT YEARS AHEAD ... with GENERAL ELECTRIC electronic components

Most electronics manufacturers face the continuing challenge of staying ahead of obsolescence. These General Electric components, designed specifically for the needs of the '60s, can help solve that problem.

Custom-built d-c power supplies such as this silicon rectifier unit (designed to charge a 7,000,000 joule capacitor bank every 15 minutes) give you efficient power to meet special requirements. G-E power supplies can be designed to meet virtually *any* high-voltage d-c requirement from approximately 10-kv to 1000-kv, d-c, and from milliamperere values to 250 amperes. Save time, space, and money by specifying G.E. Our Holyoke, Mass. plant stands ready to supply the units you need.

For more information, circle 840 on reader service card.



AC and DC BIG LOOK Panel Meters are now available in a complete family, including 2½-, 3½-, and 4½-inch designs. BIG LOOK meters give you truly distinctive appearance, excellent readability and extra-long operating life. With the BIG LOOK design, you get up to 28 percent scale increase, large numerals which cannot be obscured by the pointer and elimination of shadows. Self-shielded mechanism on d-c meters eliminates interaction.

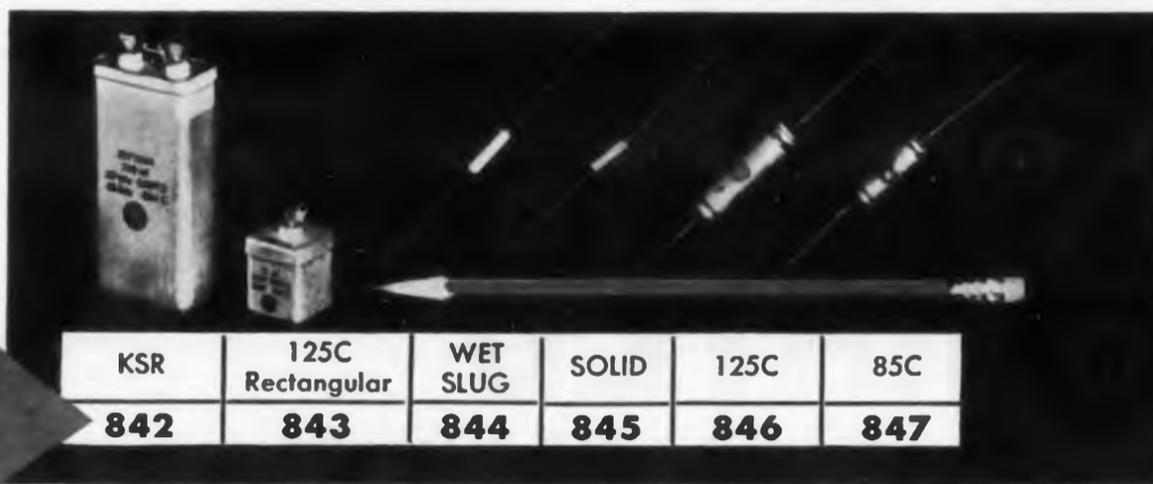
Circle 841 on reader service card.



The complete line of General Electric Tantalitic* capacitors fills a wide range of critical electronic applications. Small in size and unsurpassed in reliability, G-E Tantalitics perform within specification requirements even at environmental extremes.

For more information about General Electric Tantalitic capacitors, circle these numbers on the reader service card.

* Registered trademark of General Electric Co.



NEW PRODUCTS

NEW Tantalitic Capacitors in ratings to 300 volts

The General Electric Company has announced the availability of a new high-voltage foil capacitor, rated to 300 volts at 85C and 250 volts at 125C, in both polar and non-polar designs. The new units are smaller than any previously available capacitor with similar voltage ratings and also provide size and weight advantages over series arrangements of lower voltage units.

Circle 848 on reader service card.



NEW Radar Transformer

Typical of G.E.'s line of custom-designed high-voltage transformers, this new 1800-lb pulse unit has a specially developed molded epoxy bushing for operation above 250 kv. It incorporates a special series reactor for protection from load transients. The new unit is still another example of the wide range of specially engineered high-voltage transformer products available from General Electric.

For more information on these and other specialty transformers, circle 849 on reader service card.



GENERAL  ELECTRIC

671-01

← CIRCLE
ELECTR

EDITORIAL

High Hopes for WESCON

Each year, every electronics show or convention is expected to be "bigger and better than ever." Certainly this year's WESCON shows every promise of living up to this customary expectation.

The convention is housed in Los Angeles' new Memorial Sports Arena and a new annex adjacent to the building—both fully air conditioned. New equipment, systems, and components will be displayed in 958 booths. (New items being shown for the first time are reviewed in this issue on p 106 to p 199.) More than 200 authors and panelists will participate in the technical program which includes 44 sessions (see p 28).

Finally, many interesting trips to local electronics plants are scheduled, and the usual popular social events and activities should make WESCON a bang-up affair this year. (More details on p 26.)

We shall be especially interested in observing the operation of the "new approach to the effective interchange of advanced electronic engineering concepts," promised for the technical session.

Making preprints available at registration time, arranging special panel-discussion sessions on questions arising out of the day's formal talks, exploring a broader range of subjects such as "The Woman's Role in Engineering" and "Working with Engineers," and attempting to brief speakers on better techniques of oral presentation are highly commendable program-committee efforts to make a WESCON visit really profitable.

We shall be adding our bit to these efforts as well. We shall once again be publishing **ELECTRONIC DAILY**, covering WESCON activities during the show. We shall be on hand at Booth 2714-5 to say hello and to answer questions about **ELECTRONIC DESIGN**. We'd like to hear your comments on the magazine; we'd like to get to know you. But especially, we'd like to talk over your articles or ideas for articles.

We have three major specifications for articles in **ELECTRONIC DESIGN**. First, the article must have solid, interesting information. Second, it must be practical. Third, it must be aimed at design engineers. If you think that your article, outline, or just plain idea for an article meets these specs, please come along and talk to us. We think we can help you enhance your career and make a little money on the side.

See you at WESCON!

Edward S. Graydon

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has an enormous number
of applications . . . but
whatever the voltage delivered,
no matter how good
the regulation and
how low the distortion might be,
accuracy in many cases
is the all-important key.*

Behlman's INVERTONS®
provide frequency accuracies
up to 0.00001%!



*A wide variety of single, two
and three phase models are available
providing from 20-100,000 va and output
frequencies fixed or variable
up to 100 KC.*

*Total harmonic distortion
is only 1% max (lower
on special order):
voltage regulation is
1% no load to
full load standard
(to 0.1% on special order).*

*The test of the test
is INVERTON.*

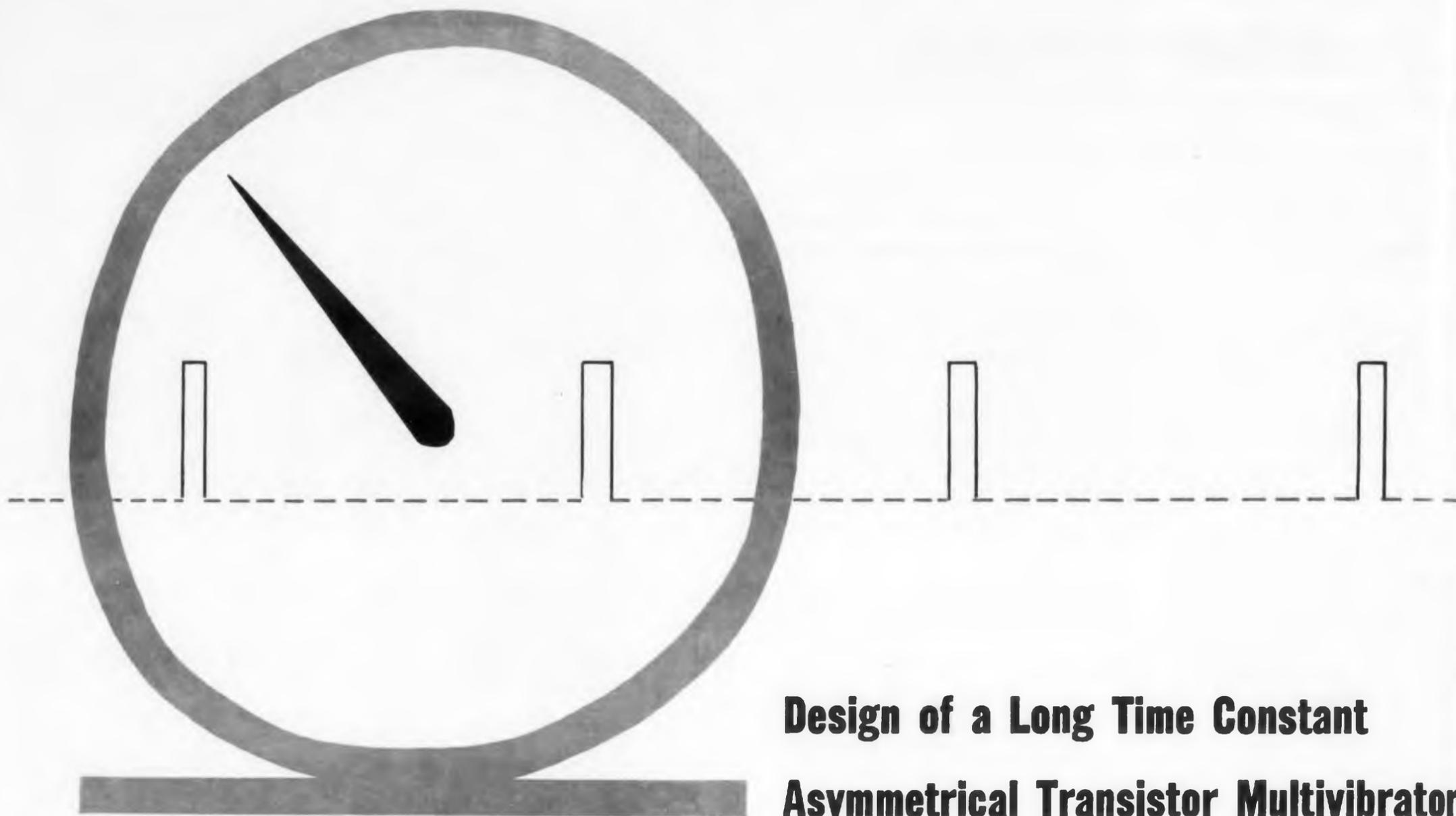
BEHLMAN **ENGINEERING COMPANY**

2911 Winona Avenue
Burbank, California

A subsidiary of Electronic
Energy Conversion Corporation



See Behlman at Wescon Booth #452
CIRCLE 58 ON READER-SERVICE CARD



Design of a Long Time Constant Asymmetrical Transistor Multivibrator

Long time constant asymmetrical multivibrators are often inefficient in terms of supplying sufficient current for relays or stepping switches. The design steps, together with a special Equation Derivation section, are presented as an aid in such applications. A typical design example is outlined to illustrate the procedure.

Maury I. Marks*

Electronic Development Section
International Resistance Corp.
Philadelphia, Pa.

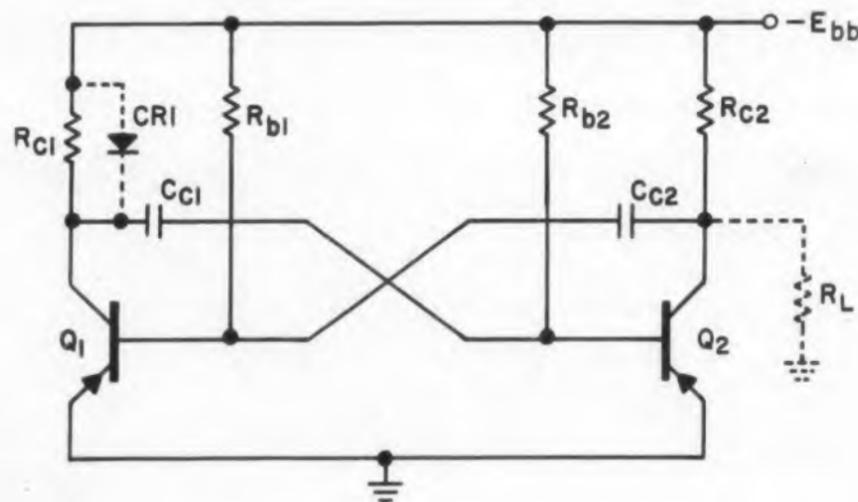


Fig. 1. An asymmetrical free running transistor multivibrator with load (relay coil R_{c1}) in the collector of briefly conducting Q_1 . An alternate load position, in series with collector resistor R_{c2} , is wasteful of power.

*The work described above was done while the author was employed at American Electronic Laboratories, Philadelphia, Pa.

AN ASYMMETRICAL transistor multivibrator followed by a driver stage is often used to supply brief intervals of power every few seconds to a relay coil or stepping switch. With proper circuit design, including most efficient load placement, the driver stage can be eliminated with subsequent decrease in overall complexity, number of components and cost.

Large Base Resistor Limits Collector Load

A free-running transistor multivibrator which has a long period, on the order of seconds, must employ very large cross coupling capacitors to achieve long time constants. Because the capacitors are usually the largest in physical size and the heaviest in weight of the circuit elements comprising the multivibrator, they limit the minimum physical size and weight of the circuit. Also, large value electrolytic capacitors have the further dis-

advantages of changing capacity with age and ambient conditions.

Since the RC product determines the time constants, the circuit designer may be tempted to use very large base resistors and smaller cross-coupling capacitors to attain the desired periods. However, it is the base resistor which determines the collector load of the transistor for saturated operation. Saturated operation is often desirable, since nearly all of the available supply voltage is applied to the load when the transistor is in the conducting state.

If a large value base resistor is used, then the collector load must be correspondingly light. If a heavy load, such as a relay coil, is to be driven from the multivibrator, an extra stage of gain must often be added to the circuit. This extra stage increases the cost, the complexity, the number of components and reduces statistically the reliability of the circuit.

Asymmetrical Multivibrator Characteristics

In many cases, the two time constants of the multivibrator are unequal. That is, one of the two transistors may be in conduction for a period of seconds, and the other for a period of milliseconds. The application of power to the coil of a relay or stepping switch with regularity every few seconds is one very common application of the asymmetrical transistor multivibrator. By employing a very large base resistor and small cross-coupling capacitor to achieve the longer of the two time constants it is possible to drive a heavy load without wasting power.

To see what is meant by wasting power, consider the free running multivibrator of Fig. 1 and its waveforms shown in Fig. 2. If power is to be applied to a load for the shorter period of time t_1 , the load can be placed in either of two positions. Since Q_1 is conducting during the time t_1 , Fig. 2a, the load could comprise the collector resistor R_{c1} or, since Q_2 is cut off during the time t_1 , Fig. 2c, the load could be driven from the collector of Q_2 (shown dotted in Fig. 1). The latter of the two possibilities is wasteful of power since R_{c2} must be made necessarily small to obtain maximum voltage across R_L when Q_2 is cut off. However, Q_2 is conducting most of the time and the small R_{c2} would be draining unnecessary current from the supply when no current would be required at the load.

Design Equations

The operation of a free-running transistor multivibrator such as that shown in Fig. 1 is governed by the time constants $R_{b1}C_{c2}$, and $R_{b2}C_{c1}$. Transistor Q_1 will be in conduction for $0.7 R_{b2}C_{c1}$ sec, and Q_2 will be in conduction for $0.7 R_{b1}C_{c2}$ sec. To obtain maximum voltage variations at the col-

Fig. 2. Waveforms of asymmetrical multivibrator. Transistor Q_1 conducts for a short time, t_1 , while Q_2 operates over a substantially longer period, t_2 .

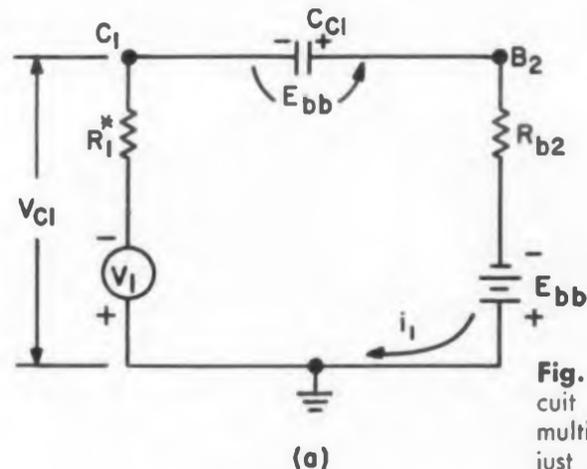
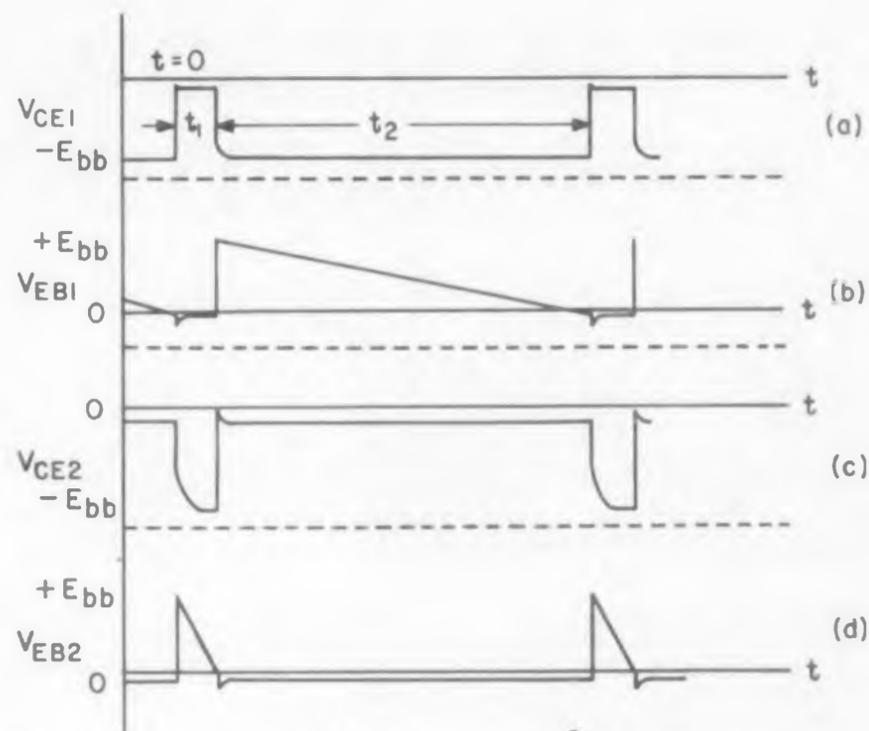
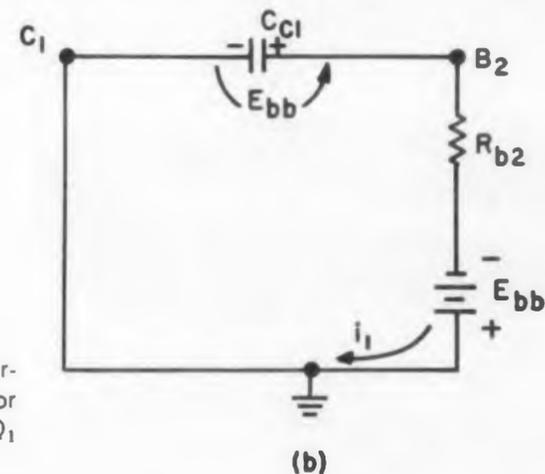


Fig. 3. Equivalent circuit of the transistor multivibrator with Q_1 just turned "on."



lectors, the transistors should be saturated when in the "on" or conducting state. Then the collector voltage will vary between E_{bb} and zero volts (actually about 0.3 v).

The base current of either transistor will be essentially E_{bb}/R_b when in saturation, and the collector current E_{bb}/R_c . Also the current gain of the transistor, β , multiplied by the base current must be greater than the collector current for saturated operation; therefore, $\beta \frac{E_{bb}}{R_b} > \frac{E_{bb}}{R_c}$. Rewriting this inequality, $R_c > \frac{R_b}{\beta}$.

Thus R_b limits the collector load R_c .

For example, if the multivibrator switched states every 3.5 sec, the circuit parameters might assume the following values:

$$R_{b1} = R_{b2} = 100 \text{ K}; C_{c1} = C_{c2} = 50 \text{ } \mu\text{f.}$$

The collector resistors, for a beta of 50, should then be greater than 2 K. However, when the conduction times of the transistors are unequal, such as shown in Fig. 2, the collector load of the transistor which is in conduction for the shorter period of time can be made independent of its base resistor. In the case shown, t_1 is less than t_2 ,

and R_{c1} is independent of R_{b1} . The following relationships are derived in the Equation Derivation Section:

- (1) $t_1 = 0.7 R_{b2} C_{c1}$
- (2) $t_2 = 0.7 R_{b1} C_{c2}$
- (3) $R_{c1} > \frac{R_1 + R_{c2}}{\beta} \left(e^{\frac{t_1}{R_1 + R_{c2} C_{c2}}} \right)$
provided $t_1 > 2(R_1 + R_{c2})C_{c2}$

R_1 is the input resistance of the transistor.

A design example will illustrate the usefulness of Eqs. 1, 2, and 3.

Typical Design Example

A relay is to be energized for a period of 35 msec, every 3.5 sec. The transistors to be used have a beta of 50.

1. First calculate C_{c2} .

$$t_2 = 0.7 R_{b1} C_{c2}$$

$$C_{c2} = \frac{3.5}{0.7 R_{b1}}$$

Since Q_1 is in conduction for the shorter period of time, t_1 , its base resistor R_{b1} does not limit R_{c1} .

(Continued on p 72)

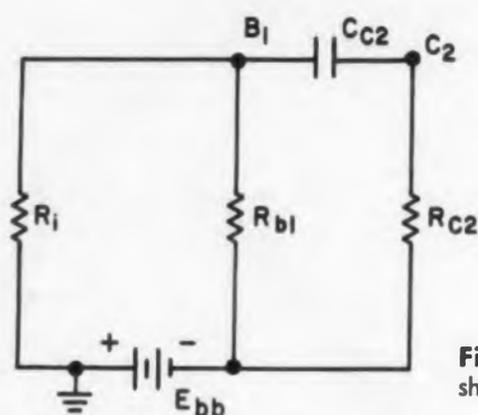
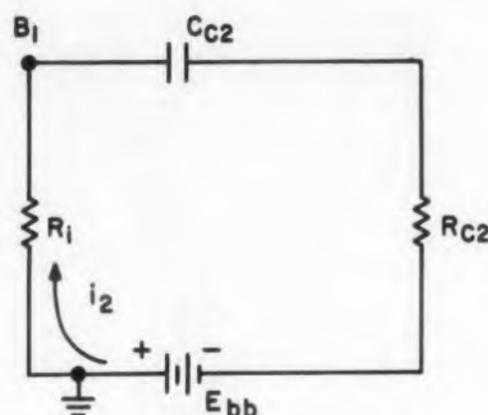


Fig. 4. Equivalent circuit showing Q_2 turning "off."

(a)



(b)

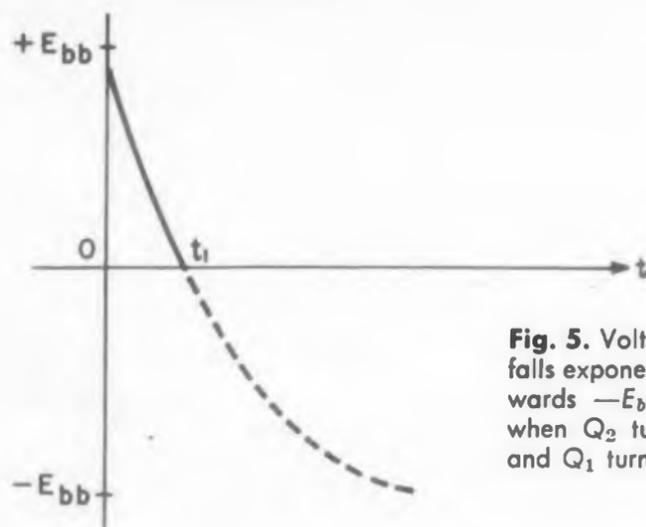


Fig. 5. Voltage V_{EB2} falls exponentially towards $-E_{bb}$ until t_1 when Q_2 turns "on" and Q_1 turns "off."

Therefore, R_{b1} is made as large as feasible. It is important to note that R_{b1} is limited by the back-biased emitter to base resistance of Q_1 , and by the leakage resistance of C_{c1} . These two resistances appear in parallel with R_{b1} when Q_1 is "off." $R_{b1} = 1$ meg is a reasonable choice.

$$C_{c2} = \frac{3.5}{0.7 \times 10^6} = 5 \mu\text{f}$$

2. Next calculate R_{c2} from $t_1 > 2(R_i + R_{c2}) C_{c2}$. R_i , the input resistance of the transistor, is a function of the load; however, it usually ranges from 1 K to 2 K. Assume $R_i = 2$ K.

$$35 \times 10^{-3} > 2(2 \times 10^3 + R_{c2}) 5 \times 10^{-6}$$

$$R_{c2} < \frac{7 \times 10^3 - 4 \times 10^3}{2} = 1.5 \text{ K}$$

3. R_{b2} is determined from $R_{b2} < (\beta)(R_{c2})$ (for saturation)

$$R_{b2} < 50 \times 1.5 \text{ K}$$

$$R_{b2} < 75 \text{ K}$$

$$\text{Let } R_{b2} = 70 \text{ K}$$

4. C_{c1} is determined from Eq. (1)

$$C_{c1} = \frac{t_1}{0.7 R_{b2}} = \frac{35 \times 10^{-3}}{0.7 \times 70 \times 10^3} = 0.715 \mu\text{f}$$

5. R_{c1} is then calculated

$$R_{c1} > \frac{R_1 + R_{c2}}{\beta} e^2$$

$$R_{c1} > \frac{2 \times 10^3 + 1.5 \times 10^3}{50} \times 7.4$$

$$R_{c1} > 518 \text{ ohms.}$$

Thus, the dc resistance of the relay must be greater than 518 ohms. The diode CR_1 shown dotted in Fig. 1 protects the transistor from the back emf of the relay coil when Q_1 goes from conduction to non-conduction. E_{bb} is selected on the basis of the wattage rating of the relay.

$$E_{bb} = \sqrt{W R_{c1}}$$

Finally, the maximum collector to base voltage rating of the two transistors must be greater than $2E_{bb}$ (see Fig. 2). ■ ■

Asymmetrical Transistor Multivibrator Equation Derivation

Consider Figs. 1 and 2. Assume Q_1 has just turned "on," and is in saturation, and Q_2 is turning "off." This instant of time will be designated as $t = 0$. Between the collector of Q_1 and ground, a voltage generator V_1 is seen in series with R_1^* (Fig. 3a). This combination represents the thevenized equivalent of the transistor Q_1 in saturation. V_1 represents the collector to emitter drop of Q_1 , and R_1^* is the impedance seen looking back from the collector.

$$1. R_1^* = \frac{R_{c1} R_{o1}}{R_{c1} + R_{o1}}; R_{o1} \text{ is the output impedance}$$

$$\text{of } Q_1 \left(\frac{1}{h_{oe}} \right)$$

$$\text{If } R_{o1} \gg R_{c1}, R_1^* \approx R_{c1}$$

The initial voltage across C_{c1} is E_{bb} with the polarity indicated in Fig. 3a. For, in the previous half cycle, the collector of Q_1 was at $-E_{bb}$ (Q_1 was "off"), and the base of Q_2 was at a very small negative voltage (Q_2 was hard "on"). During the switching time, C_{c1} loses a negligible amount of charge; thus, its voltage before Q_1 turns on is essentially its voltage at $t = 0$.

The following assumptions are now made, which are in most cases quite reasonable:

1. $V_1 \ll E_{bb}$
2. $R_1^* \ll R_{b2}$

Thus, the equivalent circuit of Fig. 3a simplifies to that of Fig. 3b. At $t = 0$, the following conditions exist:

- (1) $V_{c1} = 0$
- (2) $V_{EB2} = E_{bb}$

At $t = \tau_1$, $V_{EB2} = 0$ (See Fig. 2d).

$$\text{Therefore, (2) } V_{EB2} = E_{bb} \left(2e^{-\frac{t}{R_{b2}C_{c1}}} - 1 \right)$$

Fig. 5 shows that V_{EB2} is falling exponentially to $-E_{bb}$; however, at $t = \tau_1$, Q_2 becomes forward biased, regenerative action takes place, Q_2 turns "on," and Q_1 turns "off." Therefore, the equivalent circuits of Fig. 3 are valid only from $t = 0$ to $t = \tau_1$.

Substituting in Eq. 2, $t = \tau$, and $V_{EB2} = 0$.

Eq. 3 is obtained.

$$3. 0 = E_{bb} \left(2e^{-\frac{t}{R_{b2}C_{c1}}} - 1 \right)$$

$$4. t_1 = R_{b2} C_{c1} \log e^2$$

$$5. t_1 = 0.693 R_{b2} C_{c1}$$

Thus a relationship has been established between two

circuit parameters, and the "on" time of Q_1 . In a like manner, the "on" time of Q_2 is defined by

$$(6) t_2 = 0.693 R_{b1} C_{c2}$$

The analysis up to this point is of an introductory nature, and is entirely conventional. The usual design procedure from this point on is as follows:

R_{b2} , C_{c1} , R_{b1} , C_{c2} are selected on the basis of Eqs. 5 and 6. To insure the transistors operating in saturation so that the collector voltage swings will be maximized, the resistors $R_{c1, 2}$ are selected from Eq. 7.

(7) $R_{c1, 2} > \frac{R_{b1, 2}}{B}$ where B is defined as the dc current gain of Q_1 and Q_2 from base to collector.

It will be shown now that R_{c1} is actually independent of R_{b1} , and can be made much less than its value determined from Eq. 7, provided $t_1 < t_2$. Fig. 4 shows the equivalent circuit depicting the turning "off" of Q_2 . R_i is defined as the dc input resistance of Q_1 . The following conditions prevail:

1. Q_1 has just turned "on"; therefore, its base is at zero volts.

2. Q_2 was just "on," thus its collector, at the instant of switching also is at zero volts.

3. The preceding two conditions show that C_{c2} is not charged. (Actually, C_{c2} is charged to a voltage which is the difference between the steady state collector saturation voltage of Q_2 (about -0.3 v) and the base voltage of Q_1 , at which switching occurs (about -0.3 v). With respect to an E_{bb} as low as 5 v, the voltage across C_{c2} can still be considered zero.)

4. R_{b1} is much greater than R_i or R_{c2} .

Thus, before the collector of Q_2 can drop to $-E_{bb}$ (turn "off"), C_{c2} must become charged. It is the charging current of C_{c2} which makes R_{ic} independent of R_{b1} for the time t_1 . Neglecting R_{b1} , for the moment, it can be seen from Fig. 4b that

$$(8) i_2 = \frac{E_{bb}}{R_i + R_{c2}} \left(e^{-\frac{t}{(R_i + R_{c2}) C_{c2}}} \right)$$

The collector current of Q_1 is $B i_2$. If Q_1 is to be in saturation,

$$(9) i B_{i2} R_{c1} > E_{bb}$$

Substituting Eq. 8 in 9

$$(10) E_{bb} < \frac{B R_{c1} E_{bb}}{R_i + R_{c2}} \left(e^{-\frac{t}{(R_i + R_{c2}) C_{c2}}} \right)$$

This condition must prevail for the time t_1 , so solving (10) for R_{c1}

$$(11) R_{c1} > \frac{R_i + R_{c2}}{B} \left(e^{\frac{t_1}{(R_i + R_{c2}) C_{c2}}} \right)$$

It is important that V_{CE2} approach $-E_{bb}$, therefore the time constant in Eq. 8 $(R_i + R_{c2})C_{c2}$ should be less than t_1 . Thus, the last condition is established $t_1 > 2(R_i + R_{c2})C_{c2}$. It is interesting to note that the operation of the multivibrator is independent of E_{bb} .

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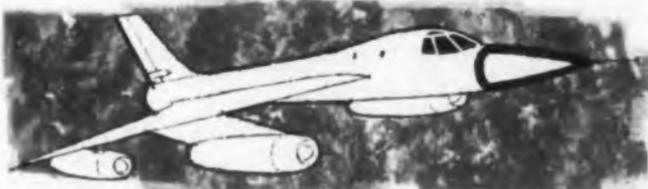
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CIRCLE 70 ON READER-SERVICE CARD

A Reliability Quiz

B. E. Phillips
The Martin Co.
Baltimore, Md.



B. E. Phillips' "Reliability Quiz" should be fun for lots of engineers—and not so much fun for others. A good reliability engineer should be able to answer his questions in 12 minutes. Can you? Mr. Phillips' responsibility for reliability work on the ground support equipment of Mace, Pershing, and Titan qualify him well for the responsibility for this quiz.

WE TALK and talk about reliability and think we have explained everything to everybody. Then we find a man with a great big gap in knowledge and understanding. Finally, we list things every reliability engineer should know so each one can see what he needs to learn. To make the list more palatable, we twist it around and convert it to the form of a quiz.

The quiz is designed for three purposes and thus is not ideal for any one of them. The purposes are:

1. To measure the knowledge and progress of reliability engineers at Martin-Baltimore.

2. To show engineers who aren't reliability specialists the types of special information they can expect a reliability engineer to bring to their project.

3. To help evaluate an applicant for reliability work.

To use the jargon of educational test specialists, this quiz is not validated nor are the questions "reliable." To validate the quiz would require a large sample of highly competent reliability engineers not readily available. The major purpose is stimulation, rather than measurement.

Some of the questions are of the background

type—the answers in themselves are not necessarily nuggets of reliability information but give a pretty firm indication as to whether the respondent has had to deal with similar questions before. Some of the questions have highly debatable answers but still provide interesting responses.

The answers are given at the end of this article. If you disagree violently, please write the author and send a copy to ELECTRONIC DESIGN. Several people helped collect these questions, and we are sure there are many more good ones. If you can think of some, send them in.

THE QUIZ

1. Define reliability.
2. State two numerical measures of reliability.
3. Define series components.
4. Define parallel components.
5. State the formula for reliability when constant failure rate applies.
6. Define "frit."
7. State the two important stresses on resistors.
8. State the two important stresses on capacitors.
9. State an important stress on relays.
10. What per-cent of troubles in operation of early production military equipments has been found to be caused by engineering errors?
11. State two important stresses on semiconductor diodes.
12. What is the approximate numerical value of $e^{0.001}$?
13. What is the approximate numerical value of $e^{-1.0}$?
14. What fraction of devices will operate for a time equal to their mean time between failures?
15. If a device is "qualification tested" so that 1,000 hr of operation without failure result, what can be said about the failure rate of the device?
16. Solve for x : $e^x = 0.05$.
Solve for x : $e^x = 0.50$.
17. What industrial association is very active in reliability?

17. What professional society is very active in reliability?
18. What business organization is very active in reliability research?
19. Name five individuals known nationally for their reliability activities.
20. Name two government officials with top responsibilities for reliability.
21. Name three phases in the life of a product in which reliability control is important.
22. Which statistical distribution is useful in determining confidence limits for failure rates based on tests for a predetermined number of failures?
23. What is the statistical test which allows the comparison of two failure rates based on tests for a predetermined number of failures?
24. If a reliability prediction, completed before release of drawings to factory, shows too low a reliability level, what is the most immediate engineering action indicated?
25. Rate the following means of attaining reliability in order of decreasing value: Derating of parts, degrading of performance, redundancy, failure reporting, failure analysis, conversion to solid-state, reliability posters, indoctrination lectures, reduction of functions, circuit analysis, reliability predictions.

26. Name three government specifications on reliability.
 27. What does the abbreviation AGREE mean?
 28. If the MTBF of a system is required to be 100 hr, how much sequential testing may be necessary to demonstrate its reliability with 90 per cent confidence?
 29. Which phrase is most closely associated with MTBF? Average life, minimum time to failure, reciprocal of failure rate during period of life when failure rate is constant.
 30. Which phrase is most closely associated with life? Average time to failure, time when failure rate becomes too high, time when 50 per cent have failed.
 31. State three items of information necessary for a successful reliability program.
 32. Name three books that contain substantial information on parts failure rates.
 33. Name the three commonly mentioned reliability states in the life of a device.
 34. In the following chronological phases of product development, which is the earliest one where reliability effort is valuable? Advanced design, detail functional design, product design, procurement, experimental fabrication, production, customer use.
- (Answers on p 76)



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	10K.....	± .5%
	50K.....	± .5%
1-3/32"	1K.....	± .25%
	10K.....	± .25%
	50K.....	± .25%
2"	1K.....	± .25%
	10K.....	± .25%
	50K.....	± .25%
3"	5K.....	± .1%
	20K.....	± .1%
	50K.....	± .1%
3"	5K.....	± .05%
	20K.....	± .05%
	50K.....	± .05%

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

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	20K....	1" Stroke	± .5%
	10K....	2" Stroke	± .25%
	20K....	2" Stroke	± .25%
	10K....	3" Stroke	± .1%
	20K....	3" Stroke	± .1%

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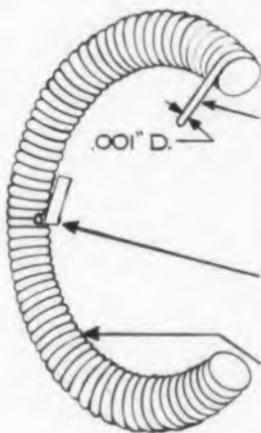
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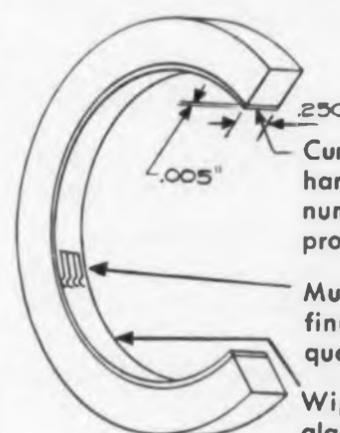


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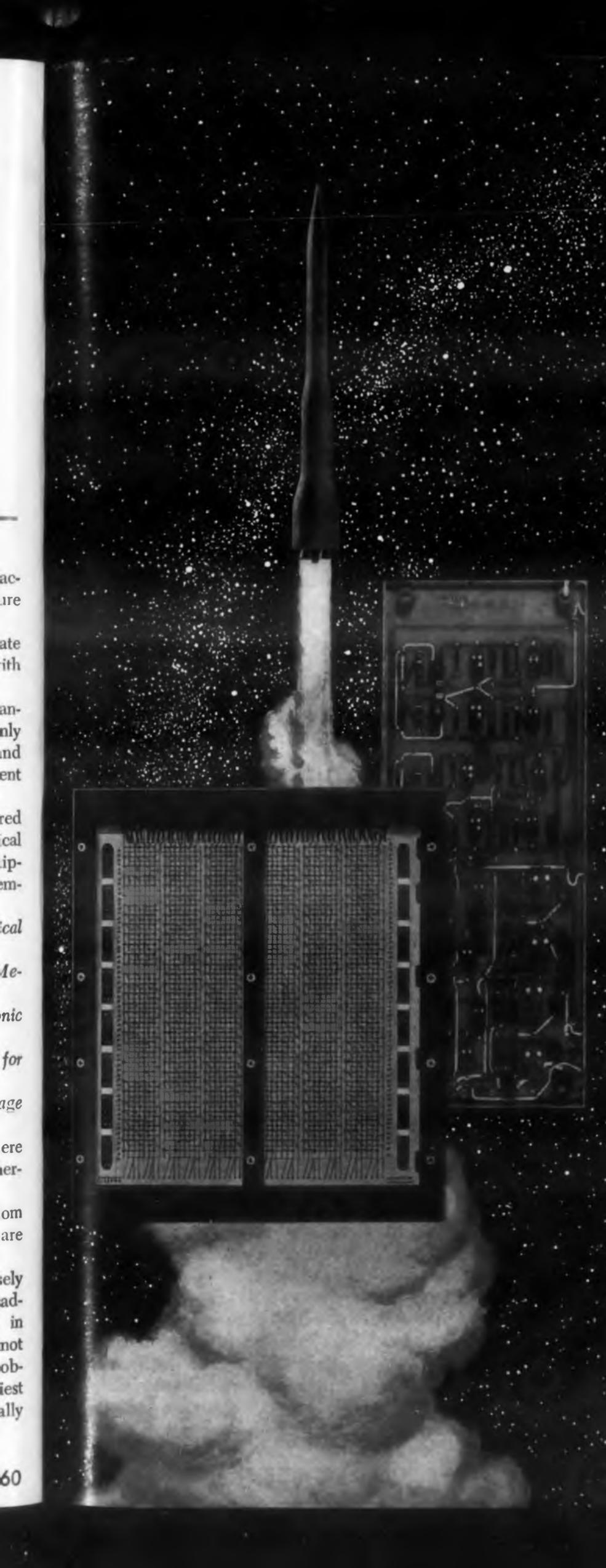
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A Reliability Quiz *(continued)*

THE ANSWERS

1. Reliability is the probability that a device will perform satisfactorily under specified conditions for a specified time.
2. Reliability can be measured by failure rate, mean time between failures, or probability of survival for a given time.
3. Series components are elements of a system whose individual failure causes system failure.
4. Parallel components are elements of a system so arranged that all the components must fail to cause system failure.
5. The reliability formula is e^{-rt} , where r is failure rate and t is time.
6. "Frit" is a Martin-invented failure rate unit equal to 10^{-9} failures per hour. We offer this as an industry standard term.
7. Resistors are stressed primarily by temperature and power dissipation.
8. Capacitors are stressed by temperature and applied voltage.
9. Relays are stressed by current through the contacts.
10. Various companies have reported that between 30 and 70 per cent of their early factory output of military equipment have been found to have design errors.
11. Semiconductor diodes are stressed by temperature and power dissipation.
12. $e^{-0.001} = 0.999$. $e^{-1.0} = 0.368$.
13. 36.8 per cent of devices will operate to MTBF if their failure rate is independent of time.
14. Failure rate is somewhere between zero and 3-million "frits" (something greater than 333 hours MTBF) at the 95 per cent confidence level, assuming constant failure rate.
15. If $e^{-x} = 0.05$, $x = 3$. If $e^{-x} = 0.5$, $x = 0.69$.
16. Aerospace Industries Association is very active, through its Electronic Reliability Panel.
17. The American Society for Quality Control is very active—also the IRE Professional Group on Reliability and Quality Control.
18. RCA, ARINC Research, Vitro and Battelle Memorial Institute are very active.
19. Leading individuals doing reliability work are C. M. Ryerson (RCA), Frank Gryna (Martin), R. Lusser (formerly of Redstone Arsenal), J. Hershey (Bell Telephone Labs.), R. Briggs (Bendix Systems), H. Voegtlen (RCA) and E. Nucci (DOD). There are many others, of course.
20. Government officials are C. M. Beyer (Office of Guided Missiles), E. J. Nucci (AGREE), G. A. Henderson (Army Ballistic Missile Agency), A. L. Jackson, Jr. (Air Research & Development Command), G. Peratino (BuWeaps), R. C. Littler (Air Material Command) and Maj. W. O. Castleberry (Hq., USAF).
21. We need reliability control in advanced design, detailed engineering, production and customer use.
22. The chi-squared distribution is related to estimated failure rates.
23. Comparison of failure rates should be based on the F-test (variance ratio).
24. This is a good one. A review of the detailed functional block diagram in search of a new concept that will avoid the high-failure rate parts will probably help most, if time permits. If not, additional derating should be considered.
25. We could write a book about this question. In the present industrial situation, the most valuable means of attaining reliability are: (a) failure analysis of early equipment units, (b) detailed circuit analysis, especially of tolerance, (c) reliability predictions when used to influence the design, (d) reducing the functions to a minimum consistent with military values. Of course, we should squeeze all these methods dry for the ultimate in reliability.
26. Reliability specifications are MIL-R-19610, MIL-R-25717, MIL-R-26667, MIL-R-26674, MIL-STD-411, MIL-R-27173 and AFBM Exhibit 58-10.
27. AGREE = Advisory Group on Reliability of Electronic Equipment.
28. This depends also upon the minimum acceptable MTBF, but 1030 hours is a good figure for R&D equipment.
29. Reciprocal of failure rate when failure rate is constant is phrase most closely associated with MTBF.
30. This is a debate question, a matter of semantics. In our opinion, life should be stated only as a function of failure rate; some uses can stand a higher failure rate and thus use equipment longer.
31. A project cannot succeed in achieving desired reliability unless it is stated: (a) What numerical reliability is required. (b) Exactly what the equipment must do. (c) What means of reliability demonstration will be used.
32. Martin-Baltimore. *Electronics and Electrical Reliability Handbook*.
Martin-Baltimore. *Missiles and Electronic Mechanical Reliability Handbook*.
RCA. *Reliability Stress Analysis for Electronic Equipment*.
Bell Telephone Labs. *Instructions and Data for Failure Rate Prediction*.
ARINC. *Improved Techniques for Design Stage Prediction*.
Minneapolis-Honeywell. *Reliability Guide*. (There are other valuable sources which are too numerous to mention).
33. Infant mortality or debugging period, random failure or reliable period and wearout region are reliability states.
34. Reliability effort ideally pays off inversely with the aging of a project; thus work during advanced design gives highest yield. However, in many companies where reliability talent is not available during preliminary design, it is probable that "experimental fabrication" is the earliest phase where a reliability engineer can really help. ■ ■



EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY IN COMPUTER DEVELOPMENT

Space Vehicle Command – An important advance in the control of space vehicles has been accomplished with the development by Lockheed scientists of space-borne, command decoders and sequence programmers. Basically, the programmers store information and, at a predetermined time when the vehicle is out of contact with ground stations, cause commands to be executed by the various subsystems. In this way, versatility of vehicle missions can be markedly expanded.

In addition, when the vehicle comes in range of ground command stations, the programmer can be given new instructions for either future or immediate action. All of the programmer's components are solid state devices. There are no moving parts nor vacuum tubes. The ferrite core memory in which information is stored is a two core-per-bit matrix.

A primary design goal was to reduce power requirements. Although the Lockheed programmer is highly complex and employs over 600 transistors, the average power consumption is only 3.5 watts, less than a Christmas tree light bulb. The development of such complex circuitry that will withstand the shock, vibration and a temperature range from -40°C to $+85^{\circ}\text{C}$ is in itself a significant achievement.

The highly precise timing necessary for the execution of the various programmed assignments is accomplished by means of a crystal oscillator – maintained at an exact temperature by means of a two phase mixture of solid and liquid inert chemical.

Engineers and Scientists: Lockheed's capability in design and development of computers is contributing to the advancement of the state of the art in a number of areas. Work is being carried on in research and development of ultra reliable digital circuitry, ferrite logic systems, and millimicrosecond switching techniques; radically new devices for pattern recognition operations; high speed digital plotters; self-organizing systems; large scale systems for the automatic storage and retrieval of information; microminiature packaging techniques; and systems research and engineering of large scale information handling complexes.

If you are experienced in work related to logic design or computer development, you are invited to inquire into the interesting work being conducted and planned at Lockheed. Write: Research and Development Staff, Dept. H-21, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed

MISSILES AND SPACE DIVISION

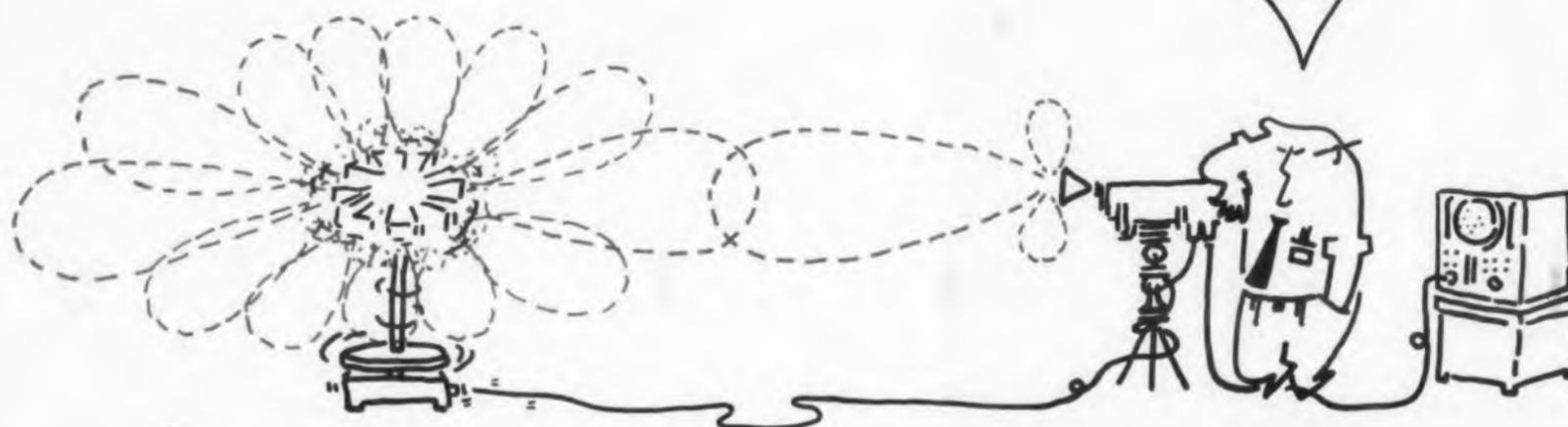
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Record Antenna Patterns Using Off-The-Shelf Test Equipment

R. L. Thomas
Design Engineer
Douglas Aircraft Co.
El Segundo, Calif

Here is a novel technique for recording antenna-radiation pattern beam-widths without resorting to special test fixtures or elaborate recording devices. The technique employs standard items of test equipment that are available in any microwave laboratory. Only a small, easily constructed control box can be considered custom-built.



IN MANY facilities where numerous half-power beam-width measurements are taken day in and day out, the elaborate recording equipment usually associated with this procedure may be at a premium. An adequate test set-up which employs readily available standard test units can avoid the costly delays that can result.

Using an oscilloscope, scope-camera, standard microwave plumbing and test-equipment, antenna-beam measurements have been obtained in the 1 to 40 kmc range that compare favorably with those obtained using elaborate recording equipment. The technique is usable in both indoor anechoic chambers and in outdoor ranges.

Test Circuit Built From Standard Components

An over-all block of the test set-up is shown in Fig. 1. The test equipment consists of:

- Rf signal generators or klystrons to provide the rf power.

- Transmitting antennas—these may be optimum gain standard horns
- High-gain amplifiers
- Detectors
- Turntable and control wiring
- Associated rf plumbing
- Dual-trace oscilloscope
- System control box

All the above test equipment, with the exception of the system control box, are in common usage in laboratories performing rf and microwave measurements. The control box, Fig. 2, may be easily fabricated and consists simply of a circuit breaker and two toggle switches. One switch is used to control the direction of rotation of the turntable while the other switch is employed to energize the camera system when a photograph of the radiation pattern is desired. The control box should be located adjacent to the oscilloscope within easy access to the operator.

The technique consists in synchronizing the

turntable rate of rotation with the horizontal sweep rate of the oscilloscope. A high-gain amplifier and a sensitive detector provide the means of obtaining a visual trace of the radiation pattern on the oscilloscope. A second amplifier and detector permits monitoring the rf power output simultaneously with the radiation pattern cut. The system may be operated quite adequately by one or two operators.

Control limit switches mounted on the periphery of the turntable, determine the azimuthal pattern coverage in degrees obtainable. Photographs presented here represent an azimuthal coverage of 200 deg or 20 deg per cm on the oscilloscope face plate. These control limit switches are also used to provide the circuitry to externally trigger the oscilloscope and camera shutter. The persistence of the oscilloscope affords ready visual radiation pattern characteristics. In addition, the camera may be used to obtain a photograph of the radiation pattern. The rise

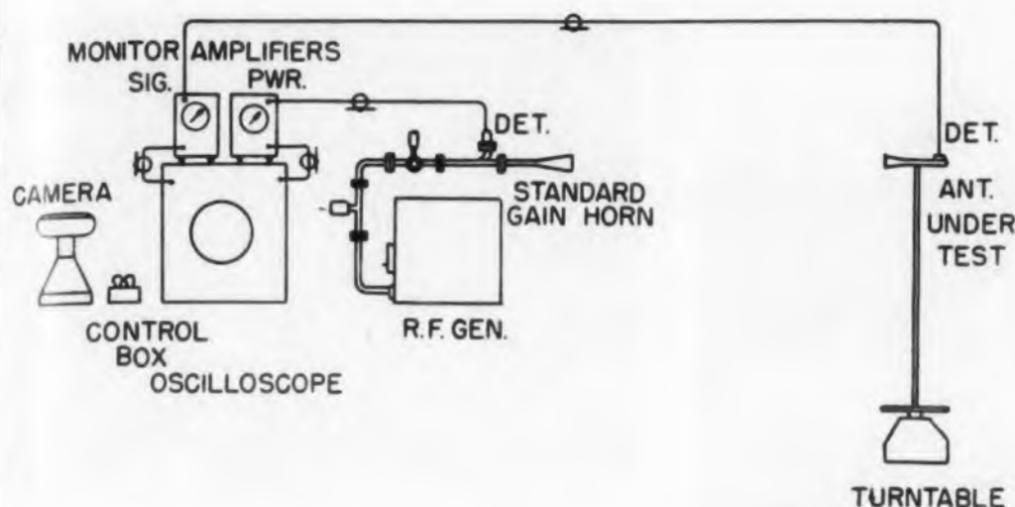


Fig. 1. Antenna beam-width-recording circuit is built from standard test components.

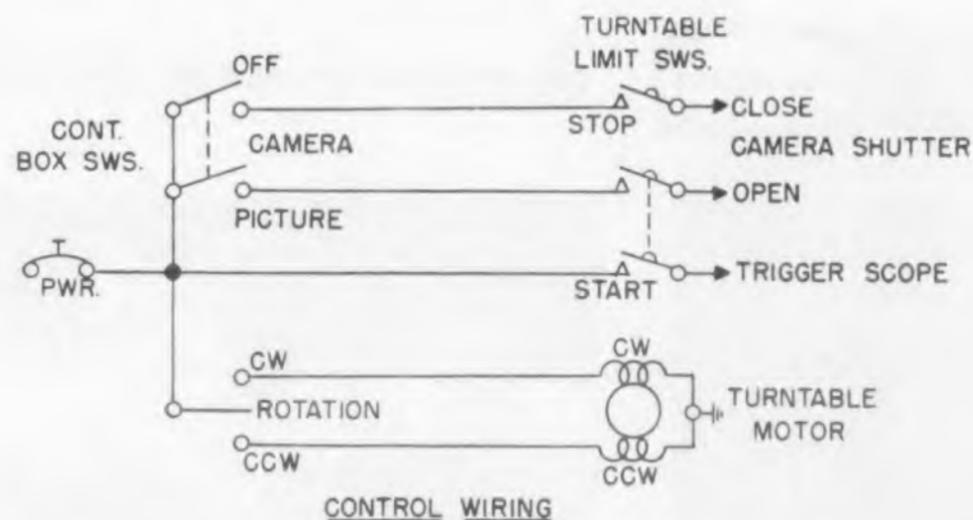


Fig. 2. Control box, only custom-built unit, controls turntable, scope and camera.

time of the oscilloscope provides a more instantaneous indication of the antenna radiation pattern characteristics than would otherwise be provided by a pen-recording device.

A Wide Choice Of Test Units May Be Used

A standard signal generator or klystron may be used as the rf source. Such factors as power output requirements, minimum allowable transmitting test distances, stability and ease of operation should all be considered in the selection of the type of rf source. When possible, standard signal generators should be used, since these devices provide greater stability and ease of operation. Standard signal generators are commercially available in frequency ranges up to about 40 kmc. These generators can deliver an rf output of at least 1 mw into a matched load.

Horn type antennas may be used as the transmitting antennas. Optimum¹ gain standard horns are very good for this application since they afford the following desirable characteristics—a useful value of gain, broadband coverage, accurate calibrations and reasonable size. Such units may be bought commercially or built in the laboratory to existing design data.²

Either bolometers or crystals may be used as the detectors of the rf energy. Each has its respective advantages and disadvantages. The bolometer is relatively poor in detection-sensitivity when compared with the crystal detector but displays "square-law" characteristics over a much broader dynamic range. Mounts are available for both in the coaxial or waveguide types—either fixed-tuned or tunable. A single broadband coaxial crystal mount³ (using tripolar video diodes) may be obtained that covers the entire frequency spectrum of 50 mc-12,000 mc. Higher frequencies will necessitate the use of waveguide types. The microwave plumbing is standard, but should provide for both vertical and horizontal polarization.

Two amplifiers, such as Hewlett-Packard 415B types are used in this recording technique. These units are usually readily available in laboratories performing rf measurements. These units contain an input signal jack for either crystal or bolometer operation. The output jacks are used to provide pattern and rf power-monitor information to the dual-trace oscilloscope. The sensitivity of these devices is about 0.1 mv at a 200-ohm level for full scale deflection. Since the units are "square-law"-calibrated, the detector response may be easily verified to ascertain "square-law" operation. The dynamic output response of these amplifiers, at a particular scale setting, is limited to 10 db. The units are also extremely useful in checking the calibration of the attenuators used in the test set-up.

Dual-Trace Scope And Polaroid Provide Permanent Record

A dual-trace oscilloscope and polaroid oscilloscope camera are required. A Tektronix Type 535

oscilloscope with a type 53/54C plug-in unit were used in obtaining the patterns shown. The rise time is about 0.035 μ sec and the persistence is such that good visual indication of the radiation pattern is obtained. The face plate was modified in order to inscribe a db scale for convenience in data reduction.

The dual-trace feature is utilized to provide a monitor of the rf power output simultaneously with the radiation pattern cut. It is very essential in performing radiation pattern measurements to know the characteristics of the rf output at the actual time the pattern is cut. Variations in rf power output will result in radiation patterns that are not valid.

Limitations of The Test Technique

The dynamic recording response of this method, as presented, is limited to about 10 db. This is due primarily to the output response of the amplifiers employed at a particular scale setting. This response is quite adequate, however, when

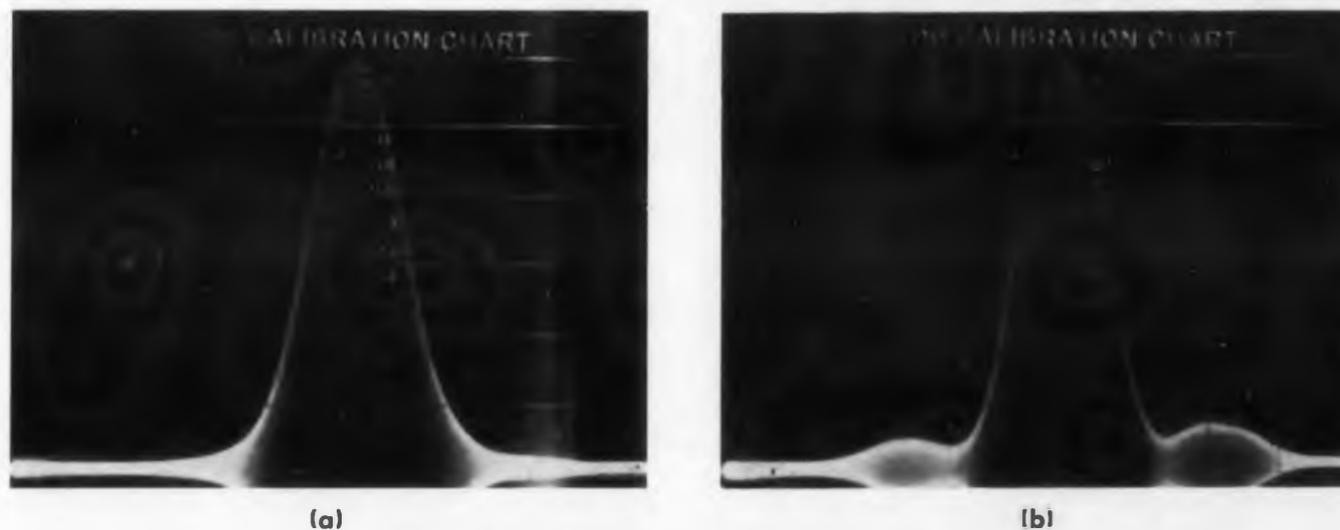


Fig. 3. Radiation pattern of 23 cm (1300 mc) standard-gain horn. Cut a is for a vertically polarized horn. Beamwidth, calculated as 29.4 deg, measures 31 deg. Cut b is for a horizontally polarized horn. Beamwidth, calculated as 28.8 deg, measures 21.3 deg.



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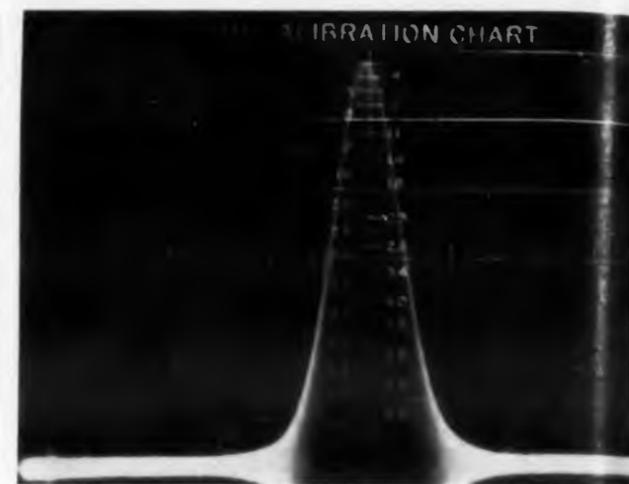
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... WHERE RESEARCH IS THE KEY TO TOMORROW



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(a)



(b)

Fig. 4. Radiation pattern of 6.67 cm (4500 mc) standard-gain horn. Cut a is for a vertically polarized horn. Beamwidth, calculated as 22 deg, measures 22 deg. Cut b is for a horizontally polarized horn. Beamwidth, calculated as 21.6 deg, measures 21.3 deg.

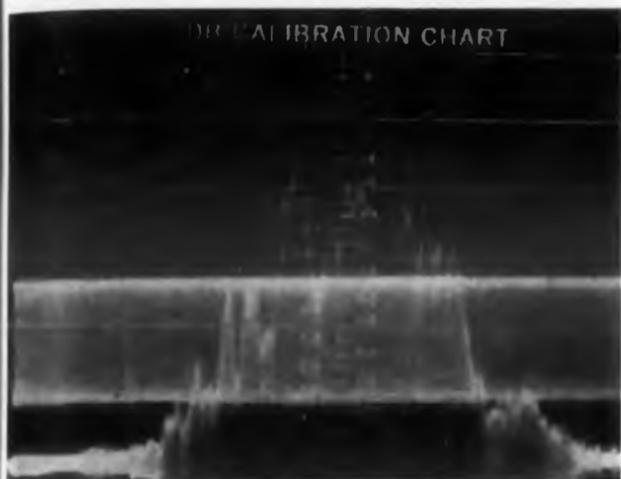
the prime interest is in the half-power beamwidth characteristics of the antenna radiation pattern. A great deal of antenna test work is concerned only with the radiation pattern half-power points. Due to the limited response of this system, it is not usable for the investigation of the side-lobe characteristics of the radiation pattern as a greater dynamic response for this type of investigation would be required. Amplifiers with greater dynamic response would, of course, increase the usefulness of this pattern-recording technique.

Radiation-Pattern Photographs

Photographs of the antenna-radiation pattern may be obtained, if so desired, for record purposes. Typical radiation pattern photographs are shown in Figs. 3, 4 and 5. Figs. 3 and 4 are patterns of a 23-cm and 6.67-cm optimum gain standard horns at their respective design frequencies. Half-power beam-width results obtained with this recording technique compared favorably with the calculated values for these horns. Half-power beamwidth of these horns was also measured with elaborate recording equipment and the values



(a)



(b)

Fig. 5. Radiation pattern of 3800 mc antenna, installed (a) and in radome (b) showing rf power output monitor superimposed on the same scope trace.

compared within 1 deg to those indicated in the photographs.

Photographs in Fig. 4 show the application of the method in antenna installation and radome evaluation tests. These photographs are included only to illustrate the simultaneous monitoring of the radiation pattern and the rf power output.

This technique is quite versatile. With proper modification, the basic principles involved can be used for a wide range of frequencies and antenna types. ■■

Acknowledgement

Mr. C. R. Peyton suggested the feasibility of this technique and assisted in its development into a usable system.

References

1. An optimum horn has aperture dimension chosen to give maximum gain when the slant height is held fixed.
2. "Design and Calibration of Microwave Gain Standards," by W. T. Slayton, NRL report No 4433, Nov. 1954.
3. Such a coaxial mount is designed to transform the coaxial line impedance (usually 50 ohms) to 65 ohms to match characteristic impedance of tripolar crystals.

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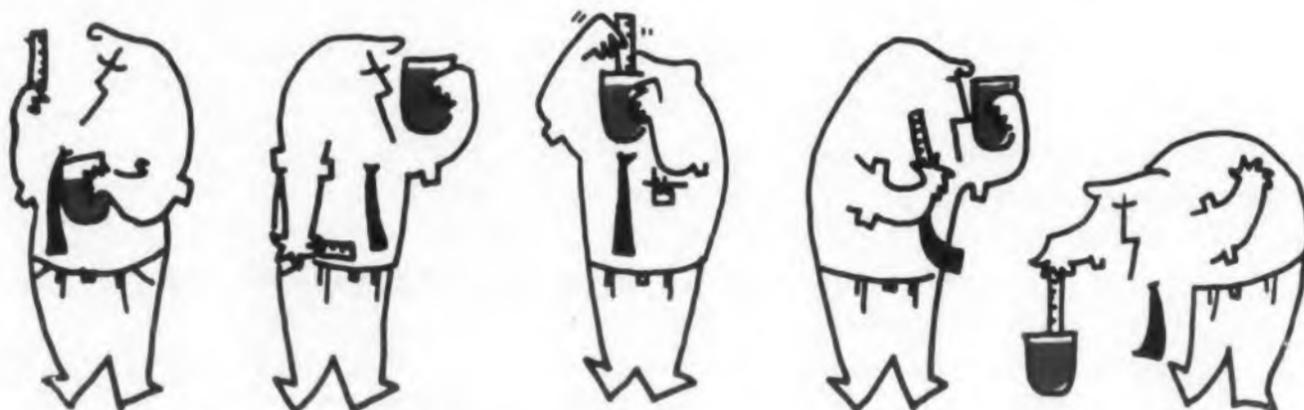
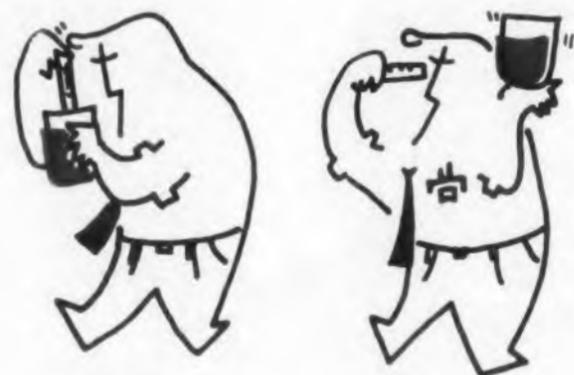
Probe Design For Capacitive Level Measurements

George Revesz

Robertshaw-Fulton Controls Co.
Eastern Research Center
Philadelphia, Pa.



As with many other aspects of instrumentation, probe design has long been more of an experimental art than a science. By cut-and-try, designers would develop a technique to perform a measurement or control function and everybody would be happy. Then cases would crop up where the technique wouldn't work and the designers would be stumped. To eliminate the guess-work in probe design, George Revesz, technical director of Robertshaw-Fulton's Eastern Research Center, developed the basic approach in this article.



CAPACITIVE probes are extremely useful for measuring levels. But probes can give erroneous measurements if there are changes in dielectric constant, conductivity, temperature, or pressure of the material level is to be measured.

Fortunately, if the frequency of the applied voltage and the probe's insulation thickness are properly chosen, the effects of parameter changes can be minimized and substantially correct measurements will result.

Simplest Level Probe, Bare Rod, Has Marked Disadvantages

In its simplest form, a probe is a metal rod mounted in the vessel whose content is to be measured. The rod must have a seal insulating it electrically from the vessel wall. The capacitance is formed by the rod (the live electrode) and the vessel wall (the grounded electrode).

In at least three important applications; the bare rod has marked disadvantages:

- Materials with a high dielectric constant are hard to measure due to large capacitance values.
- Conductive materials can't be measured at all.
- Corrosive materials are hard to handle, so very expensive metal alloys must be used.

Most Applications Need Insulated Probe

The probe would usually have an insulating sheath around the live electrode. Such a probe, sketched in Fig. 1, can be considered, electrically, as two capacitors:

1. The insulation capacitance C_i , which is the capacitance between the rod and the outside of the insulating sleeve.
2. The outer capacitance C_o , from the outside of the sheath to the vessel wall.

These two capacitances are in series. When the vessel is empty, the total capacitance C_e is a series connection of C_i and C_o .

$$C_e = \frac{C_i C_o}{C_i + C_o}$$

When the vessel is filled with a material having a dielectric constant K , C_o changes to KC_o and the system capacitance is

$$C_f = \frac{C_i C_o K}{C_i + KC_o}$$

For analysis, the whole electrode can be pictured as a series of little sections of unit length, each being either full or empty, and each with a capacitance of either C_o or C_f . A probe of unit

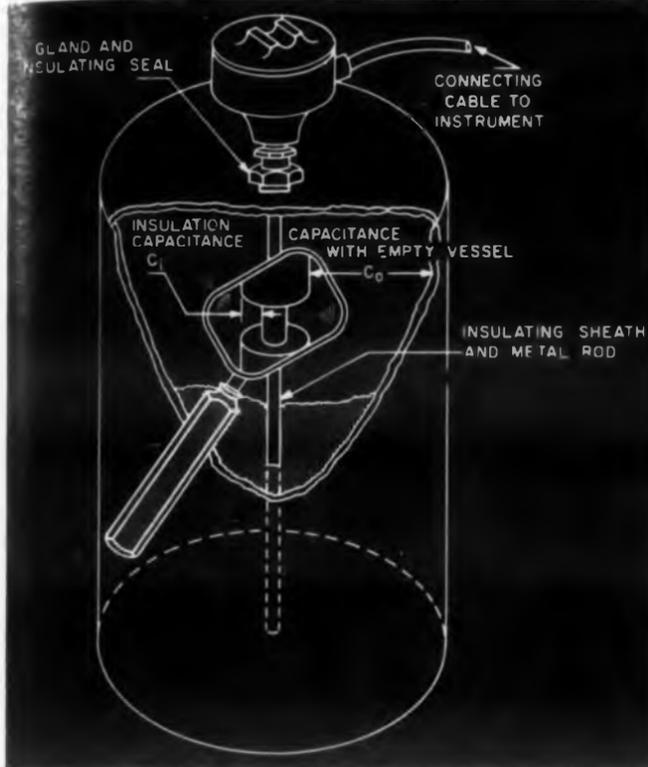


Fig. 1. Typical level-gaging probe has two capacitances in series.

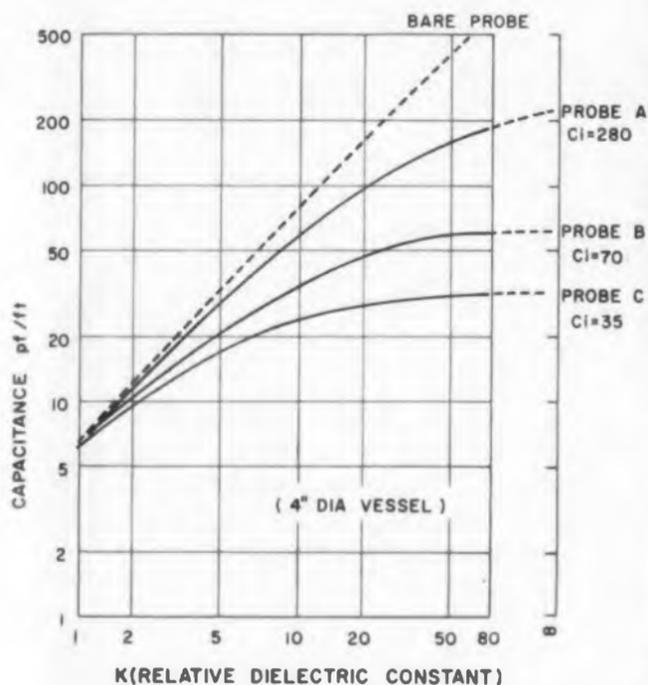


Fig. 2. Capacitance of insulated probes is a nonlinear function of the dielectric constant of the insulating sheath.

length can thus be studied and the data can be multiplied by the length of the probe to obtain the behavior of the whole probe.

Insulated Probe Capacitance Is Nonlinear Function of Dielectric

As indicated in Fig. 2, the capacitance of a particular probe is a function of dielectric constant. For insulated probes, the curves start out looking approximately linear ($C_f = KC_o$), then trail off asymptotically ($C_f = C_i$) at high K values.

(continued on p 84)

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brief specifications

RANGES	DC: 0.000 to 1,200, 12,00, 120.0, 1200 V positive or negative (automatic polarity indication). AC: Same as dc ranges (rms value of 30 to 10,000 cps sine wave). OHMS: 0.001 to 1,000 K ohms.	POWER REQUIREMENTS	105 to 125 V, 60 cps, 250 W.
ACCURACY	DC: Better than $\pm 0.1\%$ of full scale. AC: Better than $\pm 0.2\%$ of full scale up to 120 V and 200 cps. Better than $\pm 0.5\%$ of full scale above 120 V and 200 cps. OHMS: Better than $\pm 0.2\%$ of full scale.	DIMENSIONS	Portable model (illustrated): 11 $\frac{3}{4}$ " H x 11 $\frac{1}{2}$ " W x 18 $\frac{1}{2}$ " D. Rack mounting model 19" W.
INPUT IMPEDANCE	DC: 20 megohms nominal. (Effective input impedance on other than 1200 V range approaches infinity.) AC: 20 megohms shunted by 400 mmf.	WEIGHT	45 pounds.
		FINISH	Smooth gray baked enamel. White engraved panel designations.
		SPECIAL FEATURES	Printer output provisions. Static parallel; binary coded 1-2-2-4 decimal output. (Other codes optional extra.)



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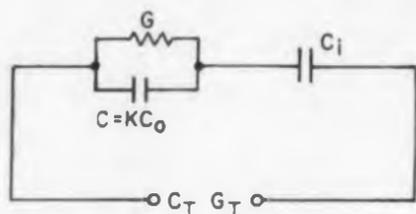


Fig. 3. Equivalent circuit of an entire probe system.

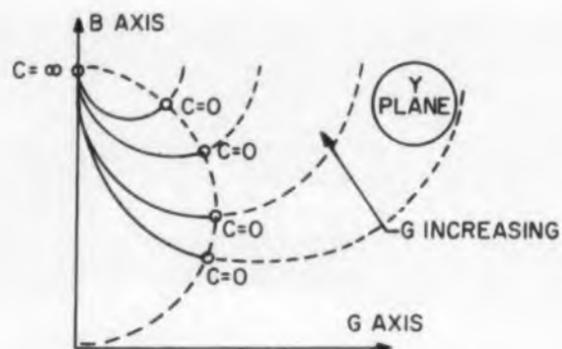


Fig. 5. A construction similar to that of Fig. 4 shows the effect of varying C with different values of G .

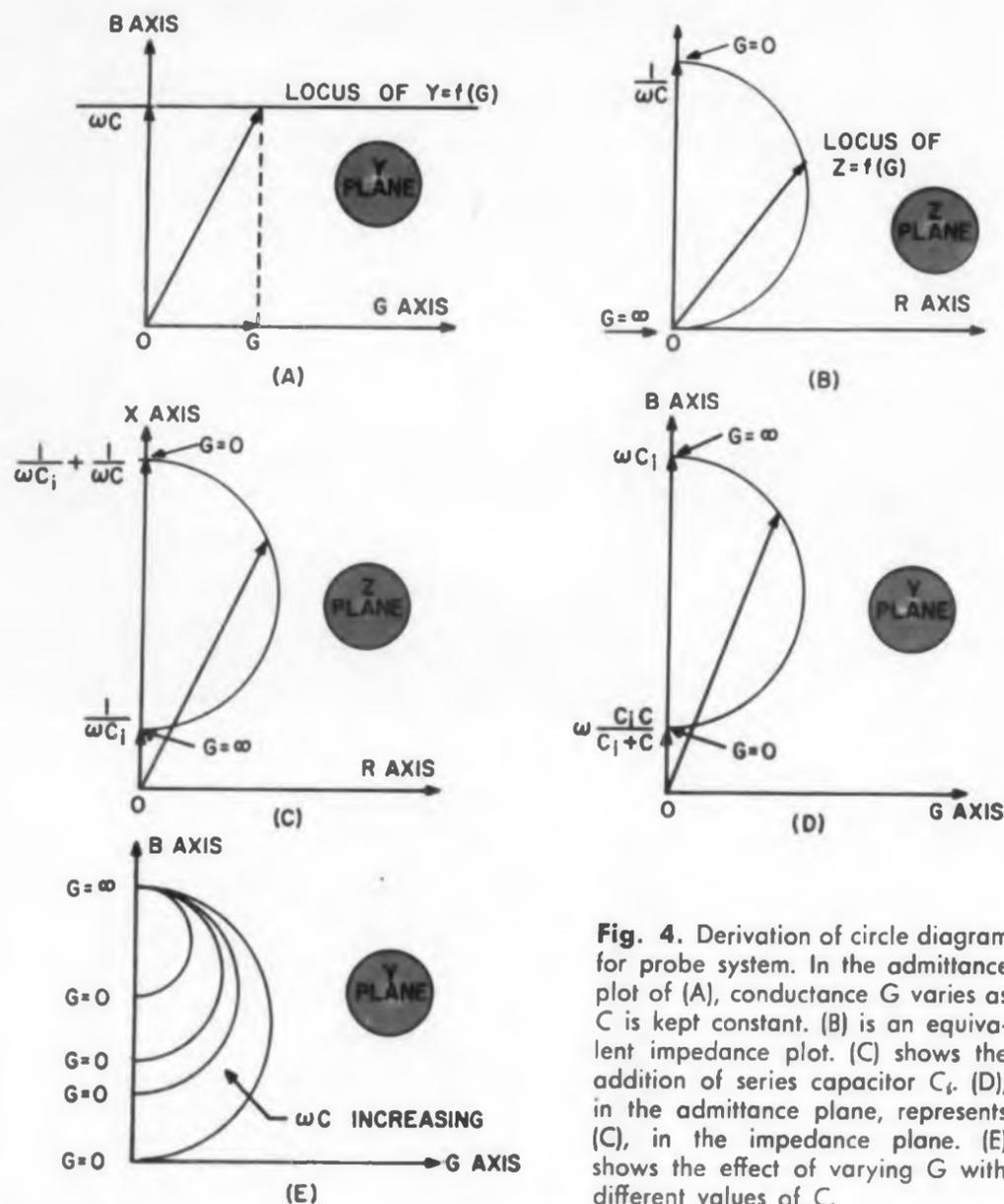


Fig. 4. Derivation of circle diagram for probe system. In the admittance plot of (A), conductance G varies as C is kept constant. (B) is an equivalent impedance plot. (C) shows the addition of series capacitor C_i . (D), in the impedance plane, represents (C), in the admittance plane. (E) shows the effect of varying G with different values of C .

For $K = 1$, the capacitance equals the unit-length capacitance with the vessel empty (C_e). The capacitance change per unit length is the difference $C_f - C_e$ where C_f depends on the dielectric constant of the material measured.

Conductive Leakage Affects Capacitance Reading

This is true only where there is no leakage in the material to be measured. When there is con-

ductance in the material to be measured, the probe system can be represented by Fig. 3. It comprises the insulation capacitance C_i in series with the parallel combination of conductance G and capacitance KC_e .

The total capacitance C_T and conductance G_T both vary as C and G vary. To understand how the variations take place, one can first consider a situation with a fixed C and a variable G . Fig. 4A shows how the admittance varies as a function of

conductance while C is kept constant. As G varies from zero to infinity, the admittance vector moves along a horizontal line.

To add the effect of C_i to this vector sum of G and C it is best to move from the admittance plane to the impedance plane of Fig. 4B where the vector moves along a semicircle as G varies. The impedance of C_i is easily added to this vector as shown in Fig. 4C.

Shifting back to the admittance plane yields

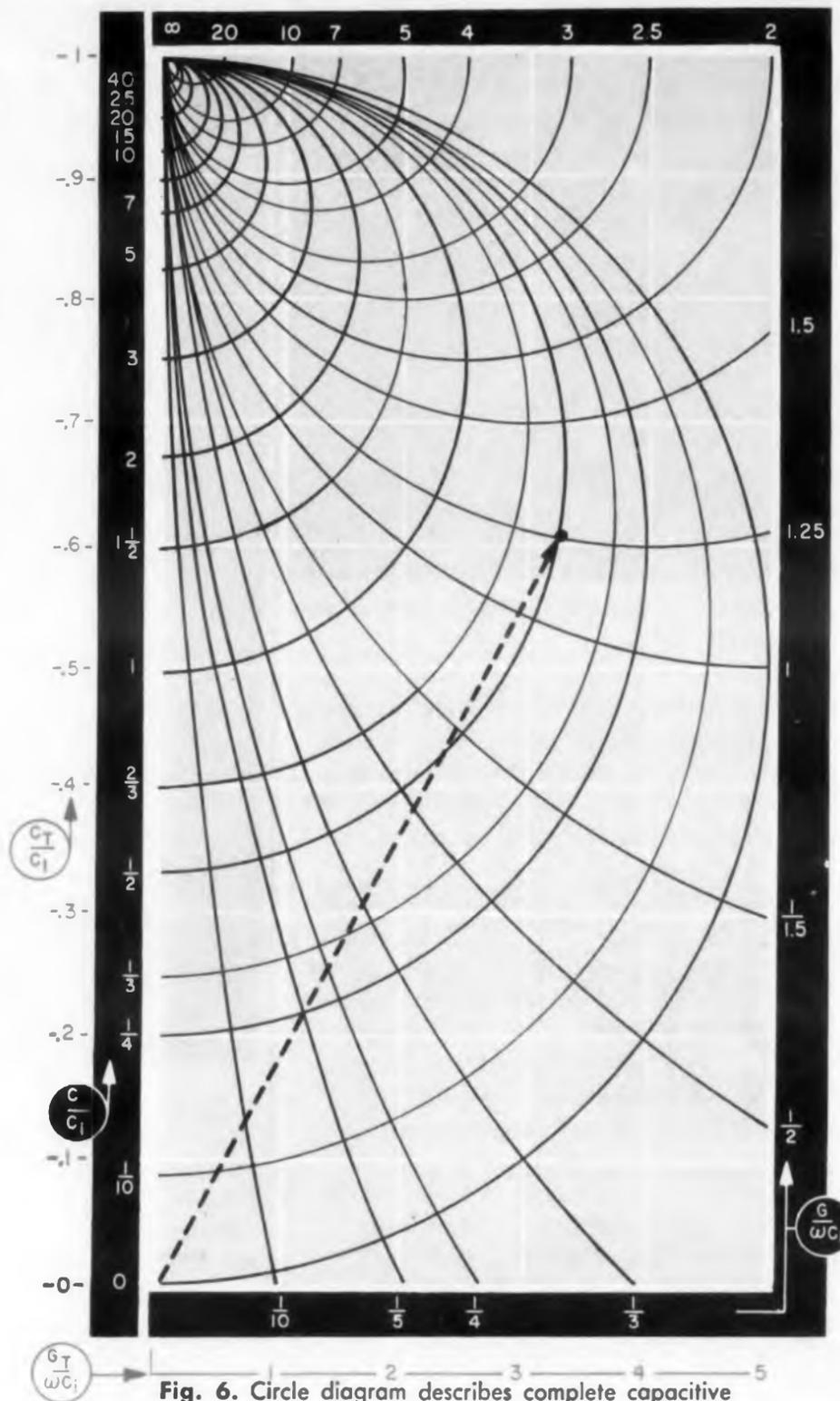


Fig. 6. Circle diagram describes complete capacitive probe network.

Fig. 4D as the probe's equivalent circuit (Fig. 3), with C constant. This is useful since the probe instrumentation measures capacity. Finally, varying C gives the family of semicircles shown in Fig. 4E.

Circle Diagram Describes Probe Network

A similar approach can yield the analogous family of semicircles of Fig. 5 for mixed G and variable C . Superimposing these two sets of semicircles gives the system of circular coordinates of Fig. 6 which completely describes the entire probe network.

Fig. 6 has been normalized so both C and G components are divided by the value of insulation capacitance C_i . Use of this circle diagram is best explained by a typical example:

The following data pertain to a particular probe: $C_i = 100$ pf, $C = 50$ pf, $R = 2.5$ K, $G = 1/R = 10^{-4}$ mhos, $f = 500$ kc. From these data one can compute C/C_i and $G/\omega C_i$.

$$C/C_i = 1/2$$

$$G/\omega C_i = \frac{10^{-4}}{2\pi \times 5 (10^5) \times 100 (10)^{-12}} = 1.25$$

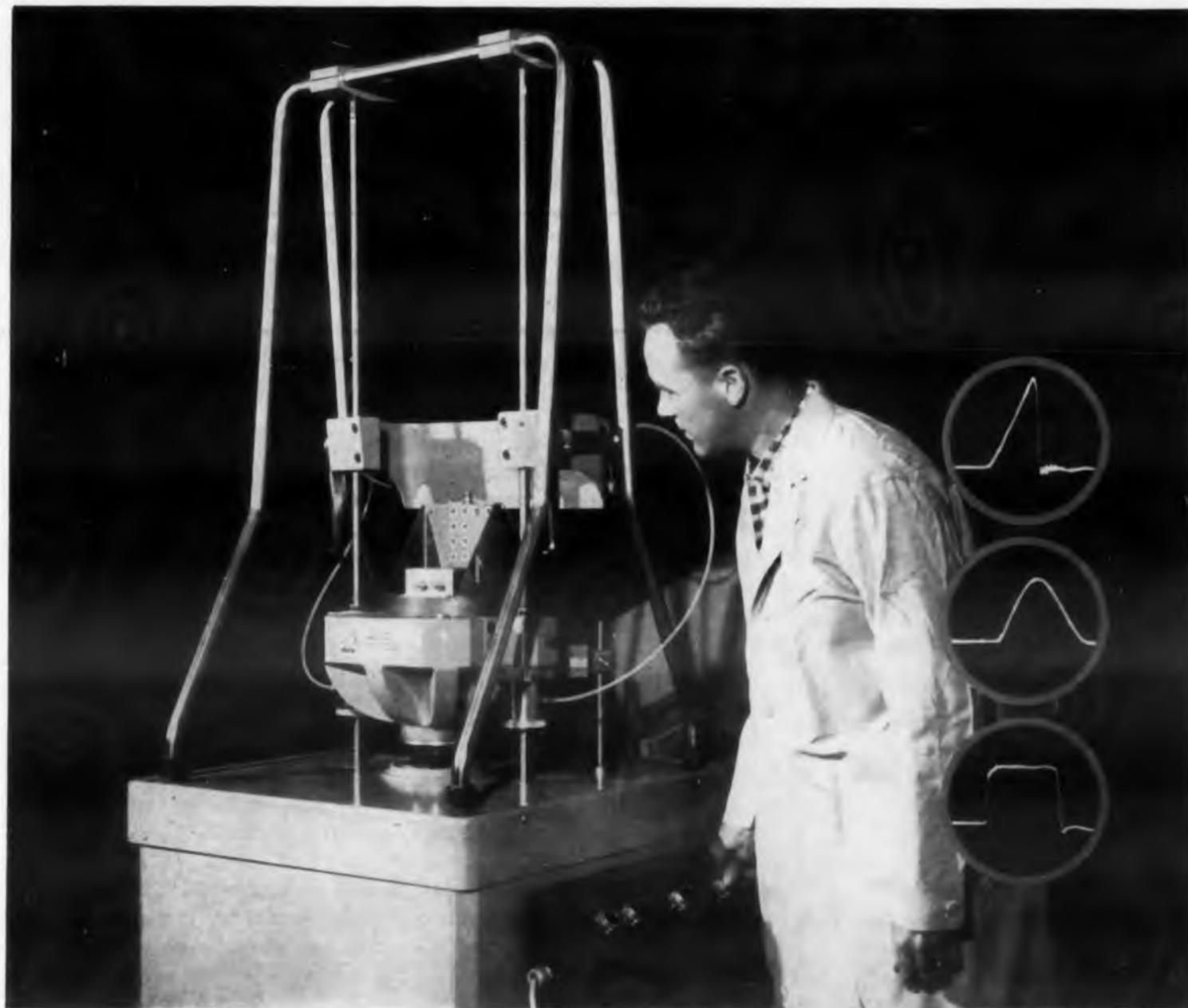
The intersection of the semicircles for these two quantities on Fig. 6 represents the end point of their vector sum. This vector represents the magnitude of the total admittance.

On this circle diagram, a curve can be plotted to describe the effect of a varying third parameter such as temperature which can influence both the dielectric constant and conductivity of the medium whose level is to be measured. To plot such a curve, it is necessary first to plot separate curves showing the variations in K and G as a function of the third parameter.

If the empty capacitance C_o is known (this is a function of geometrical arrangement of probe and vessel wall), the vessel-full capacitance per unit length KC_o can be computed.

For a specific instrument frequency and specific insulation capacitance (determined by the geometry and the insulation-sheath material), one can make points for KC_o and G from the separately plotted temperature curves and enter them on the circle diagram.

By plotting several such temperature curves on the circle diagram for different instrument frequencies and different insulation capacitances, one can determine which combination of frequency and insulation capacitance yields least change in the instrument's capacity readings over a range of temperatures. ■ ■



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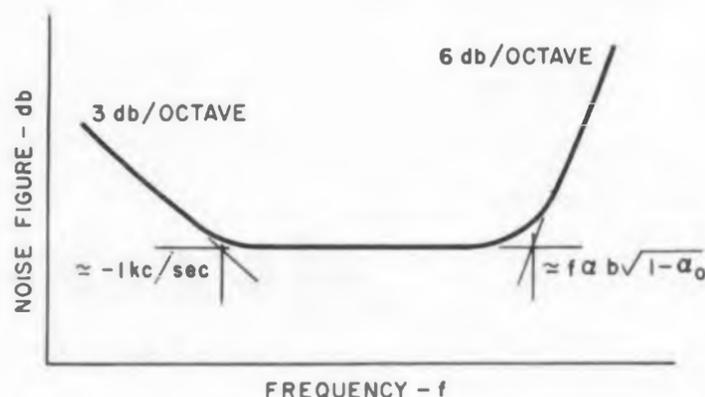
Paul J. Bénéteau
Design Engineer
Fairchild Semiconductor Corp.
Mountain View, Calif.

Papers on noise are usually fairly complex and loaded with mathematical equations and derivations. A brief description of noise sources and their origin, considerations in circuit design and a typical design example involving a low-noise application is presented as a practical guide to the design engineer.

A PART from the obvious advantages of freedom from the hum and microphony of vacuum tubes, it has now been shown that good transistors have better noise performance than tubes in fairly low-impedance applications.¹ Although tubes remain much better at high source impedance levels, the point at which it becomes equally advantageous from a noise point of view to use a tube or a transistor is roughly a source impedance of 10 K, depending on the properties of the specific devices in question.

Types and Origin of Noise

The amplitude spectrum of transistor noise is generally as shown in Fig. 1. At low frequencies, the noise is predominantly "flicker noise," or, as it varies approximately inversely with frequency,



"1/f noise." It has a slope of 3 db/octave. It is generally considered that it has two components: surface noise and leakage noise. Surface noise is caused by fluctuations of energy levels at junction surfaces which modulate the junction resistances and is strongly current dependent, whereas leakage noise is caused by leakage current across the junctions. Obviously, leakage noise will be strongly bias voltage dependent, but at low biases (less than 10 v), it is small, and at very low biases (less than 3 v), it is negligible for good transistors.

Above about 1 kc, shot noise predominates. It is generally accepted that this noise is the combination of the thermal noise generated by the ohmic resistances in the device and the noise caused by the discrete character of the currents across the junctions. While flicker noise can be considerably reduced by proper surface treatment by the device manufacturer, relatively little improvement can be made in the magnitude of the shot noise.

At higher frequencies, the noise figure of transistors increases at about 6 db/octave at frequencies higher than approximately $f_{\alpha_b} \sqrt{1 - \alpha_0}$ where f_{α_b} is the α cut-off frequency and α_0 is the

Fig. 1. Noise spectrum for a typical transistor. At low frequencies, "flicker noise" varies inversely with frequency at a slope of 3 db/octave. At higher frequencies, the noise figure increases at about 6 db/octave.

low frequency current multiplication factor. This dependence is due to the appearance of α in the equivalent noise resistance formula.

Considerations in Circuit Design

(1) It is obviously essential to use a low noise transistor. In the past silicon transistors have not had the excellent noise characteristics exhibited by many germanium devices. However, recent advances in technology have permitted the production of silicon devices with noise performance very nearly equal to that of the best germanium devices available and with vastly superior temperature, frequency and voltage characteristics.

Since there are now on the market many transistors with a noise figure of less than 10 db, the selection of these is then more a matter of desirability of other characteristics, particularly high frequency response, as described in (4) below.

(2) Flicker noise is large compared to other noise at low frequencies. Therefore, it follows that the minimum low-frequency response needed should be designed into the equipment, and if it is possible to cut off below 500 cps, then that should be done.

(3) Noise figures are strongly dependent on emitter current and source resistance. For most transistors useful as small signal amplifiers, the noise figure is minimum at some emitter current less than approximately 0.5 ma, but starts going up again at approximately 0.1 ma. Hence, 0.3-ma emitter current is suitable in most cases. For most transistors, the noise figure is more or less independent of source resistance for resistances in the range 500-1500 ohms. Therefore, it is important to use some device for impedance transformation if the source impedance is not of the order of roughly 1000 ohms. For this purpose a transformer is particularly well-suited since it is possible

ble to obtain the highly desirable added advantage of stabilizing the transistor operating point, irrespective of the I_{CO} variations. This is a particularly important consideration for germanium transistors.

(4) As mentioned previously, the noise figure of a transistor starts rising at $f \approx \frac{f_{ab}}{\sqrt{\beta_0}}$, where β_0 is the low-frequency current gain. For example, if a 3-mc low-noise pulse amplifier is desired, it becomes important to use a transistor with an alpha cut-off of at least $3 \times \sqrt{50}$ mc, or 21 mc, assuming a β_0 of 50. Unfortunately, the low current condition which insures low-noise operation conflicts with the high frequency requirement, since gain-bandwidth product, being inversely proportional to current, is much lower at low currents than the normally quoted figure.

For example, from the type 2N1613 data sheet, it is seen that the gain-bandwidth product (f_t) is typically 90 mc at $I_E = 20$ ma ($V_{CE} = 15$ v), while at 1 ma it is only 12 mc. Since the frequency dependence of β can be expressed as

$$\beta = \frac{\beta_0}{1 + jf/f_\beta}$$

where f_β is the beta cut-off frequency, f_β can be expressed in terms of the f_t by setting $\beta = 1$ at $f = f_t$. This yields

$$f_\beta = f_t/\beta_0$$

Now, using a value of $f_t = 12$ mc and $\beta_0 = 50$, the f_β then becomes 240 kc. Therefore, using even this high frequency transistor in a common-emitter stage at $I_E = 1$ ma will permit a bandwidth of only 240 kc to be obtained, while at $I_E = 0.3$ ma it will be even less. Thus it becomes very important for most low-noise applications to use the highest frequency transistor available.

Step-by-Step Design Procedure

(1) Determine the required frequency response of the amplifier. From the transistor's data sheet, determine the optimum operating point for lowest noise. Calculate f_β at that point ($f_\beta = f_t/\beta_0$) and ensure that f_β is higher than the required passband of the amplifier. If not, improve f_t by using a faster transistor, increasing the emitter current, or providing emitter degeneration.

(2) Determine the source impedance. If it is not in the range 500-1500 ohms, use a suitable transformer for coupling, if possible.

(3) Design the bias network to give required operating point and stability.

(4) Determine the lowest frequency necessary and design the circuit to give that frequency response and no lower.

Circuit Design Example

Suppose it is necessary to amplify short bursts of a sinusoidal signal, as would be encountered

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External Modulation:	Pulse, fm, square wave.
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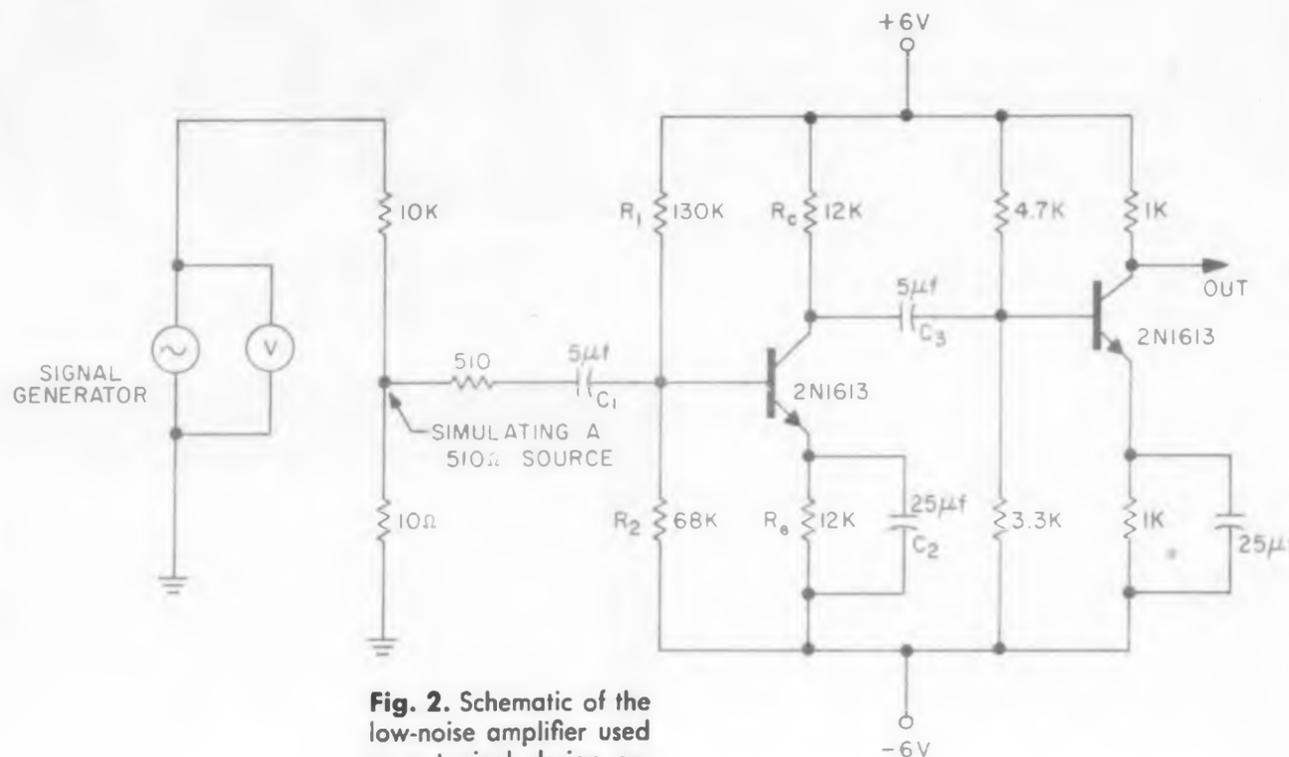


Fig. 2. Schematic of the low-noise amplifier used as a typical design example. The noise level, using unselected 2N1613 transistors, is approximately 18 μ v p-p.

in the readback from a thin magnetic head in a character recognition system. Assume further that the required passband of the amplifier was calculated from Fourier analysis to be 200 cps to 150 kc, and that the input signal was about 200 μ v from a 500-ohm source.

(1) First, select a low-noise transistor. The 2N1613, for example, has a typical noise figure of 7 db. From the 2N1613 data sheet, best noise performance occurs at $I_C = 0.3$ ma, and is fairly independent of V_{CE} . Thus, select $V_{CE} = 5$ v, $I_E (\approx I_C) = 0.3$ ma, and ± 6 v supplies. From the curve of 20 mc h_{fe} vs I_C , the gain-bandwidth product f_t is estimated to be (0.4×20) mc = 8 mc at that point. Using 50 as a typical

$$\beta_0, f_\beta = \frac{f_t}{\beta_0} = 160 \text{ kc.}$$

This meets the 150-kc requirement of the system. (2) $R_{source} = 500$ ohms, and therefore no impedance transformation will be needed.

(3) Design the bias network. Assuming the transistor is symmetrical with respect to the power supplies and $V_{CE} = 5$ v, $V_C = 2.5$ v and $V_E = -2.5$ v. Therefore

$$R_C = \frac{(6 - 2.5)}{0.3} = 12 \text{ K and}$$

$$R_E = \frac{[-2.5 - (-6)]}{0.3} = 12 \text{ K.}$$

Assuming a bleeder current of $10 I_b$,

$$R_1 + R_2 = \frac{12}{10 I_b} = \frac{12}{10 (I_C/\beta_0)} = 200 \text{ K.}$$

Similarly, assuming a 0.6 v V_{BE} drop, $V_B = -2.5 + 0.6 = -1.9$ v. Therefore, $R_1/R_2 = \frac{6 - (-1.9)}{-1.9 - (-6)} = 1.93$, and $R_1 = 131.7$ K, $R_2 = 68.3$ K. Use $R_1 = 130$ K, $R_2 = 68$ K.

(4) The low-frequency response of a common-emitter circuit is determined primarily by the emitter capacitor, since its reactance is reflected back to the input as βX_{CE} .

Hence $f_1 = \frac{\beta_0}{2\pi R C_E} = 200$ cps, where $R = R_{source} + h_{ie}$ ($1 \sim 1.5$ K). This gives $C_E = 25$ μ f. C_1 must furnish a small reactance compared to βX_{CE} . Putting $X_{C1} = (0.1)X_{C2}$, then $C_1 = 5$ μ f. The second stage is conventional.

Experimental Results

Experimental results of this amplifier (Fig. 2) with unselected 2N1613's (using batteries for the power supplies) yielded a noise level referred to the input of about 18 μ v peak-to-peak, a frequency response from 130 cps to 200 kc and a voltage gain of about 335. ■ ■

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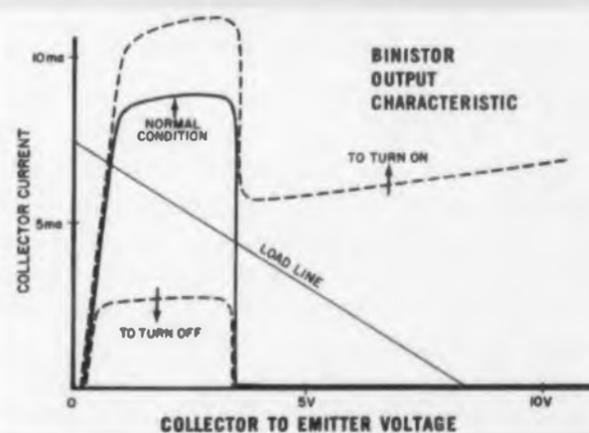
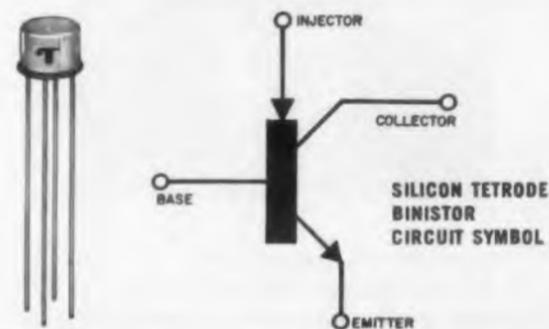
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As the number of artificial earth satellites increases, projected plans for exploration beyond the earth's atmosphere may be hampered by natural interference levels encountered. Therefore careful consideration must be given to the problems stemming from radio noise of cosmic origin, the principal source of natural interference to be expected.

Natural Interference In Space Systems

RFI

James F. Lee

Branch Leader

Radiation and Propagation Branch

Melpar, Inc.

Watertown, Mass.



Jim Lee's current work at Melpar includes the responsibility of predicting natural interference sources and their detrimental effects. His recommendations for reduction of RFI is expected to drastically cut errors in space systems designs.

SINCE earth-orbiting satellite systems are to operate under unprecedented environmental conditions and at extreme ranges, certain interference effects which have hitherto been considered relatively unimportant must now be taken into account, preferably during the early stages of system design and development. Careful consideration must be given to radio noise of cosmic origin, the principal source of natural interference to be expected in such systems.

Broadly speaking, cosmic radio emissions may be divided into two categories: (a) those which are internal to our solar system and (b) those which are external to the solar system. Fig. 1 contains a detailed breakdown of sources of such radiation which have been detected to date.

Calculation of Cosmic Noise Power

Cosmic noise generally does not emanate from point sources as assumed in conventional inverse square power calculations, but arises in sources which subtend a finite solid angle (measured in steradians or square degrees) at the earth. An important concept useful in the computation of interference levels under these conditions is that of brightness temperature.

An extended radiating source is regarded as a black body radiator with a certain absolute temperature (measured in deg K) and which emits in accordance with Planck's radiation law. A given cosmic noise source is thus assigned an equivalent black body temperature which, in most cases, depends on the particular frequency being considered. Since at radio frequencies, the Rayleigh-Jeans law is a valid approximation to Planck's law, it may be used to connect source brightness to equivalent black body temperature. The average brightness of a source, B_{av} , as observed on earth is, for practical purposes, thereby given as:

$$B_{av} = \frac{2 K T_{av}}{\lambda^2} \text{ (w m}^{-2} \text{ cps}^{-1} \text{ rad}^{-2}) \quad (1)$$

where K = Boltzmann's constant (1.38×10^{-23} joules/K)

T_{av} = average equivalent black body temperature of source, deg K

λ = wavelength

The resulting unit of brightness is, in effect, power flux density per unit bandwidth per unit solid angle subtended by the source. For convenience, the unit "jansky" (abbreviated jan) is adopted, which is equivalent to 1 w per square meter per cycle, and the unit of source brightness is given in jan rad⁻². This source brightness now can be used to compute the noise power which is received by a system.

Antenna Power Calculation

Since, in general, cosmic radio emission is randomly polarized, a 3-db loss is included in calculation of the noise power levels resulting therefrom. Thus the power received by an antenna pointed at a cosmic source is given by:

$$P = \frac{1}{2} A_e B_{av} \omega_r \text{ (w cps}^{-1}) \quad (2)$$

where P = received power per unit bandwidth
 A_e = effective aperture of the receiving antenna

ω_r = source extent (rad²)

Substituting (1) in (2), the received power in terms of the equivalent source temperature is

$$P = \frac{K T_{av} A_e \omega_r}{\lambda^2} \text{ (w cps}^{-1}) \quad (3)$$

The gain of an antenna is related to its effective aperture and beam area by the relations:

$$G = \frac{4}{\beta_r} = \frac{4\pi A_e}{\lambda^2} \quad (4)$$

where G = antenna gain over isotropic radiator
 β_r = beam area of the antenna (rad²)

From this

$$\beta_r = \frac{\lambda^2}{A_e} \quad (5)$$

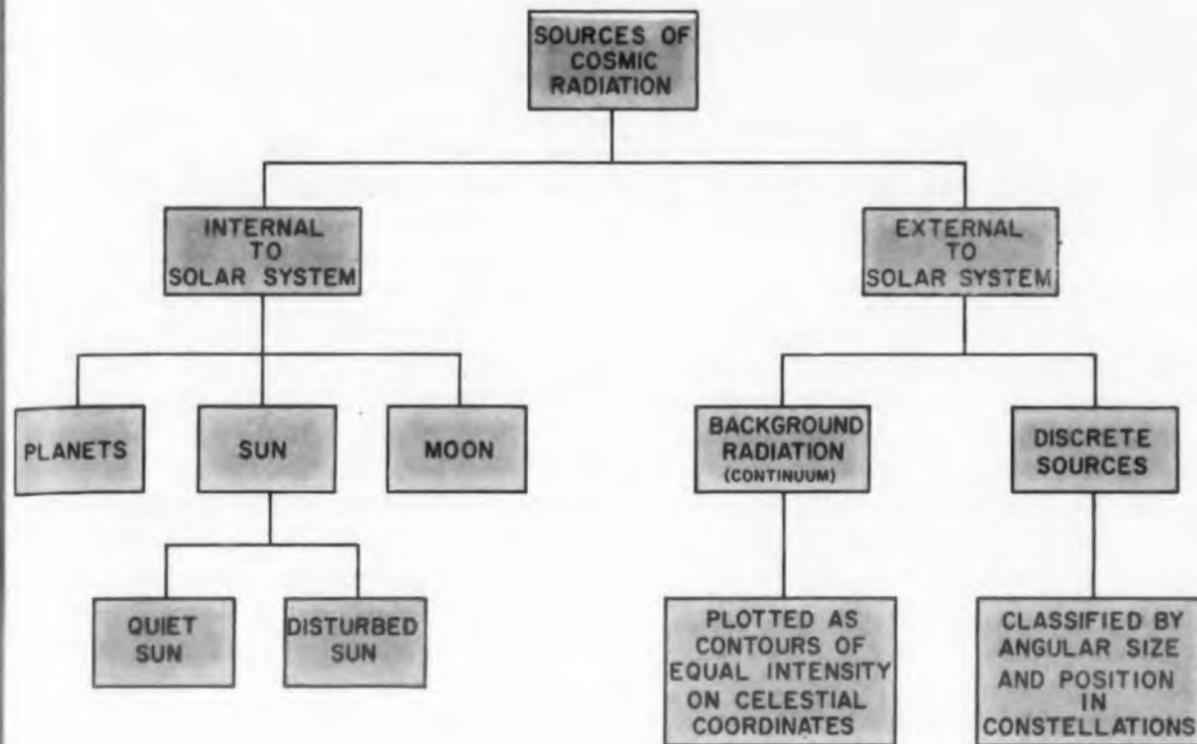


Fig. 1. Sources of cosmic radio emission—internal and external to our solar system.

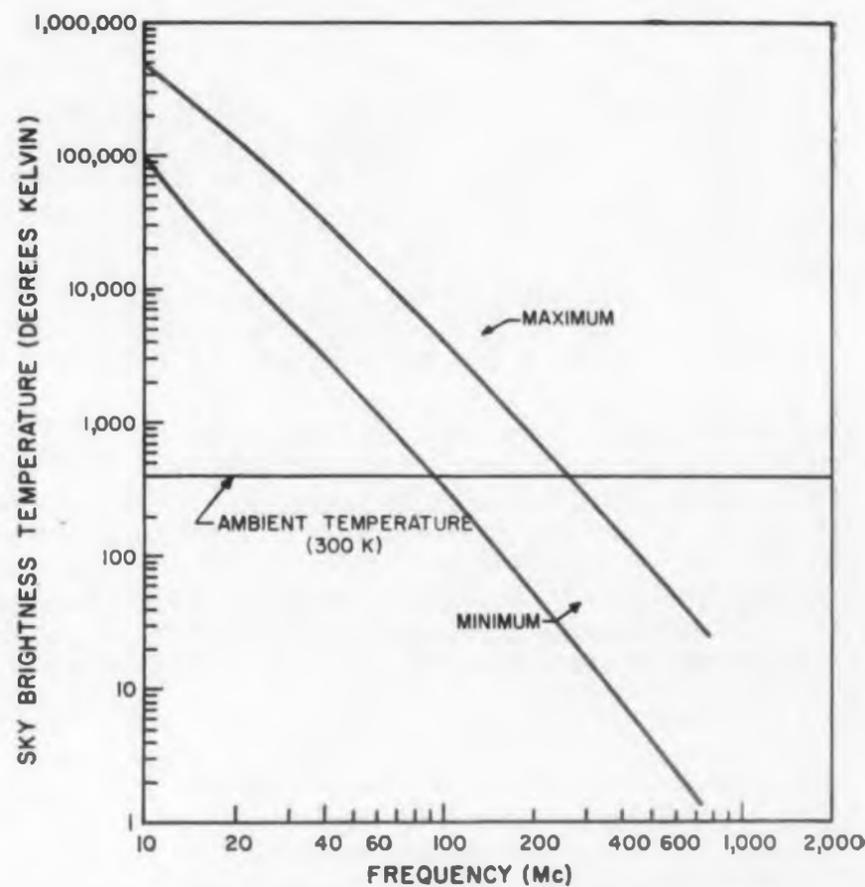


Fig. 2. Maximum and minimum levels for observed cosmic background radiation or continuum; equivalent black body temperature plotted vs frequency.

which, substituted into (3), gives

$$P = \frac{K T_{av} \omega_r}{\beta_r} \quad (\text{w cps}^{-1}) \quad (6)$$

The term $T_{av} \omega_r / \beta_r$, involving the equivalent black body temperature of the radio source may be regarded as an equivalent antenna temperature T_A .

$$T_A = T_{av} \frac{\omega_r}{\beta_r} \quad (7)$$

where ω_r and β_r may be either in units of rad^2 or degree^2 . It follows that the equivalent antenna temperature due to a cosmic noise source is lower than the associated equivalent black body temperature of the source whenever the beam angular area of the antenna is greater than the source angular area. When the beam angular area is less than the source area, however, the angular extent of the source is effectively reduced to that of the antenna beam; so that $T_A = T_{av}$, and (6) reduces to:

$$P = K T_{av} \quad (\text{w cps}^{-1}) \quad (8)$$

For cases where the antenna beam is small and the effective source temperature is constant over the beam area, the equivalent antenna temperature is taken equal to the effective temperature of the source. With low gain wide-beam antennas (such as a dipole), however, the effective antenna temperature would be obtained by computing an

average effective temperature over the source extent and multiplying this by the ratio ω_r / β_r . Received cosmic noise power thus is expressed in terms of effective antenna temperature.

Once the physical aperture of the antenna and operating frequency are specified, the received power is expressed explicitly as

$$P = \frac{K T_{av} z A_p \omega}{3283 \lambda^2} \quad (\text{w cps}^{-1}) \quad (9)$$

where A_p = physical aperture of antenna
 z = dimensionless efficiency factor
 ω = source extent in deg^2 ($1 \text{ rad}^2 = 3283 \text{ deg}^2$)

To obtain the total interfering noise level, this power per unit bandwidth is increased by a factor dependent upon the bandwidth of the receiving system. For most practical cases this is done by simply multiplying by the bandwidth in cycles, although for higher accuracies a step-by-step summation of the power over the particular frequency interval involved can be carried out.

Cosmic Radiation External to Solar System

All characteristics—spectral, temporal, and spatial—must be considered in assessing the degree of cosmic interference in a system. Cosmic radio emission consists essentially of a randomly polarized, continuous radiation having the char-

acteristics of random noise and extending over the radio spectrum from a wavelength of approximately 1 cm to at least 300 m, and with a restricted line emission from atomic hydrogen in inter-stellar space at 21 cm. The spectral characteristics of cosmic background radiations generally appear predominantly non-thermal, with resulting equivalent black body temperatures which increase with wavelength. The maximum and minimum levels for observed cosmic background radiation or continuum, are shown in Fig. 2¹ wherein equivalent black body temperature is plotted versus frequency. This radiation is distributed continuously across the sky with maximum intensities occurring in the galactic plane (which is related visually with the bright band of the Milky Way), and with minimum intensities occurring in the direction of the galactic poles.

In addition to this background continuum, extremely "bright" spots have been observed in the sky; these subtending relatively small angular areas. To date these discrete sources have been attributed only to colliding galaxies and supernovae (exploding stars), although it has been suggested by some radio astronomers that individual stars radiate energy in the same manner as the sun. (Present radio telescopes do not have sufficient resolving power to confirm this hypothesis because of the extremely small angles subtended

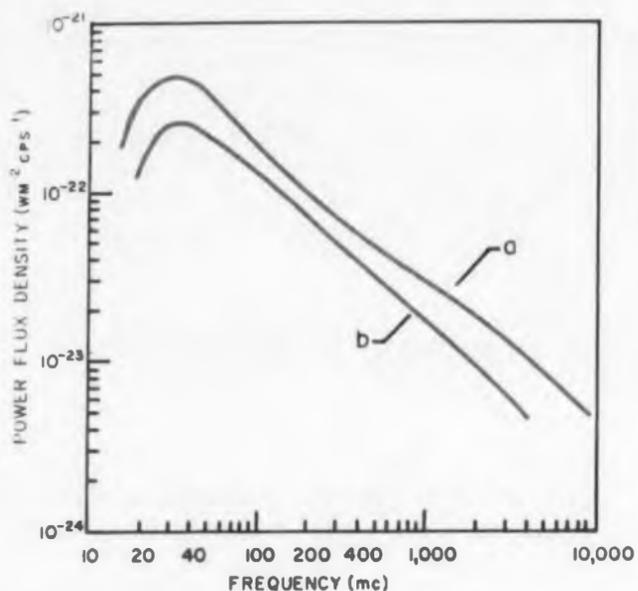


Fig. 3. Power spectra associated with the two most intense discrete sources detected to date (a) Cassiopeia A and (b) Cygnus A.

by even the nearest stars, but suggestions have been tentatively formulated for establishing an antenna capable of the required resolution.)

The frequency spectra of these discrete sources are predominantly like the continuum, and non-thermal in character. Fig. 3¹ shows the power spectra associated with the two most intense discrete sources which have been detected to date. These spectra typify the frequency dependence of most discrete sources.

In regards to spatial distribution, the positions of cosmic radio sources in the sky will appear to move with time because of terrestrial rotation. These movements may be plotted in the same manner as that used by astronomers for visible stars, and radio maps giving contours of equal brightness temperature for the background continuum have been plotted for different frequencies. In addition to this, tabulations of the sizes and positions of discrete sources are also available if required for computation purposes.²

Cosmic Radiation Internal to Solar System

The sun is the most important single source of radio emission within our solar system. At wavelengths shorter than 1 cm, its radiation is characteristically thermal as well as randomly polarized, that is, it follows the emission characteristics of a Planckian black body radiator (at 6000 K) while at wavelengths greater than 1 cm, non-thermal radiation components are present.

Under disturbed solar conditions the spectral curve of this emission tends to have a negative slope resulting in an increase of equivalent black body temperature with wavelength. "Noise storms" associated with sunspots and solar flares occur mainly in the 1-cm to 10-m wavelengths regions and are characterized by bursts of greatly enhanced radiation. The complex dynamic spectral characteristics of these noise storms are beyond the scope of the present discussion. Fig. 4³ however, indicates the solar power spectra ob-

served on earth, together with curves of the emission from a black body radiator at various temperatures. The maximum variation of intensity levels between quiet and disturbed solar conditions are also shown and it is seen that equivalent black body temperatures may lie within the range of 10^4 to 10^{10} K in the rf band.

The visible disc of the sun subtends an angle of approximately 0.5 deg when viewed from the earth but the angular size of the "radio" sun tends to be somewhat larger than this value and increases with the wavelength observed. This arises from the fact that radiation is generated in the solar atmosphere as well as from the photosphere (visible disc).

At 3,000 mc this "radio" diameter is approximately 0.75 deg, although the equivalent temperature varies considerably over the source area and shows a marked increase at the limb or edge of the visible disc. Antenna half power beam widths subtending angles less than 0.5 deg will effectively have an equivalent antenna temperature equal to the equivalent black body temperature of the sun at the specified wavelength if the antenna is pointed directly at the source. Interference power levels under these circumstances may be considerable, especially in a wide-band system.

The curves in Fig. 5 indicate the relative levels of interfering noise power across the rf band due to cosmic background radiation, solar radiation, and the radiation from Cassiopeia A, the most

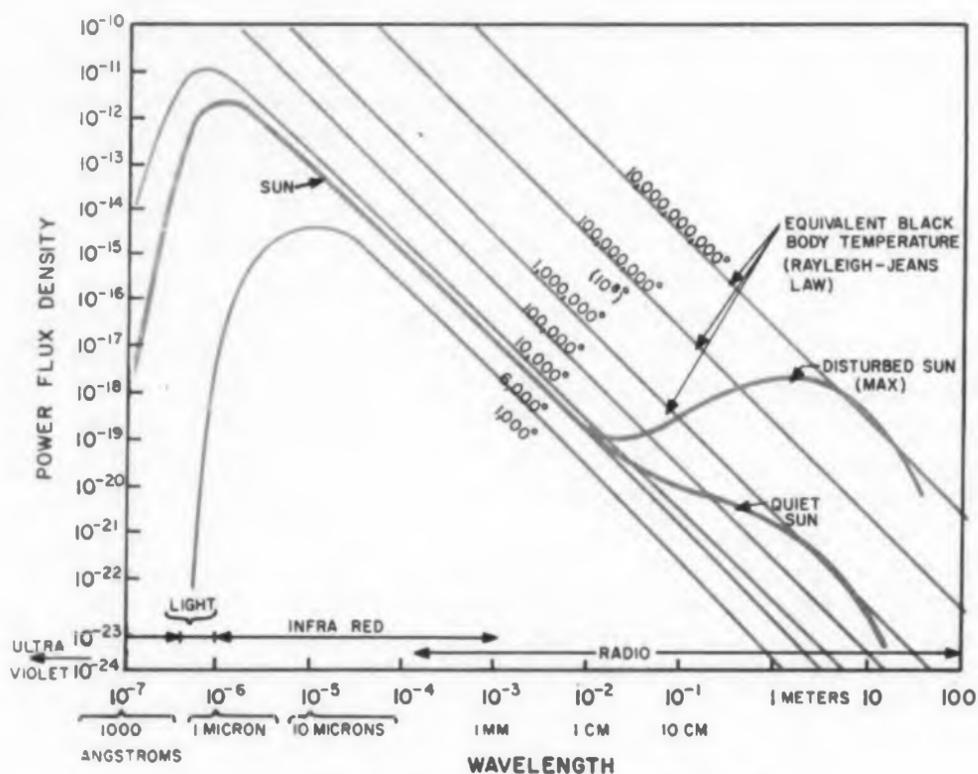


Fig. 4. Solar power spectra observed on earth.

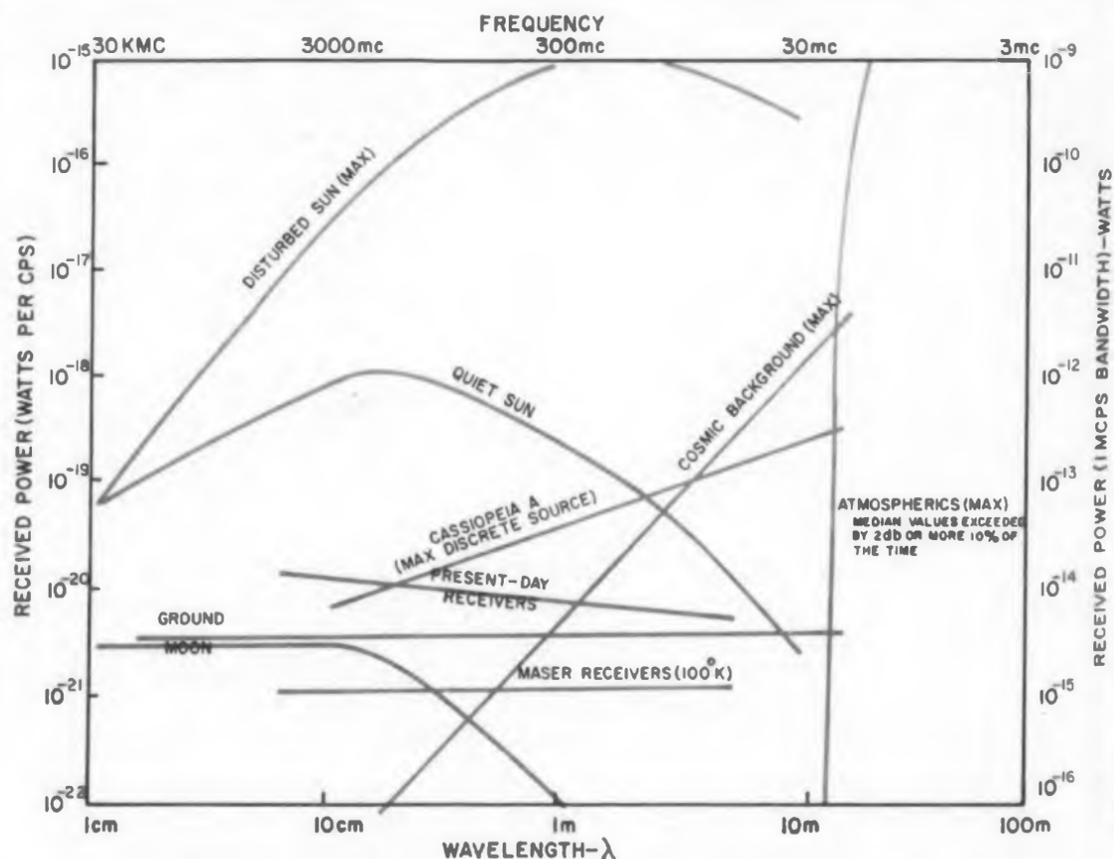


Fig. 5. Relative levels of interference noise power across the rf band due to radiation encountered in space.

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intense discrete source yet observed outside the solar system. Specifically, this date represents noise power per unit bandwidth received by a 100-ft diam parabolic antenna for radio frequencies between 15 mc and 30,000 mc. For comparative purposes the internal noise power generated by present day receivers and masers as well as the power levels of terrestrial atmospheres produced by lightning discharges and thermal radiation from the ground, are also shown. Data may be applied directly to the analysis of space communication systems.

Space Probes Aid RFI Work

It might be of interest to conjecture upon the portions of the electromagnetic spectrum which cannot be observed on earth because of ionospheric cut-off and atmospheric molecular absorption effects, and which may constitute strong interference bands in space-to-space communication systems. For instance, in the rf band lower than 10 mc, where ionospheric cut-off prohibits extra terrestrial observation, extrapolation of the cosmic background radiation curves in Fig. 2 yields equivalent black body temperatures of the order of 10⁷ K. In like manner, the negative slope of the disturbed solar radiation in this portion of the spectrum if extrapolated would yield equivalent temperatures as high as 10¹² K. Does this level of radiation actually exist in the regions above the earth's ionosphere?

Experiments with high altitude rockets are now investigating this, as well as the ultraviolet region of the spectrum which until recently had been restricted to wavelengths greater than about 2850 A by reason of ozone and oxygen absorption. Data on the radiation levels in the millimeter-wavelength range which are to a great extent shielded by molecular absorption in the atmosphere are also being obtained. No doubt gaps in our knowledge of the electromagnetic environment beyond the earth's atmosphere and in our knowledge of cosmic radio noise as it relates to the operability of future space communications systems will be filled in as appropriate instrumentation in satellites and other space vehicles becomes available. ■ ■

Acknowledgment

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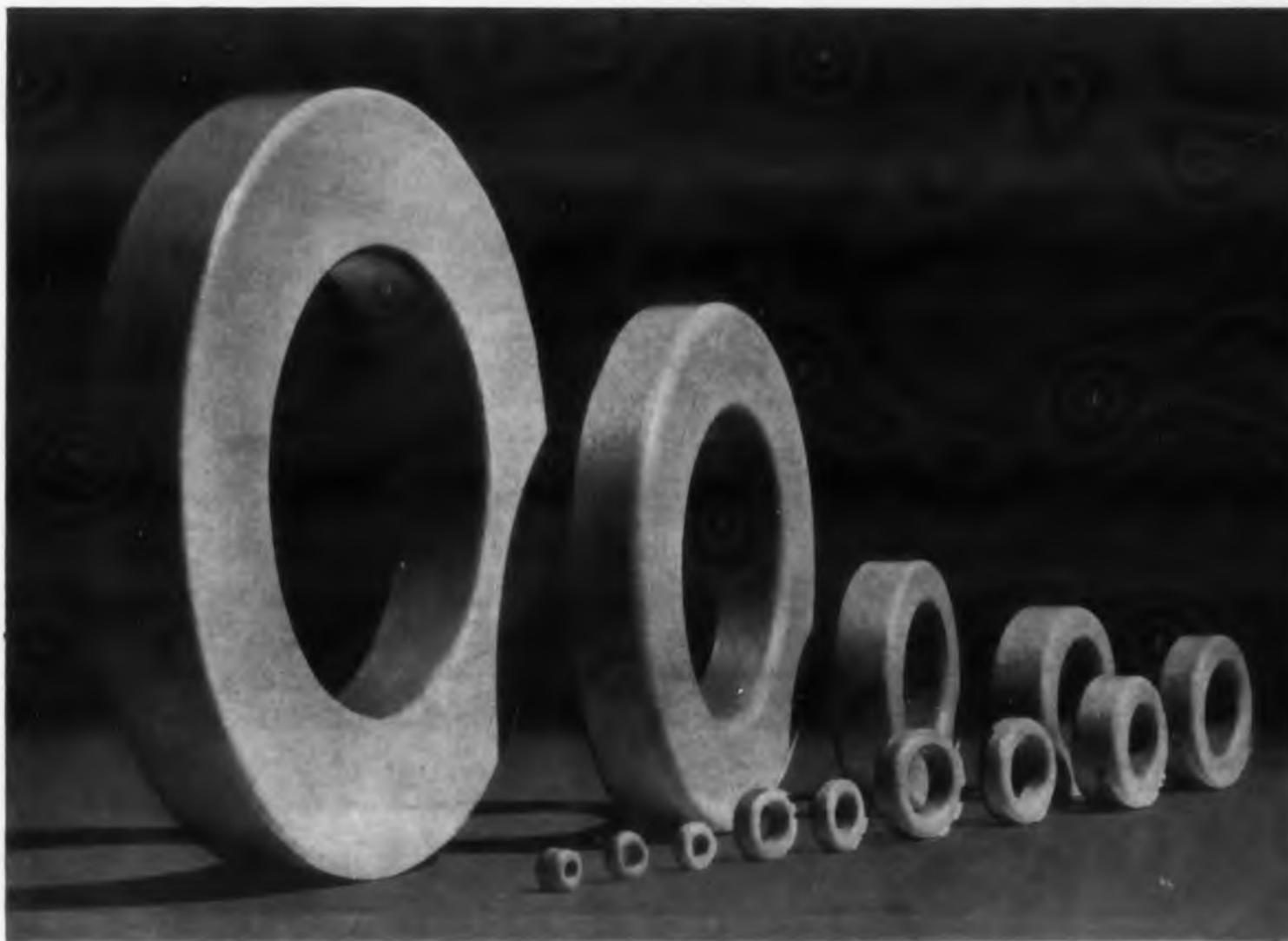


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CIRCLE 82 ON READER-SERVICE CARD

Simple Equations for Rapid Design

Pi-Network

W. M. Bauer

U.S. Naval Postgraduate School
Monterey, Calif.



IMPEDANCE-transforming pi-networks can be quickly designed with the aid of only three simple equations. Referring to the circuit shown in Fig. 1, these equations are:

$$Q_1^2 + 1 = \frac{R_1}{R_2} (Q_2^2 + 1) \quad (1)$$

$$C_1 = \frac{Q_1}{\omega R_1} \text{ and } C_2 = \frac{Q_2}{\omega R_2} \quad (2)$$

$$L = \frac{R_2 (Q_1 + Q_2)}{\omega (Q_2^2 + 1)} \quad (3)$$

where

$$Q = \omega C_1 R_1 \text{ and}$$

$$Q_2 = \omega C_2 R_2$$

The Q factors relate the energy stored in the capacitors to the shunt load resistance. In designing the network a suitable value of Q_1 or Q_2 is first assumed and the value of the other Q is calculated from Eq. 1. C_1 , C_2 and L are then computed.

To illustrate the design procedure, let us consider the problem of a 400-ohm load to be driven by a class C tuned power amplifier at a frequency

of 3 mc. The tuned power amplifier requires a load of 2060 ohms. The matching network then has R_1 equal to 2060 ohms and R_2 equal to 400 ohms. Since the input to the network consists of current pulses, a suitable value of Q_1 should first be chosen. Note that the higher the Q , the larger the capacitor, but the better will be the harmonic suppression.

The tabular compilation was made for two

Sample Calculations for
Two Assumed Values of Q .

Q_1	$Q_2^2 + 1$	Q_2	$Q_1 + Q_2$	$C_1 \mu\text{f}$	C_2	$L \mu\text{h}$
8	12.6	3.56	11.56	206	472	19.5
10	19.6	4.31	14.31	258	573	15.5

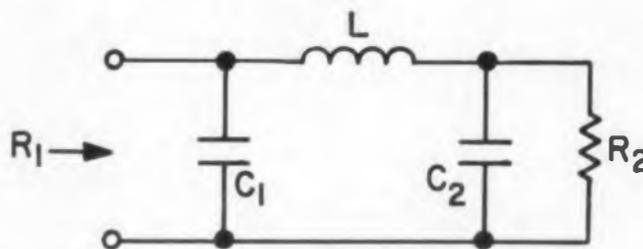


Fig. 1. This pi-network can be easily designed using the equations given in the text.

assumed values of Q_1 . The sum of $Q_1 + Q_2$ gives a comparison value for the Q of a simple tuned circuit load for which a Q of 10 to 15 is suitable.

Variation of Input Resistance

The input resistance of the pi-network will vary considerably with only a slight increase in the load capacitance.

Suppose in the network of the example where Q_1 was chosen equal to 8, C_2 increases by 5 per cent. With the same values for L and R_2 we can find the new values of R_1 and C_1 . Since Q_2 is also increased by 5 per cent:

$$Q_1 = \frac{\omega L (Q_2^2 + 1)}{R_2} - Q_2 = 10.0$$

Eq. 1 yields $R_1 = 2700$ ohms. This is a 30 per cent increase of R_1 .

Eq. 2 yields $C_1 = 197 \mu\text{f}$ which is about a 5 per cent decrease.

Laboratory Component Adjustment

After the design components have been assembled and the load connected, the desired value of R_1 can be obtained by connecting the

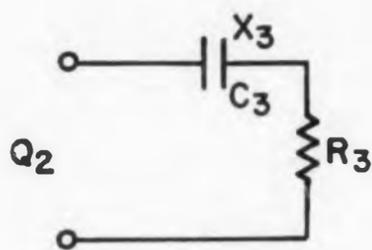


Fig. 2. The parallel R_2C_2 combination of Fig. 1 can be replaced by the series R_3C_3 .

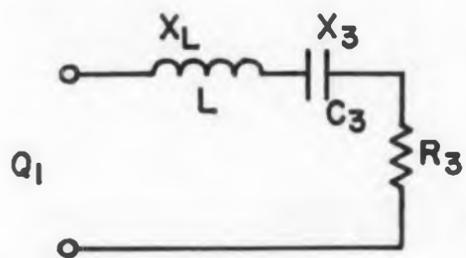


Fig. 3. The value of inductor L , placed in series with R_3C_3 , is calculated from Eq. 3.

network in series with a resistor of R_1 ohms. This combination is then connected to an oscillator set at the matching frequency. A vtvm across the input of the network is maximized by tuning C_1 . Adjustment of C_2 will make the input voltage to the net one-half of the oscillator voltage. This makes the input resistance equal to that of the series resistor.

Derivation of Design Equations

Eqs. 1-3 were derived by following the steps

below:

1. Convert the $C_2 R_2$ parallel circuit of Fig. 1 to its equivalent series circuit, $C_3 R_3$, then:

$$R_3 = \frac{R_2}{Q_2^2 + 1}$$

$$X_3 = Q_2 R_3 \quad (\text{Fig. 2}).$$

2. Connect L to this series circuit.

$$Q_1 = \frac{X_L + X_3}{R_3}$$

Therefore:

$$X_L = Q_1 R_3 - X_3 = R_3 (Q_1 + Q_2)$$

$$L = \frac{R_2 (Q_1 + Q_2)}{\omega (Q_2^2 + 1)} \quad (3)$$

3. Convert the series resistance R_3 of Fig. 3 to the equivalent shunt resistance R_1 .

$$R_1 = R_3 (Q_1^2 + 1) = R_2 \frac{(Q_1^2 + 1)}{(Q_2^2 + 1)} \quad (1)$$

References

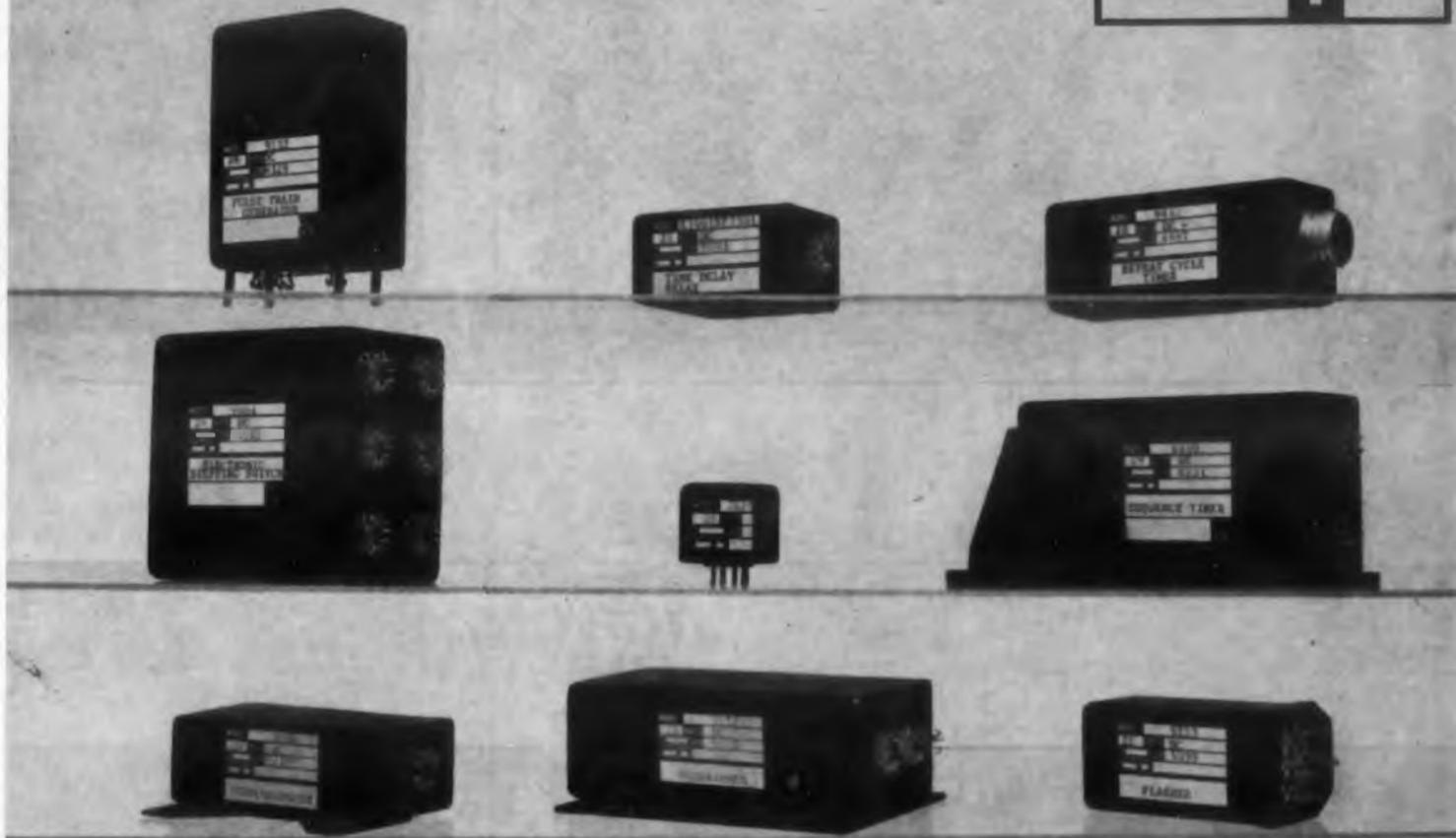
QST March & April 1957.
CQ May 1950, Sept. 1950, May 1951.

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CIRCLE 789 THRU 799 ON READER-SERVICE CARD
ELECTRONIC DESIGN • August 3, 1966

Manufactured by Lumatron Electronics, Inc. of 116 County Court House Road, New Hyde Park, L.I., N.Y., the "400" requires no lengthy calibration and set-up procedures in changing test programs, devices to be tested, or signal amplitudes. It requires no calculations—no squinting at scope screens.

Test results appear, in about a second, on a meter, precisely calibrated in nano-seconds. Readings can be programmed into a discriminator for go-no-go testing; they can be digitized for printout; they can be presented directly on a digital voltmeter; and waveforms can be monitored on a high-speed oscilloscope.

Sampling Percentage Levels Yields Better Performance

Two key factors account for the 400's versatility, speed, and accuracy. One is its use of sampling techniques; the other is its measurement between percentage levels rather than voltage levels.

With the sampling technique, instead of viewing each signal waveform in its entirety, the 400 samples 0.3-nsec slices of successive cycles of the signal. These slices can be advanced along the waveform by as little as 1 psec. The samples represent instantaneous amplitudes which, if stretched and displayed as successive dots on a crt, would recreate the original waveform, but much more slowly.

By reading the time between percentage levels rather than between voltage levels, the tester's accuracy becomes independent of the output amplitude of a device. This output amplitude may not be constant and, in fact, it may not even be known.

In a test of, say, storage time, the 400 determines the time between 90 per cent of the amplitude of the lagging edge of a self-generated test pulse and 90 per cent of the lagging edge of the output of a device under test. It generates a voltage corresponding to the time difference between these levels.

The 400, available on a 60- to 90-day delivery, costs about \$6900. A model 420, which covers the range of 1 to 1000 nsec with an accuracy of 0.4 nsec or 3 per cent, costs about \$4900.

For more information on these automatic switching time testers, turn to the Reader-Service Card and circle 250.

See this product at WESCON, Booth 2414.

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BRIEF SPECIFICATIONS

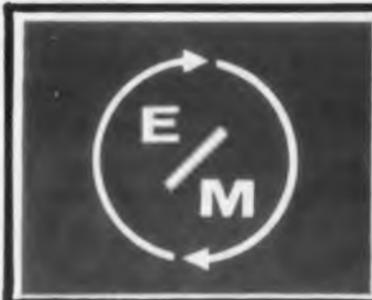
105-125 V, 50-60 CPS LINE
(Prices are F.O.B. Eatontown, New Jersey)

MODEL	OUTPUT	VOLTAGE COMPLIANCE (MINIMUM)	DIMENSIONS			PRICE
			H	W	D	
C612A	1 uA to 100 ma	100 V	3½	19	9¼	\$289
C624A	2.2 uA to 220 ma	100 V	3½	19	9¼	\$364
C621A	5 uA to 500 ma	100 V	5¼	19	15	\$479
C620A	5 uA to 500 ma	50 V	5¼	19	15	\$449

* Load regulation is 0.1% for all models except 0.2% on 1 and 2.2 uA ranges of Models C612A and C624A.

You'll find the programming feature, voltage compliance, and other performance data fully detailed in four-page Specification Sheet 3072A. Ask your local E/M representative or write . . .

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CIRCLE 789 THRU 799 ON READER-SERVICE CARD
ELECTRONIC DESIGN • August 3, 1960

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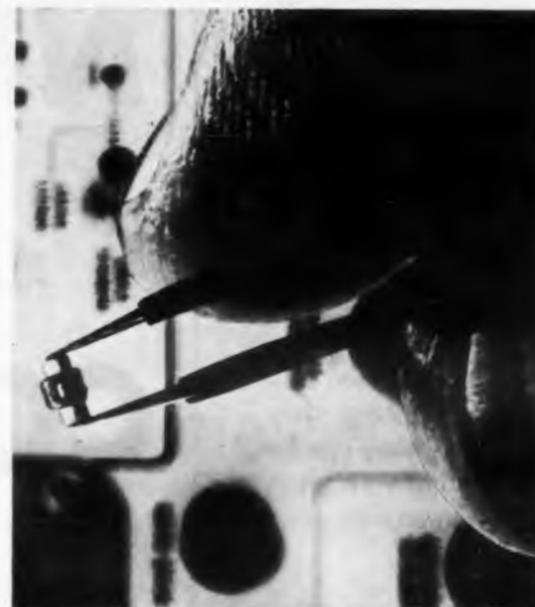
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Unpainted unit glows with red-heat as 10-amp current is sent through it.

Silicon Diode Withstands 10 Times Power Overloads, Tolerates Red-Hot Operation

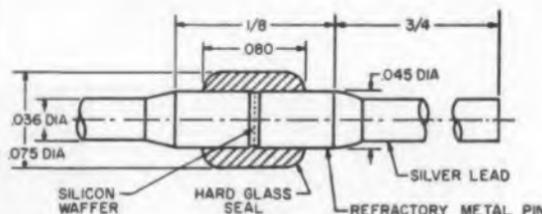
RED-HOT is the word for the miniature glass-enclosed silicon diode about to be marketed by the Unitrode Transistor Products Corp. (214 Calvary St., Waltham, Mass.) That is, it can glow with red heat and still operate satisfactorily while sustaining power overloads of up to 10 times rating. And once the overload is removed, the diode's characteristics—both electrical and mechanical—will be the same as those it had before the overload was applied.

Under rated load, the diode can operate in ambients from -195 to $+300$ C. It can withstand peak inverse voltages of

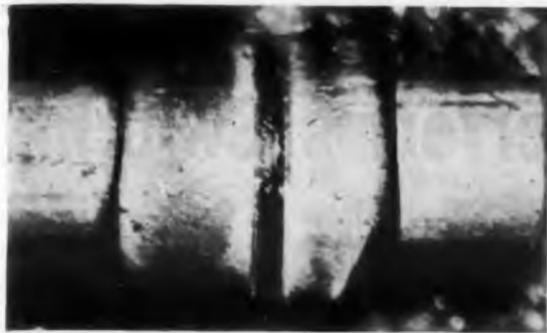
up to 10,000 v. The unitized or "Unitrode" construction also makes the diode unusually resistant to mechanical shock, vibration, and acceleration.

The construction of the diode is shown in the figure. Leads, terminal pins, and the diffused silicon wafer are bonded together into a single assembly. The glass bead completely covers the portion of the diode sensitive to environment. The glass is in intimate contact with the silicon and the pins, leaving no void in which gas, air, or other contaminants would accumulate. Since the hard-glass ambient can not contaminate the silicon surface, the surface is permanently stabilized. The electrical characteristics of the diode are fixed and independent of environmental changes.

A high power dissipation safety factor is provided by the two terminal pins which are fused to both sides of the silicon wafer. The metal pins have the same diameter as the wafer and therefore conduct heat away from the silicon and into the silver leads at a rapid rate. This is in



Tight, high-dielectric constant hardglass seal surrounds silicon wafer and refractory metal terminal pins. With the same diameter as the wafer, the pins rapidly conduct heat from the silicon to the silver leads.



Photomicrograph shows silicon-terminal pin "sandwich" and connecting silver leads.

contrast to conventional diodes, where the "whisker" spring is bonded to a small area of one side of the wafer.

All materials, including the silicon and the bonds between materials, stand up well at +500 C, compared with the 150-200 C top temperature of other diodes.

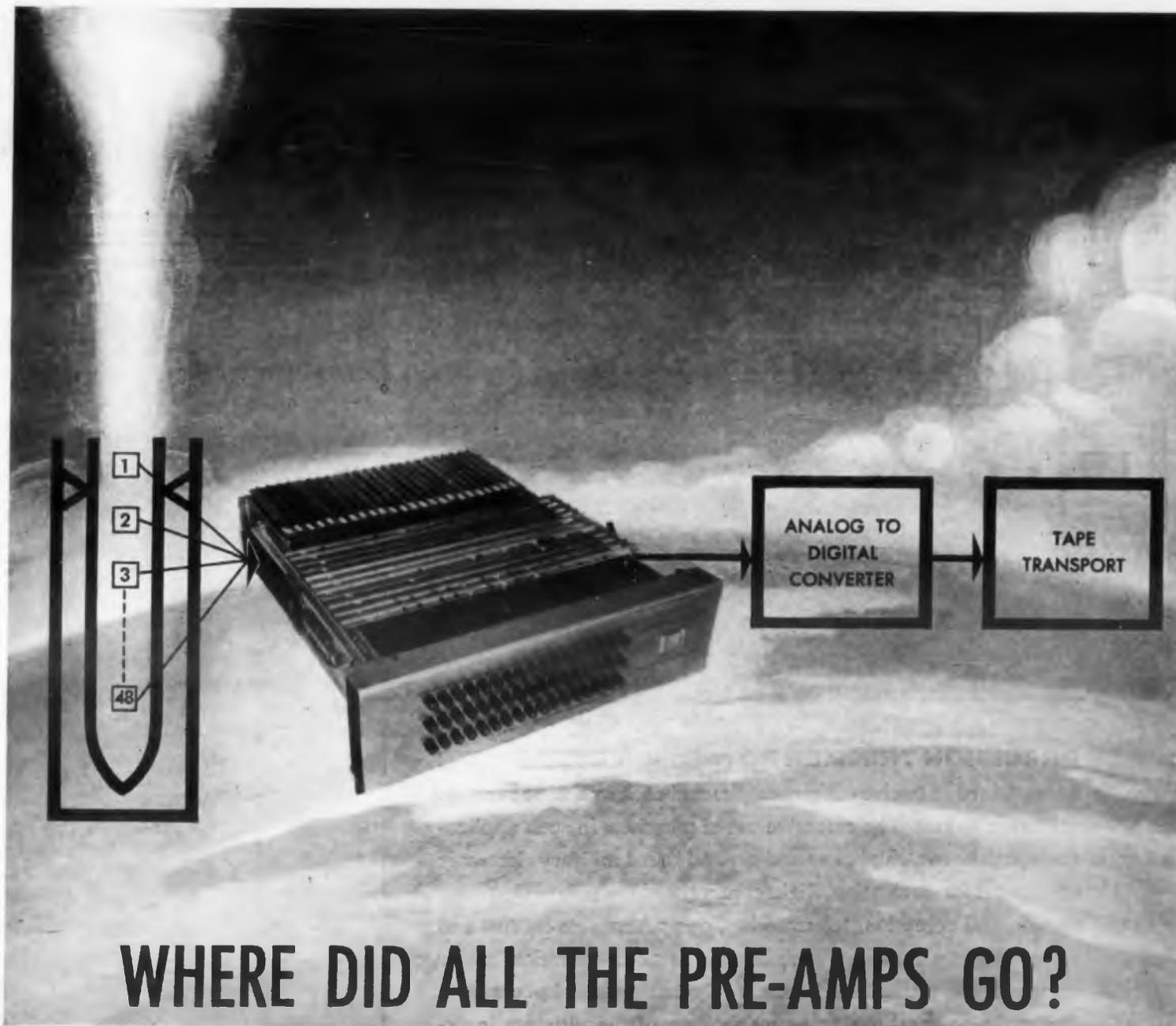
Since the glass and the terminal pin metal have been carefully matched to the same thermal coefficient of expansion as the silicon, fabrication of the diode produces an unstressed structure. Because this common coefficient is low, no ill effects are experienced in a wide range of temperature cycling, thermal shock, or other heat and cold testing. No special precautions are necessary for either iron or dip-soldering assembly procedures.

The high peak inverse voltage of the diode is a result of its complete glass sealing. This seal isolates the terminal pins from each other and fills all the space surrounding the silicon. With its high dielectric constant, the glass prevents arcing between pins which could occur when gaseous contaminants are present.

The glass-ambient diode is supplied in standard MIL and JEDEC types, such as the IN649 series, the IN540 rectifier series and the IN459A low-leakage diode series. These include piv's from 50 to 720 v, leakage currents from 0.025 to 10 μ a, and forward currents from 10 to 750 ma. Higher voltage and special types are also supplied to customer specifications. Prices are competitive with standard diode types. Delivery is within 30 days.

The diode can be seen at WESCON at the Unitrode Transistor Products Corp. booth.

For further information on this silicon diode circle Reader-Service 252.



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For other details on the Radiplex 89, write for a technical data bulletin to Radiation Incorporated, Dept. ED-8, Melbourne, Fla.

Circled area indicates small space (5¼" high) occupied by 48-channel Radiplex multiplexer in standard cabinet. Unit directly above Radiplex is a Radicon analog-to-digital converter.



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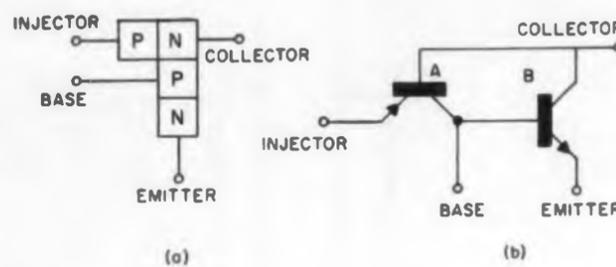


Fig. 1. (a) Physically the silicon binistor resembles a four-layer switch. (b) Equivalent circuit for the binistor.

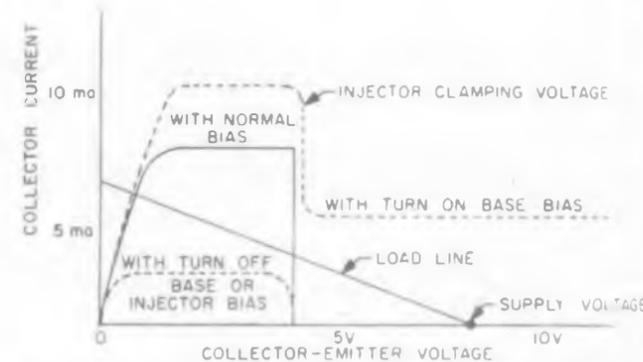


Fig. 2. Binistor E-I characteristics with varying input bias conditions.

Condensed Binistor Specifications

Typical Turn-off Current Gain	50 @ 15 ma Collector Current
Operating Collector Current Range	50 μ a to 15 ma
I_j critical	0.5 ma @ 5 ma Collector Current
Operating Temperature Range without Temperature Compensation	-65° C to 150° C

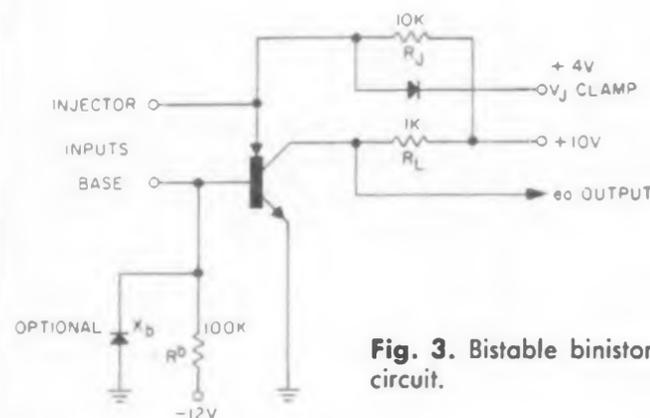


Fig. 3. Bistable binistor circuit.

SWITCHING and storage circuits can now make use of the binistor—a new semiconductor device with many of the properties of a flip-flop. And while the typical flip-flop requires at least 13 components, the equivalent binistor stage requires only 4.

A bistable, negative resistance device, the binistor is manufactured by the Transitron Electronic Corp. (168-182 Albion St., Wakefield, Mass.) It depends largely on an external voltage supply for its negative resistance characteristic. Consequently it is very stable and uniform in manufacture. Input and output voltage swings are comparable in level with typical transistor and diode circuits. Further, it can realize high current and voltage gains and can operate from -80 C to $+200\text{ C}$.

The first binistors to be made available will be of silicon, npn tetrode construction. In structure it resembles a four-layer switch, Fig. 1a. The output current is taken from an intermediate layer. The upper junction serves only as a "latch" to hold the device on when it is in the conducting stage. The main npn transistor A is designed for a high alpha and the pnp transistor B is designed to have an emitter breakdown voltage at least as high as the collector breakdown voltage of transistor A. Equivalent circuit is shown in Fig. 1b.

Essentially the operation of the binistor involves the gating of base current to the main transistor through the latching transistor. This gating in turn depends primarily on the collector voltage and the injector clamping supply voltage. If the collector is cut off, it will remain cut off, and if saturated it will remain saturated. An E-I output characteristic is shown in Fig. 2. The binistor's specifications are condensed in the table.

In addition to its application as a bistable device, Fig. 3, the binistor has been designed into several other simpler circuits. It has been used in a ring counter and in a coincident current memory with non-destructive readout. Further investigation is required to establish applications for the binistor as a small-signal negative resistance device.

Where applicable, prices will be competitive with germanium and silicon transistors. Quantities are available through Transitron's distributors.

For further information on this binistor turn to the Reader-Service Card and circle 253.



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Ultra-High Regulation Featured In All-Transistor Supply

LOAD regulation of less than 0.0005 per cent plus $25\ \mu\text{v}$ can be obtained from a new transistorized dc power supply. Continuously variable, the 0-36 v, 1-amp supply operates from standard voltage sources of $115 \pm 10\ \text{v}$ or $220 \pm 10\ \text{v}$ with line frequencies of from 50 to 1000 c.

Designed by Krohn-Hite Corp. (580 Massachusetts Ave., Cambridge 39, Mass.) power supply model UHR-T361 has a line voltage stability of less than 0.0002 per cent plus $10\ \mu\text{v}$, for a ± 10 per cent line voltage change, a hum and noise level of less than $50\ \mu\text{v rms}$, and a ± 0.01 per cent or $\pm 1\ \text{mv}$ (whichever is greater) output voltage drift for an 8-hr period.

Temperature coefficient of the supply is 0.01 per cent per deg C, or 7 mv per deg C (whichever is greater). This is the same value found in other commercially available units. However, its effect may be to detract somewhat from the remarkably high line and load regulation otherwise obtainable.

The supply differs from conventional units in that it uses two interlocked regulators—a main regulator and a pre-regulator. The main regulator is a series type with a high-gain (94 to 114 db) am-

plifier. With this high gain, the internal impedance at dc and low frequencies is less than $250\ \mu\text{ohm}$.

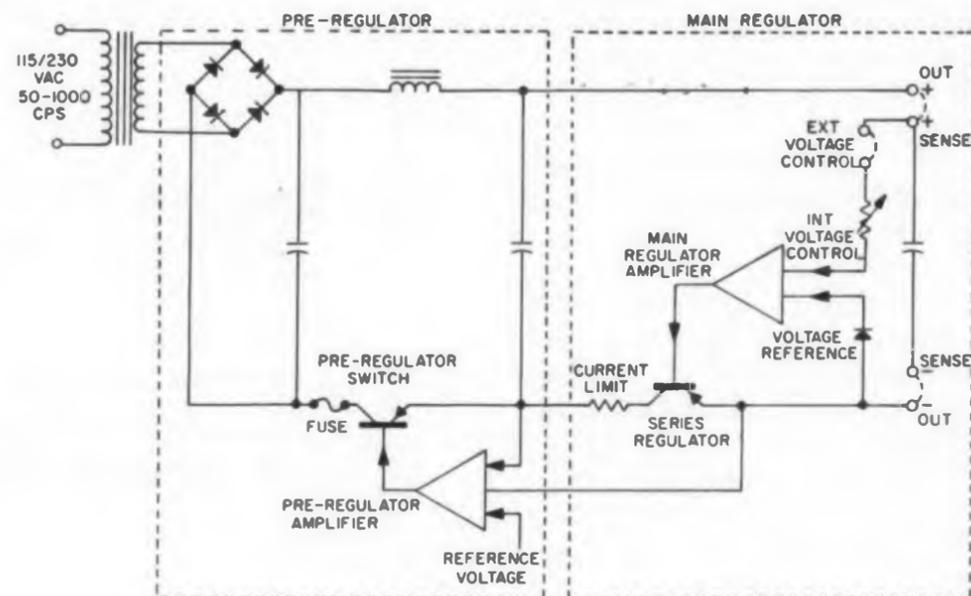
The pre-regulator acts as a very efficient transistor switch which maintains the voltage across the series regulator constant, independent of line voltage or load changes.

Stabilization of the main regulator allows the output voltage to recover to within $10\ \mu\text{v}$ of its pre-set level within 25 μsec after the application or removal of a large load.

Because the efficiency of both regulators is high, convection cooling is adequate up to an ambient temperature of $60\ \text{C}$. If this temperature level is exceeded an automatic sensing device shuts the supply off.

No derating is required at maximum voltage and current output. Full rated current can be drawn with 100 per cent duty cycle at any output voltage, and at any line voltage within the specified range.

Output voltage of the Model UHR-T-361 is continuously adjustable by a precision ten-turn potentiometer, coupled to a three-digit, ten-turn counting dial. This dial registers from 0 to 36 v and is



SIMPLIFIED SCHEMATIC DIAGRAM

Power supply circuit uses two interlocked regulators to achieve its 0.0005 per cent load regulation.



Bench-model supply has digital voltage dial, accurate to 50 mv. The dial is also featured on rack-mounted units.

settable to 50 mv. The potentiometer resolution is 1.6 mv. Model variations also have continuously adjustable voltage control by a precision single-turn potentiometer, or with four decade-rotary selector switches.

Short circuit and overload protection is provided by a current-limiting circuit which automatically restores the output voltage when the load fault is removed. Current limits can be set at 50, 100, 200, 500 and 1,000 ma. Under short circuit or overload conditions, the output current will not exceed the selected limit current by more than 10 per cent.

The supply has provisions for both remote voltage control and remote sensing. For remote sensing, separate SENSE terminals are available to permit full regulation of the output voltage at a remote load. Rated power can be delivered to a load 100 ft away with a static output voltage change of less than 500 μ v between no load and full load. The ripple is less than 250 μ v rms.

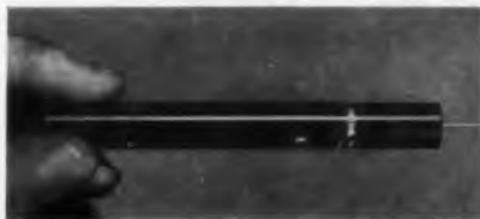
Available in both rack mounted and bench models, the power supply is priced at about \$750 with delivery scheduled for the fourth quarter of 1960. Other models in the power supply line—UHR-T363 (0-36 v, 0 to 3 amp); UHR-T365 (0-36 v, 0 to 5 amp); and UHR-T3610 (0-36 v, 0 to 10 amp)—will be ready for delivery in 1961, when prices will be announced. The supplies will be on display at WESCON, Booth 713.

For further information turn to the Reader-Service Card and circle 254.



GENERAL INSTRUMENT SEMICONDUCTOR REPORT

Design Notes...



G.I. ENCAPSULATES UNIQUE HOLD-OFF DIODE

Problem: A well-known systems manufacturer needed a series hold-off diode for use in a dc resonant charge radar modulator. Conditions: PIV of 12KV; Operating temperature, 100° C; Inverse current at PIV, 150 μ a; Average current, 120 ma; Peak charge current, 260 ma. In addition, specifications called for a transient capability of 21 KV dc for .07 second.

Solution: G.I. produced a unit which far exceeded these requirements. The encapsulated unit (pictured above) is only 1/2" in diameter and 4 1/4" long. It is capable of continuous operation beyond maximum required parameters.

ENCAPSULATED ASSEMBLIES BUILT TO SPEC MEASURES 1 CUBIC INCH

G.I. recently designed a comparator bridge for missile use, which contains 4 resistors and 16 diodes (print at right). The entire bridge is encapsulated within a 1 cubic inch module, has 8 studs for plug-in mounting. The unit meets customer requirements, and is capable of continuous operation in ambients up to 150° C.



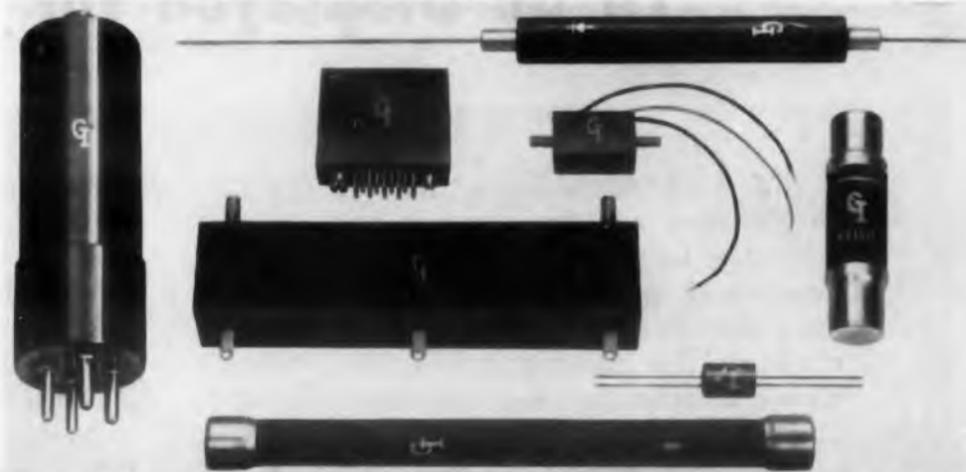
MICROMINIATURE DIODE DESIGNED FOR 1,500 PIV SERIES OPERATION

General Instrument Engineers solved another customer problem in a diode that measures .08" diameter by 1/4" long. Space

requirements made it necessary to assemble an "electrically cold" unit. This specially designed diode was produced with the rigid requirements of 1,500 PIV, leakage of less than .02 μ a, and a forward drop of less than 2V @ 100 ma.



G. I. Offers Reliability on the Circuit Level



ENCAPSULATED ASSEMBLIES ARE DESIGNED TO YOUR SPECIFICATIONS, SAVE COST OF...

• Engineering • Production • Quality Control

General Instrument offers circuit modules with the exact parameters needed for your specialized applications . . . regardless of configuration, electrical or environmental requirements. Typical applications include: rectifiers, amplifiers, comparators, bridges, limiters, blocking and flip-flops.

These packaged assemblies provide proved reliability for the entire circuit . . . feature high resistance to vibration, shock, moisture and humidity, combined with high heat dissipation. These assemblies range from printed circuit boards, ultra-high PIV microminiature diodes, minimal size encapsulations, as well as packages weighing hundreds of pounds.

• **ENGINEERING:** Experienced General Instrument Engineers study your specifications, draw on G.I. research, development and production facilities in making an assembly to exceed your most stringent requirements.

• **PRODUCTION:** Years of General Instrument experience in volume semiconductor manufacture is applied to the production of encapsulated assemblies. G.I. saves you the expense of stocking, testing, selection and encapsulation. Maximum use of welded connections assures excellent resistance to vibration and shock.

• **QUALITY CONTROL:** Components, as well as completed circuit modules are subjected to 100% electrical and environmental testing . . . exceeding the most stringent industrial and military specifications. Finished units are guaranteed to surpass your most rigid requirements.

CONTACT GENERAL INSTRUMENT for full information on the services offered by the Special Products Division. Our engineers will work closely with you—in your own plant, if necessary—to produce an encapsulated assembly designed for your modular applications or complete circuit needs.



SEMICONDUCTOR DIVISION GENERAL INSTRUMENT CORPORATION

65 Gouverneur St., Newark 4, New Jersey

4449

CIRCLE 91 ON READER-SERVICE CARD

103

Most Products at WESCON To Be Displayed for First Time

LIKE A PERSIAN bazaar, this year's WESCON show will thrive on customer curiosity.

The lure for the customers will be displays by hundreds of equipment manufacturers of everything from computers to cable connectors. The companies' top salesmen and engineers will explain and demonstrate the equipment to as many touring engineers as well listen.

Most of the products will be displayed for the first time. According to the company responses to an ELECTRONIC DESIGN questionnaire, the products may not be revolutionary, but many will feature clever, and even ingenious, innovations on existing devices.

Data Equipment

Tape recorders, many using transistors, are being designed more frequently in modular form. Several types will be shown by Ampex Corp., and by Minnesota Mining and Manufacturing Co.

The bandwidth of the Ampex model is 300 to 250,000 cps at a tape speed of 60 ips. The Minnesota company's model has a bandwidth of 50 to 120,000 cps at a low tape speed. At a tape speed of 120 ips, this unit is said to have an upper frequency limit of 1 mc. Both models can record on seven wide-band tracks. Miniature recorders, to be shown by Pacific Electro-Magnetics Co., also are multi-channel, and have 100 kc bandwidths.

A high-speed printer, also in modular form, will be displayed by Beckman Instruments, Inc. The unit prints 12-digit numbers in either black or red, and accepts data from Eput meters or digital voltmeters.

A data transmitter to be shown by Gates Radio Co. is reported to have uniform frequency response from dc to 50 kc. The unit's carrier-frequency range is 130 to 150 mc, with 50 w output.

Packard Bell will display its first general purpose computer. The low-cost, small-size unit—\$30,000 and 110 lb—can be operate at 41,666 instructions per second. Its capacity is 1,808 words,

but can be extended to 15,888 words at additional cost.

Servo System Components

A dc voltage proportional to the phase difference between an input and a reference signal is obtained from a demodulator and phase detector to be shown by Varo Manufacturing Co. The device has uniform (within 3 db) response between 700 and 1500 cps.

American Electronics Inc. will show motor tachometers of greater precision than that available in its previous models. The units have a 2.75 v output per 1000 rpm \pm 0.25 per cent from 60 to 80 C.

An angular oscillating table for frequency-response testing of gyros, accelerometers and guidance systems will be displayed by Micro Gee Products, Inc. The table is designed to be electro-dynamically driven by an audio oscillator. Operation only at 60 cps can be obtained by driving the unit from a Variac connected to the power lines. Rate information is fed to an oscilloscope or a recorder for presentation. The table's upper frequency limit is 100 cps.

At least two companies will display servo-motor speed-reducer and gear heads. They are Bowmar Instrument Corp. and Dynamic Gear Co. The Dynamic model offers 190 ratios from 7:1 to 595:1. The Bowmar model offers ratios from 10:1 to 2,025:1, and is 1/2 in. in diameter by 3/4 in. long. Dynamic said its gear ratios were accurate to within 0.5 per cent.

And last, but hardly least, there will be displays of servo-motors. One unit, from Kearfott, weighs 3 oz and has minimum stall torques ranging from 1.8 to 20 oz-in. Gearheads for the unit come in 28 ratios from 7.62:1 to 1254:1.

Microwave Equipment

Vswr measurement instruments will be displayed by Polytechnic Research and Development Co. and FXR, Inc. The Polytechnic model is an electronic amplifier with four regular scales

and one expanded scale. It is for use with slotted sections. The FXR model uses the incident and reflected power technique to make measurements. It measures microwave energy directly.

FXR also will display precision attenuators with a range from 0.3 to 30 db. The attenuation value "fixed" into each unit is the customer's choice. The attenuation is dependent of the ambient temperature, according to the company. Other devices to be shown by FXR are: interchangeable slotted sections, ferrite isolators, and direct-reading coaxial frequency meters with a range from 3.95 to 11 kmc.

Additional microwave equipment will be exhibited by these firms: Frequency Standards Corp., an absorption-type wavemeter for use as a marker cavity; Sylvania Electric, a microwave diode for K-band applications; Emerson & Cunnig, a bistatic microwave reflector; Huggins Laboratories and Microwave Electronics Corp., traveling wave tubes.

Semiconductors and Tubes

Semiconductor firms will bring out their latest versions of silicon devices. Pacific Semiconductor, Inc. and International Rectifier Corp. both will show silicon rectifiers. IRC has several models—two replace mercury vapor tube types 8008 and 872A; a third, in the form of stacked modules, can be used to give 750 amp output; a fourth can handle surges up to 1000 amps. The Pacific devices are rated at 12,000 through 30,000 v.

Transitron Electronic Corp. will display 18 types of diffused mesa silicon transistors. They include small signal, intermediate power and high power units. Motorola Semiconductor Products Inc. will show industrial power transistors. These units are rated for continuous operation at junction temperatures of 100 C; power dissipation is 90 w. Raytheon will show silicon transistors for high temperature applications.

Despite an apparent preponderance of silicon devices, there will be a representative showing of non-silicon diodes. Raytheon will exhibit its types 1N275 and 1N277 for airborne and missile equipment. Delco Division of GM will show its line of tunnel diodes.

Evidence that tubes still are around will come from Raytheon, Westinghouse, and RCA. Raytheon and RCA will show power tubes that can deliver 40 kw at 1215 mc and 400 kw at 30 mc, respectively. RCA will also have a triode of pencil-tube design for use as a tunable oscillator. Westinghouse will display a combination low-mu triode and sharp-cutoff pentode for use in industrial power supplies.

Power Supplies

Electronics companies are continuing their competition for the market in transistorized, well-

regulated, low-ripple power supplies.

One innovation comes from Power Designs Inc., which will display a unit that can be used as a constant-voltage or a constant-current source. Its range is 1 to 40 v at 0 to 500 ma. Regulation in either mode of operation is reported to be better than 0.05 per cent. The ripple is said to be less than 500 μ v, when used as a voltage source, and 25 μ amp, when used as a current source.

Six companies report their low-voltage power supplies have ripples of 2 mv rms maximum and regulations not greater than 10 mv from no load to full load. They are: Invar Electronics Corp.; Perkin Engineering Corp.; Kearfott; Mid-Eastern Electronics; Power Designs Inc.; and North Electric Co.

Test Instruments

Voltmeters, ohmmeters, ammeters, oscilloscopes and signal generators for a multitude of applications and in a multitude of sizes continue to be poured onto the market.

The voltmeters all promise accuracy within 1 per cent, and a possible headache for the designer who must choose from the many types available.

The signal generators displayed will give pulses, and sinusoidal uhf and microwave frequencies. A diode recovery test unit made by Lumatron Electronics consists essentially of a pulse generator with pulse heights variable between 0 and 100 v, and pulse width variable from 5 to 50 nsec. A pulse generator to be exhibited by Electro-Pulse, Inc., has a repetition rate variable between 100 cps and 10 mc, with a 12 v open-circuit output.

Most of the oscilloscopes displayed will be of the general purpose type with upper frequency limit around 500 kc or 15 mc.

Oscilloscopes with upper frequency limits around 1 to 2 kmc also will be exhibited. Tektronix, Inc. will show a 1-kmc model that uses an accelerating potential of 24 kv. The viewing area is 2 by 6 cm.

Lumatron Electronics, Inc., will exhibit a trigger-rate converter that reportedly permits viewing of 60-mc sine waves on 30-mc oscilloscopes.

Noise measurement equipment will be displayed by Quan-Tech Laboratories. One unit measures resistor noise voltage at 1000 cps; another measures transistor noise at 100, 1000, and 10,000 cps simultaneously.

In addition to these products, grouped arbitrarily according to their obvious, and sometimes overlapping, applications, there are many that fail to fall neatly into these categories.

These include portable TV cameras, environmental test chambers, antennas, radar transponders, and a prodigious assortment of hardware from insulators to coil winders.

If you can spare the shoe leather, however, you'll see them all. ■ ■

HIGH SPEED SILICON COMPUTER DIODES with uniformly typical recovery time of 2 millimicroseconds were first made available in commercial quantities one year ago by Microwave Associates.

Today, Microwave Associates silicon mesa switching diodes are setting the computer industry standard. Extremely low reverse leakage (even at elevated temperatures), excellent forward characteristics, and superb reliability under severe mechanical and environmental conditions make these diodes suitable for a very wide range of applications. Major users have called these diodes excellent "universal switching diodes."

Production quantities are now replacing germanium and silicon computer diodes of both standard and newer types. They are priced competitively for large volume orders and delivery is off-the-shelf.

Faster, more sophisticated diodes for tomorrow's computers are on the way from Microwave Associates. Our leadership in this field is the result of years of experience with silicon semiconductor devices which operate at tomorrow's speeds. This experience, added to your own, will accelerate your computer progress.



CIRCLE 92 ON READER-SERVICE CARD

NEW PRODUCTS

Over 200 products on display at this year's WESCON are described in the following columns

Includes items generally specified by engineers designing electronic original equipment. Use the Reader's Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.



Switching Tube Has Four Electrodes Per Position 567

Type BX-1000 multiposition electronic switching tube has a four-electrode structure per position. The fourth electrode, called the shield grid, makes possible three new functional characteristics: constant switching input requirements are unaffected by output level; for constant switching grid input requirements, the target operates over a wide range of output voltages; it allows for the operation of non-linear devices having non-linear characteristics in terms of time. Weighing 1.5 oz, the tube occupies 3 cu in.

Burroughs Corp., Electronic Tube Div., Dept. ED, P.O. Box 1226, Plainfield, N.J.
Price & Availability: \$24.50 in single quantities; deliveries have started.
 Booth 2136-2137.



Digital Voltmeter Offers Print Connection 569

Model 484 industrial digital voltmeter offers printer connection and automatic control. Designed for applications requiring $\pm 0.01\%$ accuracy, it is a four digit unit. The meter measures dc voltages from ± 0.001 and ± 999.9 . Using one of the firm's preamplifiers extends the range to ± 99.99 and ± 999.9 mv, full scale. Using one of the firm's ac-to-dc converters, the unit measures ac voltages from 0.001 to 999.9 v, 30 cps to 10 kc. When operated with plug-in accessories, the meter can form the nucleus of automatic data logging systems for a wide range of applications.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.
Price & Availability: Price is \$2,150 complete; production models available within 90 days.
 Booth 2815-2816.

Speed Reducers And Gearheads Designed With Whole-Number Ratios 568



Designed with whole-number ratios, these Buord size 11 frame speed reducers and gearheads eliminate the need to make extensive calculations. They have postless type construction and offer ratios that are accurate to within 0.5%. The units come in over 190 stock ratios, from 7:1 to 5950:1. Mounting on standard Buord MK 14 servomotors, the units are designed for either opposite or direct rotation. They are lubricated for life, operate in temperatures from -55 to $+100$ C, and measure 1.42 in. over-all. Output torque is 75 oz-in.

Dynamic Gear Co., Inc., Dept. ED, Dixon Ave., Amityville, N.Y.
Price & Availability: Stock units are available in two weeks maximum; reducers and gearheads from stock are priced from \$88 to \$78, respectively.
 Booth 438.

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 3

RAYTHEON 1,000,000-WATT MAGNETRON LOGS OVER 13,000 HOURS IN MOBILE RADAR

This is the first reported history of a Raytheon QK-358 magnetron substantiated with an exhibit. Still, there are numerous other cases in which these exceptional Raytheon tubes have been clocked in excess of 10,000 hours, radiating at peak power.

The case in point concerns the application of a QK-358 magnetron in an AN/FPS-8 radar, for which the General Electric Company is the prime contractor. When the tube was replaced after 13,000 hours of service for "preventative maintenance" reasons, it was returned to Raytheon where the tube was found to be operating within specifications. Findings showed it to be highly stable and still capable of radiating more than one megawatt of power.

A large measure of the reliable operation and outstanding life of the QK-358 was achieved through special attention given to its unique characteristics in the overall design of the radar transmitter.

For your information, the QK-358 is a mechanically tunable pulsed-type oscillator with an integral magnet and is designed for coupling to a standard 3" x 6" waveguide. Typical operating characteristics include:

Frequency Range "L" Band
Peak Power Output 1.3 Mw
Average Power Output 1,630 W



AN/FPS-8 high-power search system by General Electric, used primarily in aircraft control and early-warning operation. The complete mobile version (AN/MPS-11A) shown here, can be airlifted or carried on nine trucks and two trailers.



Life testing of Raytheon tubes, such as the QK-358 magnetron, for six weeks or more serves as a quality check of their performance characteristics as recorded and plotted against time.

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Co., Waltham 54, Mass. In Canada: E. Waterloo, Ontario. In Europe: Zurich, Switzerland.

Excellence in Electronics



A LEADER IN CREATIVE MICROWAVE TECHNOLOGY



Electro-Optical Relay 570 Has No Moving Parts

Having no moving parts, this electro-optical relay is designed to replace a substantial portion of relays, potentiometers and commutators in their existing applications. Called a Raysistor, the unit has a conductance on-off ratio of 1,000,000:1 and is capable of speeds up to 100 operations per sec. It includes a light source in the control end which, when excited, actuates a photo-conductor in the signal end, allowing either ac or dc information to pass.

Raytheon Co., Industrial Components Div., Dept. ED, Newton 58, Mass.

Booth 2017-2018.



Microwave Attenuators 571 Cover 2.6 to 90 Kmc Range

The Series 175 attenuators cover frequency ranges from 2.6 to 90 kmc. Attenuation range for each model is from 0.3 to 30 db. A unit's fixed attenuation is accurately calibrated and then permanently locked at the value required. This value is maintained regardless of ambient temperature or humidity.

FXI, Inc., Dept. ED, 25-26 50th St., Woodside 77, N.Y.

Booth 2325-2326.

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Ballantine's Model 302C
BATTERY-POWERED
 AC Electronic Voltmeter
 measures rms of a sine wave
100 μ v to 1000 v
 at frequencies
2 cps to 150 kc

USE it for measurements on ungrounded or symmetrical circuits.

NO HUM, with gain to 60 db. No flutter.

INPUT IMPEDANCE
 2 megohms shunted by 10 or 25 pf.

ACCURACY OVER ENTIRE SCALE better than 3%, except below 5 cps and above 100 kc.

ACCESSORIES available to extend voltage range from 20 μ v to 10,000 v and to measure AC currents from 0.1 μ a to 10 a.



Price: \$255.

13 years of production experience has resulted in making this one of the most useful and reliable VTVM's in the Ballantine line.

Write for brochure giving many more details

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 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.

CIRCLE 94 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

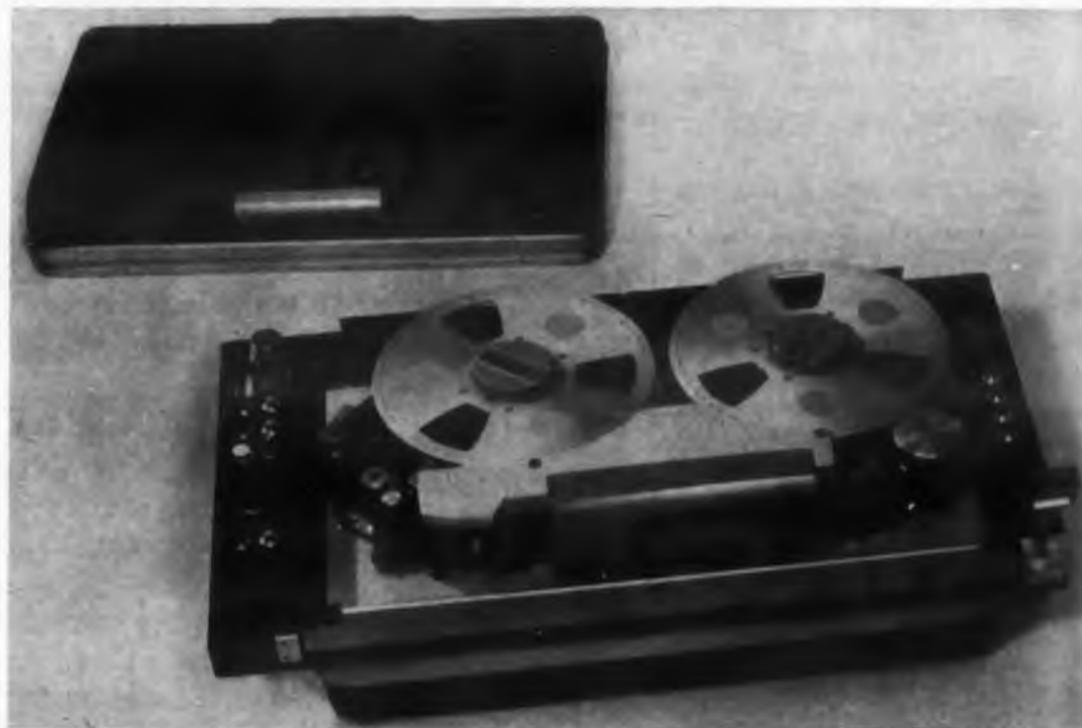
Latch-In Relay Requires
 2-1/16 x 1-1/2 In. Panel Space

572



Requiring 2-1/16 x 2-1/2 in. of panel space, the Class 11LHS relay consists of two complete, miniature type relays mounted together. Armatures of the two relays are mechanically interlocked so that energizing one armature latches it in and releases the other armature. Coils and contact mechanisms of each relay are complete and entirely independent of the other relay, except for the latch-in levers. Operating voltages or currents, and contact arrangements of the two relays can be entirely different. The unit is available hermetically sealed or with removable covers for dc continuous or intermittent duty with up to four Form C contacts per relay.

Magnecraft Electric Co., Dept. ED, 335D W. Grand Ave., Chicago 51, Ill.
 Booth 955.



Airborne Recorder Handles
 From 10 Cps to 4 Mc

573

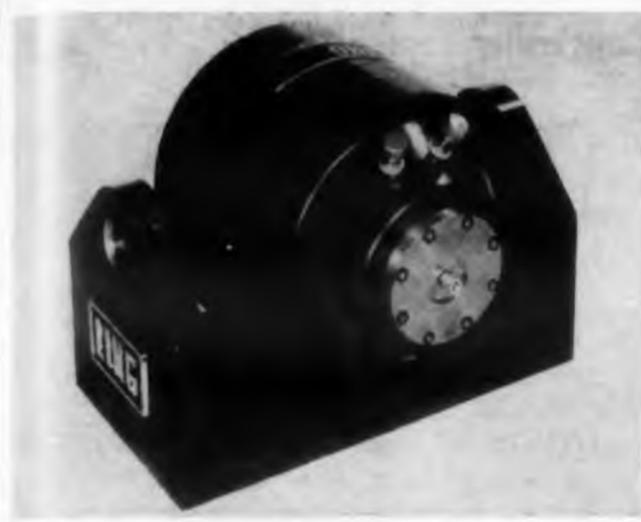
Designed for military and scientific applications, model AR-300 airborne recorder, shown, handles two channels of information over the frequency range of 10 cps to 4 mc. Amplitude response is flat within 3 db over this frequency range. Solid state components and etched circuitry are used throughout the system. It displaces 3.5 cu ft and weighs less than 150 lb, including tape. A ground unit, model FR-700, is a complete recording and reproducing system and has the same electronic characteristics as the AR-300. Both units record two channels of auxiliary information with a frequency response from 200 cps to 15 kc.

Ampex Corp., Instrumentation Div., Dept. ED, 934 Charter St., Redwood City, Calif.

Availability: By December, 1960.

Booth 2004-2006.

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Vibration Testing Shaker **574**
Rated At 25 Lb

Model LPM25 Permag vibration testing shaker is rated at 25 lb. It can serve as a vibration testing system for small components and also as a back-to-back accelerometer calibration unit. The unit is linear through the entire vibration range, 5 to 10,000 cps. A phenolic diaphragm protects the shaker from foreign particles that are commonly present in testing environments.

Ling Electronics, Dept. ED, 1515 S. Manchester Ave., Anaheim, Calif.
Price & Availability: Net price is \$995; available from stock by August 15.
Booth 2501.



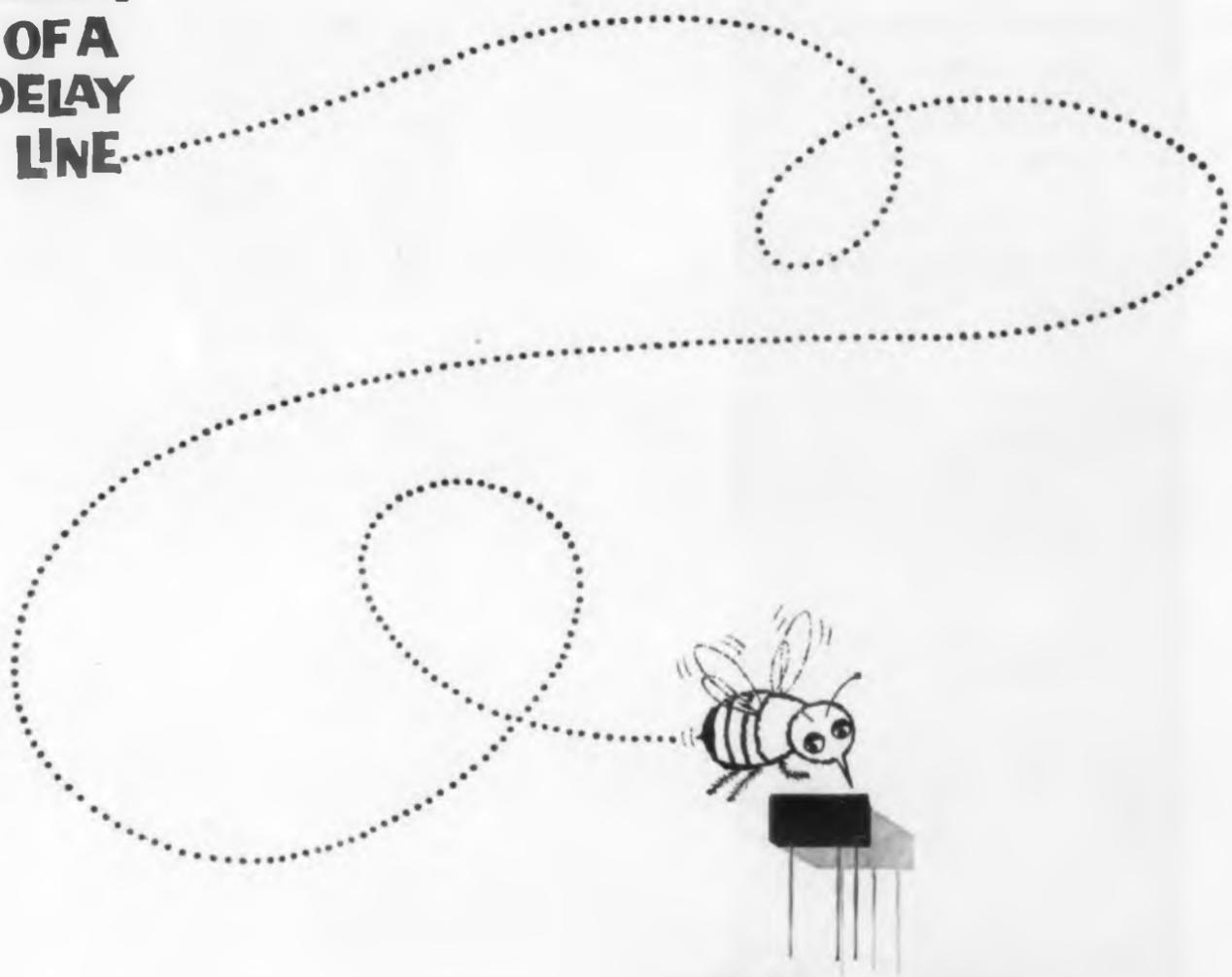
Ferrite Isolators Rated **575**
At 10 W Avg

Rated at 10 w avg power and up to 2 kw peak power, the Series 157 broadband waveguide and coaxial ferrite isolators have frequency ranges from 3.95 to 26.5 kmc. They are said to provide maximum isolation and minimum insertion loss when used to reduce the vswr presented by a load or antenna or when eliminating anomalies caused by long line effects in oscillator outputs. The isolators are intended, primarily, for bench test setups. Lengths vary from 4.5 to 8.75 in.

FXR, Inc., Dept. ED, 25-26 50th St., Woodside 77, N.Y.
Price & Availability: Deliveries from 30 to 45 days; prices per unit vary from \$220 to \$450.
Booth 2325-2326.

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**A
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OF A
DELAY
LINE**



**ESC'S NEW
SUBMINIATURE
LUMPED CONSTANT
DELAY LINE***

Model 16-92 is the latest example of creative versatility from ESC, America's largest producer of custom-built and stock delay lines. The specifications: 1/10 usec. delay, 1,600 ohm impedance, 1/4" x 1/4" x 1/2" dimensions. Only ESC produces so many different delay lines, for so many varied applications. From the largest to the smallest, ESC has the best, most economical answer to your particular delay line problem. Write today for complete technical data.

**shown actual size*



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ELECTRONICS CORP. 534 Bergen Boulevard, Palisades Park, New Jersey

Distributed constant delay lines • Lumped constant delay lines • Variable delay networks • Continuously variable delay lines • Step variable delay lines • Shift registers • Video transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

AUGAT

COMPLETE LINE OF SOCKET ASSEMBLIES FOR MICRO-MINIATURE RELAYS

Combining Holding Clip And
Built-In Socket For Unmatched
Reliability Under Severe Condi-
tions Of Shock And Vibration.



HORIZONTAL MOUNTING
(Solder Cup Contacts)



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CIRCUIT MOUNTING



VERTICAL MOUNTING
(Solder Cup Contacts)



VERTICAL PRINTED
CIRCUIT MOUNTING



SOCKET ONLY WITH
MOUNTING SADDLE
(Solder Cup Contacts or
Printed Circuit Pins)

Patent Pending

These assemblies will accomodate
Micro-Miniature relays as manufac-
tured by G. E., Elgin, Sigma, Allied,
Potter & Brumfield, Clare, Iron Fire-
man, Babcock and many others.

For additional information
write for catalog RS-160

AUGAT BROS., INC.

31 Perry Avenue
Attleboro, Massachusetts

See us at the Wescon Show. Booth #2840
CIRCLE 96 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Radar Transponders

503

For missile tracking systems



Type SST-101 transponder is a general purpose crystal-video unit intended for tracking intermediate range missiles, drones and piloted aircraft. The unit has solid state circuitry and withstands extreme environments. Signal variations of -35 to 0 dbm result in a beacon delay of only 12 nsec. The unit measures $7 \times 4\frac{1}{2} \times 2\frac{5}{8}$ in. and weighs 4 lb, 1 oz. The Type SST-102 transponder is a superheterodyne unit for long range missile tracking applications. It uses a solid state modulator switch, a ferrite circulator and mesa transistors. It is designed for use with chain radars and has a delay stability of less than $0.05 \mu\text{sec}$ over an 80 db dynamic range. The unit measures $8 \times 9.3 \times 3.1$ in.

Motorola Inc., Military Electronics Div., Dept. ED, 8201 E. McDowell Road, Phoenix, Ariz.
Booth 2021-2022.

Direct Writing Oscillographs

502

Response is dc to 100 cps



Two instruments, Models 299 and 301 direct writing oscillographs, are single-channel units in 21 lb brief-case type packages. Both units have a frequency response from dc to 100 cps within 3 db and a maximum sensitivity of 10 mv per chart division. Model 299 writer has a direct-coupled amplifier intended for dc input signals. Model 301 writer contains an oscillator, a high gain carrier amplifier, and a phase-sensitive demodulator for ac recording of transducer output levels.

Sanborn Co., Industrial Div., Dept. ED, 175 Wyman St., Waltham 54, Mass.
Booth 608-609.

Continuity Tester

583

For production or lab use



The Circuitester is for production line or lab wiring continuity checks. It is a transistorized buzzer that provides an audible tone when path resistance is less than 0.5 ohms. Path resistance changes between 0.5 and 15 ohms change the pitch of the buzzer substantially; above 15 ohms there is no tone. The device tests for direct wire paths and is not sensitive to paths through inductances or capacitors.

Invar Electronics Corp., Dept. ED, 323 W. Washington Blvd., Pasadena, Calif.
Booth 2322.

Rate Gyros

549

Subminiature, fluid-filled



The Series A2016 fluid-filled rate gyros measure less than 1 in. in diameter and 2.45 in. long. Units are available either with a simple viscous-shear type damper, providing a relatively constant damping ratio, or with a mechanism compensating for fluid viscosity within 20% from -55 to $+85$ C, without heaters. The gyros are available in two- or three-axis rate sensing packages. Most parts are interchangeable.

Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.
Booth 626-627.

Pressure Transducers

521

Have expanded scale outputs



The Series P2-1253 pressure transducers are applicable where interest lies primarily in the upper end of a pressure transducer's range, that is from 475 to 550 psi. Full 0 to 5 v dc output is concentrated in this portion of the range, rather than being dissipated in areas of no interest. Units have high output with no amplification needed. Accuracy is better than 0.15%.

Wiancko Engineering Co., Dept. ED, 255 N. Halstead St., Pasadena, Calif.

Price & Availability: Units, made to order, can be delivered in 6 weeks at \$725, less quantity discounts.

Booth 420-421.

Cable Jacketing

548

For cables of decreasing diameter

This tapered Zippertubing provides a tight-fitting cable jacket for cables where branch-outs create decreasing diameters. Wires can be pulled through perforations in the tapered tubing to permit attachments to termination points. One man can apply the tubing without special tools.

The Zippertubing Co., 752 S. San Pedro St., Los Angeles 14, Calif.

Booth 2320.

Germanium Transistors

551

For audio and switching applications

Types 2N524 through 2N527 transistors are pnp germanium units designed for audio and moderate-frequency switching applications. Collector-to-base voltage is -45 v max; collector-to-emitter voltage, -30 v max; emitter-to-base voltage, -15 v max; collector current, 500 ma max; power dissipation, 225 mw max. Typical current gain at an I_c of 20 ma is from 35 for the 2N524 through 91 for the 2N527, with other transistors having intermediate values. The base lead is connected to the metal case. Package has a JEDEC-TO-5 type outline.

Pennsylvania Electric Products, Inc., Semiconductor Division, Dept. ED, 730 Third Ave., New York 17, N.Y.

Booth 2058-2059.

For these applications too...



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CBS 7548	Practical secondary-emission pulse amplifier with 4 ns rise time at 1 amp.	CBS 7732	Stable high-gain r-f pentode replacing 6CB6.
CBS 7721	Frame-grid, wide-band pentode with gain-bandwidth product of 465, Gm of 35,000, and I_m of 22 ma.	CBS 7733	Stable high-perveance video pentode replacing 12BY7A.
CBS 7728	Stable medium-mu twin triode replacing 12AT7.	CBS ECC88/6DJ8	High-gain, low-noise, frame-grid twin triode.
CBS 7729	Stable high-mu twin triode replacing 12AX7.	CBS E88CC/6922	Ruggedized version of ECC88/6DJ8.
CBS 7730	Stable medium-mu twin triode replacing 12AU7.	CBS E280F/7722	Frame-grid, wide-band pentode with gain-bandwidth product of 362, Gm of 26,000, and I_m of 20 ma.
CBS 7731	Stable vhf triode-pentode replacing 6U8.		

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CBS instrument tubes

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MEDICAL ELECTRONICS
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See what these CBS Instrument Tubes can do for you. Check the many types available. Order them from your local sales office. Test them in your designs.

UNIQUE FEATURES

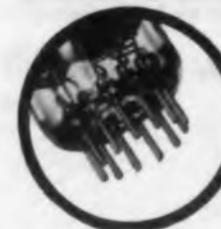
Only in CBS Instrument Tube versions of standard receiving tubes, will you find all these advantages:

- Stable characteristics
- Gold-plated base pins
- Tight test limits
- Maximum value and performance per dollar for critical sockets
- Extensive life tests*
- Coil heaters

10,000-HOUR WARRANTY

*Include unique 100-hour life assurance tests... comprehensive 1000-hour life tests... 5000-hour informational life tests.

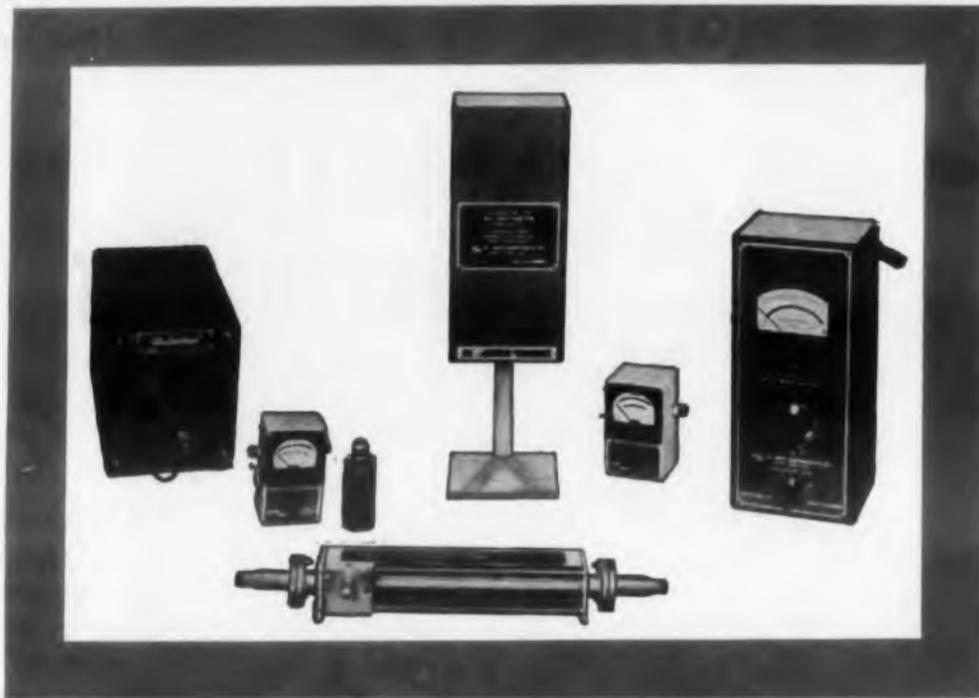
GOLD-PLATED BASE PINS



The high-conductivity, gold-plated base pins used on all CBS Instrument Tubes typify their built-in premium quality.

MicroMatch

RF POWER STANDARDS LABORATORY



MicroMatch equipment is used to establish a reference standard of RF power to an accuracy of better than 1% of absolute.

THE 64IN CALORIMETRIC WATTMETER establishes RF power reference of an accuracy of 1% of value read, and is used to calibrate other wattmeters. Five power scales, 0-3, 3-10, 10-30, 30-100, and 100-300 watts, are incorporated in the wattmeters for use in the 0-3000 mcs range.

711N and 712N FEED-THROUGH WATTMETERS, after comparison with the 64IN, can be used continuously as secondary standards and over the same frequency range as covered by the primary standard. The MODEL 711N is a multirange instrument covering power levels from 0 to 300 watts in three ranges, 0-30, 30-75, and 75-300 watts. MODEL 712N covers power levels of 0 to 10 watts in three switch positions, 0-2.5, 2.5-5, and 5-10 watts full scale.

636N and 603N RF LOAD RESISTORS absorb incident power during measurements. MODEL 636N is rated at 600 watts, and MODEL 603N is rated at 20 watts. Both models perform satisfactorily over the entire frequency range to 3000 mcs. These loads, in conjunction with the MODELS 711N and 712N Feed-through Wattmeters, form excellent absorption type Wattmeters.

152N COAXIAL TUNER is used to decrease to 1.000 the residual VSWR in a load. The tuner is rated at 100 watts, and its frequency range is 500-4000 mcs.

For more information on Tuners, Directional Couplers, R. F. Loads, etc., write



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CIRCLE 59 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Solenoid

584

Life is 20,000,000 cycles



No. 32 solenoid, designed primarily for use in computers and data processing, lifts up to 8 oz intermittent or 6 oz continuous duty and has a life of 20,000,000 cycles. It operates on 6 to 110 v dc with 3 w continuous or 6 w intermittent duty. Enclosure is steel shell; terminals are plug-in or lead types; mounting is 4-28 threaded bushing. The size is 0.5 in. in diameter and 3.5 in. long.

Guardian Electric Mfg. Co., Dept. ED, 1550 W. Carroll Ave., Chicago 7, Ill.
Booth 840-841.

Silicon Power Transistors

552

Dissipate 15 w

Types 2N1067, 2N1068, 2N1483, 2N1484, 2N1485 and 2N1486 power transistors are diffused-junction, npn silicon types rated at 15 w power dissipation. Temperature range is -65 to +175 C. These units have high beta and low saturation resistance. They are hermetically sealed in welded metal cases. Packages conform to the JEDEC-TO-8 outline.

Silicon Transistor Corp., Dept. ED, 150 Glen Cove Road, Carle Place, L.I., N.Y.
Availability: Delivery is immediate.
Booth 744.

One Part Casting Resin

515

Has low-loss, high-temperature properties



Stycast TPM-4C casting resin is a one part compound, and has a dissipation factor below 0.0003 from 10^2 to 10^{10} cps and excellent thermal stability to 400 F. The resin, when cured, is rigid and can be used for structural applications.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

Price & Availability: The resin is available from stock. A 2-lb sample kit is \$9.00.
Booth 120-121.

**CANCER'S
DANGER
SIGNALS**

**CAN BE
SAFETY
SIGNALS**

You can do two things to guard yourself against cancer: Have an annual health checkup. Alert yourself to the seven danger signals that could mean cancer:

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2. A lump or thickening in the breast or elsewhere.
3. A sore that does not heal.
4. Change in bowel or bladder habits.
5. Hoarseness or cough.
6. Indigestion or difficulty in swallowing.
7. Change in a wart or mole.

If your signal lasts longer than two weeks, go to your physician. Give him the chance to give you the chance of a lifetime.

**AMERICAN
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SOCIETY**

Regulated Power Modules 558

Have five-year life expectancy

The Series RPM regulated power modules have a five-year life expectancy and are designed for a maximum operating temperature of 65 C in continuous use. Regulation is 0.05%. Ripple is 1 mv, rms, max. Units are designed to meet MIL-E-16400-B specifications.

ACDC Electronics, Inc., Dept. ED, 2979 N. Ontario St., Burbank, Calif.

Price & Availability: Units, priced from \$215, are available in 3 to 4 weeks.

Booth 2230.

Knobs 561

Meet MIL specs

Series 500 knobs, designed to MS-91528 specifications for military applications, are available in six types. Rounds, skirted rounds, dial-skirted rounds, plain and skirted pointers and crank types are included. Six different sizes are provided in either MIL spec matte black or in mirror finish. Knobs are molded of Tenite No. 2, with ribbed construction in large diameter models. Each has two hardened set screws. Either 1/4 in. MIL spec or 1/8 in. diameter shaft holes are available.

Lerco Electronics, Inc., Dept. ED, 501 S. Varney St., Burbank, Calif.

Availability: Knobs for immediate delivery are available.

Booth 2504.

Magnetic Amplifiers 566

For servo motor applications

Series MAT magnetic amplifiers are designed for servo motor applications in transistorized circuits. Power outputs up to 18 w at 115 v, 400 cps, are available. Units are hermetically sealed and meet MIL specs.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.

Booth 430.

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ELECTRONIC DESIGN • August 3, 1960

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NIXIE®
INDICATOR TUBES

Write today, for your Readout Fact Finder (Shows actual comparison of indicator devices).

Lowest Cost • Smallest Size • Lightest Weight

No darkening

Most easily under all

No shifting focus or misalignment

All electronic

No costly replacement or servicing

Lowest power requirements

No bulb or filament failure

Meet maximum temperature, shock and vibration specifications



B6033

No segmented failure

Longest Life
100,000 Hours

No matrix driver required



B4032

display

read — conditions



B5031

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High Inductance

WEE-DUCTOR

The R.F. Choke that's so small
you can pack 200,000
to a cubic foot

Tiny, new, WEE-DUCTOR covers a full range of inductances from 0.10 μ H to 56,000 μ H yet it measures only 0.157" x 0.375".

Unique ferrite sleeve and core construction provides 560,000 to 1 inductance range in a tiny package . . . and yet when assembled side-by-side, exhibit less than 2% coupling.

Essex WEE-DUCTORS are available immediately from stock. WEE-DUCTORS are the latest addition to Essex's broad line of Standard R.F. Choke Coils.

Essex Electronics Standard Line of R.F. Chokes

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L μ H	.1-56,000	.1-100	1.0-1,000	1.0-10,000
Max. Res. Ω	.035-499	.02-6.0	.04-21	.03-80
I Max. mA	3000-26	4000-220	2700-125	4000-80
Dia.	.157	.188	.250	.310
Length	.375	.440	.600	.900

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CIRCLE 68 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Tape Recorder

577

For instrumentation or laboratory use



Model CP-100 seven- or 14-channel recording and reproducing system is a reel-to-reel machine for instrumentation or general laboratory applications. It accommodates 0.5- or 1-in. tape on 10.5-in. reels and provides tape speeds of 1-7/8, 3-3/4, 7-1/2, 15, 30, and 60 ips. Cumulative flutter is below 0.6% peak-to-peak at 60 ips, tape speed deviations are $\pm 0.25\%$ max, and start time is less than 3 sec. Frequency response from dc to 200 kc is available. The unit can be operated in its mobile case or mounted in a 19-in. rack. It can be used at altitudes to 10,000 ft.

Ampex Corp., Instrumentation Div., Dept. ED, 934 Charter St., Redwood City, Calif.
Booth 2004-2005.

Magnetic Modulators

582

Range is 60 cps to 10 kc



The F5A magnetic modulators have a standard frequency range of 60 cps to 10 kc but can operate as high as 100 kc with low-impedance units. The dual-channel type F5A113 has a signal winding resistance of about 700 ohms. Single-channel type F5A114 is also offered. Originally intended for use as a circuit element in conjunction with amplifiers in servo systems, the units can also be used with thermocouples, strain gages, computing devices, and telemetering equipment.

Motorola, Inc., Aviation Electronics, Inc., Dept. ED, 3302 Airport Ave., Santa Monica, Calif.

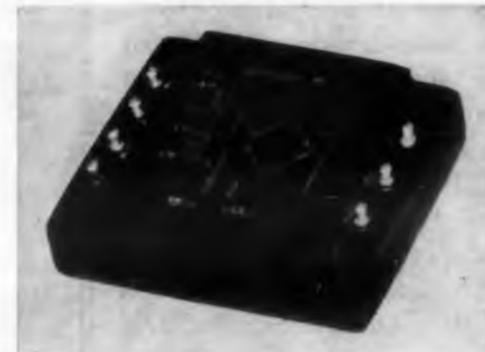
Price & Availability: Delivery is from stock. Dual channel units are priced at \$81.67 and single channel units are priced at \$45.83.

Booth 2021-2022.

Demodulator-Phase Detector

556

For missile and aircraft applications



The Model 1806 demodulator-phase detector is designed for guidance applications in missiles and aircraft. The unit provides a dc voltage proportional to the amplitude difference between the signal input and reference input. Frequency response is 700 to 15,000 cps. The device is encapsulated in epoxy resin.

Varo Manufacturing Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

Booth 2332.

Nylon Cable Clamps

518

Can be opened, closed, readjusted

Lok-Strap nylon cable clamps and ties have miniature quick-release tabs that hold the clamp securely around the wire, but which release quickly to allow adjustment of wires. Wire harnesses from 1/8 to 2 in. can be accommodated.

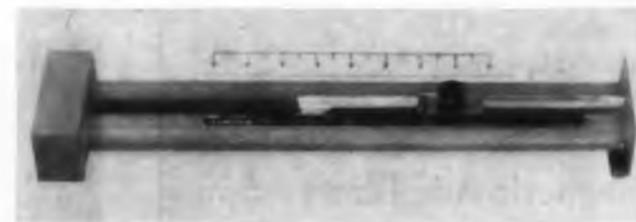
Panduit Corp., Dept. ED, 14461 Waverly Ave., Midlothian, Ill.

Booth 346.

VHF Phaser

576

Has relative phase adjustment of 65 deg at 100 mc



Model 2260 vhf phaser provides a relative phase adjustment of 65 deg at 100 mc to 270 deg at 400 mc with no change in the physical length of the phaser. Input and output terminals are type N, 50-ohm coaxial. The impedance match is maintained over the entire range of adjustment and frequency.

Meridian Metalcraft, Inc., Dept. ED, 8739 S. Millergrove Dr., Whittier, Calif.

Price & Availability: \$225 ea in small quantities; from stock.

Booth 2519.

Variable Linear Reactor

391

Range is 10 to 5,120 ohms

This variable linear reactor has an impedance range of 10 to 5,120 ohms. The unit has eight coils, each with a maximum rating of 90 v at 2.5 amp. The max volt-ampere rating is 7500 va. Inductance of the unit increases linearly with the applied voltage without saturation or wave distortion. The reactor measures about 6 x 5-1/2 x 27 in. and weighs 35 lb. Applications are in development and test laboratories, power supply systems and as a ballast for fluorescent or mercury vapor lamps.

Sylvania Electric Products, Inc., Sylvania Lighting Products Div., Dept. VLR, Dept. ED, Ipswich, Mass.

Availability: Units are immediately available.

Booth 2009-2010.

Zener Diodes

429

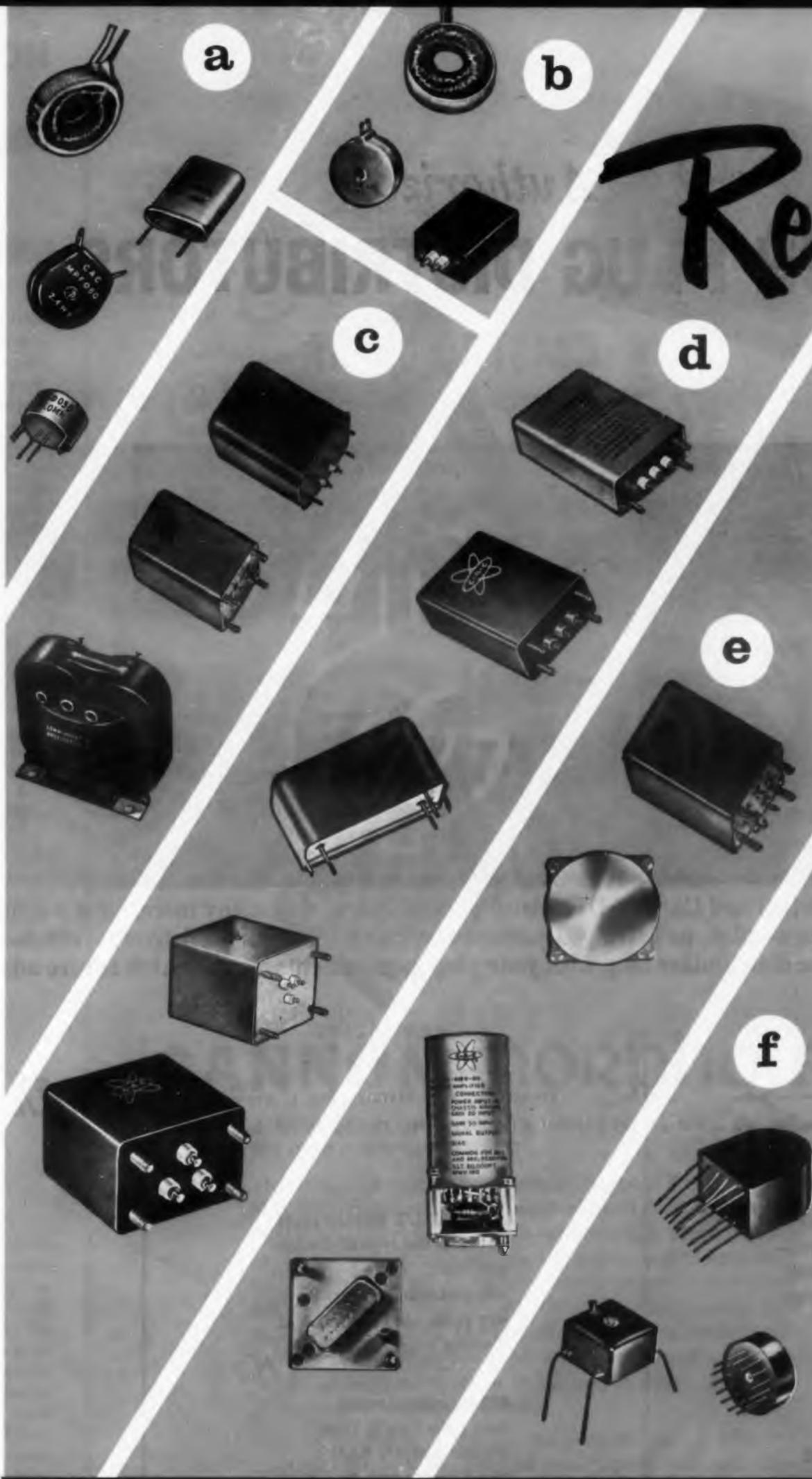
Power rating is 10 w

These Zener diodes are rated at 10 w. Types 1N1603 through 1N1609 diodes have breakdown voltages from 8.2 to 27 v, in test currents from 250 ma to 70 ma dc, and in Zener impedances from 0.25 to 4.5 ohms. Types 1N2498 through 1N2500 diodes have breakdown voltages from 10 to 12 v at a test current of 500 ma and a dynamic impedance of 2 ohms. Types 1N1816 through 1N1836 diodes are rated at 13 to 91 v at 500 to 50 ma, and Zener impedances from 2 to 35 ohms. Types 1N2008 through 1N2012 diodes are rated at 100 to 150 v at 50 ma, and Zener impedances from 40 to 82 ohms. Types 1N2043 through 1N2049 Zener units are rated from 6.2 to 27 v breakdown, at 1 amp to 150 ma dc test currents and Zener impedances of 0.8 to 8 ohms.

Hoffman Electronics Corp., Dept. ED 3761 S. Hill St., Los Angeles, Calif.

Booth 946.

CIRCLE 116 ON READER-SERVICE CARD



C-A-C
Communication
Accessories
Company

Reliability

in Components

precision delivery quality

a Sub-miniature Toroids

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b Standard Toroids

A wide variety of inductance values, Q's and permeabilities to fulfill your requirements. Advanced winding techniques assure the finest performance obtainable. Many types and values available from stock.

c Power Transformers— Laminated Transformers— Reactors—Foil Wound Transformers

Many types designed to MIL-T-27A. High quality commercial specifications, hermetically sealed or encapsulated. Custom designed to circuit and mechanical requirements.

d Low Pass—Band Pass—Telegraph— Aircraft Navigation Filters and Delay Lines

L-C filters utilizing high Q toroidal inductors. C-A-C's years of experience in the design and manufacture of tight tolerance networks results in superior performance and reliability. C-A-C engineers welcome your inquiries.

e Magnetic Amplifiers

C-A-C specializes in development of magnetic amplifiers for specific applications—in conjunction with servo-motors, computers—both low and high level.

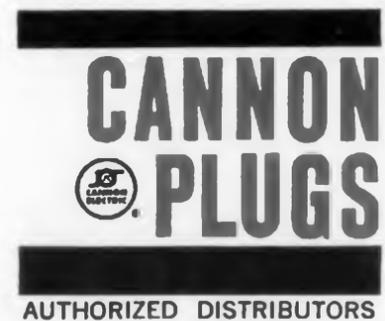
f Plastic Packaged Inductors

As a pioneer in the plastic packaging of inductors, C-A-C has developed practical techniques assuring high performance in the smallest physical size. For printed wiring and chassis-mounted applications.

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 ELECTRONIC DESIGN • August 3, 1960

NEW FROM CANNON



KQ/KR MINIATURE PLUG A new miniature plug designed to meet the severe requirements of today's and future missiles and aircraft. Also adaptable for general purpose applications, these new plugs fill an important industry need. The KQ/KR features a single receptacle which will accept either of two quick coupling devices—a push-pull or a bayonet-lock mating device—and is fully tested for high-altitude performance. Integral construction features crimp-type, probe-proof contacts; monobloc insert-grommet assembly; polarization by multiple keyways.

CIRCLE 64 ON READER-SERVICE CARD



CRIMPEE COAXIAL PLUGS A completely solderless RF coaxial plug using a simplified crimping method for high-speed assembly. Fits many applications, such as mobile communications equipment, ham radio sets, and television master antenna distribution systems. This new CRIMPEE mates with the standard UHF Series of RF receptacles, and is available for five coaxial cables; RG-8/U, 9/U, 11/U, 58/U, and 59/U. An inexpensive crimping tool is provided for quick and easy assembly of the plug to its cable.

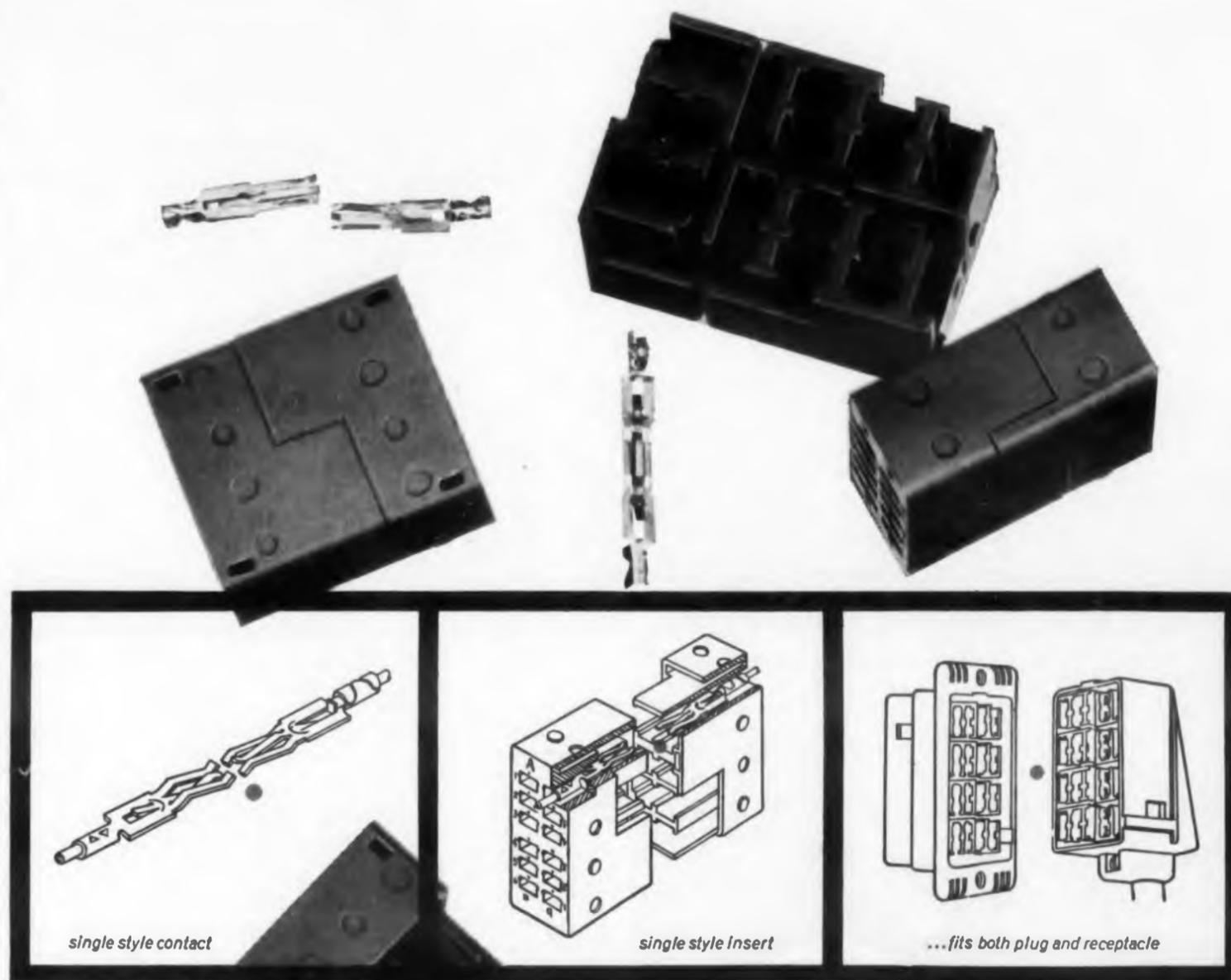
CIRCLE 65 ON READER-SERVICE CARD



CANNON/TUCHEL PLUGS Micro-miniature plugs incorporating a completely new operating principle. Electrical contact is made by pushing the pin into a claw-like socket. Contact reliability is increased by means of several springs of diminishing diameter and overlapping each other. This new Cannon/Tuchel construction insures a greater mechanical grip of interlocking parts, provides automatic cleaning of contacts, and increases electrical effectiveness even in the smallest space. These micro-miniature plugs are designed especially for aircraft, portable instrumentation, and other miniature electronic equipment.

CIRCLE 66 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960



CANNON morpho* PLUGS



A NEW DEVELOPMENT FOR INDUSTRIAL AND MANY MILITARY APPLICATIONS

The unique hermaphrodite-modular design of Cannon's new MORPHO lightweight plugs provides unusual flexibility and versatility! Especially intended to meet commercial applications such as computers, business machines, and communication equipment inexpensively and with complete reliability—these unusual plugs are equally well suited for many military requirements. The MORPHO line features hermaphrodite crimp type contacts and hermaphrodite modular insulators which fit both plug and receptacle. Currently available in 12, 24, and 36 contacts...allows numerous alternate insert positions.

Write for Catalog MH-1 today for the complete story of MORPHO ...another reason why you should consult the world's most experienced plug manufacturer for all your plug requirements.



* trademark pat pend

CANNON PLUGS

CANNON ELECTRIC COMPANY • 3208 Humboldt St., Los Angeles 31, Calif.

CIRCLE 67 ON READER-SERVICE CARD

WOULD 30 DAY DELIVERY HELP? Then call Helipot. We'll deliver BECKMAN® Panel Meters... in a variety of styles, shapes and models... within 30 days after receipt of your order. Specials may take 45 days.

Fact is, quick delivery and customer service go along with every BECKMAN meter... voltmeters, ammeters, milliammeters, and microammeters... in sizes ranging from 2½" to 4½".

Best of all, they are excellent meters... and we can prove it! A Certified Test Report (which you may have for the asking) gives details of rigidly controlled tests conducted to find out just how good our meters are. In all cases, units tested met or exceeded MIL-M-10304A. Like we said: they are excellent meters.

Clearly, if you need panel meters, call Helipot. Delivery is dependable, quality is excellent, and the price is right. The other things we could say in favor of these meters are contained in the latest meter Data File. Send for it: your meter problems will be solved.



Beckman Helipot

POTS : MOTORS : METERS
Helipot Division of
Beckman Instruments, Inc.
Fullerton, California



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CIRCLE 74 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Conductive Cement

513

Cures at room temperature

Eccobond solder 70 C cement is a two-component, epoxide-based, room-temperature curing conductive adhesive. Volume resistivity is less than 0.1 ohm-cm. The cement has a coarse texture, and is intended for metal-to-metal surface joints rather than delicate electronic wiring. It is suitable for heat conducting and rf shielding joints.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

Price & Availability: The cement, available from stock, is \$5.00 per lb.

Booth 120-121.

Triode-Pentode Regulator Tube 520

For industrial power supplies

The Type WL-7734 regulator tube is a low-mu triode and sharp cut-off pentode intended for industrial power supplies. The triode acts as a series regulator under control of the pentode which is used as a dc amplifier. Sections have separate cathodes, each with a heater-cathode rating of -300 v. With a 50-v plate potential and zero bias, the triode will conduct 70 ma with a plate dissipation of 70 w max. The pentode has a plate resistance of over 7 meg with 100 v plate voltage, 50 v screen voltage and bias adjusted for 100 µa of plate current.

Westinghouse Electric Corp., Electronic Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.

Price & Availability: Consumer retail price is \$5.45. Sample quantities are available immediately.

Booth 2342.

Capacitors

546

For silicon controlled rectifier applications

These capacitors are designed for use in commutating circuits where a silicon controlled rectifier is exposed to a dc voltage. The units have low, series inductance and resistance. They are available in stud-mounting tubular types with high heat dissipation, and in rectangular paper dielectric units. Stud mounted units are available from 1 to 4 µf at 140 v peak, and operate to frequencies of 10 kc. Rectangular units are available to 60 µf and 200 v dc.

General Electric Co., Capacitor Dept., Dept. ED, Hudson Falls, N.Y.

Availability: Tubular units are available only in prototype quantities; rectangular capacitors can be shipped in production quantities.

Booth 2122-2123.



SURE...I had a heart attack'

Jack Morgan, oil worker, is one of thousands back at work after a heart attack.

New drugs, new treatment, the latest knowledge developed through heart research helped pull them through.

You don't have to have heart disease to appreciate the story of Jack Morgan and the value of research supported by the Heart Fund. Whatever your job, your life depends on your heart. Whatever protects your heart is a sound investment in your future.



Transistorized Power Supply 559

For laboratory applications

Model MTRO36-15 power supply is a transistorized dc unit intended for general laboratory use requiring precision regulation. Output is 0 to 36 v at 15 amp, regulated to within 10 mv. Ripple is 2 mv, rms, max. The device contains a magnetic amplifier and a transistorized regulator. It measures 19 x 17 x 7 in., and is constructed for rack mounting.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

Price & Availability: Units will be available from stock by September 1, 1960; price is \$1,045. Booth 760-761.

Induction Motor 562

Delivers 12.4 hp

The Model F-25-2 induction motor is capable of delivering 12.4 hp at 11,600 rpm. The unit measures 5-1/2 in. diameter and 9-3/16 in. long, and weighs 17.72 lb. The device is a three-phase motor, fully enclosed and explosion-proof and protected from thermal overload. It is designed for airborne or ground based axial vane blower applications. Input power is 200 v, 400 cps, 3 phase. MIL specs are met.

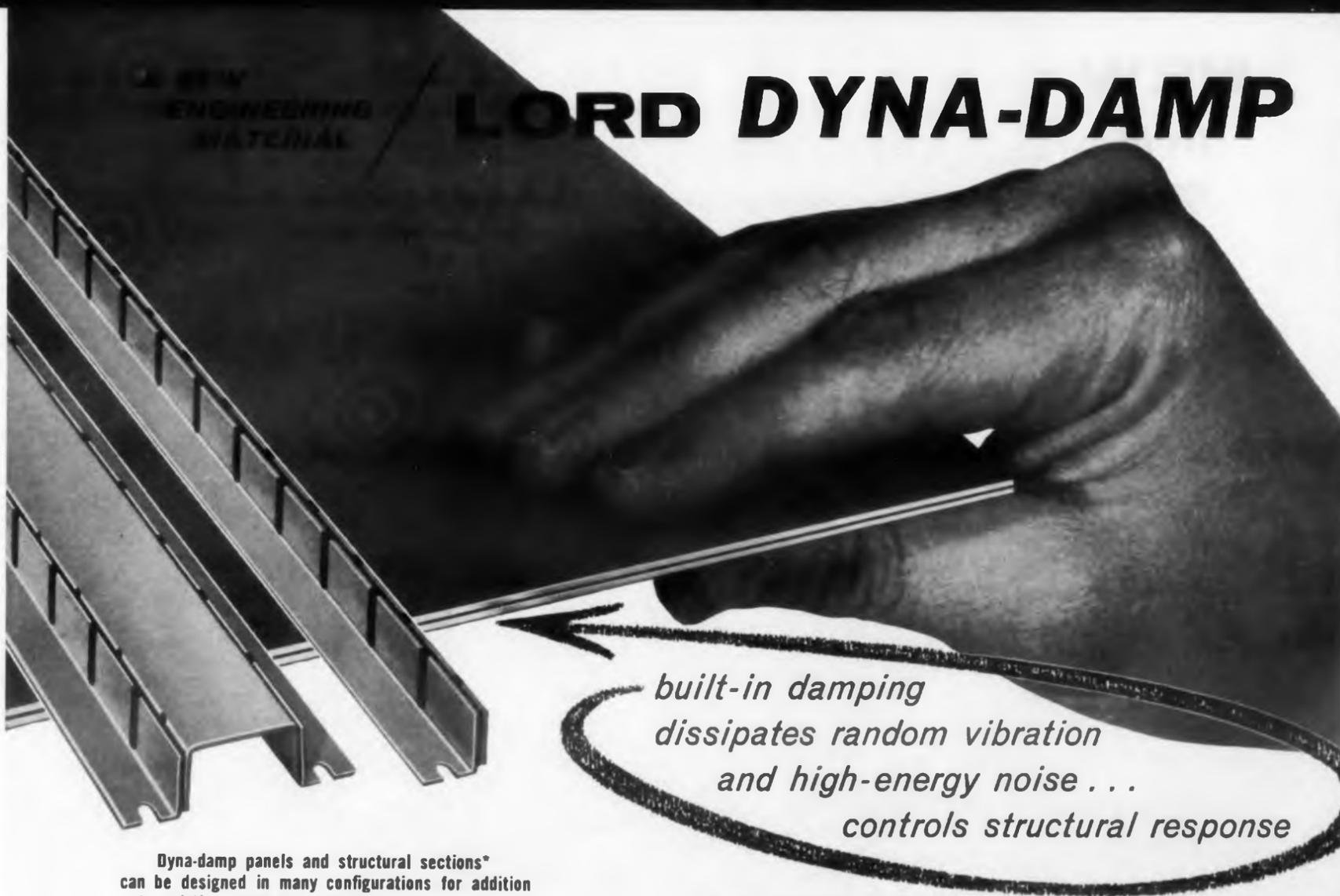
Kearfott Div., General Precision Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.
Booth 626-627.

Power-Line Isolation Transformers 564

Input-output capacitance less than 0.1 pf

The HIT-Series power transformers isolate input and output for critical circuit. Capacity coupling between primary and secondary circuits is less than 0.1 pf. Input and output are 115 v, 60 cps. Power ratings up to 600 w are available. MIL specs are met.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.
Booth 430.



Dyna-damp panels and structural sections* can be designed in many configurations for addition to existing structures or fabrication as complete damped assemblies.

Lord announces Dyna-damp—a new engineering material that counteracts broad-band "white" noise and vibration. It offers a new, better way to solve acoustic fatigue and structural response problems.

Dyna-damp's laminated design converts vibratory energy into shear strains which are dissipated in a highly damped viscoelastic layer. The damping medium is a special form of BTR® elastomer, bonded between metal elements to give structural integrity and load-carrying strength.

In jets, missiles, ships, vehicles, electronic units—wherever control of resonant response is required—Dyna-damp can introduce dramatically improved performance, higher reliability. It is available to industry in sheet and structural sections or in engineered, finished products for use as primary or secondary structures, electronic chassis, complete mounting systems.

Design engineers can obtain further information and able application assistance on Dyna-damp from the nearest Lord Field Engineering Office or the Home Office, Erie, Pennsylvania.

*patent applied for

FIELD ENGINEERING OFFICES

ATLANTA, GEORGIA - Cedar 7-9247
BOSTON, MASS. - Hancock 6-9135
CHICAGO, ILL. - Michigan 2-6010
DALLAS, TEXAS - Riverside 1-3392
DAYTON, OHIO - Baldwin 4-0351
DETROIT, MICH. - Diamond 1-4340
KANSAS CITY, MO. - Westport 1-0138

LOS ANGELES, CAL. - Hollywood 4-7593
NEW YORK, N. Y. (Paramus, N. J.)
New York City - Bryant 9-8042
Paramus, N. J. - Diamond 3-5333
PHILADELPHIA, PA. - Pennypacker 5-3559
SAN FRANCISCO, CAL. - EXbrook 7-6280
WINTER PARK, FLA. - Midway 7-5501

"In Canada—Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY • ERIE, PA.

Radically Improved damping is illustrated by typical decay rate traces.



Undamped: 2024 T-3 aluminum panel



Damped: 3-ply Dyna-damp panel

DYNA-DAMP FEATURES

High strength: bonded construction provides structural integrity across complete part. Ultimate strength: 60% of solid aluminum. Shear strength of BTR layer: over 500 psi. Climbing drum peel strength: over 60 lbs.

Light weight: lighter than aluminum sheet of equal thickness.

Excellent fatigue life: proved greatly superior to aluminum in acoustic tests to 170 db.

Broad temperature operation: -65° to +250°F.

Ease of fabrication: can be punched, sheared or stretch formed by standard methods . . . fastened by riveting or adhesive bonding . . . sections can also be spot welded.

Environmental resistance: good strength and damping ability maintained after 7-day immersion in aircraft fluids.



See us at the 1960 WESCON—Booth 403-404.

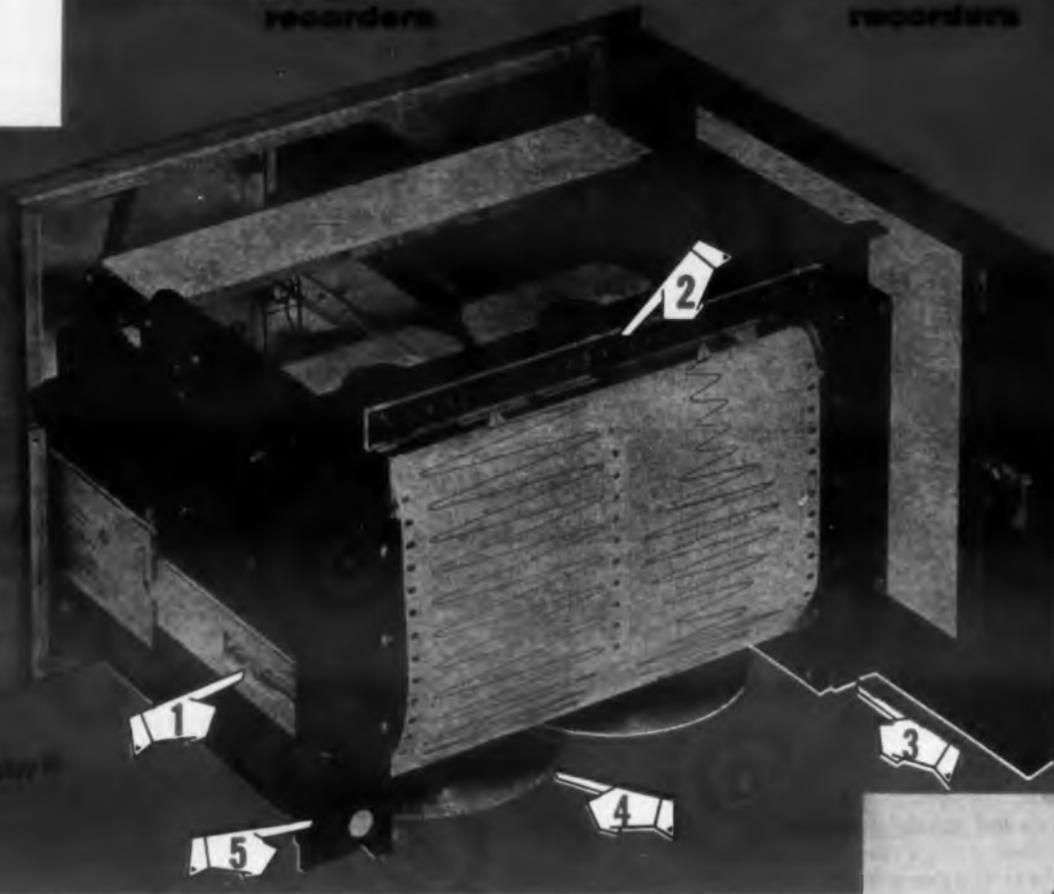
CIRCLE 75 ON READER-SERVICE CARD

NEW
from
TI

FLUSH-MOUNTING

recti/riter[®]
recilinear galvanometric
recorders

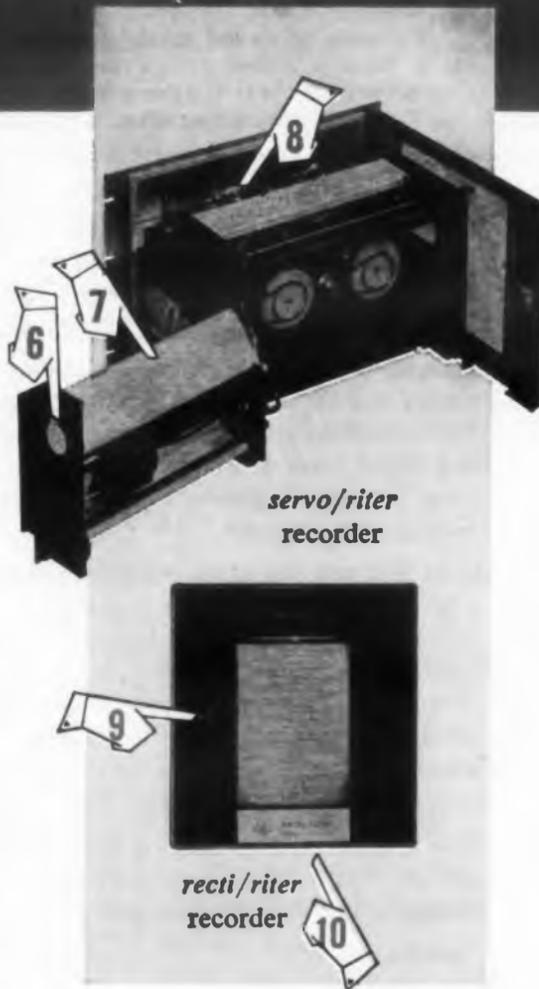
servo/riter[®]
self-balancing potentiometric
recorders



Exclusive convenience features are added to industry-proved recording performance

The NEW flush-mounting *recti/riter* and *servo/riter* recorders (single, dual, and wide channel) contain these operating conveniences, while retaining the reliability and performance characteristics of the proved TI portable recorders.

1. Chassis rolls out and quickly disconnects for maximum ease of installation, adjustment or servicing.
2. Illuminated scales and pointers maintain high readability regardless of room light level.
3. Fingertip releases for chassis roll-out and swing-open chart carriage.
4. Flexible wide range zero adjustment on *recti/riter* recorder. One-half span of calibrated zero suppression provided in each direction.
5. Four-position switch provides off-on, in./hr., standby, and in./min.
6. Chart speed change gears provide 10 standard speeds.
7. Swing-open chart carriage permits easy paper loading and adjustment. Simply lift up to remove carriage. Advanced design eliminates chart drive gear train lash . . . gives better paper position accuracy.
8. Interior design provides flexibility and adequate space to add special functions with ease.
9. Dust tight case has key lock available for limited access. Dimensions: Single recorders—11½" W., 12⅞" H., 16" D.; Dual recorders—16¾" W., 12⅞" H., 16" D.
10. Panel may be easily modified to permit paper feed through bottom of door.



Write for complete information . . .

*A Trademark of Texas Instruments

**INSTRUMENTATION
GROUP OF**



**TEXAS INSTRUMENTS
INCORPORATED**
GEOSCIENCES & INSTRUMENTATION DIVISION
3609 BUFFALO SPEEDWAY • HOUSTON 6, TEXAS

NEW PRODUCTS

AT WESCON

Miniature Band Pass 563 Filters

For printed circuits

The Series MNF and MWF band pass filters are miniature devices covering frequencies from 400 through 70,000 cps with 7.5% and 15% bandwidths, respectively. The filters are designed for printed-circuit applications in transistorized circuits. Filters come in two sizes: 1-3/16 in. sq x 1/2 in. weighing 1 oz; and 23/32 in. sq x 1/2 in. weighing 1/3 oz. Input and output impedance is 10 K. Units are hermetically sealed and meet MIL specs.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.

Booth 430.

Magnetically Shielded 560 Tape Container

Holds single 10 in. reel

These tape containers will hold one 10-in. reel of magnetic tape. The container is constructed of a Netic alloy that will protect the tape from extraneous magnetic fields, even if accidentally placed on a tape degausser. A label on the container identifies its contents. Containers can be padlocked. They are non-shock sensitive, non-retentive, and do not require periodic annealing to retain shielding effectiveness.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.
Booth 2629.

Power Transformers 565

For transistorized circuits

Types H-141 through H-147 power supply transformers are designed to power transistorized circuits from 115 v ac input. Outputs are from 10 to 21.5 v at up to 20 amp. Both full-wave and half-wave models are available. Units are hermetically sealed and meet MIL specs.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N. Y.

Booth 430.

◀CIRCLE 71 ON READER-SERVICE CARD

Wirewound Potentiometers

462

Diameter is 7/8 in.



The 2100 Series Micropot, wirewound potentiometers have a 7/8 in. diam and are available in 10-turn and 3-turn models. Resistances to 100 K are offered. The assemblies can withstand over 1 million revolutions without exceeding tolerances. Servo or bushing mountings are available. Zero-based or independent linearity is offered. Units will withstand 1000 v rms between shaft and terminals. MIL specs for environment are met.

Amphenol-Borg Electronics Corp., Borg Equipment Div., Dept. ED, 120 S. Main St., Janesville, Wis.
Booth 848-849.

Readout Driver Modules

475

Triggered by 3 v at 300 μ a



Types TR-40 and TR-57 driver modules are designed to operate the miniature Nixie and the standard and super Nixie indicator tubes, respectively. The driver circuits employ 10 npn transistors in breakdown condition, with current limited by the indicator tube. Signals of 3 v at 300 μ a are sufficient to trigger the circuits. The modules are designed for panel mounting and for operating temperatures of -30 to +55 C.

Burroughs Corp., Electronic Tube Div., Dept. ED, P.O. Box 1226, Plainfield, N.J.

Price & Availability: Modules without indicator tube are priced from \$25 to \$30 depending on quantity. Units are available from stock.
Booth 2136-2137.

For fast, high-resolution servo positioning

Inland d-c torque motors

From 0.1 to 3000 pound-feet

High torque-to-inertia at the output shaft

A typical stabilization application requiring a peak torque of 60 ounce-inches now uses an Inland torquer with a torque-to-inertia ratio of 5350 radians/sec.². This torquer replaces a gear train servo motor that had a ratio at the output shaft less than *one-tenth* that of the Inland torquer.

Direct drive promotes system accuracy

Direct drive without servo motor gear trains reduces friction and eliminates backlash and elasticity, leading to better over-all system accuracy.

COMPACT PANCAKE SHAPE now available in d-c torquers through exclusive Inland design



Exclusive commutator and brush rigging design

Patented features enable Inland to combine the compact pancake configuration with low-power input —high-torque output characteristics of a d-c torquer.



TYPICAL RATINGS FOR 20 OZ.-IN. TORQUERS

	T-1321-D	T-1321-B	T-1321-C
PEAK TORQUE, OZ.-IN.	20	20	20
VOLTS AT PEAK TORQUE, STALLED AT 25°C	31.4	24.8	39.6
AMPS AT PEAK TORQUE	1.82	2.25	1.46
TOTAL FRICTION, OZ.-IN.	0.5	0.5	0.5
ROTOR INERTIA, OZ.-IN. SEC. ²	.001	.001	.001
WEIGHT, OUNCES	5	5	5

For complete data on these or other d-c pancake torquers up to 3000 pound-foot output, address Dept. ED, Inland Motor Corporation of Virginia, Northampton, Massachusetts.



INLAND MOTOR CORPORATION OF VIRGINIA

A SUBSIDIARY OF KOLLMORGEN CORPORATION
NORTHAMPTON, MASS.

Factory: Radford, Virginia

CIRCLE 101 ON READER-SERVICE CARD



space-age assignment: TOTAL RELIABILITY

First man in space! He'll be dependent on the skill and integrity of those who have fabricated and powered his private world. Dependent upon the reliability of every component in it.

Gudeman's continuing progress in capacitor development means ever higher confidence levels, unprecedented reliability today, even higher standards in sight for tomorrow. This ideal of building uncompromising quality into the product is found in all of the various components produced by every Gudeman manufacturing facility.



A new Gudeman Development! The new Gudeman MR463 MEGA-REL capacitors (25% smaller than MIL-C-14157A & MIL-C-26244(USAF) requirements, yet equivalent electrically and environmentally) reflect the creative engineering and constant design improvements that mark all Gudeman products.

CAPACITORS BY GUDEMAN

THE GUDEMAN COMPANY
MAIN OFFICE—340 W. Huron St., Chicago 10, Ill.
MFG. BRANCHES: Terryville, Conn.; Visalia, Calif.

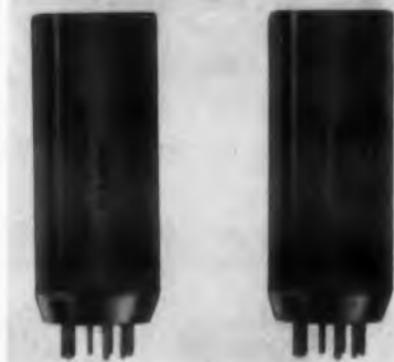
CIRCLE 102 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Magnetic Core Circuits

471

Frequency range is 0 to 250 kc



These magnetic-core circuits, including shift registers, pulse gates and core drivers, operate from 0 to 250 kc and are physically and electrically compatible with the T-Series transistor circuits. One core in these circuits will produce the flip-flop action of two transistors. The units are packaged in T-Series containers measuring 7/8 in. in diameter and 2-3/16 in. long, and fit miniature tube sockets.

Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif.

Price & Availability: The units, made to order, can be delivered in 30 days and are priced at \$15. Booth 1017.

Analog Tape Recorder

476

Range is 300 to 250,000 cps



The Model FR-600 tape recorder has a frequency range of 300 to 250,000 cps and a 60-in.-per-sec tape speed. Seven tracks of wideband information plus one track for voice are provided on the 1-in. tape. Reels, with 14-in. diam, provide 24 min of recording time. At the end of a reel, a second transport is automatically activated. The instrument utilizes solid-state, modular design. Precise phase response with amplitude response flat ± 3 db over full bandwidth is provided for fm/fm telemetry recording.

Amplex Corp., Instrumentation Div., Dept. ED, 934 Charter St., Redwood, Calif.
Booth 2004-2005-2006.

BRAND-REX CABLEMANSHIP

the big difference
in Teflon® Insulated
Wire and Cable!

From the smallest single U/L approved hook-up wire to the most complex Teflon primary insulated and jacketed multiconductor cable, Brand-Rex Cablemanship makes the big difference.

Brand-Rex Cablemanship is a combination of technology, skill, progressive cable design engineering, the production capability of three modern plants and technical field service . . . all delivered through a tightly-knit organization backed by the vast resources of the American Enka Corporation.

Regardless of how varied your requirements may be for conductors, lay-up patterns, shields, armors or jackets, your specifications will be met when you place your confidence in Brand-Rex!



Write for complete information and samples today.

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WILLIAM BRAND-REX
DIVISION

American ENKA Corporation
SUDBURY ROAD, CONCORD, MASS.

CIRCLE 103 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

RF Power Density Meter

474

Range is 200 to 10,000 mc



Model NF-157 rf power density meter directly reads power densities from 0.1 to 2000 mw over a continuous frequency range of 200 to 10,000 mc. The unit uses small batteries as a power source and any of three constant-gain probes. Power is measured by a thermistor element in a temperature-compensated dc bridge. The unit weighs 10 lb. Suggested applications include personnel safety indication in strong rf fields, near-field intensity measurement and detection of hot spots and leakage near antennas.

Empire Devices Products Corp., Dept. ED, Amsterdam, N.Y.

Price & Availability: Units, priced at \$1,975, can be delivered in 30 days.

Booth 2819-2820.

Data Transmitter

479

Frequency response is dc to 50 kc



The Model CS-1976 data transmitter provides uniform frequency response from dc to over 50,000 cycles. Carrier frequency range is 130 to 150 mc. Power output is 50 w. The unit is designed for rack mounting.

Gates Radio Co., Dept. ED, Quincy, Ill.

Price & Availability: The transmitter, priced at \$1,875, can be delivered in 120 days. Units will be available from stock in 1961.

Booth 1069.

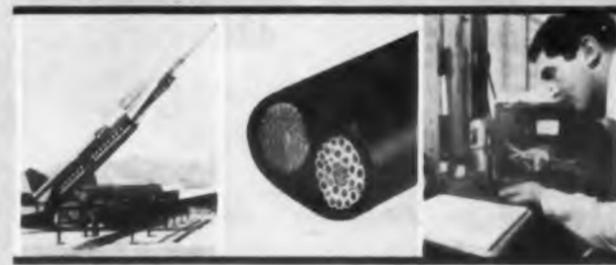
The big difference in
MIL-C-13777B
Neoprene Jacketed Cables!

BRAND-REX CABLEMANSHIP

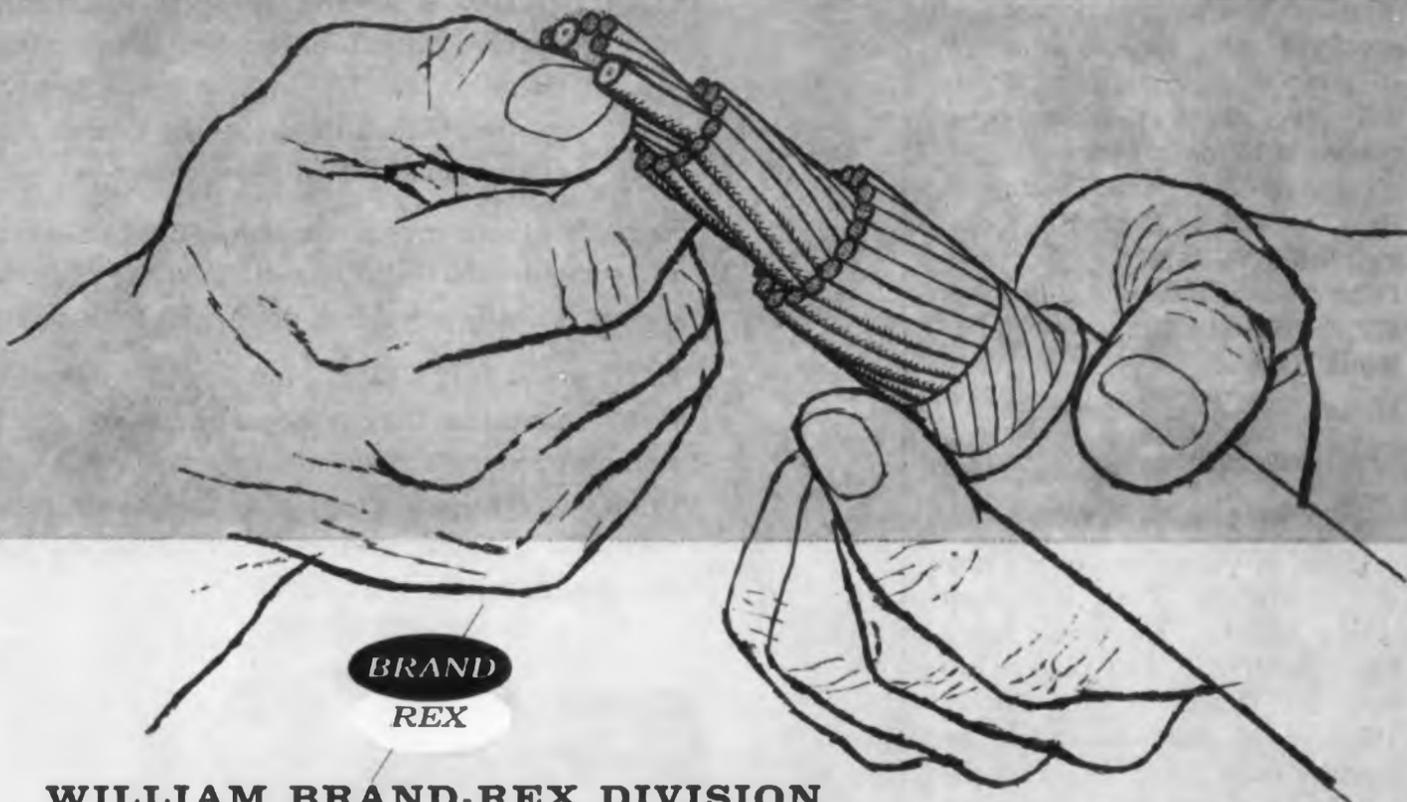
Missilemen, especially, know the advantages of neoprene jacketed cables . . . low temperature flexibility, abrasion resistance, and resiliency. And missilemen who are also cablemen know it pays at the count down to count on Brand-Rex **Cablemanship!** And you should too. For there's more to the absolute reliability of Brand-Rex cables than just rigid inch-for-inch adherence to specifications!

Brand-Rex **Cablemanship** involves technology and skill, of course. But there's much more. Add broad cable engineering services through a tightly-knit organization of progressive cablemen backed by the vast resources of the American ENKA Corporation. Then consider the production capability of three modern quality-controlled plants strategically located from coast to coast. When you include instantly available technical field service . . . then, you have Brand-Rex **Cablemanship!** Then you know why Brand-Rex neoprene jacketed cables have an envied record for absolute reliability.

Whatever your requirements for wire or cable, no matter how rigid your specifications for conductors, lay-up patterns, insulation, shielding or armoring, count on the **Cablemanship** of Brand-Rex. Information and samples available upon request.



Left: Resiliency and low-temp flexibility make Brand-Rex MIL-C-13777B neoprene jacketed cable ideal for missile ground control. **Center:** Polyethylene insulated primaries, neoprene jacketed, positioned in the cable exactly as per spec. **Right:** Brand-Rex quality control procedures cover every step of manufacture.



WILLIAM BRAND-REX DIVISION

American ENKA Corporation

DEPT. NC, 39 SUDBURY ROAD, CONCORD, MASSACHUSETTS

Vinyl, Teflon, Polyethylene, Nylon and Silicone Rubber Wires and Cables
Electrical Tubing and Sleeving — UHF Cast Plastics — Plastic Extrusions

See us at the
Wescon Show
Booth 223

CIRCLE 104 ON READER-SERVICE CARD

NEW PRODUCTS

AT WESCON

Preformed Solder 428

For automated assembly

These Solderforms consist of solder and flux shaped into washers, discs, coils or any other configuration desired. They are suited for automated assembly of transistors, diodes and other electronic devices.

Kester Solder Co., Dept. ED, 4201 Wrightwood Ave., Chicago 39, Ill.

Booth 320.

Glass-Ceramic Cement 426

Thermal expansion matches glass

Pyroceram cement No. 89 is designed to seal glasses and other materials with thermal expansions between 80 and 92×10^{-7} cm per cm per deg C. Electrical properties are similar to those of Pyroceram cement No. 95. The cement fires at about 450 C, and the resulting seal is serviceable up to about 425 C. The cement also seals metals and ceramics. The cement is a finely powdered glass applied in a low viscosity vehicle. Upon firing, it partially crystallizes, resulting in a vacuum tight, devitrified seal.

Corning Glass Works, Industrial Bulb Sales Dept., Dept. ED, Corning, N.Y.

Price & Availability: A 1-lb kit is \$12.50; 5 lb are \$58.

Booth 853-854.

Oscilloscope 427

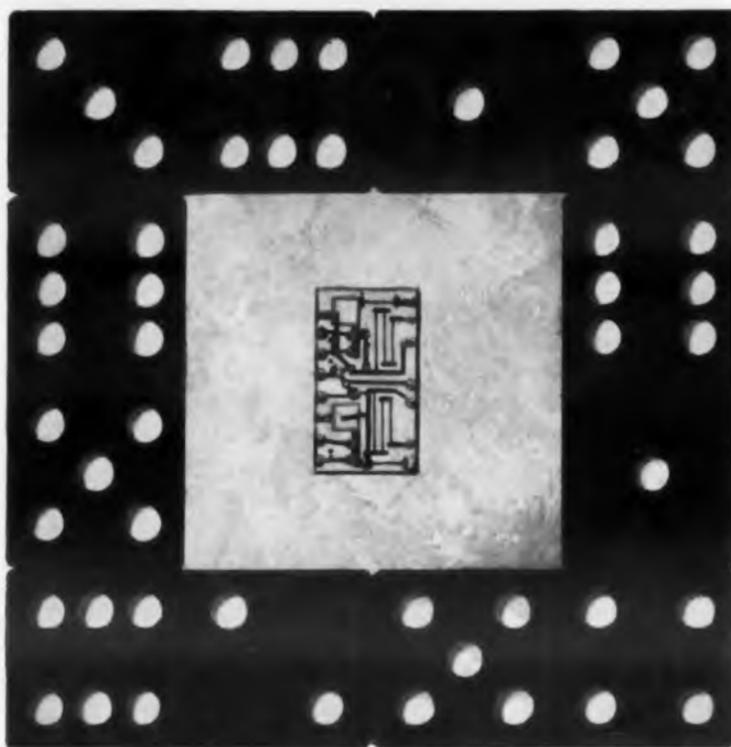
Range is to 30 mc

Model 170A oscilloscope is a rugged, militarized 30-mc instrument with a 5-in. crt. The device has a beam finder and dual plug-in system. An attachable unit, Model 166D sweep delay generator, delays the main sweep to permit detailed examination of a complex signal or pulse train.

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

Booth 651-652-653-654.

FROM LABORATORY CURIOSITY TO MISSILE TRAJECTORY...



MICROELECTRONIC GRAY MATTER FORM

TOMORROW'S air and sea launched ballistic missiles will fulfill a pivotal role in the nation's retaliatory arsenal. Directing their flight will be revolutionary guidance computers, miniaturized to a point far beyond the limit of conventional design techniques.

But before this degree of miniaturization can be achieved in a computer *that must be more than a laboratory curiosity* a radically new design philosophy must be applied.

Engineers at G.E.'s Light Military Electronics Department are meeting the challenges of size and sophistication by pursuing a predominantly *functional* approach to micro-electronics...exploiting the versatility of tunnel diodes and other semiconductors in conjunction with thin film circuit wafers.

And by designing for microminiaturization from the start, not only is it feasible to achieve far greater component densities—the development of standardized circuits and functional modules also reduces the numbers of components and connection interfaces, significantly enhancing predicted reliability.



OR MISSILE GUIDANCE

Electronics engineers with experience and interest in this burgeoning field are invited to write informally for additional technical data or information on specific professional opportunities.

Address inquiries to Mr. R. Bach, Department 76-MH.

LMED

LIGHT MILITARY ELECTRONICS DEPARTMENT

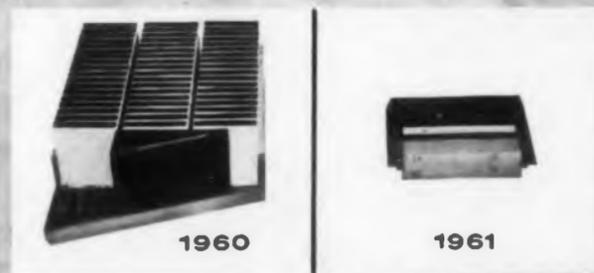
GENERAL ELECTRIC

FRENCH ROAD, UTICA, NEW YORK



"FRATERNAL TWINS"

The unit at left represents a missile-borne computer developed by Light Military and miniaturized by conventional techniques to near the limit of 1960's state of the art. The 1961 experimental model along side (providing equivalent function) will be designed for microelectronics employing LMED's thin film wafers in modular construction. It is about 1/20th the size of its "fraternal twin."



IF Transformer 361

For use with a balanced mixer

Type 1502 if transformer, for use with DB-665 balanced mixers, is designed to match the push-pull output of a balanced mixer to the single-ended input of an if amplifier. The unit permits the amplifier to be located remotely. Output is matched to a 50-ohm coaxial transmission line.

DeMornay-Bonardi, Dept. ED, 780 Arroyo Parkway, Pasadena, Calif.

Price & Availability: \$138 to \$154; from stock.

Booth 2214-2215.

Subcarrier Oscillator 364

Linearity is 0.1% of bandwidth

Model 10087 subcarrier oscillator has a linearity of 0.1% of bandwidth. Frequency and sensitivity stability are within 0.3% over the temperature range of 0 to 85 C and 0.6% over the temperature range of -18 to +100 C. Made to IRIG standards, the unit is available for channels 8 through 18 and A through E. Configuration, size, and weight, are similar to model 10077.

Hoover Electronics Co., Dept. ED, 110 W. Timonium Road, Timonium, Md.

Booth 2822.

DC Power Supply 418

For laboratory, circuit development work

The Model P60-1 power supply provides continuously adjustable outputs of 0 to 6, 0 to 30 and 0 to 60 v dc at 1 amp. The supply, designed for laboratory and circuit development work, is unregulated. A three-scale voltmeter is located on the front panel. Ripple is 0.5%. Several units can be stacked on top of one another.

Consolidated Avionics Corp., Dept. ED, 800 Shames Drive, Westbury, N. Y.

Price & Availability: Units, available from stock, are \$95.00.

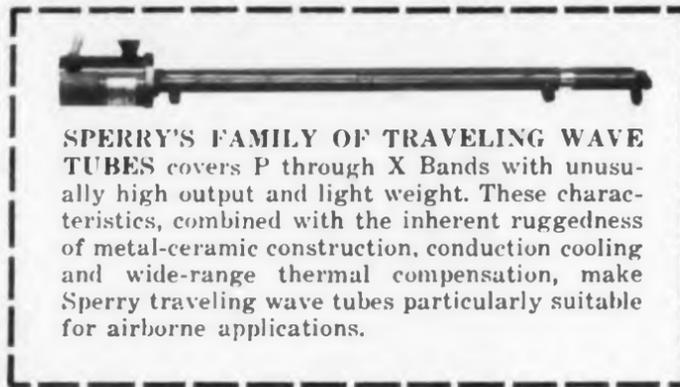
Booth 2255.

◀ CIRCLE 912 ON CAREER INQUIRY FORM, PAGE 233

TIME means both money and reputation to system builders. To help customers save both, over 10,200 klystron and traveling wave tubes have been shipped **ON TIME** from Sperry's Gainesville, Florida plant. If prompt tube delivery is vital to your system, call Gainesville, FRanklin 2-0411 collect, for full information about Sperry capabilities.



Gainesville, Florida • A Division of Sperry Rand Corporation



NEW PRODUCTS

AT WESCON

Coil Winding Machine 417

Handles coils from 0.065 in. ID

Model S Toroyd coil winding machine will handle a full range of wire sizes. It will wind coils measuring from 0.065 in. ID to 5.25 in. OD at 1600 rpm. The machine does both random and precision winding. Set-up and change-over time is rapid. The instrument will operate in conjunction with Model 1C-601 inductance comparator to wind precise inductances.

Electrical Specialty Co., Dept. ED, 2820 E. 12th St., Los Angeles 23, Calif.

Availability: Delivery is 4 to 6 weeks.

Booth 308.

Vacuum Gage 431

Range is 10 to 200 mm Hg

Model SP-3 vacuum gage gives direct-reading pressure measurements over a range of 10 to 200 mm Hg. The instrument is unaffected by atmospheric changes. A noble-metal thermopile and nickel-plated tube assure freedom from outgassing, system contamination, corrosion and rust. Applications include impregnation and vacuum drying. Models capable of monitoring up to five positions are available.

Hastings-Raydist Inc., Dept. ED, Hampton, Va.

Booth 705.

Rack-Mounting Oscilloscope 434

Range is dc to 450 kc

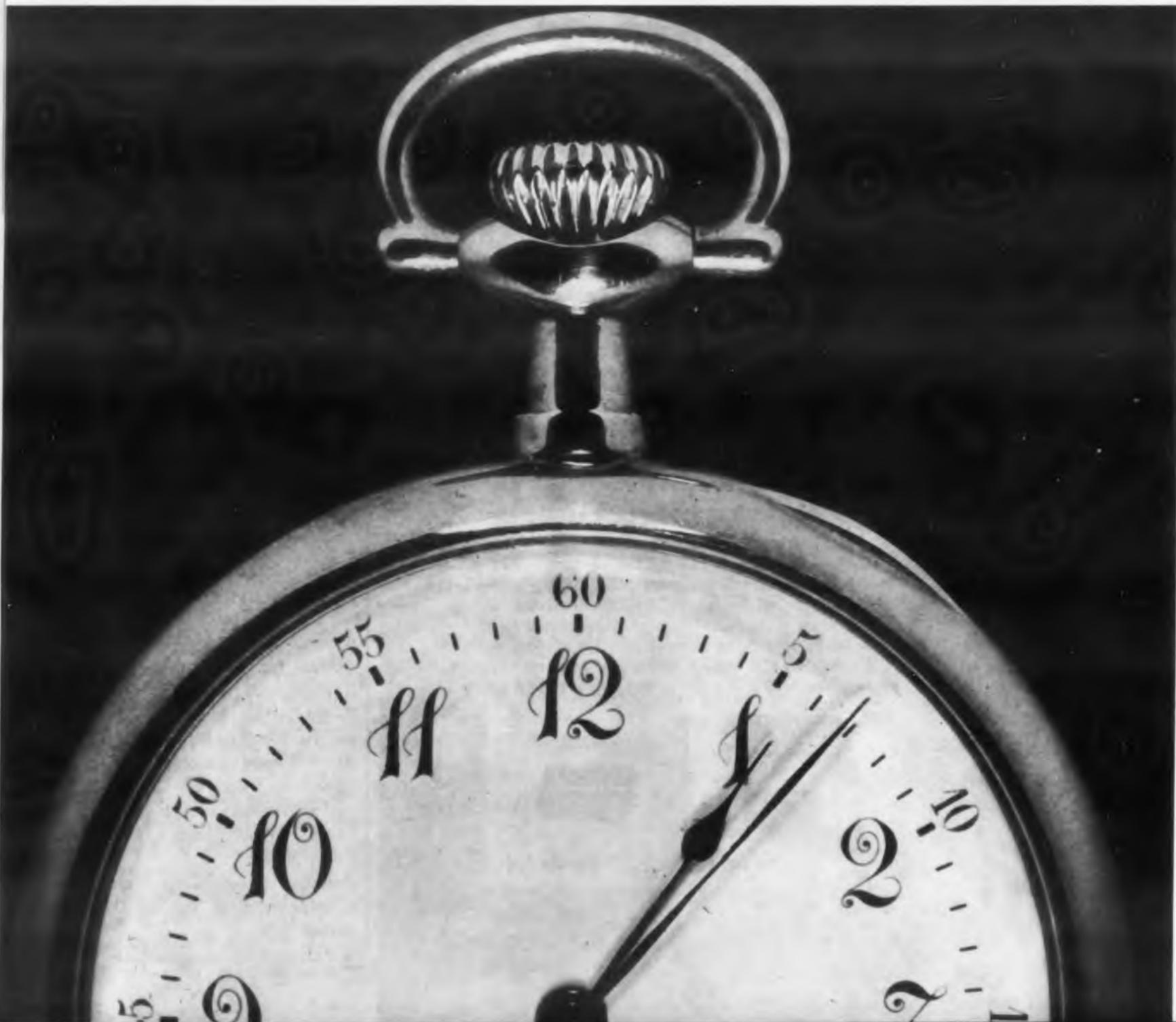
The Model RM503 oscilloscope is a rack-mounting version of the Model 503 unit. Sensitivity of the instrument is 1 mv per cm; range is dc to 450 kc in 14 calibrated steps. The unit measures 7 x 19 x 16-1/2 in.

Tektronix, Inc., Dept. ED, P.O. Box 500, Beaverton, Ore.

Price: Model RM503 oscilloscope is \$640.

Booth 817-818.

◀ CIRCLE 105 ON READER-SERVICE CARD



Hermaphroditic Connectors 436

Have snap-in contacts

The MH Series connectors have hermaphrodite contacts and insulators that fit both plugs and receptacles. Contacts are snap-in, crimp type. The plugs are designed for commercial applications such as business machines, computers and communications equipment.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

Booth 2836-2837.

Resistance Measuring System 379

For precision production testing

Model 242 resistance measuring system consists of a Model 240-R Kelvin ratio bridge, an RS-925 decade resistance standard and a Model 800-R generator-detector, all housed in a 29.5 x 19.5 x 15.1 in. metal cabinet. Direct resistance can be measured to within 0.01%, and like resistors can be compared to 1 ppm. Model 241 resistance comparison system is similar, but without the resistance decade standard.

Electro Scientific Industries, Inc., Dept. ED, 7524 S. W. Macadam Ave., Portland 19, Ore.

Price & Availability: Prices are: Model 242, \$3400, Model 241, \$2300, both job Portland. Availability is 60 days.

Booth 649-650.

High-Vacuum Diode 437

For rectifier and surge limiter uses

Type 8020W high-vacuum diode tube has rectifier or surge-limiting industrial applications. It has a graphite anode for cool operation, a non-frangible filament, a large circumference, kovar-top, cap seal and dual getter traps.

United Electronics Co., Dept. ED, Newark, N.J.

Price & Availability: The tube is priced at \$28.50, available from stock.

Booth 2501-2502.

194 styles in stock for immediate delivery



For that precision engineered look—specify Raytheon knobs



You'll see Raytheon control knobs on the finest precision instrument panels everywhere. There are nine types in six sizes—tactile shapes, color and color caps—plus hundreds of modifications on special order. All standard knobs are available in either high-gloss mirror or non-reflective matte finish. All conform to MS91528A; tactile shapes to Navy drawing RE10F651A.

... SEND TODAY FOR FACT-FILLED FOLDER on Raytheon control knobs, electrical components and panel hardware. Address Raytheon Company, Department 6836E, Newton, Massachusetts.



RAYTHEON COMPANY
Industrial Components Division
66 Chapel Street, Newton, Mass.

Excellence in Electronics



Expert Night Pilot. In certain smaller types of bats, their amazingly precise echolocation enables perfect navigation and hunting of insects. Although the natural sonar system of bats is the smallest known, ounce for ounce and watt for watt it is billions of times more efficient than any sonar equipment that has ever been made by man.



Tiny Control Center. Synchronous at 24,000 r.p.m. in less than five seconds — using overvoltage techniques — this 2 oz., subminiature floated rate gyro assures stable, precise flight control of missiles, special weapons and space vehicles. MPB bearings on critical main shaft help assure accuracy under 150 G's of shock and 30 G's vibration to 2000 cps on any axis.



Man With Miracles. Friction, inertia, and today's ever-shrinking component space provide an exciting challenge to MPB Sales Engineer, Gene Burrichter. Working closely with engineers and scientists he constantly helps solve miniaturization problems throughout industry. MPB Sales Engineers are ready to give you similar assistance.

Miracles in Miniaturization

ACTUAL SIZE OF THE MPB BEARINGS
IN SUBMINIATURE GYRO SHOWN ABOVE

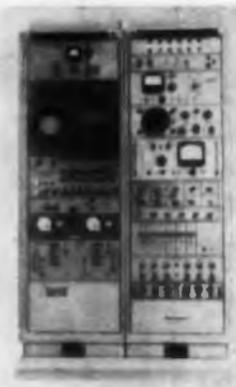
In modern miniaturization many components have become so small they can hardly be seen. Yet they keep on doing as much work — or more — and getting closer to their designers' objectives. To engineers with new projects in this rapidly widening field, MPB's unequalled research facilities offer opportunities for highly effective teamwork. For details, and for a catalog on MPB bearings, the world's largest line, write to **Miniature Precision Bearings, Inc.**, 908 Precision Park, Keene, N. H.

MPB Helps you perform
miracles in miniaturization

CIRCLE 107 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON Vibration Control System

521



Works with any
amplifier-shaker

Model 1011 random vibration control system applies and controls random vibration. It is compatible with any power amplifier and electrodynamic shaker combination. Test specifications can be matched closely in minutes. Continuous monitoring of shaker output performance indicates any change during tests. A mix of two signals may be varied while test is in progress. The output may be tape recorded.

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

Price & Availability: Units are priced at \$18,750 and are available from stock.

Booth 842-843.

Wet-Anode Tantalum Capacitors

473



For airborne and
missile application

These M-type wet-anode tantalum capacitors provide ranges from 1.75 to 330 μ f in voltages up to 125 v dc. Units are compact and designed to withstand rugged service with a 2000-hr life at a maximum temperature of 85 C. Capacitors are available in three case sizes.

ITT Components Div., International Telephone and Telegraph Corp., Dept. ED, 815 San Antonio Road, Palo Alto, Calif.
Booth 2044-2045.

DC Power Supply

522



Regulates either current or voltage

The Model 4005 transistorized dc power supply may be operated as a constant-voltage source, a constant-current source, a constant-voltage source with automatic current limiting, or a constant-current source with automatic voltage limiting. The range of 1 to 40 v at 0 to 500 ma is covered. Regulation is better than 0.05%. Ripple is less than 500 μ v or 25 μ a. The unit measures 5-3/4 x 8-5/8 x 11-3/4 in. Panel adapters are available for rack mounting.

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

Price: \$143.50 fob Westbury.
Booth 2305.

Silver-Zinc Battery

523



Discharges at 250 amp for 1 min

The Model P-3001 Silvercel silver-zinc battery for missile applications has a nominal capacity of 4 amp-hr. It can be discharged continuously at 250 amp at 25 v for 1 min, or pulsed at currents up to 1500 amp. The unit, designed for flight control systems, telemetering and guidance, is automatically activated in 1/2 sec and has a dry shell life of 5 yr. The battery measures 4 x 6 x 10 in. and weighs 15 lb.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York, N.Y.

Availability: Units can be delivered in 90 days.
Booth 551.

DRESSEN-BARNES

BOOTH 1011

WESCON PREVIEW

25 TRANSISTORIZED AND VACUUM TUBE LABORATORY DC POWER SUPPLIES



NEW! REGULATED LABORATORY DC POWER SUPPLIES are available in many combinations of output voltage and current: from 0 up to 1000 volts; 100 milliamperes up to 15 amperes. A large number of unregulated supplies are also available.

40 MIL-SPEC OR BEST-COMMERCIAL-PRACTICE TRANSISTORIZED OR VACUUM TUBE MODULAR DC POWER SUPPLIES



NEW! REGULATED MIL-SPEC or BEST-COMMERCIAL-PRACTICE MODULAR DC POWER SUPPLIES are available in many combinations of output voltage and current: from 5 up to 500 volts; 15 milliamperes up to 6 amperes. Unregulated, but voltage adjustable, supplies are also available: 28 volts at 2, 5, or 10 amperes. All supplies can be connected in series for higher output voltages.

A TYPICAL D/B RACK MOUNTING KIT FOR MODULAR DC POWER SUPPLIES

TRANSISTORIZED MODULE

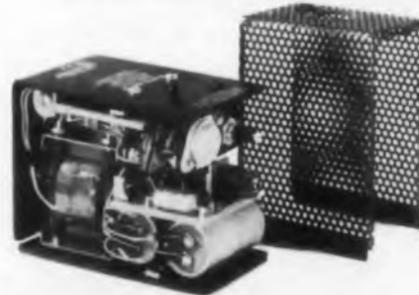
MAGAMP MODULE



VACUUM TUBE MODULE

NEW! STANDARD 19 INCH RACK MOUNTING KITS will accommodate up to six modules. These kits are ideal for the multiple output combinations often required. Kits are also available for sale separately. Kits are available with 5 1/4 inch, 7 inch, and 8 3/4 inch high panels. Other versions are available for mounting a single or two modules when this is all that is required. Meters, switches, pilot lights, remote sensing, etc., can be provided as required.

26 COMPACT TRANSISTORIZED LIMITED-RANGE DC POWER SUPPLIES



NEW! TRANSISTORIZED MODULES SPECIALLY PACKAGED TO PROVIDE PROPER HEAT DISSIPATION. These modules are completely repairable. Output ratings start at 2 volts at 750 MA and are available up to 55 volts at 200 MA. The modules may be connected in series for higher voltage requirements. Extended voltage ranges also available. All units have these features: external voltage adjust, fuse, choice of octal plug or solder terminals, removable vented case, and heat sinks. All units are short-circuit proof.

SIZE OF ALL UNITS:

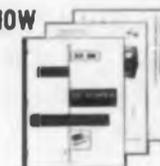
2 3/4" x 3 3/4" x 5"

DRESSEN-BARNES CORP.

250 NORTH WINDS ROAD, FAIRFAX, CALIFORNIA 94533

SEND FOR YOUR WESCON LITERATURE NOW

- QUICK REFERENCE CHARTS
- 1960 CATALOG
- DATA SHEETS ON NEW MODULES



CIRCLE 108 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Photomultipliers

460



Sensitive to visible light

Types CL-1002 and CL-1003 photomultiplier tubes are 10 stage end-on units sensitive to visible light. The tubes have 2 in. and 3 in. diameters respectively. Plano-concave faceplates and curved-surface photocathodes provide a very short, transit time spread. The tubes are designed to withstand shock and vibration.

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

Price & Availability: Tubes, available from stock, are priced at \$55 for the CL-1002 and \$115 for the CL-1003.

Booth 2523.

Transistor Noise Analyzer

526



Measures at 100, 1000 and 10,000 cps

The Model 310 transistor noise analyzer measures the noise inherent in transistors at three separate frequencies simultaneously: 100, 1000 and 10,000 cps. The low-frequency bandpasses measure $1/f$, or fluctuation noise; and the higher frequency bandpass measures "shot" noise. The system automatically corrects for variation in transistor gain. The instrument can be supplied with a 1,000-cycle filter only for MIL checks.

Quan-Tech Laboratories, Dept. ED, Boonton, N.J.

Price & Availability: Unit with three filters, \$1,800; unit with 1,000-cps filter only, \$1,450. Delivery is about 10 weeks.

Booth 1029.

NEW FROM FXR

the Latest in Precision Microwave Components



FERRITE ISOLATOR Model X176

- Waveguide Sizes from 3.95 to 26.0 KMc.
- Coax from 2.0 to 4.0 KMc.
- Full bandwidth operation.
- Isolation 10 to 30 db depending on frequency range.
- Insertion loss 1 db max.
- VSWR 1.15 max. waveguide; 1.2 max. coax.

"Promises may get thee friends; but non-performance will turn them into enemies."

Ben Franklin

The growth of FXR in the microwave industry is ample proof that product performance has fully supported product promises.

This holds true for the specifications of these fine new components, which represent the latest advances in their respective types.

Prompt deliveries are also a promise.



FIXED COAXIAL ATTENUATORS

Model 180

- Operation from 1 — 12.4 KMc. (2 to 12.4 KMc for 20 db)
- Attenuation Values 3, 6, 10, 20 db.
- Low VSWR and frequency sensitivity.
- Type N connectors.

STANDARD STEP ATTENUATOR Model X176

- Step loss (by pushing rod) 40 db.
- Calibration and frequency sensitivity ± 0.4 db max.
- Full waveguide operation from 8.2 to 12.4 KMc.
- Stability dependent only on coupling through holes in waveguide.
- VSWR 1.1 max.
- Insertion loss 0.5 db max.



DLATO
Model
5.0 KMc.

ing on

2 max. c



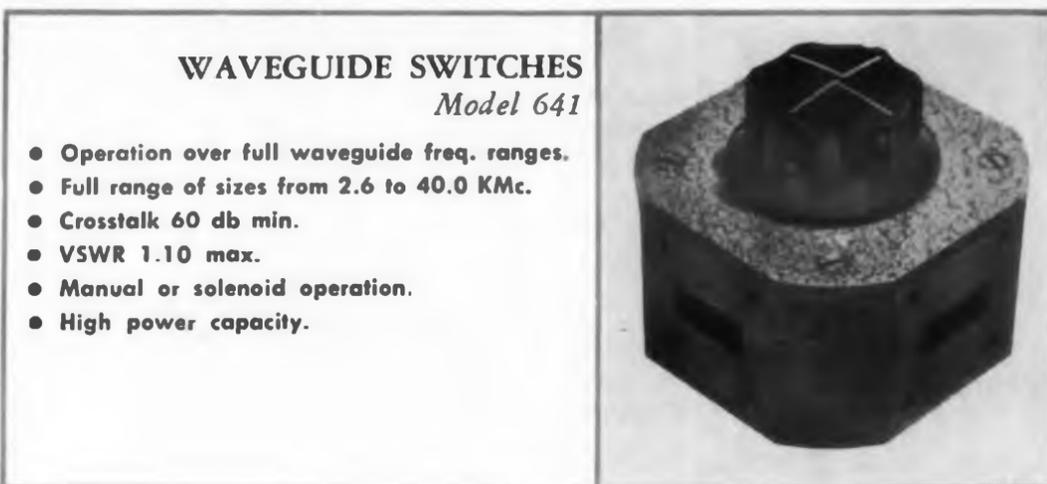
COAXIAL BROADBAND BIDIRECTIONAL COUPLERS Model 616 and 617

Operation over a two octave freq. range.
Model 616 — 250 to 1000 Mc.
617 — 1000 to 4000 Mc.
Coupling 20 db, frequency sensitivity
± 1.5 db.
Directivity 20 db min.
Attached individual calibration curves.



FIXED PRECISION ATTENUATORS Model 175

- Operation over full waveguide frequency ranges.
- Full range of sizes from 2.6 to 40 KMc.
- Stability dependent only on locked mechanical setting.
- Frequency sensitivity ± 0.3 db to 20 db.
 ± 0.5 db 20 to 30 db.
- VSWR 1.15 max.
- Factory set values from 0.5 to 30 db.



WAVEGUIDE SWITCHES Model 641

- Operation over full waveguide freq. ranges.
- Full range of sizes from 2.6 to 40.0 KMc.
- Crosstalk 60 db min.
- VSWR 1.10 max.
- Manual or solenoid operation.
- High power capacity.

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FXR at the WESCON SHOW

Precision Microwave Equipment • High-Power Modulators • Radar Components • Electronic Test Equipment

CIRCLE 109 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

Time Code Generator

533

Frequency stability is 3 parts in 10^8



The Model ZA-802 time code generator supplies either a 17-bit binary coded time signal produced each second or a slow rate 13-bit signal produced each 15 sec at a 1 pps rate. Both codes indicate hours, minutes and seconds. Frequency stability of the instrument is three parts in 10^8 , or 1 sec per month. An external frequency standard may be substituted for the internal crystal oscillator. A 1 pps signal is available for comparison with WWV time ticks. The unit occupies 7 in. of standard 19-in. rack space. Depth is 17 in. Construction is all solid state.

Electronic Engineering Co. of Calif., Dept. ED,
1601 E. Chestnut Ave., Santa Ana, Calif.
Price: \$7,050 fob Santa Ana.
Booth 2527-2528.

Non-Magnetic Latching Relays 532

Mechanically locks in position



Type A-2A relay is a non-magnetic latching unit that mechanically locks in either the open or closed position, and requires a new command pulse before it can be reactivated. Contacts are plug-in type, assuring contact under extreme conditions and permitting loads up to 20 amp at 26.5 v dc. Energizing current is 0.25 amp at 18 to 32 v dc.

Mitchell Camera Corp., Astromics Div., Dept. ED, 611 W. Harvard St., Glendale, Calif.
Price & Availability: Units will be in stock by September 1, 1960; price is \$48.50 for less than 50 units, \$34 for over 50.
Booth 838A.

The future ...
from your
point of view

A good day's growth for a hard
day's work.

A position to suit your talents,
experience and ambition.

Opportunity to exercise full
initiative in Research,
Radar, Doppler Naviga-
tional Systems, Magnetic
Memory Systems, Micro-
wave and Computers.



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Management awareness encouraging exploration beyond the
range of present knowledge.

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Radar Circuitry

Experience and state-of-the-art knowledge in one or more
of these: oscillators, cw or pulse modulators, video, IF or
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supplies, pulse coders and decoders, phase detectors, MTI
cancellers. Projects include: R&D of advanced techniques;
ground, airborne, space equipment.

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Advanced degree in physics or engineering physics, plus
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For confidential discussion, please write:

Eugene Rust
Laboratory for Electronics
75 Pitts Street, Boston 14, Massachusetts



Laboratory for Electronics

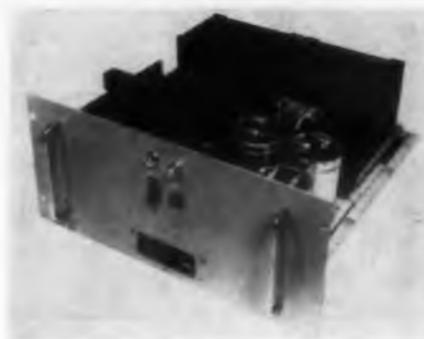
CIRCLE 913 ON CAREER INQUIRY FORM, PAGE 233

NEW PRODUCTS AT WESCON

DC Power Supply

541

Rated up to 10 amp



This power supply can be made for any dc
voltage output, up to 3 kw power, at 10 amp.
Regulation is within 0.6% for changes of $\pm 10\%$
line voltage, 0 to full load current, 0 to 50 C.
Noise and ripple is 0.3%. Response time is 25
msec with 50% change in load. Unit has overload
protection. It measures 19 x 8-3/4 x 20 in., is
designed for rack frame, or drawer mounting,
and weighs 150 lb.

North Electric Co., Electronics Div., Dept.
ED, Galion, Ohio.

*Price & Availability: Units are made to consumer
requirements, can be delivered in 60 to 90 days,
and are about \$630.*

Booth 2612-2613.

Electronic Timer and Counter 456

Operates to 10 mc



The Model 7370 universal timer is a 10-mc in-
strument capable of performing as a high-speed
counter, as an events-per-unit-time or as a time
interval meter. Time intervals from 0.3 μ sec to
10 million sec, 116 days, can be measured. The
output is displayed on a seven-place readout
panel; binary-coded output is provided for digital
recording equipment. Used in conjunction with a
computing transfer oscillator, the instrument will
measure frequencies to 21,000 mc.

Berkeley Div., Beckman Instruments, Inc.,
Dept. ED, 2200 Wright Ave., Richmond 3, Calif.

Price: The instrument is priced at \$1975.

Booth 2514-2515.

Voltage Regulator and Power Supply Users:
**RAYTHEON ESTABLISHES
PROGRAM 2020**

**MATCH YOUR REQUIREMENTS
FROM AMONG THESE 2,020
STANDARD RAYTHEON REGULATORS**

The general design features of each model are described in the accompanying text. For more detailed information, see the Selection Guide included in this advertisement. It is available for free on request.

The general design features of each model are described in the accompanying text. For more detailed information, see the Selection Guide included in this advertisement. It is available for free on request.

HOW TO USE THE SELECTION GUIDE

Column numbers in brackets indicate the number of units available in each category. For more detailed information, see the Selection Guide included in this advertisement. It is available for free on request.

STEP 1

1. Determine the required output voltage and current. For more detailed information, see the Selection Guide included in this advertisement. It is available for free on request.

STEP 2

2. Determine the required input voltage and current. For more detailed information, see the Selection Guide included in this advertisement. It is available for free on request.

STEP 3

3. Select the appropriate model from the Selection Guide. For more detailed information, see the Selection Guide included in this advertisement. It is available for free on request.

STEP 4

4. Verify the selected model meets all requirements. For more detailed information, see the Selection Guide included in this advertisement. It is available for free on request.

**±1% Line Voltage
Regulators**

Output voltage constant to ±1% over the full range of input voltage. For more detailed information, see the Selection Guide included in this advertisement. It is available for free on request.

**±1% Filament Voltage
Regulators**

Output voltage constant to ±1% over the full range of input voltage. For more detailed information, see the Selection Guide included in this advertisement. It is available for free on request.

**±1% Power Supply
Voltage Regulators**

Output voltage constant to ±1% over the full range of input voltage. For more detailed information, see the Selection Guide included in this advertisement. It is available for free on request.

**RAYTHEON VOLTAGE REGULATORS
STANDARD MODEL SELECTION GUIDE
LINE VOLTAGE REGULATORS**

Output Voltage (V)	Output Current (A)	Model No.	Output Voltage (V)	Output Current (A)	Model No.
117	50	101	250	10	101
117	50	102	250	10	102
117	50	103	250	10	103

FILAMENT VOLTAGE REGULATORS

Output Voltage (V)	Output Current (A)	Model No.	Output Voltage (V)	Output Current (A)	Model No.
5.0	0.5	104	5.0	0.5	104
5.0	0.5	105	5.0	0.5	105
5.0	0.5	106	5.0	0.5	106

POWER SUPPLY VOLTAGE REGULATORS

Output Voltage (V)	Output Current (A)	Model No.	Output Voltage (V)	Output Current (A)	Model No.
150	0.5	107	150	0.5	107
150	0.5	108	150	0.5	108
150	0.5	109	150	0.5	109



NEW RAYTHEON STANDARD VOLTAGE REGULATOR MODELS INCLUDE COMPONENT STYLE UNITS WITH EXTERNAL CAPACITORS FOR CONVENIENT UPRIGHT OR HORIZONTAL INSTALLATION ON ELECTRONIC EQUIPMENT CHASSIS • APPARATUS STYLE UNITS FOR USE WHERE A COMPLETELY SELF-CONTAINED INSTALLATION IS DESIRED • OPEN STYLE UNITS (WITHOUT END BELLS) • CORD AND RECEPTICAL PLATE FOR LINE APPLICATIONS...REGULATOR SELECTION GUIDE LETS YOU CHOOSE FROM 2,020 DIFFERENT UNITS.

Now, Raytheon provides 2,020 standard magnetic voltage regulator models for AC loads and DC power supply applications with easier selection, faster delivery, lower cost.

It's the easiest, most economical way yet devised to assure you of exactly the voltage regulator you need.

Raytheon's Regulator Selection Guide provides a simple, reliable means of selecting input and output voltages, volt-ampere rating and type of mounting. By using the Guide included in the new Raytheon voltage regulator catalog you can quickly determine size, weight and other pertinent data to aid you in selecting the unit that best suits your requirements. Your selection is made from 2,020 standard voltage regulator models, all available for prompt delivery.

In addition to their use in countless AC appli-

cations, these new regulators provide many significant advantages for the DC power supply designer. Using the Selection Guide, he can readily select the appropriate regulator model directly on the basis of DC output voltage and power requirements.

An extremely wide range of AC voltage ratings is available from 2.3 to 1,055 volts and up to 10,000 volt amperes. Regulation on all models is ± 1% for line voltage variations of ± 15%.

Fill in the coupon and receive your copy of our VOLTAGE REGULATOR SELECTION GUIDE AND CATALOG No. 4-265.

**CHECK THESE BENEFITS OF
NEW RAYTHEON VOLTAGE REGULATORS**

- Lower prices and prompt delivery of 2,020 standard models
- Isolated secondaries on all models
- Negligible external field
- Output stabilization to ± 1%
- No tubes or moving parts to service
- Self protecting against short circuits and surges



Excellence in Electronics

RAYTHEON COMPANY
Power Supply & Voltage Regulator Operations
Keeler Avenue, South Norwalk, Connecticut

SEE US AT THE WESCON SHOW—Booth 2020

Raytheon voltage regulators are also available from your local Raytheon distributor

CIRCLE 110 ON READER-SERVICE CARD

RAYTHEON COMPANY
Power Supply & Voltage Regulator Operations
Keeler Avenue, South Norwalk, Connecticut

Gentlemen:

Please send by return mail my copy of Raytheon's
VOLTAGE REGULATOR SELECTION GUIDE & CATALOG.

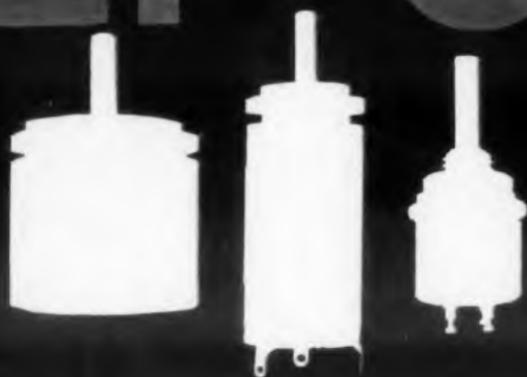
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Title _____

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HIGH PRECISION, SUBMINIATURE POTENTIOMETERS FOR MISSILES AND AIRCRAFT...

FOR EXTREME PRECISION IN MINUTE PACKAGE... single-turn potentiometers are available that provide maximum reliability and precision in units from 25% to 40% smaller than competitive models... the world's smallest ten-turn pot is also available in this line.

FOR STABILITY OVER EXTREME TEMPERATURE RANGE... a series of high-temperature, high-performance potentiometers, weighing less than ten grams, easily withstands the environmental rigors of airborne applications... operating ranges up to +250°C.

FOR GREATER FLEXIBILITY AND RELIABILITY... a series of high-precision, subminiature potentiometers can be readily ganged without the use of bulky clamping rings, and each wiper positions independently to meet any phasing need... the MILPOT line of the highest quality potentiometers is designed to provide maximum reliability and accuracy in rugged environmental applications where space is at a premium.

For full specifications on the complete line of MILPOT potentiometers, write for Data File ED-1114-2.



Series 319 gangable potentiometers

Series 341 multi-turn high precision potentiometers

Model 304 subminiature single-turn potentiometer

DAYSTROM, INCORPORATED
PACIFIC DIVISION
9320 Lincoln Boulevard, Los Angeles 45, Calif.

MILPOT



BIG POT PERFORMANCE from TINY POT PACKAGES



MINIATURE WIRE-WOUND GANGABLE POTS (Model 319) solve many complex phasing, reliability, space and linearity problems. Each ganged section is $\frac{7}{8}$ " x $\frac{1}{4}$ " high and is ganged without clamping rings for exceptional stability. By means of an exterior access opening, each wiper is independently adjustable through 360°. Maximum reliability is ensured by a rugged plastic body, even step linearity, fine resolution, low noise characteristics and long life over a range of 100 ohms to 200K.



SUBMINIATURE TEN-TURN POTS (Model 341) are the smallest ten-turn pots available. Just $\frac{1}{2}$ " x 1", they combine rugged mechanical construction with precise electrical characteristics to withstand severe shock or vibration without loss of stability. Unique "V" guides and spring-loaded rods eliminate backlash. Superior heat dissipation allows power ratings up to 2.5W at 40°C. Wipers on either side of the resistance element provide outstanding resolution from 1K to 600K.

For complete specs on these extraordinary units, contact our Representative in your area, or write for Data File ED-1119-2.

DAYSTROM

PACIFIC DIVISION
9320 LINCOLN BOULEVARD
LOS ANGELES 45, CALIF.
CIRCLE 111 ON READER-SERVICE CARD

← CIRCLE 112 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Miniature Tape Recorder 537

For wideband multi-channel recording



Wideband multi-channel recording under rugged environmental conditions is the primary application for the Model PMR-300 tape recorder. The unit measures 10 x 6 x 4-1/2 in., weighs 4-3/4 lb and requires less than 18 w from a 24-v dc source. Recording bandwidth is 100 kc at 30 ips, and lower speeds with proportionately reduced bandwidth are available. Modular electronic circuits for up to seven channels on 1/2-in. tape are available.

Pacific Electro Magnetics Co., Dept. ED, 942 Commercial St., Palo Alto, Calif.

Price & Availability: Units are made to order, and can be delivered in 90 days. Prices vary from \$3,000 to \$7,000 depending on the number of channels.

Booth 414.

Klystron Tube Mounts 472

For testing and operation



These klystron tube mounts are designed to simplify klystron mounting for tests and operation. Free access to tuning adjustments, forced air cooling and AN type connectors are provided. The mounts are constructed of cast aluminum, and connecting cables for power supplies are available.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, L.I., N.Y.

Price: Mounts for Varian, Sperry, Raytheon and EMI klystrons are \$60, \$85, \$100 and \$125 respectively.

Booth 822-823.

For Government Spec Wire the Leaders Specify

ALPHA electronic WIRE

Alpha offers a complete line of Mil-W-76A Wire from stock for immediate delivery from your local distributor or the factory.

Alpha Military Wire, produced to the highest standards, is used by every major manufacturer engaged in defense projects. Write for your free Alpha Wire catalog

MIL-W-76A

MIL-W-76A	DESCRIPTION (Single conductors)	VOLT RATING	CONDUCTOR SIZE	STOCK COLORS	ALPHA NUMBER
TYPE LW UNCOVERED PLASTIC	stranded tinned copper, light wall thermoplastic insulation. 80°C	300	20-30	*1-10 & *14-22	1685-1690
TYPE LW NYLON JACKET	stranded tinned copper, light wall thermoplastic insulation, clear nylon jacket overall. 80°C	300	20-30	*1-10 & *14-22	1675-1680
TYPE MW UNCOVERED PLASTIC	stranded or solid tinned copper, thermoplastic insulation. 80°C	1000	12-24 (stranded) 16-22 (solid)	*1-30	1550-1567
TYPE MW SHIELDED	stranded tinned copper insulation, tinned copper shield overall. 80°C	1000	12-24	Conductors 16-24 Colors *1-10 Conductors 12-14 Colors *1-3	1350-1356
TYPE MW NYLON JACKET (SHIELDED)	stranded tinned copper, thermoplastic insulation, tinned copper shield overall, jacket over shield. 90°C	1000	16-22	*1	1371-1374
TYPE MW NYLON JACKET	stranded tinned copper, medium wall thermoplastic insulation, clear nylon jacket overall. 90°C	1000	12-22	Conductors 16-22 Colors *1-10 & *14-22 Conductors 12-14 Colors *1-6	1504-1509
TYPE MW GLASS BRAID	stranded tinned copper, thermoplastic insulation, lacquered glass braid overall. 80°C	1000	12-22	Conductors 16-22 Colors *1-19 Conductors 12-14 Colors *1 & *14-22	1590-1595
TYPE MW GLASS BRAID SHIELDED	stranded tinned copper, white thermoplastic insulation, lacquered glass braid tinned copper shield overall. 80°C	1000	12-22	*1	1361-1366
TYPE HW UNCOVERED PLASTIC	stranded tinned copper, heavy wall thermoplastic insulation. 80°C	2500 (22-14) 600 (12-6)	6-22	Conductors 6-16 Colors *1-3 Conductors 18-22 Colors *1-10	1571-1579 & 1561-1567
TYPE HW GLASS BRAID	stranded tinned copper, heavy wall thermoplastic insulation, lacquered glass braid overall. 80°C	600	6-10	*1, 14, 15	1598-1599/6

- | | | | | |
|-------------|---------------------|------------------|-----------------------|------------------------|
| 1. White | 7. Brown | 13. Dark Blue | 19. White/Brown | 25. White/Black/Yellow |
| 2. Black | 8. Orange | 14. White/Black | 20. White/Orange | 26. White/Black/Blue |
| 3. Red | 9. Gray (slate) | 15. White/Red | 21. White/Gray | 27. White/Black/Brown |
| 4. Green | 10. Violet (purple) | 16. White/Green | 22. White/Violet | 28. White/Black/Orange |
| 5. Yellow | 11. Tan | 17. White/Yellow | 23. White/Black/Red | 29. White/Black/Violet |
| 6. Lt. Blue | 12. Pink | 18. White/Blue | 24. White/Black/Green | 30. White/Black/Gray |

*Alpha can create for you over 40,000 military approved striped color combinations.



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.

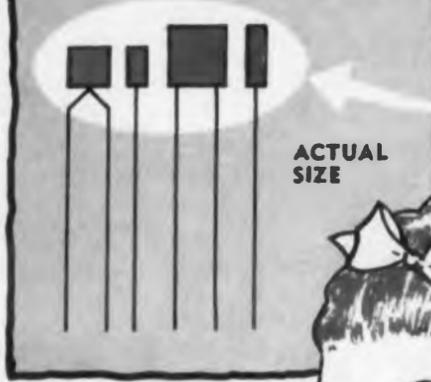
WESCON BOOTH 2617-18

WESCON BOOTH 2617-18

WESCON BOOTH 2617-18

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WEST-CAP's New "Red Head" CERAMIC CAPACITORS



ACTUAL
SIZE

SLIM AND TRIM

SUB-MINIATURES
FOR PRINTED
CIRCUITS AND
CRITICAL SPACE
APPLICATIONS



Extreme stability •
Low dissipation
factor • High insul-
ation resistance •
Operates under
most rigid environ-
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-55°C TO 150°C
200 VOLTS DC

EXCEEDING
MIL-C-11015B /18 /19

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ELECTRIC
MANUFACTURING CO.



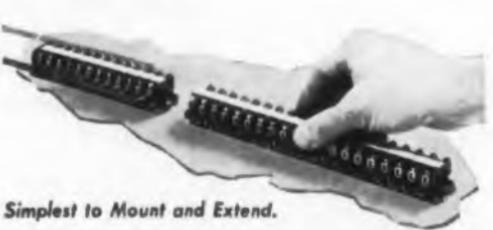
SYMBOL OF QUALITY

Brochure upon request

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CIRCLE 114 ON READER-SERVICE CARD

MD pres-SURE-blocks—DESIGNED for QUICK Assembly and EASY Changes



ANY NUMBER OF CIRCUITS — pre-assembled lengths of 20 snap fit circuits (1-1/8" w. x 63/64" h.). No single pieces to handle, pull off or add circuit groups as needed. Single snap-on end section completes block.

HAND ASSEMBLED without hardware; only 2 parts to handle; use mounting screws only every 12 circuits. Channel mounting also available; integral or separable marking strips.

LARGER CAPACITY IN LESS SPACE—#22 thru #8; conservative 750 volt A.I.E.E. rating ... Choice of contacts (7/16" o.c.) for stripped or terminal-ended wires (can be combined in single block).

LENGTHEN IN SERVICE without removing mounting screws or losing contact space.

USE FEWER CIRCUITS by grouping common wires—decrease jumpering; no unused contacts.



Tubular contacts fully approved by U.I. Blocks fully approved for 600 V by C.S.A.

Write for Bulletin ELD-8

Booth 507
Production Engineering Show
Chicago—Sept. 6-16

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BUCHANAN

ELECTRICAL PRODUCTS CORPORATION
HILLSIDE, NEW JERSEY

CIRCLE 115 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Silicon Rectifiers

536

Handle 45 to 150 amp, and surges of 1000 amp



These Quad-Sealed silicon rectifiers are rated from 45 to 150 amp at 50 to 600 v over a temperature range of -20 to +130 C. They can withstand surge currents of 1000 amp peak. They are recommended for industrial power and battery charging applications. Stud mounted, flat base and reverse polarity types are available.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

Price & Availability: In quantities of 1 to 99, \$6.53 to \$45.60 each. Delivery is from stock. Booth 284.

Digital Modules

470

Transistor and magnetic-core types



These solid-state transistorized modules are rated at medium speeds of 200 kc and high speeds of 3 mc; the magnetic types are rated at medium speeds of 50 kc and high speeds of 100 kc. Transistorized NOR logic modules and high-temperature modules are also available. All modules have 15-pin connectors.

Packard Bell Computer Corp., Dept. ED, 1905 Armacost Ave., Los Angeles 25, Calif.

Price & Availability: Prices range from \$30 to \$200 per unit. Modules can be delivered in 15 to 60 days. Booth 2264.

THIS CARD IS AN ADDED SECRETARY



Like a good secretary, *Electronic Design's* reader service card works quickly and efficiently to obtain the information you request. Cards now bear AIR MAIL pre-paid postage for western areas, but even more important, your requests are forwarded to advertisers within ONE DAY OF RECEIPT. Special pre-typed labels also help to cut down the time required to get the data you want in the mail and on its way back to you.

Another Improved Reader Service
... Only Available in

ELECTRONIC DESIGN
a HAYDEN publication
New York • Chicago • Los Angeles
London

Slip Ring Brush Assembly

579

With low noise level



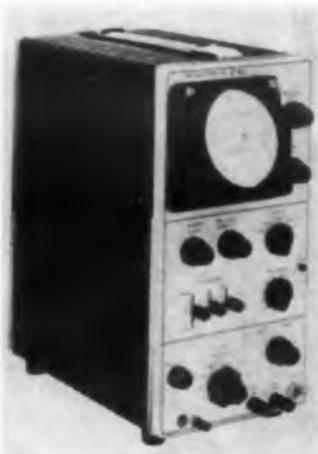
This slip ring brush assembly is manufactured on modular tooling which permits any number of rings from 1 to 32 to be furnished without tooling costs or time delay. The silver graphite brush rides in a rectangular groove on the coin silver ring resulting in reduced noise levels.

Costello & Co., Fabricast, Inc., Dept. ED, 2740 S. La Cienega Blvd., Los Angeles 34, Calif.
Availability: *Delivery time is 10 to 20 days.*
Booth 408.

Portable Oscilloscope

581

Has high writing speed



Model S42 high-writing-speed oscilloscope uses a 4-in. cathode ray tube. Operating at 3.7 kv, it provides a brightness so that a 1- μ sec, single-shot pulse can be seen and photographed. Balanced low-drift amplifiers have a bandwidth of dc to 6 mc up to 100 mv per cm. Gain is 10 mv per mc. Features of the S31 that are retained include time and voltage calibration with built-in square-wave calibrator and automatic sync and selective triggering. Maximum speed is 0.1 μ sec per mc. The unit weighs 18 lb.

The Scopes Co., Inc., Dept. ED, P. O. Box 56, Monsey, N.Y.

Price: \$465.
Booth 2210.



SERIES 1698



SERIES 1522



SERIES 1527



SERIES 1591



SERIES 1806



SERIES 1370



SERIES 1804

*The Name That Counts
in the West...*

Veeder-Root Western



There's now a new meaning to "The Name That Counts" on the West Coast. Veeder-Root has expanded its operations to include engineering, manufacturing, and service facilities from a new plant at Glendale, California.

Veeder-Root/Western represents your best single source for the latest in counting technology and counting devices for all functional designs and applications. Coupled with other Veeder-Root facilities, and the Research and Development headquarters at Hartford, a complete selection, as well as modification of all types of mechanical and electromechanical counters, will now be available to West Coast industry.

See us at Wescon — Booth 956

The staff of Veeder-Root/Western will be on hand to show you the complete line of Veeder-Root Counters. And whatever your Counting and Control requirements, wherever you are, make sure you contact . . . The Name That Counts!

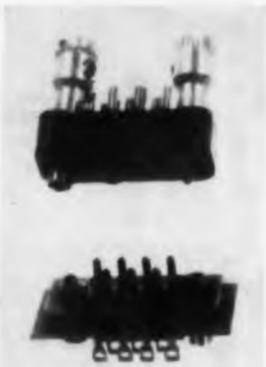
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CIRCLE 69 ON READER-SERVICE CARD

Atlas SUBMINIATURE CONNECTORS



ATLAS subminiature connectors are available in 5, 7, 14, 20, 26, 29, 34, 42, 50 & 75 contacts. A complete line of subminiature connectors is available in any desired combination of guide pins, guide sockets, polarized screw locks, hoods, or protective shells.

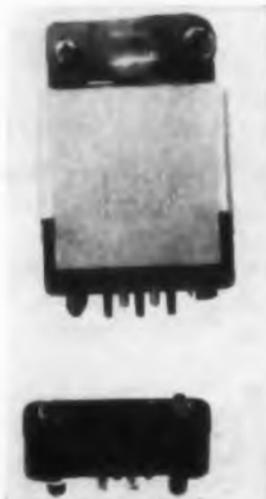
Precision machined phosphor-bronze or beryllium copper contacts with solder cups, tapered, or turret terminations are standard.

Our products meet or surpass all applicable MIL-SPECS.



Voltage Breakdown at Sea Level 1950V. RMS
Current Rating 5 Amps.
Solder Cup #20 AWG Wire

ATLAS CONNECTORS CORPORATION engineers, develops, and manufactures a wide variety of microminiature, subminiature and printed circuit connectors. The precision, reliability, and the soundness of basic design principles are the product of a well integrated staff of capable engineers and skilled labor. You can rely on ATLAS for experience, precision, and strict adherence to early delivery schedules.



ATLAS CONNECTORS CORPORATION
1860 Broadway
New York 23, N.Y.
PLaza 7-1982

CIRCLE 117 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Dual-Synchro Position Indicator 539

Accuracy is ± 0.03 deg

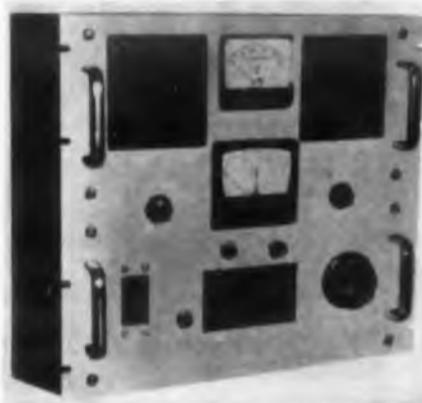


Series IU dual synchro position indicators are designed for accurate, non-ambiguous indication of linear or angular position of transmitter units. The indicators can be read accurately within ± 0.03 deg from a 5-1/4 in. panel mounting. A separate synchro receiver is geared to each pair of concentric dial pointers. Model IU-3 indicator can be reset to zero with respect to an arbitrary reference point; Model IU-6 indicator monitors mechanisms with fixed reference points.

Scientific-Atlanta, Inc., Dept. ED, Atlanta, Ga. Booth 539-540.

DC Power Supply 545

Delivers 50 amp at 36 v dc



The Model HC 36-50 transistorized power supply is rated at 0 to 36 v from 0 to 50 amp dc, and has a line regulation of 0.05% and a load regulation better than 0.1% for 0 to full load changes. Ripple is less than 2 mv. Input power is 208 v, 60 cps, 3-phase, four-wire wye. The bias supply, amplifier and overload circuitry are contained in separate plug-in modules. Dimensions are 17.5 x 20 x 19 in. for rack mounting.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commercial St., Springfield, N.J.

Price & Availability: \$2995 fob Springfield; delivery is 90 days.
Booth 2312.

RF Power Triode 540



Delivers 400 w continuous output

The Type ML-7482 tube is a general purpose, vapor-cooled triode that can deliver a 400 kw continuous output as a class C amplifier or oscillator at 30 mc. It can also deliver 2.5 megawatts as a pulsed rf amplifier and can switch 14 megawatts in a pulse modulator at a relatively long pulse duration. The grid and cathode are ruggedly mounted, coaxially, and have low-inductance, high-conductivity rf terminals.

Machlett Laboratories, Inc., Dept. ED, 1063 Hope St., Springdale, Conn.
Booth 2020.

Cable Connectors 553

Have up to 104 contacts



Series 2500 connectors are available in 14, 26, 34, 50, 75 and 104 contact sizes with removable contacts for No. 14 to 24 AWG wire. Contacts are supplied separately and are wired independently, permitting mounting of connector plug and socket units before wiring is completed. Crimp termination eliminates soldering. Contacts can be removed and replaced quickly without disturbing the connector body. Molding material is glass filled Plaskon Alkyd (MIL-M-14F, type MAI-60) or glass filled Diallyl Phthalate (MIL-M-19833, type GDI-30).

Continental Connector Corp., Dept. ED, 34-63 56th St., Woodside 77, N.Y.
Booth 855.



FOR IMMEDIATE LARGE QUANTITY DELIVERY AT FACTORY PRICES

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.



60 HERRICKS ROAD, MINEOLA, L. I., N. Y.

PIONEER 6-6520, TWX G-CY-NY-880U

CIRCLE 118 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

Bourns Trimpot® Instead of a Fixed Resistor?

Yes, these units meet the same Mil-Specs that fixed resistors meet and give you the added advantage of adjustability! Because of their design and construction, Trimpot potentiometers are virtually unaffected by the most severe shock and environmental conditions—a fact proven repeatedly in major missile and space programs.

Trimpot units offer several kinds of savings. They minimize the need to maintain stocks of close-tolerance resistors—you can adjust to compensate for the variances of fixed components. Production labor costs are cut, too, for Trimpot units eliminate

trial-and-error matching of fixed units to the system. Savings also carry over to maintenance because the technician can adjust equipment quickly in the field—no time and dollars spent to replace components.

Before you specify fixed units, investigate all the advantages offered by Trimpot potentiometers. Over 20 basic models (wire-wound and carbon)—in four terminal types and three mounting styles—are available on short notice from stocking distributors or factory. Get the facts...write for the new Trimpot brochure and list of distributors.



Exclusive manufacturers of Trimpot®, Trimit® and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.



CIRCLE 119 ON READER-SERVICE CARD

CUT COSTS ON BLIND

OR OPEN

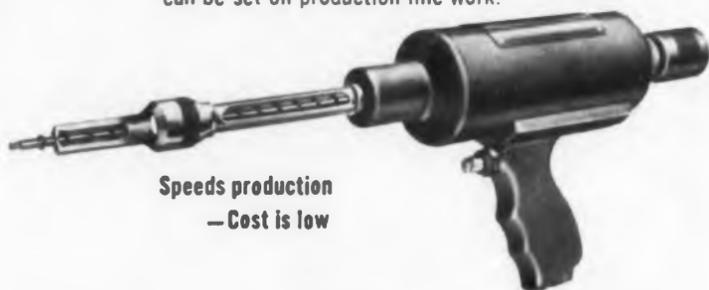
FASTENING

with HIGH SPEED

Chobert®

AUTOMATIC RIVETING

The fastest blind riveting method known... gives uniformly excellent fastening every time. One man, even unskilled, easily completes rivet installation from one side of the work in either open or blind riveting applications in less than 2 seconds. Up to 2000 rivets an hour can be set on production line work.



Speeds production
— Cost is low

EASILY OPERATED...FAST...DEPENDABLE

The Automatic Chobert High Speed Riveting Gun holds a mandrel of up to 65 rivets, each automatically held ready for installation as fast as the operator can position the portable gun. Hand placing and bucking of rivets is eliminated...no finishing is required. Chobert simplifies blind or open fastening on vertical, horizontal or overhead surfaces, even areas normally considered inaccessible.

EVERY RIVET UNIFORMLY SET

Each rivet expands evenly, assuring uniformity of strength and vibration resistance, without distortion or marring sheet metal. Chobert aluminum or mild steel rivets are available in diameters from 3/32" to 1/4".

The Chobert System is successfully used by leading manufacturers of appliances, industrial equipment, electronic components, aircraft, missiles and other sheet metal fastening operations.

WRITE TODAY FOR BULLETIN R-660



AVDEL

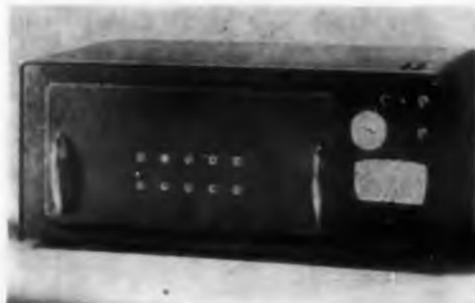
210 SOUTH VICTORY BOULEVARD • BURBANK, CALIFORNIA

CIRCLE 120 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Portable Temperature Chambers 542

Temperatures maintained within ± 0.2 F



The Series 1060 portable temperature chambers maintain temperatures within ± 0.2 F from -100 to $+500$ F. Control is accomplished by a meter-relay and copper-constantin thermocouple. Cooling is by liquid and solid CO_2 , and heating is by 650-w electric elements. A centrifugal blower assures temperature uniformity throughout the chamber. A rack mounted model, two bench models with test volumes of 10 x 7 x 7 in., and a wide-drawer model with a test volume of 16 x 7 x 7 in. are available.

Delta Design, Inc., Dept. ED, 7460 Girard Ave., La Jolla, Calif.

Price & Availability: Units are available from stock and are priced from \$585 to \$720. Booth 2621.

Wire Sonic Delay Lines 465

Delay is 2 μsec to 20 msec



These wire sonic delay lines use piezoelectric transducers for the inputs and fixed outputs and magnetostrictive transducers for the adjustable outputs. Available delays are 2 μsec to 20 msec, with ± 0.1 μsec tolerance. Maximum operating frequency is 1.25 mc. Piezoelectric drives have a power loss of 10 to 15 db; magnetostrictive types have losses of 20 to 25 db. Output amplitude is stable, generally within 10% for changes in input frequency, repetition rate or temperature.

General Electric Co., Heavy Military Electronics Dept., Defense Industries Sales, Dept. ED, Court St. Plant, Syracuse, N.Y. Booth 2716.

Quadrature Rejection Circuit 544

Operates at 400 cps



The Model D4821-01 quadrature rejection circuit eliminates input signal components which are 90 deg out of phase with a reference signal. It is designed for signals of 400 ± 60 cps at 0.005 to 6 v. Minimum rejection ratio varies from 35:1 to 50:1, depending on signal voltage. The in-phase signal component appears as a square-wave output of magnitude proportional to load and input signal. The device operates from synchro, pre-amplifier or other signal sources into servo amplifiers. The unit, transistorized, weighs 4 oz and meets Mil specs.

Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J. Booth 626-627.

DC Power Supply 458

For transistorized equipment



Model ZA-720 DC Power Supply, shown, provides a dual 12-v, 5-amp output. Model ZA-721 is a transistorized, 12-v, 1-amp dc power supply that plugs into a standard 14-pin miniature socket. A 33-v ac tap is included with this model. For both models, voltage regulation is 0.1%, and ripple is less than 0.001 v rms. The units are intended as a power source for equipment using T-Series digital plug-in circuits, N-Series decade counters and R-Series indicators. Model ZA-720 measures 5-1/4 x 19 x 16 in., and Model ZA-721 measures 3-3/4 x 4-3/4 x 2-3/16 in.

Engineered Electronics Co., Dept. ED, 1441 E. Chestnut Ave., Santa Ana, Calif. **Price & Availability:** Model ZA-720 is \$995, and ZA-721 is \$215. Both are available from stock. Booth 1017.

Bearing Analyzer 439

Checks balls, rollers up to 10 in. OD

Model BA-20 bearing analyzer checks balls or rollers and all raceways in a 1/2 min. The machine locates the position and sizes of flaws, and indicates unserviceable bearings both visually and audibly. Relative torque, surface finish and lubricant contaminants are indicated. The instrument inspects all bearings up to 10 in. OD. It occupies 18 in. sq of bench space.

Bearing Inspection, Inc., Dept. ED, 3311 E. Gage Ave., Huntington Park, Calif.

Price & Availability: The machine, priced at \$4,600, can be delivered in 90 days.

Booth 105.

High-Voltage Rectifier 438

Inverse voltages to 30 kv

Type 705WA rectifying tube is rated for 100 ma dc at inverse voltages up to 30 kv. The device operates at an ambient temperature of 125 C. Lead wires are made of heavy-duty tungsten.

United Electronics Co., Dept. ED, Newark, N.J.

Price & Availability: The rectifier, available from stock, is priced at \$30.

Booth 2501-2502.

Bearing Washer 440

Washes sizes up to 7 in. OD

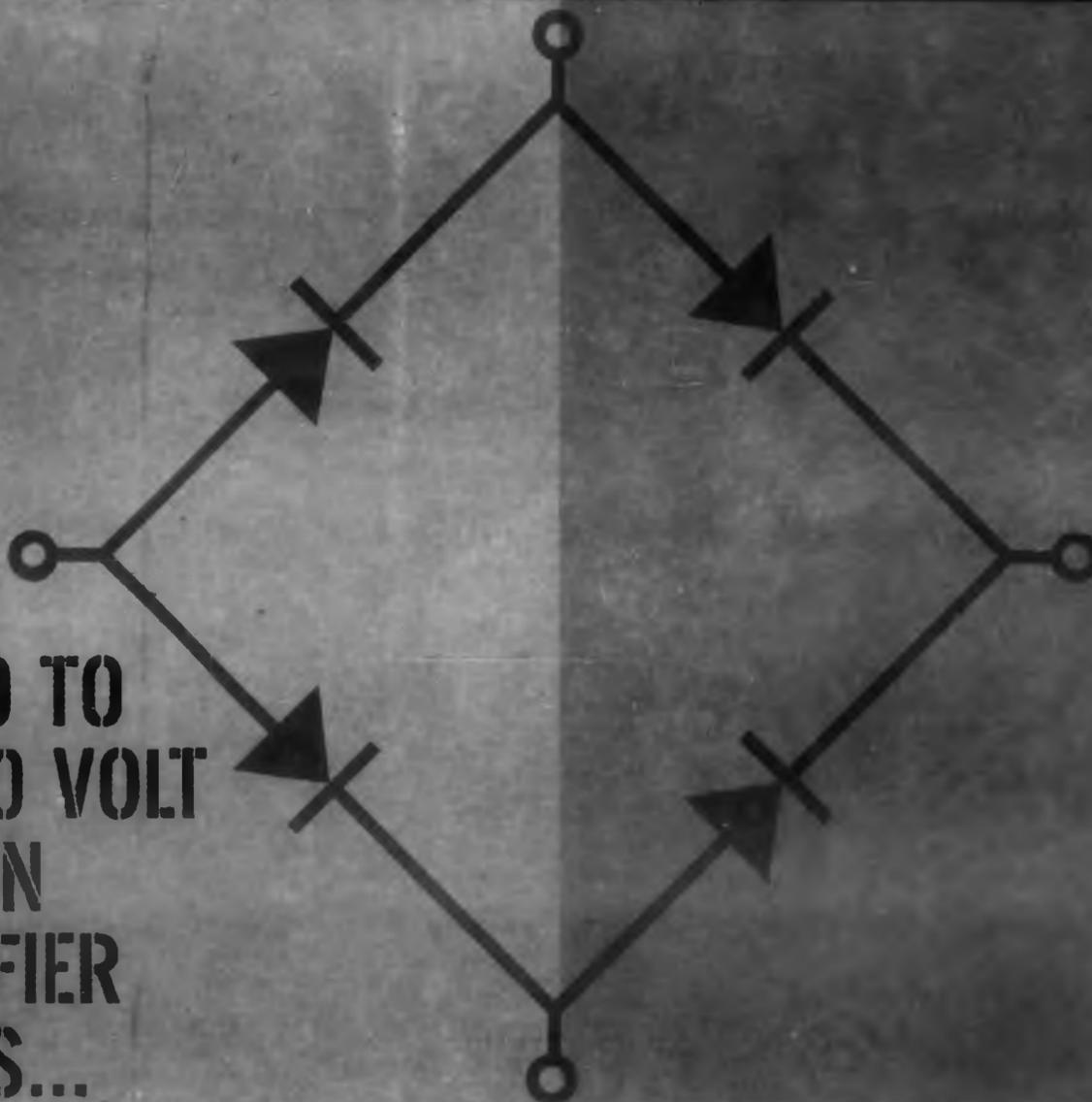
Model MC-4-1 bearing washer will wash all anti-friction bearings from small instrument sizes to 7 in. OD types. Solvent and air under pressure is used in a cleaning action not requiring removal of shields or seals. The machine will wash from 60 to 200 bearings an hour. The washer is self-contained and occupies a bench space of 18 by 30 in.

Bearing Inspection, Inc., Dept. ED, 3311 E. Gage Ave., Huntington Park, Calif.

Price & Availability: The washer is priced at \$2500 and can be delivered in 90 days.

Booth 105.

NEW! 12,000 TO 30,000 VOLT SILICON RECTIFIER SERIES...



with no voltage derating over entire range -55°C to 175°C !

Ten new Very High Voltage silicon cartridge rectifiers rated from 12,000 to 30,000 volts are now available in production quantities from P S I.

Designated 1N3052 through 1N3061, the new units are added to the existing P S I line to provide 19 EIA types with voltages ranging from 1,000 to 30,000 volts.

NOTE THESE OTHER FEATURES:

- 1—Easy to mount, compact, light weight
- 2—Non-metallic electrically "cold" case
- 3—All welded construction
- 4—Meet all applicable MIL specs
- 5—Lowest voltage drop—highest current ratings—best reverse leakage characteristics of any available types

This new series is ideally suited to radar modulator and power supply applications.

Like the widely accepted 1N1730 series (1,000 to 5,000 volts) and the 1N2382 rectifier series (4,000 to 10,000 volts) the new types are of special significance where light weight, unusual ruggedness and high reliability are of prime importance.



Write or wire for detailed specifications, prices and delivery schedules.
NEW CONDENSED PSI CATALOG ALSO NOW AVAILABLE!

Pacific Semiconductors, Inc.

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.
12955 CHADRON AVENUE, HAWTHORNE, CALIFORNIA

ELECTRICAL SPECIFICATIONS

TYPE NUMBER	PEAK AND CONTINUOUS INVERSE DC VOLTAGE -55°C to $+175^{\circ}\text{C}$ (Vdc)	EQUIVALENT RMS VOLTAGE (Vdc)	MAXIMUM RATINGS		
			FORWARD DROP AT 100 mAdc AT 25°C (Vdc)	AVERAGE RECTIFIED CURRENT* (mAdc)	
				25°C	100°C
1N3052	12,000	8,450	70	100	50
1N3053	14,000	9,900	75	100	50
1N3054	16,000	11,300	80	100	50
1N3055	18,000	12,700	85	100	50
1N3056	20,000	14,150	90	100	50
1N3057	22,000	15,500	95	100	50
1N3058	24,000	17,000	100	100	50
1N3059	26,000	18,350	105	100	50
1N3060	28,000	19,750	120	100	50
1N3061	30,000	21,150	125	100	50

*Half Sine Wave, Resistive or Inductive Load. For higher Ambient Temperature derate average rectified current linearly to zero at 175°C .

OTHER SPECIFICATIONS

1. Inverse Current at Rated Inverse Voltage: 10 μA Max at 25°C and 100 μA Max at 100°C .
2. Maximum Non-Recurrent Surge Current: .008 second, 2.5 Amps at 100°C .
3. Operating Temperature Range: -55°C to $+175^{\circ}\text{C}$.

CIRCLE 121 ON READER-SERVICE CARD



Like Autonetics, Bendix, Boeing, Chalco,
Convair/Astronautics, GE, Magnavox,
Martin, McDonnell, Radioplane,
Ramo Wooldridge, and STL:

Count on Hydro-Aire for Reliable Transistorized Time Delay Devices

Available now: time delay relays, sequence timers, and computer timing modules. Custom-designed and built by Hydro-Aire for these valued customers. All can be readily adapted to meet a broad range of requirements, or we can custom-design to your specs. Write for a prompt quote.

NEW ELECTRONICS CATALOG describes Hydro-Aire solid-state devices including time delay devices, voltage regulators, power supplies, and inverters. Write on company letter-head for your copy.



CIRCLE 122 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Metalized Mylar Capacitors 457

Capacitances of 0.001 to 0.68 μ f



Series DE capacitors are available from 0.001 to 0.68 μ f in 200, 400 and 600 vdc values. Made with metalized Mylar, the units are encased in epoxy tubes. Operating temperatures are -55 to $+85$ C; insulation resistance is 10,000 meg; dissipation factor is less than 1% at 25 C. The 0.001 to 0.033 μ f units measure 0.57 x 0.29 x 0.17 in.

Electron Products, Dept. ED, 430 N. Halstead St., Pasadena, Calif.
Booth 621.

Differential DC VTVM 455

Ranges from 0.3 to 100 v dc



Model 410 differential dc vtvm is capable of 1% accuracy with full scale ranges of ± 0.3 to ± 100 v dc in six steps. Input impedance is 20 meg (single) 40 meg (differential). The unit measures 8 x 7-3/4 x 6 in.

The Decker Corp., Dept. ED, 45 Monument Road, Bala-Cynwyd, Pa.

Price & Availability: Units, available from stock, are priced at \$375 each in small quantities.
Booth 2315-2316.

Traveling Wave Tube 528

For broad-band, low-noise preamplification



The Type M2101-B traveling wave tube is a broad band, periodically-focused low-noise device

designed for preamplification applications in the 8 to 11 kmc range. It provides a minimum of 10 mw rf power, has a low-level gain of 25 db and a nominal noise figure of 13 db. The tube is of metal-ceramic ruggedized construction, ppm focused, and is temperature compensated.

Microwave Electronics Corp., Dept. ED, 4061 Transport St., Palo Alto, Calif.

Price & Availability: Price is \$3,000; delivery is 30 days.

Booth 2154.

Portable Television Camera 531

For low light-level industrial application



Model 81 industrial image-orthicon camera provides television monitoring at low light levels. The units are completely transistorized, light in weight, and provide an 800-line resolution. They measure 5 x 5 x 20 in. and weigh 15 lb. The camera is operated remotely from a control unit, also of transistorized, modular construction.

Thompson Ramo Wooldridge, Inc., Dage Television Div., Dept. ED, 10th St., Michigan City, Ind.

Booth 2166.

Sweep Oscillator 477

Provides frequencies of 1 to 2 kmc



The Model 628A sweep oscillator provides cw and swept rf frequencies from 1 to 2 kmc. The device has independent, direct-reading frequency, sweep-rate and sweep-range controls. The oscillator can be used with an oscilloscope or on mechanical recorders.

Hewlett-Packard Co., Dept. ED, 1051 Page Mill Road, Palo Alto, Calif.

Booth 651-652-653-654.

AC Timing Motor 441

Length is 7/8 in.

The Series 42100 ac timing motors are 5-oz devices that have a running torque of 30 oz-in. The units are 7/8 in. long; rotor speed is 300 rpm. Output speeds are from 300 rpm to 1/6 rph. Voltage ratings range from 6 to 230 v at 20 ma max. Direction of rotation is electrically controlled. Temperature rise is 40 C max, and power input is 2.5 w max. Both steel and brass gears are available.

A. W. Haydon Co., Dept. ED, 232 N. Elm St., Waterbury, Conn. Price: The units are priced from \$1.50 to \$5.70, depending on quantity.

Booth 457-458.

Tantalum Capacitors 433

Rated at 0.33 to 0.82 and 2.2 to 5.6 μ f

The Series TSP1 tantalum capacitors range in value from 0.82 to 0.33 μ f at 50 v dc and 85 C. Their case size is 1/8 in. in diameter and 1/4 in. long. The units weigh about 1/2 gm. The Series TSP2 capacitors range in value from 2.2 to 5.6 μ f at 50 v and 85 C. Their diameter is 0.172 in. and length is 0.438 in. They weigh about 1.2 gm.

U. S. Semiconductor Products, Dept. ED, 3540 W. Osborn Road, Phoenix, Ariz.

Booth 2239-2240.

Distributor Module 435

Operates at 100 kc

Model D-9000 distributor module uses a Type BX-1000 Beam-X switch with 10 output positions. The module provides nine of these outputs for useful work, while the tenth cascades additional modules in a distributor system. Operating voltage of the unit is 60 to 300 v; input pulses to 100 kc are accepted. Output currents of 2.5 ma are provided.

Burroughs Corp., Electronic Tube Div., Dept. ED, P.O. Box 1226 Plainfield, N.J.

Booth 2136-2137.

CIRCLE 123 ON READER-SERVICE CARD



MAGNETIC CONTROLS chooses Tung-Sol flasher for Polaris guidance system temperature control

Magnetic Controls' portable temperature control maintains the Polaris guidance and stabilization system at safe temperatures while the system is in storage or in transit. Up until the time the system becomes operational in the submarine-launched missile, the control equipment keeps the temperature within a prescribed range. Should the temperature deviate, however, beyond preset tolerances, visual and audio alarms are set off to alert operators who can then quickly spot the system at fault for immediate inspection.

Magnetic Controls specified the Tung-Sol 608 Flasher as the trigger for the visual warning signal. Many competitive types were put under critical evaluation before the Tung-Sol Flasher was chosen. The reasons for selecting Tung-Sol, according to Magnetic Controls: "We demanded a compact unit which was readily available and which met our rigid reliability requirements. The Tung-Sol flasher was the only one which met these demands."

"We were also gratified by the cooperation and assistance of Tung-Sol engineers who designed a suitable mounting clip for the flasher when we encountered difficulty in locating one," Magnetic Controls reports.

Tung-Sol's outstanding experience in the design, development, production of special purpose flashers is readily available to you. Like all Tung-Sol components — tubes, semiconductors and miniature lamps — Tung-Sol flashers are the product of the highest manufacturing standards and assurance practices which have made Tung-Sol the name synonymous with the finest in componentry. Tung-Sol Electric Inc., Newark 4, New Jersey. TWX: NK193.

Technical assistance is available through the following sales offices: 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. Canada: Toronto, Ontario.



 **TUNG-SOL**[®]

RACK-AND-PANEL CONNECTORS THAT ARE SELF-ALIGNING

Forget about usual misalignment between plug and receptacle in modular unit installations with new Deutsch self-aligning cylindrical rack-and-panel

connectors. Just slide the drawer home, and each spring mounted plug floats into engagement with its receptacle.

Spring pressure then maintains environmental interfacial seal.

For detailed information on the only complete line of environmental cylindrical rack-and-panel connectors contact your local Deutsch representative today or write for data file "C-8"



The Deutsch Company
ELECTRONIC COMPONENTS DIVISION
Municipal Airport • Banning, California

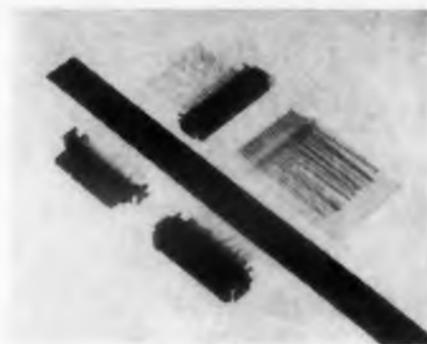
CIRCLE 124 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Miniature Connectors

464

For printed and modular circuits



The Micro-Min series of circuit connectors, shown, has 38 double-side contacts and is intended for flat-form packaging of such units as printed-circuits. Connector length is 1-5/16 in. and contacts are on 0.05-in. centers. Micro-Mod connectors, designed for "stick" or modular packaged circuits, consist of a receptacle and polarized plug 0.38 in. sq. They have 12 contacts on 0.075-in. centers.

Amphenol-Borg Corp., Amphenol Connector Div., Dept. ED, 1830 S. 54th Ave., Chicago 50, Ill.

Booth 848-849.

Microwave Modulator

468



Covers 5,400 to 35,000 mc

Model 10002 microwave modulator will accommodate any of 76 magnetrons, covering 5,400 to 35,000 mc with peak outputs from 20 to 500 kw. The modulator includes a high-voltage power supply variable from 0 to 8 kv at 200 ma, a pulse generator with an output of 37 kv at 40 amp that is variable from 180 to 300 pulses per sec, meters, and viewing connectors.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, L.I., N.Y.

Price: The unit is priced at \$9375.
Booth 822-823.



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

See Us at WESCON Booth 2805
CIRCLE 127 ON READER-SERVICE CARD
CIRCLE 130 ON READER-SERVICE CARD

Function Generator

359

Analog type



This analog function generator is an electro-mechanical analog computer designed for arbitrary function generation on one variable expressed as a function of one or more variables. The functions are programmed on a plug-board arrangement which stores 441 discrete voltage values. Over-all system accuracy is better than 1% and frequency response is more than 5 cps over full scale. Maximum resolution is 0.02%.

Link Div. of General Precision, Dept. ED, Binghamton, N.Y.

Price & Availability: \$6,900 ea; 90 to 120 days for delivery.

Booth 641-642.

Velocity Multiplier

408

One linear, one non-linear output



Model VM-1019 velocity multiplier for missile applications provides a potentiometer shaft position as a function of a dc signal input. The unit has two modes of operation the first provides an output on each of two potentiometers as a linear function of an input signal of 0 to 2.33 v dc; the second mode provides a similar but non-linear function of a 0 to 5.86 v dc signal. Accuracy is $\pm 2\%$. Power requirements are: 115 v, 400 cps, 6.3 v, 400 cps, 200 v dc unregulated, and 200 v dc regulated for a feedback circuit at 10 ma max.

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

Availability: Units, made to order, can be delivered in 60 days.

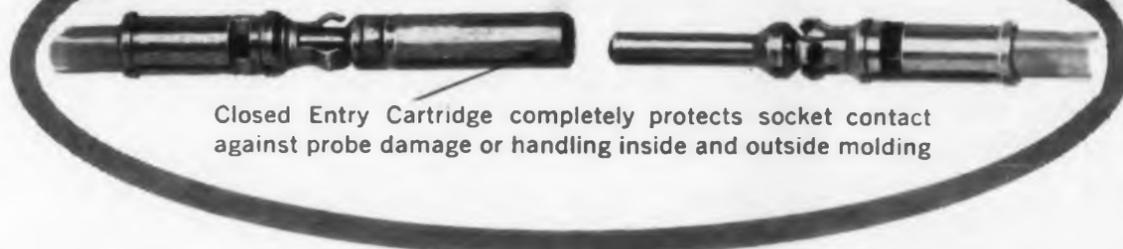
Booth 2349.

← CIRCLE 130 ON READER-SERVICE CARD
ELECTRONIC DESIGN • August 3, 1960

New! REMOVABLE CONTACT

BY CONTINENTAL CONNECTORS

ENLARGED VIEW TO SHOW DETAIL
OF PRECISION MADE SCREW MACHINE CONTACT



Closed Entry Cartridge completely protects socket contact against probe damage or handling inside and outside molding

Eliminate all connector soldering operations with Continental Connector's new, improved removable contact with crimp terminations. Extra wide, three-tine spring clutch on pin and socket provides maximum holding area between contact and molded block. Contacts are supplied separately and are wired independently. This permits mounting of plug and socket connector units at any convenient time without waiting for completion of wiring operation.

Wire crimping is fast and easy with hand or automatic power crimping tools readily available for small or quantity production. Contacts are quickly removed and replaced with a simple, low cost hand tool.

These removable contacts are designed for use with Continental Series 25 Miniature Rectangular connectors in sizes of 14, 26, 34, 50, 75 and 104 contacts. Both socket and pin contacts are made of phosphor bronze with gold plate over silver plate. Terminations accommodate any #16 to #22 AWG wire. Removable contact connectors are interchangeable with existing fixed contact types.

For complete technical data bulletin on Continental Removable Contact Connectors, write to Electronics Division, DeJUR-AMSCO CORPORATION, 45-01 Northern Boulevard, Long Island City 1, N. Y. (Exclusive Sales Agent.)



MANUFACTURED BY
CONTINENTAL CONNECTOR CORPORATION,
AMERICA'S FASTEST GROWING LINE OF
PRECISION CONNECTORS

EASY 3-STEP PROCEDURE FOR WIRING AND INSERTION OF CONTACTS



1—CRIMPING . . . One motion with crimping tool quickly crimps contact securely to wire



2—INSERTION . . . Simple hand held insertion tool inserts crimped contact into molding



3—REMOVAL . . . Special spring-loaded removal tool removes contact and wire with one motion

← CIRCLE 131 ON READER-SERVICE CARD

NEW PRODUCTS

AT WESCON

Backward Wave Oscillators 360

Eight types offered

Types L-3291 through L-3298 backward wave oscillators are lighter and smaller than types L-3141 through L-3148. The five tubes with the highest frequencies have identical magnets, making them interchangeable with only one change in rf output. The other three tubes are also identical, but are slightly larger.

Litton Industries, Electron Tube Div., Dept. ED, 960 Industrial Road, San Carlos, Calif.
Booth 2104.

Teflon Terminal 363

Has 0.03-in. diam through-hole

Type RFT-SM-40-SL feed-through Teflon terminal has a through hole 0.03-in. in diameter. A slotted terminal top facilitates bringing the lead through the terminal for wrap-around connection. The device can be used in header applications and is particularly suitable for potentiometer requirements.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N.Y.
Booth 954.

Silicon Rectifiers 387

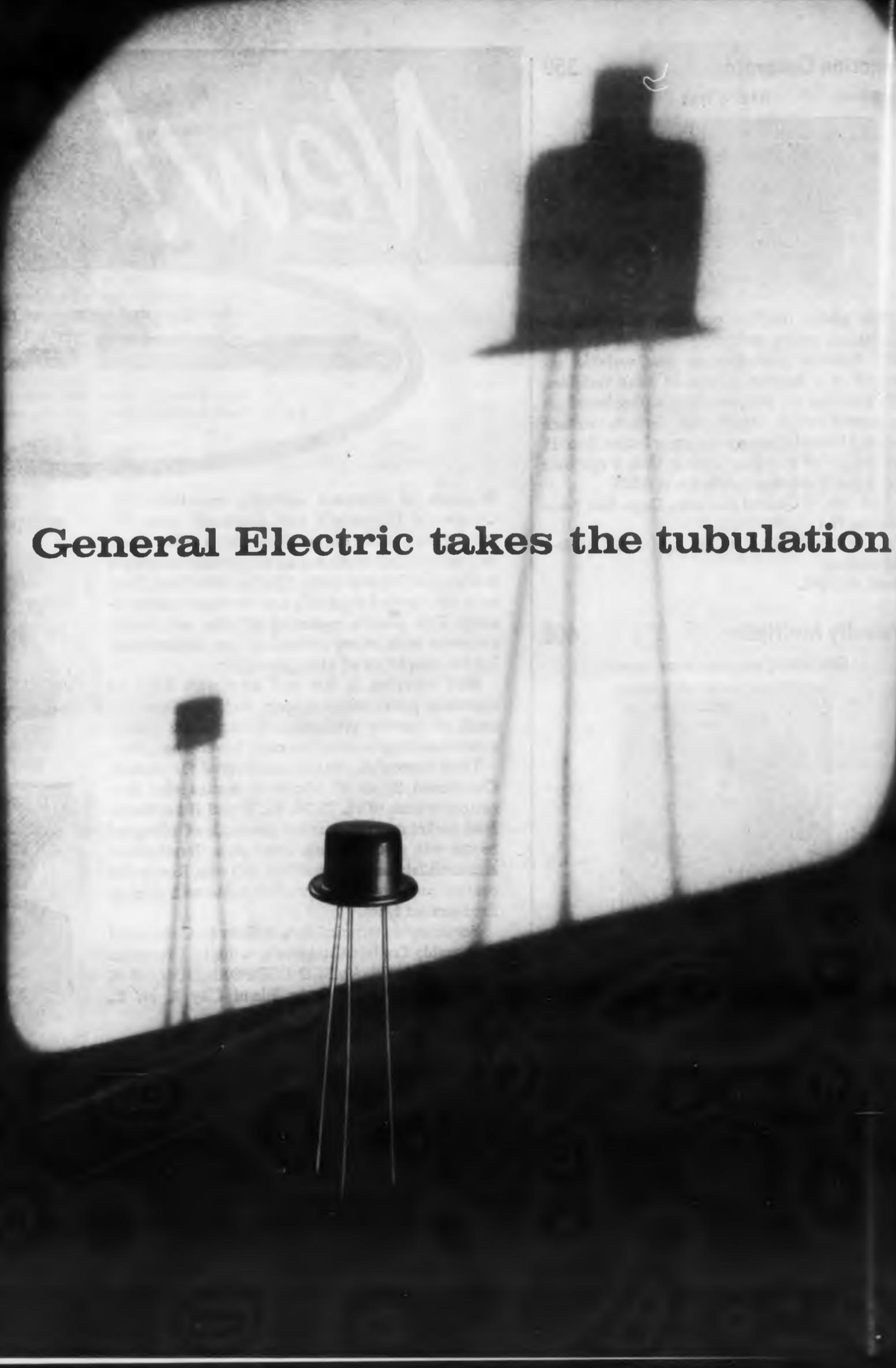
Rated at 12,000 to 30,000 v

Types 1N3052 through 1N3061 silicon rectifiers are rated at 12,000 through 30,000 v. Of the wire-in, coaxial lead design, the units are 1/2 in. in diameter and from 4 to 8 in. long. No voltage derating is required up to 175 C. Uses are in radar modulators and power supplies.

Pacific Semiconductors, Inc., Dept. ED, 10451 W. Jefferson Blvd., Culver City, Calif.

Availability: Immediately, in production quantities.

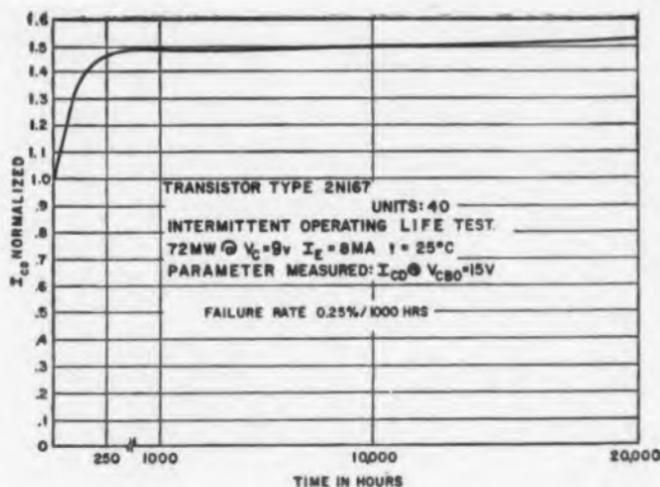
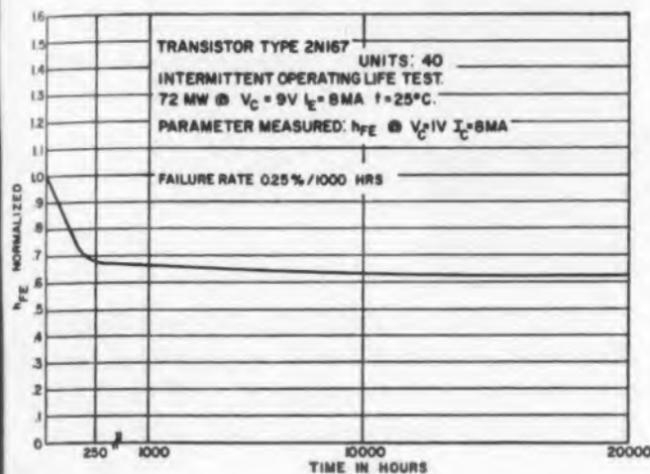
Booth 2812-2813.



General Electric takes the tubulation

General Electric transistors hold the record in rate-grown reliability

General Electric has manufactured millions of rate-grown transistors in the past seven years. As a result of this experience, G.E.'s parameters are exceptionally stable and a vast amount of reliability data has been accumulated, some of which is shown here. These curves cover 29 lots of General Electric 2N167, tested to MIL-T-19500/11.



The rate-grown process produces a small, clean junction which exhibits almost no drift or deterioration at high voltages and offers the user low I_{CO} and I_{EO} . Two new types, the 2N1510 and 2N1217, will be useful for low-level switch and neon indicator applications. Both the 2N1217 and 2N167 operate at extremely low current and leakage levels, making them ideal for starvation circuits of 2 ma or less.

off rate-grown NPN transistors!

Remove the tubulation (pinch-off) from rate-grown transistors without sacrificing reliability? General Electric has done just that and even improved reliability with stabilized beta and collector cutoff current. Prices have been reduced on some types up to 20%.

Removal of the tubulation was made possible by adding a sieve or getter. Improved beta and collector cutoff current results from a 125-hour $85^\circ C$ bake, which also improves the paint's resistance to solvents and chipping. Pellet, pellet mount and processing are identical to the previous process before encapsulation. Then a sieve is added rather than evacuation and subsequent pinch-off. The sieve is the same used and proved for years on G.E.'s PNP low-frequency 2N525 and PNP high-frequency 2N396 lines.

The high-reliability 2N78A and 2N167A have guaranteed $71^\circ C$ I_{CO} and tight AQL's. The 2N78A also features a 20 volt BV_{CEO} rating compared with the 2N78's 15 volts. The 2N167A, in addition to $71^\circ C$ I_{CO} , has a lower I_{EO} . For more information, see your G-E Semiconductor Sales Representative or Authorized Distributor. General Electric Company, Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

ADVANTAGES TO YOU: 40% lower height • Reduced prices • Stabilized I_{CO} and h_{FE} . All units baked 125 hours at $85^\circ C$ • Greater resistance of paint to solvents, chipping, and salt spray • Improved low-temperature performance and reliability.

Type No.	Maximum Ratings				Electrical Parameters					
	P_{cmw} @ $25^\circ C$	BV_{CE} BV_{CB}	I_C ma	T_J $^\circ C$	h_{FE}	MIN @ I_C ma	MIN $f_{\alpha mc}$	MIN $G_{\alpha db}$	MAX I_{CO} (μa) @ V_{CB}	
2N78	65	15	20	85	45	1	5	27	3	15
2N78A	65	20	20	85	45	1	5	29	3	15
2N78A (Cert)	65	20	20	85	45	1	5	29	3	15
2N167	65	30	75	85	17	8	5	—	1.5	15
2N167A	65	30	75	85	17	8	5	—	1.5	15
USAF2N167A (per MIL-S-19500/11)	65	30	75	85	17	8	5	—	1.5	15
2N169A	65	15	20	85	34	1	—	27	5	15
2N119B	65	25	75	85	17	8	5	—	1.5	15
2N1217	65	20	20	85	40	2	5	—	1.5	15
2N1510	75	75	20	85	8	1	—	—	5	75

IN STOCK FOR FAST DELIVERY FROM YOUR AUTHORIZED GENERAL ELECTRIC DISTRIBUTOR

GENERAL ELECTRIC

AC Current Probe 377

For vtvm or oscilloscope readings

Model 456A ac current probe converts ac current functions to voltage functions for direct reading on a vtvm or oscilloscope. The probe clamps onto the current-carrying wire, taking measurements without direct connection to the test circuit. The instrument's bandwidth of 20 cps to 15 mc permits oscilloscope viewing of current waveforms; unity conversion of 1 mv to 1 ma permits direct current reading on voltmeters. The unit weighs 3 lb.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Road, Palo Alto, Calif.

Price & Availability: The unit is priced at \$190.00; availability is 14 weeks.

Booth 653-654.

Printed Circuit Connectors 390

Have bifurcated contacts

Series 5011 Varicon printed circuit connectors, with bifurcated contacts, accept Series 53 taper pins. The insulator body is a glass-filled diallyl phthalate. The units have integrally molded board guides and a single row of contacts on 0.2 in. centers.

Elco Corp., Dept. ED, M St. below Erie Ave., Philadelphia 24, Pa. Booth 724-725.

Handles 386

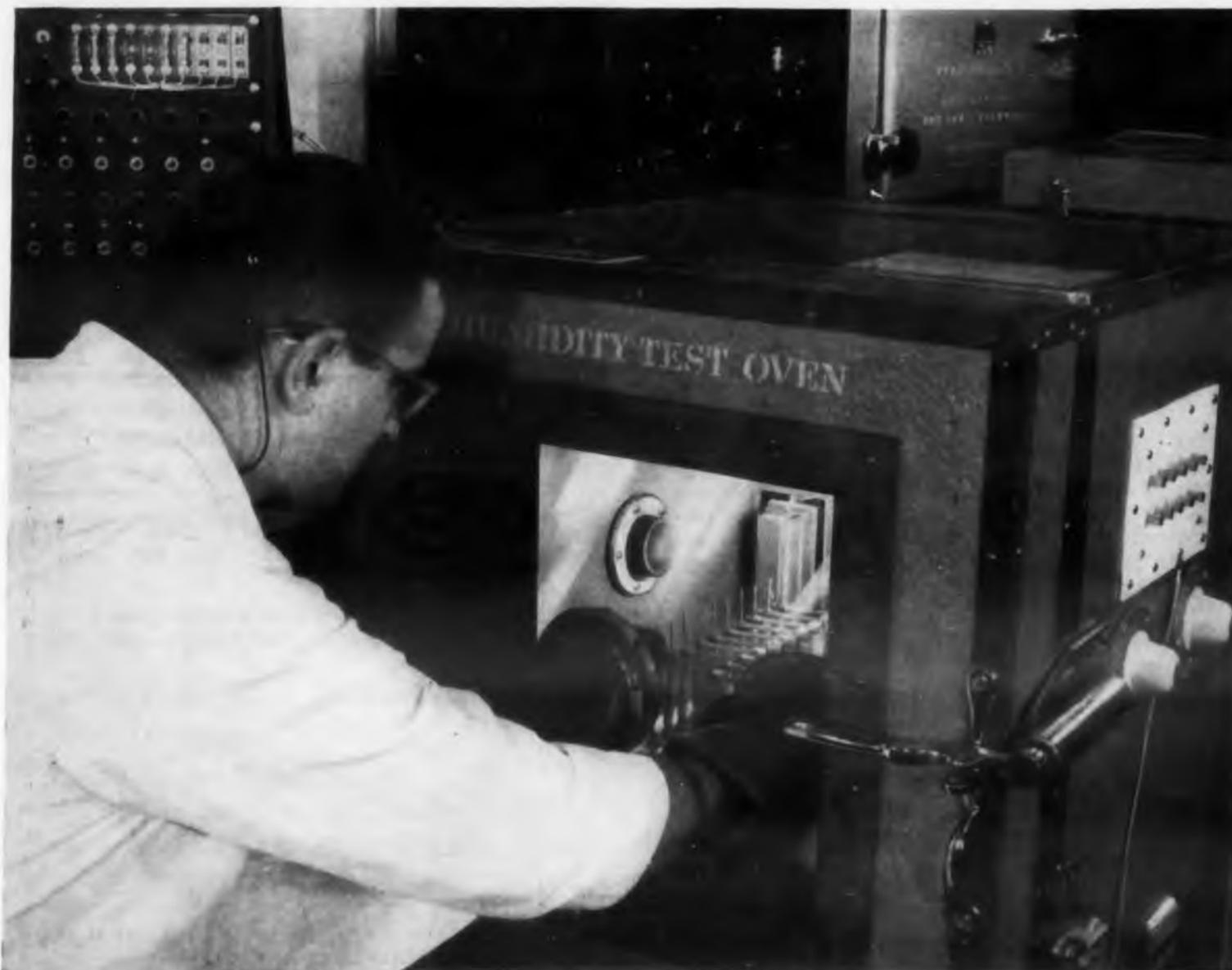
Come in four lengths

These panel handles are offered in the following sizes: type 1260, 2 x 1-5/16 in.; type 1261, 3 x 1-5/16 in.; type 1262, 4 x 1-1/2 in.; and type 1263, 6 x 1-3/4 in. Made of brass per ASTM B-121, alloy 4, they have black oxide or 0.0005-in. nickel plate finish.

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

Booth 747.

◀ CIRCLE 132 ON READER-SERVICE CARD



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.

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



Better Things for Better Living . . . through Chemistry

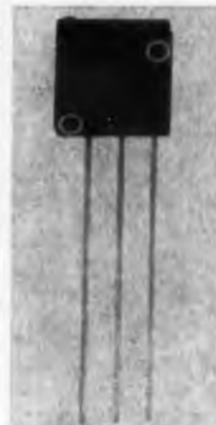
DU PONT
MYLAR
POLYESTER FILM

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NEW PRODUCTS AT WESCON

Trimmer Potentiometers

358



Temperature range is -55 to +150 C

Series 316 Squaretrim trimmer potentiometers, designed for printed circuit applications, operate over the temperature range of -55 to +150 C. A circular resistance element eliminates the effects of differential thermal expansion. These miniature units stand 2,000 cps vibration and shock of 30 g. Standard models are offered in resistance values of 10 ohms to 100 K.

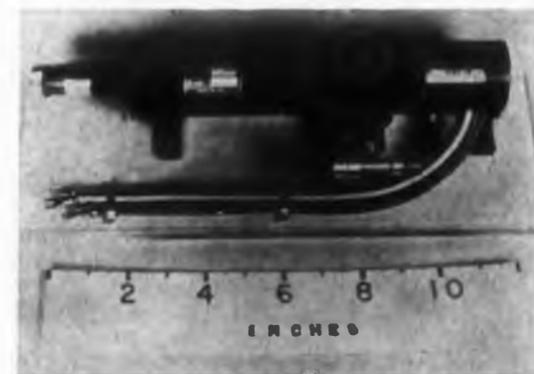
Daystrom, Inc., Pacific Div., Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.

Price & Availability: \$6.10 ea for standard units in quantities of one to nine. Standard units are delivered from stock; others, in 30 days. Booth 1039-1040.

Traveling Wave Tubes

356

Cover 7,000 to 11,000 mc



Suited to operate in series as an amplifier chain, types L-3266 and L-3236 PPM-focused traveling wave tubes cover 7,000 to 11,000 mc. Minimum saturated cw power is 20 mw for the L-3266 and 2 w for the L-3236. Each tube provides a small signal gain in excess of 33 db. Applications are in ECM repeaters, radar-target enhancement systems, frequency diversity radar transmitters, and equipments requiring general-purpose microwave amplifiers. Both tubes weigh less than 4 lb and measure about 1 ft long.

Litton Industries, Electron Tube Div., Dept. ED, 960 Industrial Road, San Carlos, Calif. Booth 2104.

Latching Relay

Coaxial type



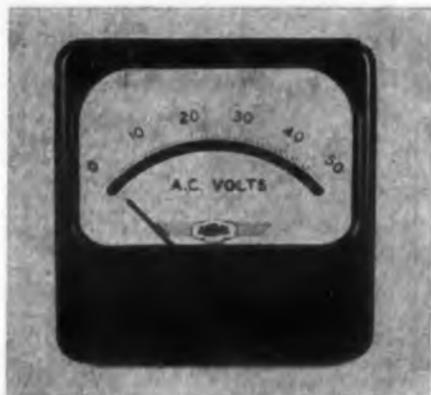
Type RC5 latching vacuum relay is for 50-ohm, 1-5/8-in. coaxial lines. It provides a means of remotely or manually switching for communications, and radar transmitters. The device has a frequency range of 0 to 100 mc with a vswr of 1.02 max at 30 mc and 1.05 max at 60 mc. Power rating is 25 kw cw avg at 30 mc into a matched load. The relay has greater than 60 db isolation at 30 mc. Relay actuation is available for 24- or 115-v dc solenoids. Two spdt microswitches are available at auxiliary contacts for remote indication.

Jennings Radio Manufacturing Corp., Dept. ED, P.O. Box 1278, San Jose 8, Calif.

Price & Availability: \$518 ea in quantities of one to 10. Delivery time is 30 to 45 days. Booth 2520-2521.

Precision Voltmeters and Ammeters

Are accurate to 1%



These meters, with anti-parallax mirror scales, are accurate to 1%. Parts are machine turned, with spring-mounted jewel bearings. Meter ranges are from 50 μ a to 500 amp dc, 100 μ a to 20 amp ac, 10 mv to 750 v dc, 8 to 500 v ac. Ac meters are rectifier type. Meters measure from 2-1/2 to 6-3/4 in. sq.

Airpax Electronics Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

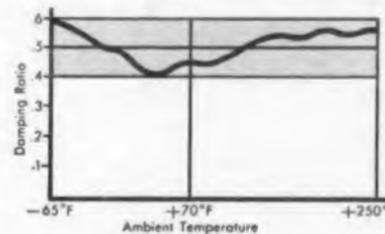
Price & Availability: Priced from \$29.75 to \$54.40, the meters can be delivered in 7 days. Booth 711-712.

352



New Miniature Rate Gyro

WARM-UP TIME after motor run-up... ZERO!



When the chips are down and immediate action is a must, the new Honeywell Miniature Rate Gyros, Type M-100, are always ready. The typical damping of 0.6 at -65°F is obtained *without benefit of heat* from the spin motor, and is held virtually constant up to a temperature of

$+250^{\circ}\text{F}$. The gyro spin motor, requiring only 15 seconds run-up time, will operate on one (split), two, or three phase power, and is isolated from ground.

Other features of the Type M-100 include: unique quadrilever spring construction to produce greater shock and vibration capabilities than a comparable torsion bar gyro; elimination of one gimbal bearing for lower threshold; maintenance of preload throughout severe environmental conditions through exclusive spin motor construction.

Type M-100 is specifically designed for autopilot damping, radar antenna stabilization, and fire control applications. Its small size, high performance, and ruggedness suit it particularly for advanced military aircraft and guided missile applications. Write for Bulletin M-100 to Minneapolis-Honeywell, Boston Division, 40 Life Street, Boston 35, Mass.



Honeywell Miniature Rate Gyro
Type M-100
shown actual size

- Full Scale Range: To 400 degrees/sec.
- Linearity: Less than 0.1% of full scale to 1/2 range, less than 2% to full range
- Shock and Linear Acceleration: to 150G
- Size: 1" diameter, 2 1/2" long
- Threshold-Resolution: Less than 0.01 degrees/sec.
- Damping: 0.4 to 0.6 from -65°F to $+250^{\circ}\text{F}$
- Vibration: 20 G to 2000 cps
- Weight: Less than 6.0 ounces

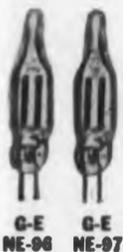
75th
PIONEERING THE FUTURE
YEAR

Honeywell

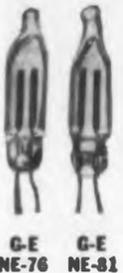
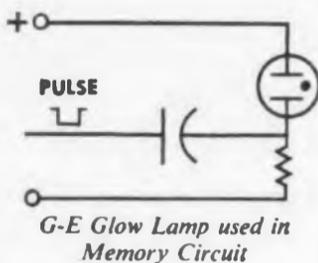
Military Products Group
SINCE 1885

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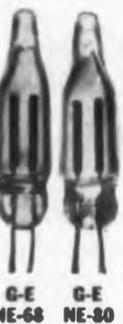
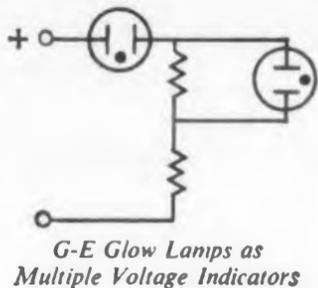
4 ways to use General Electric Glow Lamps as Circuit Components



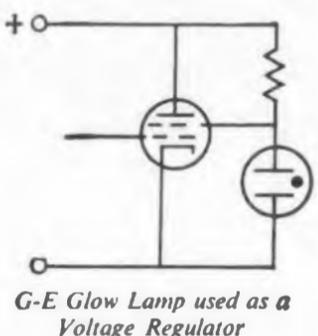
1. As a MEMORY DEVICE, because of the differential between starting and operating voltages. Both the General Electric NE-96 and NE-97 are well suited for switching circuits and counters where they can function as transfer elements and as indicators of state or sequence.



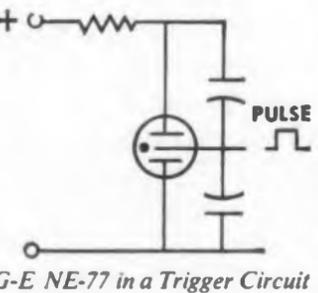
2. As a VOLTAGE INDICATOR, because of their critical starting voltage. The G-E NE-76 and the NE-81 are stabilized and selected for close tolerance on starting voltage. Both find use in gating circuits, logic matrices, switching circuits or as an indicator of input or output levels.



3. As a VOLTAGE REGULATOR, because of their constant operating voltage range. The General Electric NE-68 and its "first cousin", the G-E NE-80 (closer tolerance), function effectively wherever voltage regulation is required. (Glow Lamps for higher current applications are also available.)



4. As a TRIGGERED SWITCH. A low current signal applied to the trigger (third electrode) starts this lamp, permitting conduction of peak current surges up to 100 m.a. in the power circuit. It can be used in counting circuits or as a control device with photocells, thermostats or moisture sensors in trigger circuit.



For more information, write for: Specification Sheet # 3-092 "G-E Glow Lamps for Circuit Component Use". General Electric Co., Miniature Lamp Dept. M-021, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 135 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON Tape Equipment

Search and control system



The ZA-821 tape search and control system employs a 24-bit, binary-coded-decimal time code detection technique. The system rapidly searches the desired tape area, switches the transport (which may be at a remote location) to playback speed, and provides contact closures for operation of auxiliary equipment during preset intervals. Recycling of the selected playback area is automatic. Solid-state circuitry is used throughout. The unit occupies 15-3/4 in. on a 19 in. rack. Maximum depth including connectors is 18 in.

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

Price & Availability: Price is \$11,400 fob Santa Ana; delivery is 90 days. Booth 2527-2528.

DC Charging Reactors

For pulse modulator applications



These dc charging reactors are used in pulse modulators for klystrons in linear accelerators and high power radar. They may be epoxy resin encapsulated or oil insulated, depending on the requirements. The unit shown operates at 8 amp dc average current from a dc source voltage of 15 kv. Its peak current rating is 20 amp. Inductance rating is 0.5 h and pulse repetition rate is 800 pps.

Electro Engineering Works, Dept. ED, 401 Preda St., San Leandro, Calif.
Availability: Made on order. Booth 601.

370

MAGNETRON CONNECTORS

by *jettron*

Specify JETTRON for all types of magnetron connectors for vital military or commercial equipment. Complete facilities for the design and production of "specials" and other precision components including sockets and cable assemblies.

Magnetron Input Connector Cat. 9000-C

Fits 4J52A and similar Magnetrons. Features floating heater contact, eight-prong heater cathode contact of silver plated heat treated beryllium copper. Molded silicone encloses metal body.



Magnetron Input Connector Cat. 9005-C

Fits 4J52A and similar Magnetrons. Features identical to Cat. 9000-C. In addition has 75 mil thick silicone insulated cables for higher potential applications. Made with 4700 μ f built-in capacitor.



Magnetron Input Connector Cat. 9040

One of the many "Specials" Jettron has made. Basic Input Connector with floating heater contact. Supplied with or without bypass capacitor. Normally potted to the magnetron input end.



Magnetron Input Connector Cat. 9050

Fits Miniature Magnetrons such as L-3028B. Beryllium copper heater and cathode contacts assure dependable contact. Silicone cup fits snugly over magnetron input end. Leads insulated with silicone.



Magnetron Input Connector Cat. 9060

Fits Miniature Magnetrons such as L-3028B. Features similar to Cat. 9050 but supplied less silicone enclosure. Leads extend axially from body of connector. Normally potted to magnetron input end.



Call or write for bulletins on special sockets, magnetron and other connectors

JETTRON PRODUCTS • INC

56 Route 10, Hanover, New Jersey
Telephones: TUcker 7-0571-0572

Sales Engineers in Principal Cities

CIRCLE 136 ON READER-SERVICE CARD

Oscilloscope Preamplifier

388

Gain is 40 db

Model SPR-100 oscilloscope pre-amplifier has a gain of 40 db. Response is flat from 500 kc to 250 mc. The unit provides a 60-cps square wave response. Its vswr is less than 1.08.

Jerrold Electronics Corp., Dept. ED, The Jerrold Bldg., 15th and Lehigh, Philadelphia 32, Pa. Booth 426-427.

Air Data Computing System

389

Supplies flight data for fighter systems

The central air data computing system designed for the F-104G supplies flight data intelligence to systems including the auto-pilot, in-range computer, fire control computer, position and homing indication, and internal navigator. The system consists of a transducer package and total temperature sensor. Information from these units is fed to a computer package which supplies Mach, altitude, pressure, air speed and angle of attack information.

The Garrett Corp., AiResearch Manufacturing Co., Dept. ED, 9851-9951 Sepulveda Blvd., Los Angeles 45, Calif.

Booth 2056-2057.

Stand-Off Terminals

385

Double-turreted

These double-turreted, Teflon stand-off terminals are 0.148 in. in diameter and fit into a 0.136 ±0.002-in. hole, accommodating panel thicknesses of 1/16 to 1/4 in. The following heights are offered: type 4025, 1/4 in.; type 4026, about 9/32 in.; type 4027, about 5/16 in.; and type 4028, 11/32 in. They are finished in silver plate or electro-tin plate and are constructed of brass.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass. Booth 747.



KCP SERIES

KT SERIES

KR SERIES

three for dependability at low cost

MEET P&B's FAMILY OF "K SERIES" RELAYS

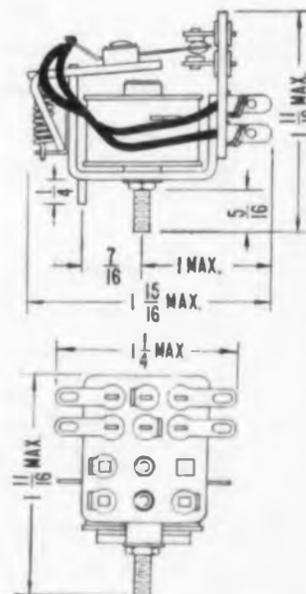
Here are only three of a large family of "K Series" relays by P&B. Blood brothers all, they are distinguished by fine craftsmanship and design maturity. Together they will handle a multitude of switching requirements.

Many design engineers find it saves time, saves money to integrate their circuits with related P&B relays. Makes sense, doesn't it?

KR—A small, lightweight relay used widely in communications and automation. Engineered for long life and dependability. 3PDT max. AC or DC. (See engineering data.)

KT—Designed for antenna switching. Capacitance: 0.5 mmfds between contacts. Terminal board is glass melamine and stack insulation is glass silicone for minimum RF losses to switch 300 ohm antenna line. 3 PDT max. AC or DC.

KC—Low cost plate circuit relay with sensitivity of 125 mw per pole. Factory adjusted to pull-in on specific current values. Available open, hermetically sealed or in clear plastic dust cover with standard octal-type plug. 3 PDT max. DC.



KR ENGINEERING DATA

GENERAL:
Breakdown Voltage: 500 volts rms minimum between all elements.

Temperature Range:
DC Coils—45°C to 85°C.
AC Coils—45°C to 70°C.

Terminals:
Pierced solder lugs standard, Octal 8 and 11 pin plug-in headers available.

Enclosures: Type K—Hermetically sealed.
Type P clear cellulose acetate dust cover.

CONTACTS:
Arrangements: 3 Form C (3PDT) max.
Material: 1/8" dia. fine silver (gold plated).
Other materials available to increase contact capacity.
Load: 5 amperes 115V 60 cycle resistive.

COILS:
Resistance: 16,500 ohms max. AC or DC.

Power: 1.1 watts minimum to 4 watts maximum for DC at 25°C ambient.

Duty: Continuous.
Insulation: Centrally impregnated with insulating varnish.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

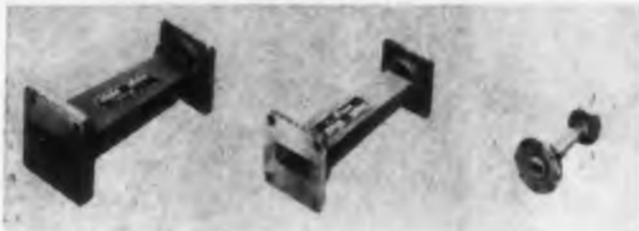
IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

CIRCLE 137 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON Tapered Transitions

355

Frequency range is 3.95 to 140 kmc



Offered in any of 60 combinations of input and output sizes, the DB-108 line of tapered transitions covers the frequency range of 3.95 to 140 kmc. Energy can be transferred from one size of waveguide to a waveguide of another size using only one transition. Standard UG-n/U cover flanges are supplied with the units. All units are plated with nickel over silver over copper.

DeMornay-Bonardi, Dept. ED, 780 Arroyo Parkway, Pasadena, Calif.

Price & Availability: \$50 to \$270 ea; delivery in two weeks to 30 days.

Booth 2214-2215.

Resistivity Bridge

453

For ultra-pure water

Model RD-336 "Solu-Bridge" checks the resistivity of hot, ultra-pure water used in washing of semiconductor materials. Range of the instrument is 1 to 18 meg per cm specific resistance, and a manual temperature compensator calibrated for 70 to 100 C is included.

Industrial Instruments, Inc., Dept. ED, 89 Commerce Road, Cedar Grove, N.J.

Booth 2314.

Attenuator

394

Range is dc to 500 mc



Model AV-50, laboratory rf attenuator has a range of dc to 500 mc. Attenuation is 0 to 62.5 db in 0.5-db steps. Vswr is 1.15 at 250 mc and 1.4 at 500 mc.

Jerrold Electronics Corp., Dept. ED, The Jerrold Bldg., 15th and Lehigh, Philadelphia 32, Pa. Booth 426-427.

Hi-G BALANCED ROTARY RELAYS

**MICRO-MINIATURE
B SERIES
150 to 300 MW**



DC TYPE	AC TYPE	NOTES
B	BR	Terminals on .200 centers for grid-board application.

SPECIFICATIONS:

CONTACTS: SPDT or DPDT, standard rating 2 amps at 32 VDC. Dry circuit and special contacts also available.

COIL: Up to 5K. AC units have 1/2 wave diode rectifier mounted internally for use over wide frequency range.

COIL VOLTAGE: Up to 115 volts.

SENSITIVITY AT PULL-IN: 300 mw standard, for standard vibration, shock and contact ratings. Sensitivity changes as ratings change.

VIBRATION: 5-2000 cps at 20 G, standard.

SHOCK: 50 G, 11 ms operating, standard.

TEMPERATURE RANGE: -65°C to +125°C, standard.

HEADER STYLES: hook, plug-in, 1.5" leads and 3" leads.

ENCLOSURE STYLES: 5 standard mounting configurations including bracket, strap, and stud styles.

**MICROMINIATURE
SENSITIVE
BC SERIES**

25 MW - SPDT
40 MW - DPDT



SPECIFICATIONS:

CONTACTS: SPDT or DPDT, standard rating 2 amps at 32 VDC. Dry circuit and special contacts also available.

COIL: Standard Coil Resistance available to 10K. Standard DC coil tolerance is ± 10%. Closer tolerances and higher coil resistances available.

SENSITIVITY AT PULL-IN: 25°C standard, 40 mw for DPDT; 25 mw for SPDT.

VIBRATION: 20 G to 2000 cps for standard sensitivity, for best sensitivity 10 G to 500 cps.

SHOCK: 50G for 11 ms for standard sensitivity, 30G for 11 ms for best sensitivity. These ratings energized or de-energized with no contact opening.

TEMPERATURE RANGE: -65°C to +125°C standard; higher temperature units, special.

CASE DIMENSIONS: .4" x .8" x 1.275"

HEADER STYLES: hook, plug-in, 2.99" and 1.5" leads.

ENCLOSURE STYLES: 5 standard mounting configurations including bracket, strap, and stud styles.

**S & R
SERIES**



DC TYPE	AC TYPE	NOTES
S	R	Std. Hi-G miniature unit in can 1.076 dia. x 1-15/16" high, hook terminals.
SP	RP	Plug-in version of S, R. Sockets available from Hi-G.

SPECIFICATIONS:

CONTACTS: 1 to 4 pole, form C. Standard rating 4 amps resistive at 115 V AC or 28 V DC. Dry circuit and other special contacts also available.

COIL: Up to 25K standard. AC units have 1/2 or full-wave diode bridge rectifier mounted internally for use over wide frequency range.

COIL VOLTAGE: Up to 350 volts.

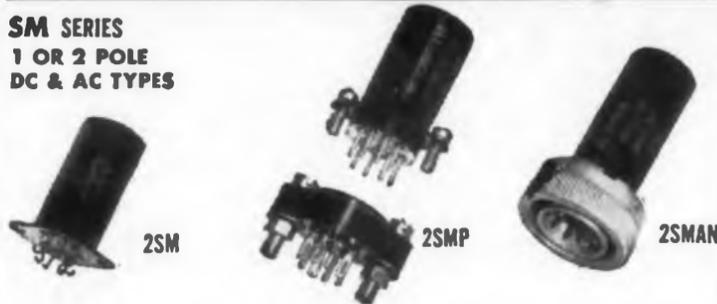
SENSITIVITY AT PULL-IN: 700 mw standard, for standard vibration, shock and contact ratings. Sensitivity changes as ratings change.

VIBRATION: 5-2000 cps at 20 G, standard.

SHOCK: 50 G, 11 ms operating, standard.

TEMPERATURE RANGE: -65°C to +125°C, standard.

**SM SERIES
1 OR 2 POLE
DC & AC TYPES**



DC TYPES	AC TYPES	NOTES
SM	SMR	Std. Hi-G sub-miniature in can .635 dia. x 1 1/4" high. 8 hook terminals.
SMP	SMRP	Same as above except straight pins for plug-in, Relay socket available from Hi-G.
SMAN	SMANR	Employs AN type connector (8 terminal) total length of unit 1 1/8".
SMA	SMAR	Adaptation of SM to obtain 8 equally spaced hook terminals 1 1/2" can.
SMAP	SMARP	Same as SMA except header for 7 pin miniature tube socket, or header for 9 pin noval tube socket.

SPECIFICATIONS:

CONTACTS: SPDT or DPDT, Standard rating 2 amps resistive at 115 V AC or 28 V DC. Dry circuit and other special contacts also available.

COIL: Up to 5K. AC units have 1/2 or full-wave diode bridge rectifier mounted internally for use over wide frequency range.

COIL VOLTAGE: Up to 115 volts.

SENSITIVITY AT PULL-IN: 700 mw standard, for standard vibration, shock and contact ratings. Sensitivity changes as ratings change.

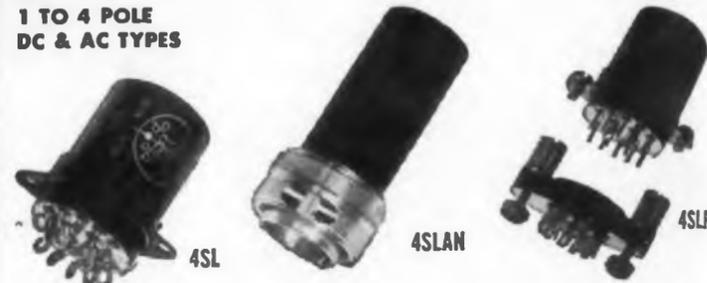
VIBRATION: 5-2000 cps at 20 G, standard.

SHOCK: 50 G, 11 ms operating, standard.

TEMPERATURE RANGE: -65°C to +125°C, standard.

The above specifications represent a complete line of our Rotary Balanced Relay capabilities.

**SL SERIES
1 TO 4 POLE
DC & AC TYPES**



DC TYPES	AC TYPES	NOTES
SL	SLR	Std. Hi-G miniature unit in can 1.076" dia. by 1 1/2" high. Hook terminal.
SLP	SLRP	Same as SL units, except straight pins for plug-in, Relay socket available from Hi-G.
SLAN	SLANR	AN connector (size 20 shell). Total length of unit 3-3/16".

SPECIFICATIONS:

CONTACTS: 1 to 4 pole form C. Standard rating 3 amps resistive at 115 V AC or 28 V DC. Dry circuit and other special contacts also available.

COIL: Up to 25K, standard. AC units have 1/2 or full-wave diode bridge rectifier mounted internally for use over wide frequency range.

COIL VOLTAGE: Up to 350 volts.

SENSITIVITY AT PULL-IN: 700 mw standard, for standard vibration, shock and contact ratings. Sensitivity changes as ratings change.

VIBRATION: 5-2000 cps at 20 G, standard.

SHOCK: 50 G, 11 ms operating, standard.

TEMPERATURE RANGE: -65°C to +125°C, standard.

New products not shown are: SPDT Dice Cube Relay, 4 pole Microminiature and 8 PDT units. See us at the WESCON Show Booth 666



HI-G, INC.

BRADLEY FIELD | TEL: NA 3-2481 • TWX: 562
WINDSOR LOCKS, CONNECTICUT

CIRCLE 138 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

Hi-G TIME DELAY RELAYS

1, 2 OR 4 POLE DC TYPES



The Time Delay Relays shown here are all standard units. Most units are custom manufactured utilizing faultless Time Delay circuitry combined with relays, custom adjusted in our own plant to meet stringent requirements.

TYPE	CONTACT ARRANGEMENT	CONTACT RATING	MAXIMUM CURRENT DRAIN @ 25°C
1107	1PDT	2A, 32 V DC Resistive	100 MA.
1108	2PDT	2A, 32 V DC Resistive	150
1109	4PDT	2A, 32 V DC Resistive	200
1110	4PDT	5A, 32 V DC Resistive 3A, 115 V AC Resistive	300

ELECTRICAL CHARACTERISTICS

INPUT VOLTAGE: 18-31 VDC

TIME DELAY: 50 milliseconds- 180 sec., on "make" only,

TIME DELAY TOLERANCE: 10% Standard over Temperature range, closer tolerances available.

RECYCLE TIME: 20 milliseconds maximum. The recycle time is the time required to attain 95% of normal time delay when power is interrupted after timing cycle is completed.

RECOVERY TIME: .1 sec. Max. 50 MS to 90 Sec.
.5 sec. Max. 91 Sec. to 180 Sec.

The recovery time is the time required to attain 90% of normal time delay when power is interrupted during timing cycle.

RESET TIME: 10 Milliseconds Max. The reset time is the time required for the contacts to return to normal position when power is removed.

ENVIRONMENTAL CHARACTERISTICS

TEMPERATURE: -55° to +85° C

VIBRATION: 20 G to 2000 CPS

SHOCK: 50 G 11 ± 1 millisecond duration

INSULATION RESISTANCE: 1000 Megohms @ 500 VDC

SEALING: 80,000 ft.

LIFE: 100,000 operations minimum

DIELECTRIC STRENGTH: 1000 VRMS, 60 cps. @ sea level

NOTE: The Time Delay Relays described in this advertisement are standard units. Special units are available at other voltages, time delays, tolerances, and other environmental characteristics. Delay times may be obtained on break only (with or without power) and other special timing requirements. Mounting configuration variations are available. Please consult factory regarding these requirements.

SEE US AT THE WESCON SHOW BOOTH 666

BRADLEY FIELD | TEL: NA 3-2481 • TWX: 562
WINDSOR LOCKS, CONNECTICUT

Power Triode

367

Rated at 60 kw



The type D-1008, a ceramic-metal power triode designed to withstand environmental extremes, is a water-cooled tube with a heavy-wall copper anode and mesh-type cathode. The tube is rated at 60 kw, full-power input to 50 mc and reduced input to 110 mc, with maximum anode dissipation of 20 kw. Applications include use as a class C amplifier, or as an oscillator in dielectric and induction heating service. The tube can switch 220 amp at 18 kv as a hard-tube radar modulator.

ITT Components Div., Electron Tube Div., Dept. ED, P.O. Box 412, Clifton, N.J.

Price & Availability: The D-1008 is available for immediate shipment and priced at \$380. Booth 2044-2045.

Multiplier Phototube

372

For ultra-violet and visible light



The type 7664 photomultiplier has 10 stages and is sensitive to visible and ultra-violet light to 1800 Å. An adjustable focusing electrode controls photo-electron efficiency. Average sensitivity is 60 µa, with a minimum of 50 µa for white light. The window has a 1-1/2 in. min diameter. Average cathode sensitivity at max response, and 210 v between cathode and other electrodes, is 0.056 per µa per µw. Average current amplification at 150 v per stage is 2 million.

Allen B. Du Mont Laboratories, Inc., Electronic Tube Sales Dept., Dept. ED, 750 Bloomfield Ave., Clifton, N.J.

Price & Availability: The type 7664 is priced at \$250 each and is available for immediate delivery. Booth 1023-1024.



HI-G, INC.

CIRCLE 139 ON READER-SERVICE CARD



Education

alone is not a true measure
of an engineer's ability

But without it you're on the outside looking in!

To us, while there is no substitute for education, professional engineering worth stems from a variety of things that merely *start* with a formal education. Throughout your engineering career there are rough edges to be smoothed. There's doing, re-doing, and doing again. There's frustration and despair. There's happiness and utter elation. There's growth and confidence and respect. There's maturity and courage of convictions. *This* is your ability, shaped, polished and made strong by conditions and people around you.

This evolution is by no means exclusive to us at RCA West Coast. We do, however, try to bring it out earlier and have you make more of it than most. Like to try? We have exceptional career opportunities for:

Advanced Systems Engineers, Development and Design Engineers, and Project Engineers with experience in these areas: Electronic Countermeasures, Data Processing and Computer Systems, and Missile Ground Support Systems.

For further information about us, *and you*, see the box at right.



RADIO CORPORATION OF AMERICA
WEST COAST MISSILE AND SURFACE RADAR DIVISION

The name you know is the place to grow!

CIRCLE 900 ON CAREER INQUIRY FORM, PAGE 233

RCA
WEST COAST

Call collect or write:
Mr. O. S. Knox
EMpire 4-6485
8500 Balboa Blvd.
Dept. 360-H
Van Nuys, California



NEW PRODUCTS AT WESCON

Trigger Rate Converter

399

Provides rates to 300 mc



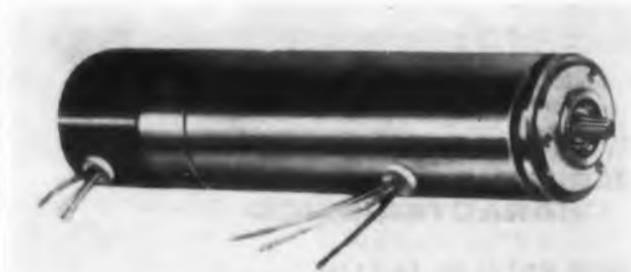
Model 602 trigger rate converter permits triggering rates to 300 mc and higher with conventional and sampling oscilloscopes. The device makes it possible to view sine waves up to 60 mc on 30-mc oscilloscopes. Pulses generated have risetimes in millimicroseconds and a 50-kc repetition rate. The pulses are synchronous with the input signal.

Lumatron Electronics, Inc., 116 County Court House Road, New Hyde Park, L.I., N.Y.
Price & Availability: \$440; from stock.
Booth 2414.

Tachometer

402

Motor-integrating type



This motor-integrating tachometer, size 10, has a diameter of 0.937 in., a rotor moment of inertia of 3 gm-cm² and an acceleration at stall of 9,500 radians per sec². The scale factor is 2.5 v per 1,000 rpm and the linearity from 0 to 3,600 rpm is $\pm 0.12\%$. Temperature range is -55 to $+125$ C. The device is suitable for use in analog computers and velocity regulation systems.

Bendix Corp., Eclipse-Pioneer Div., Dept. ED, Teterboro, N.J.
Booth 1050-1051.

Power Transistors

451

Meet military specifications

Thirty-four additional industrial power transistors have been issued under the Meg-A-Life certified reliability program. The units are designed for continuous operation at junction temperatures of 100 C, and are housed in TO-3 packages. Power dissipation is 90 w and thermal resistance

is 0.8 C per w. Each production lot of these transistors undergoes mechanical, electrical, environmental and life testing according to MIL-S-19500B specifications.

Motorola Semiconductor Products, Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

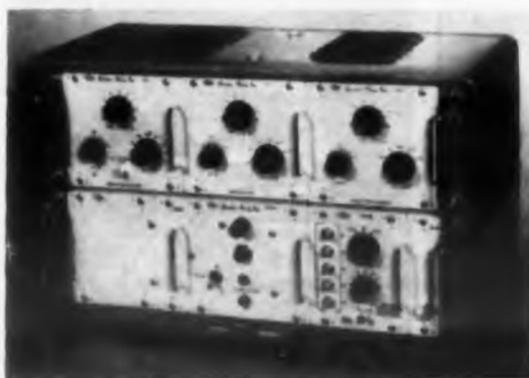
Price & Availability: Units in quantities of 100 and over are priced from \$1.80 to \$9.00. They are available from stock.

Booth 2021-2022.

Pulse Generator

351

Repetition rate is 10 mc to 100 cps



Model 4550A 10-mc pulse generator has a repetition rate that is variable from 10 mc to 100 cps, a variable delay of 0.02 to 1,000 μ sec, a variable duration of 0.05 to 1,000 μ sec, and a rise time of less than 10 nsec. The output amplitude is 12 v open circuit, 8 v into a 180-ohm load.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.

Price & Availability: \$1,695 ea; 60-day delivery. Booth 412-413.

Chart Recorders

404

Single and dual-channel models



These single and dual-channel galvanometric chart-recorders have flush-mounting design for panel installation. They have swing-out chart carriers and a slide-out chassis. A zero adjustment provides for zero settings over the entire scale as well as zero suppression above and below scale.

Texas Instruments, Inc., Dept. ED, 3609 Buffalo Speedway, Houston 6, Tex.

Price & Availability: \$495 for the single units, \$925 for the dual type; 60-day delivery.

Booth 735-736.

NEW

TRANSISTOR - REGULATED

- *Five-Year Warranty*
- *Transient-Free Output*
- *Exclusive Regulator Circuit*

Two new lines of power supplies — one high and one low voltage line — are available now from POWER SOURCES, INC. Both lines feature the exclusive POWER SOURCES regulator circuit that provides full protection for the transistors *without* DC fuses or circuit breakers. Both lines are warranted for *five full years*. Warranty includes all semi-conductor components. Cooling systems of advanced design insure long life and trouble-free operation.

For complete specifications on POWER SOURCES high and low voltage solid state power supplies, write or phone today.



Specify POWER SOURCES BY

POWER SOURCES, INC. Burlington, Massachusetts

See a Demonstration at WESCON • Booth No. 831-A

CIRCLE 140 ON READER-SERVICE CARD



Model PS4232

115-325 volts DC out
at 1.5 amp maximum



Model PS4330

0-36 volts DC out
at 30 amp maximum

POWER SUPPLIES

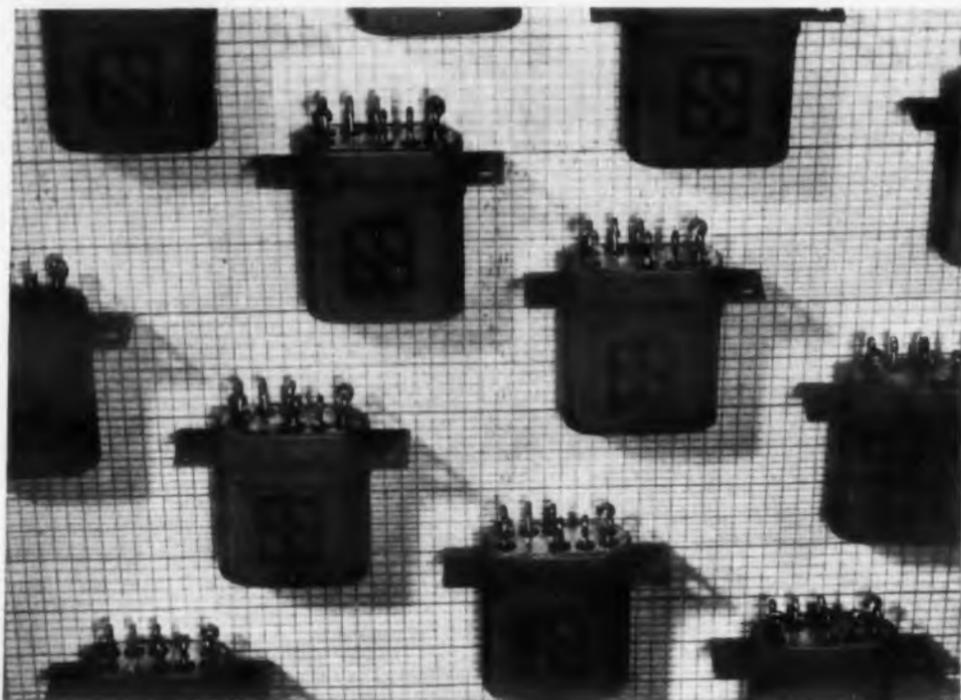
High Voltage Supply Specifications

	PS4222	PS4230	PS4232
DC Output Range	35-215 volts 0-1.5 amps	90-300 volts 0-1.5 amps	115-325 volts 0-1.5 amps
AC Input	105-125 volts, 50-60 cps*, all models		
Regulation (line)	Better than 0.1% or 0.2 volts over entire input range		
Regulation (load)	Better than 0.1% or 0.2 volts for no-load to full load		
Transient Response	Output remains within regulation limits for step-function change of 10 volts in 105-125 volt input range Output remains within regulation limits for changes from no-load to full-load or full-load to no-load		

Low Voltage Supply Specifications

	PS4305	PS4315	PS4330
DC Output Range	0-36 volts 0-5 amps	0-36 volts 0-15 amps	0-36 volts 0-30 amps
AC Input	105-125 volts, 50-400 cps, all models		
Regulation (line)	Better than 0.025% or 3 mv over input range		
Regulation (load)	Better than 0.05% or 5 mv, no-load to full-load variation		
Transient Response	Output remains within regulation limits for line voltage steps of 10 volts within input range Output recovers in 100 μ sec for no-load to full-load or full-load to 10% load step changes.		

*400 cps available on order



This is the new Union Crystal Case Relay

The UNION 2-PDT General Purpose Crystal Case Relay is designed to consistently meet the requirements of MS 24250, Mil-R-25018, Mil-R-5757C. Use it where minimum size and *optimum reliability* are essential—in control systems, computers, airborne and guided missile electronic equipment.

To provide vibration immunity, we have incorporated a unique feature in this relay's armature suspension system. A torsion wire is anchored to the armature and backstrap. It acts as a biasing spring; supports the armature and eliminates end play. The relay uses the rotary principle of operation, found in the entire line of extremely reliable Union Switch & Signal miniature relays.

The 2-pole, double throw, bifurcated contact structure increases reliability and efficiency in dry circuit applications. UNION Crystal Case Relays are designed for continuous operations in the -65°C to $+125^{\circ}\text{C}$ range.

Union Switch & Signal's manufacturing capabilities and experience make it possible to provide these quality relays in quantity. Manufacturing techniques make it possible to provide the ultimate in reliability.

The new UNION Crystal Case Relay is available with the 0.2" grid-spaced header or "S" type header, with solder lugs, plug-in terminals, or 3-inch leads, and for various operating voltages.

Contact Union Switch & Signal for additional information about this new Crystal Case Relay. Write for bulletin 1064.

Vibration: 20 G—2,000 cps

Shock: 50 G

Temperature Rating: -65°C to $+125^{\circ}\text{C}$

Contact Rating: Dry circuit to 2 amp., 28-volt DC resistive load.

See the new UNION General Purpose Crystal Case Relay at the WESCON Show, Memorial Sports Arena, Los Angeles, California, August 23-26, 1960, Booth 2828-2829.

"Pioneers in Push-Button Science"



UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY —

PITTSBURGH 18, PENNSYLVANIA

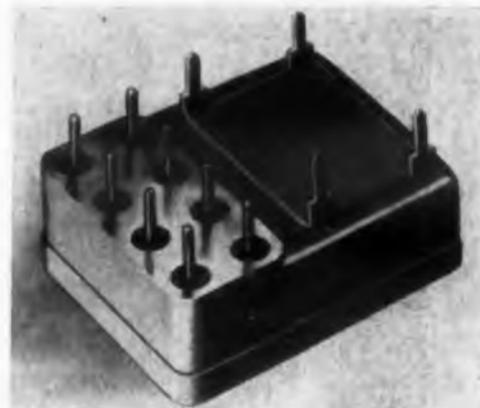
CIRCLE 141 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

DPDT Relay

405

For printed circuit use



Style 6A dpdt relay is similar to the firm's style 6 relay but is smaller. Installed height is about 0.44 in. Terminals and mounting tabs conform with the 0.2-in. grid pattern. The unit operates at coil powers lower than those required for larger current-sensitive relays in the same class. It switches load currents of 2 amp resistive and higher at 26.5 v dc or 115 v ac. It stands 50 g shock and 20 g vibration at 2,000 cps.

Price Electric Corp., Dept. ED, Frederick, Md.
Price & Availability: \$9.45 ea in quantities of 100 to 499; 30- to 45-day delivery.
Booth 459.

Motor Tachometer

409

Unit is temperature-compensated

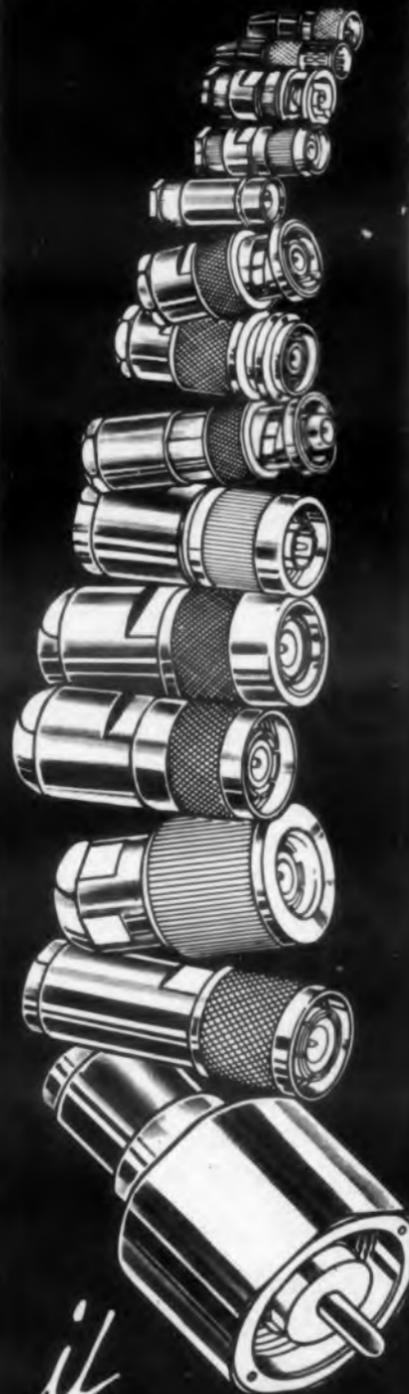


Model 15A23D-O1C motor tachometer is a precision temperature-compensated, non-frequency sensitive instrument. Output is 2.75 v per 1,000 rpm $\pm 0.25\%$ from 0 to 70 C, with adjustability to $\pm 0.01\%$ from 60 to 80 C. Linearity to 3,600 rpm is within $\pm 0.07\%$. The unit is designed for missiles, computer packages, electronic systems and airborne or ground support control units. Environmental Mil specs are met.

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

Availability: Delivery is 60 days.
Booth 2349.

Connectors



*if
it's co-ax
we make it!*

Technical Brochures are available upon request.

Automatic

METAL PRODUCTS CORP.
323 BERRY ST., B'KLYN 11, N.Y.

Telephone: EVergreen 8-6057

CIRCLE 142 ON READER-SERVICE CARD
ELECTRONIC DESIGN • August 3, 1960

Copper Clad Laminates

383

Thickness is 1/200 in.

A number of thin, copper clad laminates are available in lengths up to 100 ft. Among them are 1- or 2-oz copper bonded to 0.005-in. Kel-f, 0.005-in. Teflon-FEP, 0.007-in. Teflon-glass cloth, 0.005-in. linear polyethylene and 0.006-in. Mylar. Copper clad vinyl, Mylar vinyl and glass-reinforced silicone rubber will be available in the future.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.
Booth 804-805.

Subcarrier Oscillator 365

Input impedance is 50,000 ohms

Model 10081 subcarrier oscillator provides a full frequency deviation output for only 20 mv input and has an input impedance of 50,000 ohms. Linearity is within 1% of bandwidth and frequency stability is within 2.5% over the temperature range of 0 to 85 C. All the functions of a low-level dc balanced input amplifier as well as those of a subcarrier oscillator are contained in the unit.

Hoover Electronics Co., Dept. ED, 110 W. Timonium Road, Timonium, Md.
Booth 2822.

C-Band Attenuator 382

Attenuation exceeds 25 db

Model TFA-1 is a C-band, electrically variable attenuator. Attenuation range exceeds 25 db from 4900 to 5800 mc. The insertion loss is less than 1 db, and temperature range is -55 to +125 C. It can handle 3 w average and 3 kw peak power. The unit has a 1.12-in. diam and 3.18-in. length. Weight is 6 oz. Applications include fast AGC circuits, remote level control systems, and use as a modulator or fast-acting switch.

The Bendix Corp., Electron Tube Products, Red Bank Div., Dept. ED, Eatontown, N.J.
Booth 1046-1047.

CIRCLE 143 ON READER-SERVICE CARD

CONVECTION COOLED GUARANTEED 5 YEARS

LAMBDA Transistorized Power Supplies

LA Series

5 and 10 AMP • 0-34 VDC



3½" Panel Height on 5 AMP Models

CONDENSED DATA ON LA SERIES

LA 50-03AM (with meters)	0-34 VDC, 0-5A	\$425.
LA 100-03AM (with meters)	0-34 VDC, 0-10A	540.
LA 50-03A (without meters)	0-34 VDC, 0-5A	395.
LA 100-03A (without meters)	0-34 VDC, 0-10A	510.

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

Regulation: Line Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 100-130 VAC. Load Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input: 100-130 VAC, 60 ± 0.3 cycle. This frequency band amply covers standard commercial power lines in the United States and Canada.

Ripple and Noise: Less than 1 millivolt rms.

Ambient Temperature: 50°C—continuous duty.

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.

Size:

LA 50-03A	3½" H x 19" W x 14⅜" D
LA 100-03A	7" H x 19" W x 14⅜" D

LT Series

1 and 2 AMP • 0-32 VDC



Compact 3½" Panel Height

CONDENSED DATA ON LT SERIES

LT 1095M (with meters)	0-32 VDC, 0-1 AMP	\$315.
LT 2095M (with meters)	0-32 VDC, 0-2 AMP	395.
LT 1095 (without meters)	0-32 VDC, 0-1 AMP	285.
LT 2095 (without meters)	0-32 VDC, 0-2 AMP	365.

MODEL VOLTAGE BANDS

LT 1095, LT-1095M	0-8, 8-16, 16-24, 24-32
LT 2095, LT-2095M	0-8, 8-16, 16-24, 24-32

Regulation: Line Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC. Load Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input: 105-125 VAC, 50-400 CPS.

Ripple and Noise: Less than 1 millivolt rms.

Ambient Temperature: 50°C—continuous duty.

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.

Size:

LT 1095	3½" H x 19" W x 14⅜" D
LT 2095	3½" H x 19" W x 14⅜" D

SEND TODAY FOR COMPLETE DATA.



LAMBDA ELECTRONICS CORP.

11-11 131 STREET • DEPT. 2 • COLLEGE POINT 56, N. Y. • INDEPENDENCE 1-8500

See us at Wescon, Booths 2114 and 2115

if you need compact cooling devices
...you need



Westinghouse

**SILICON POWER
RECTIFIERS
AND
TRANSISTORS**

NOW IN STOCK

**YOU CAN OBTAIN
UP TO 1000 PIECES
OF MOST TYPES
AT
FACTORY PRICES
FROM**

Schweber

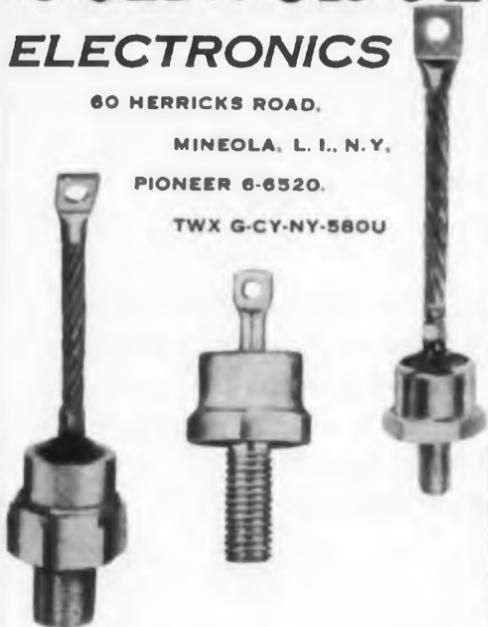
ELECTRONICS

60 HERRICKS ROAD,

MINEOLA, L. I., N. Y.

PIONEER 6-6520.

TWX G-CY-NY-580U



CIRCLE 129 ON READER-SERVICE CARD



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need

WESTINGHOUSE THERMOELECTRIC COOLERS

NOW AVAILABLE AT REDUCED PRICES

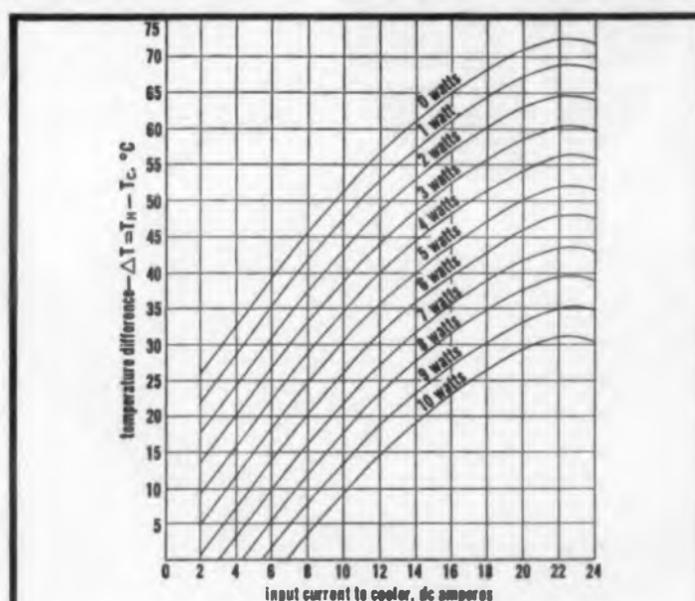
Now you can have the space and weight savings of Westinghouse "Component-Matched" thermoelectric coolers—with new cost savings, too. Prices are reduced on standard units, up to 50%!

Exclusive Westinghouse "Component-Matched" configurations! With no moving parts, Westinghouse Thermoelectric coolers provide dependable, compact, lightweight cooling where it is necessary to reduce component temperature below ambient. These unique "Component-Matched" coolers feature exterior cooling surfaces or inner-cooled chambers with tailor-made dimensions to fit specific requirements. As a result of new production facilities, a wide range of configurations can be offered to electronic equipment designers.

Only Westinghouse guarantees minimum ΔT ratings! Recent Westinghouse improvements in thermoelectric materials and assembly techniques have made it possible to guarantee minimum ΔT ratings for each cooling unit. Thus, a designer can select the unit he needs knowing in advance what the temperature drop will be from the hot to the cold side of the cooler.

Immediate military and industrial applications include: Photocells, photomultiplier tubes / Germanium transistors / Infrared detectors / Mechanical and electrical instruments / Laboratory and portable medical equipment / Controlling temperatures of solids, liquids and gases.

Westinghouse engineers who developed these new thermoelectric coolers will be glad to provide engineering assistance in your applications. For full information, contact your local Westinghouse representative, or write: Westinghouse Electric Corporation, Semiconductor Dept., Youngwood, Pennsylvania. SC-1000



Typical $\Delta T^\circ C$ versus input current—
Types WX814-H, WX816-H

**"Buy and Try"—from Westinghouse distributors
—standard WX814 and WX816 Coolers for
immediate delivery at new reduced prices.**

EASTERN

CAMERADIO	Pittsburgh, Pa./EX 1-4000
CRAMER ELECTRONICS, INC.	Boston, Mass./CO 7-4700
ELECTRONIC SUPPLY	Melbourne, Florida/PA 3-1441
GENERAL RADIO SUPPLY CO., INC.	Camden, N.J./WO 4-8560
KANN-ELLERT ELECTRONICS, INC.	Baltimore, Md./TU 9-4242
MILGRAY ELECTRONICS	New York, N.Y./RE 2-4400
RADIO & ELECTRONIC PARTS CORP.	Cleveland, Ohio/UT 1-6060
SCHWEBER ELECTRONICS	Long Island, N.Y./PI 6-6520

MIDWESTERN

ELECTRONIC COMPONENTS FOR INDUSTRY CO.	St. Louis, Mo./WO 2-9917
INTER-STATE RADIO & SUPPLY CO.	Denver 4, Colo./TA 5-8257
LENERT CO.	Houston, Texas/CA 4-2663
RADIO DISTRIBUTING CO.	Indianapolis, Ind./ME 5-8311
SEMICONDUCTOR SPECIALISTS, INC.	Chicago, Ill./NA 2-8860
UNITED RADIO, INC.	Cincinnati, Ohio/MA 1-6530

WESTERN

ELMAR ELECTRONICS	Oakland, Calif./TE 4-3311
HAMILTON ELECTRO SALES	Los Angeles, Calif./BR 2-8453
NEWARK ELECTRONICS CO.	Inglewood, Calif./OR 4-8440

**YOU CAN BE SURE...IF IT'S
Westinghouse**



Westinghouse

SILICON POWER
RECTIFIERS
AND
TRANSISTORS

NOW IN STOCK

YOU CAN OBTAIN
UP TO 1000 PIECES
OF MOST TYPES
AT
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FROM

Schweber

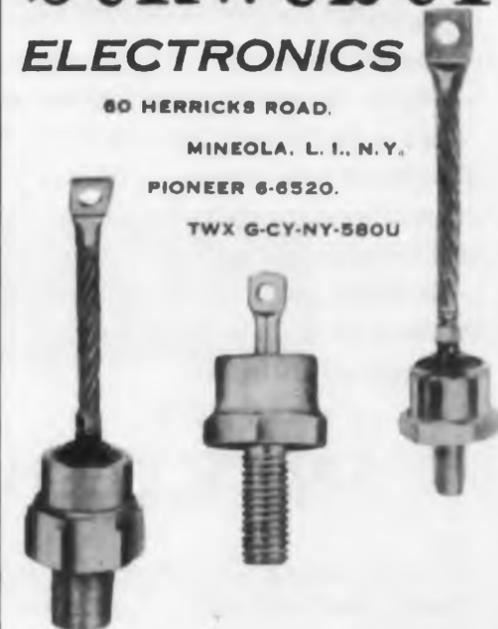
ELECTRONICS

60 HERRICKS ROAD.

MINEOLA, L. I., N. Y.

PIONEER 6-6520.

TWX G-CY-NY-580U



CIRCLE 129 ON READER-SERVICE CARD
◀ CIRCLE 144 ON READER-SERVICE CARD



The Air Force Missile Family... Scions of Space Technology

Science and technology, especially as they relate to missile art, have advanced further in the last six years than in the preceding six centuries. Any review of the many milestones successfully attained since 1954 reveals an epic of hard work, inventiveness, accomplishment, and singleness of objective. This single objective—the achievement of operational weapon capability at the earliest possible date—is being realized.

The Air Force missile family including Atlas, Thor, Titan, and Minuteman, has achieved progress beyond expectation in a program unmatched for magnitude and complexity.

Space Technology Laboratories has had the responsibility since 1954 for the over-all systems engineering and technical direction of these programs. STL's scientific and technical management capabilities have not only helped to hasten the day of operational capability for Air Force ballistic missiles, but have also been applied in carrying out related space probe and satellite projects.

Scientists and engineers with outstanding qualifications find unusual opportunities for their skills and disciplines at STL. Positions on STL's technical staff are now available for those who wish to add a new dimension to their careers. Resumes and inquiries are invited.

SPACE TECHNOLOGY LABORATORIES, INC.

P. O. Box 95004, Los Angeles 45, California • STL
Florida offers immediate opportunities to outstanding



Instrumentation Engineers. Write: Mr. George S. Cherniak,
STL, P. O. Box 4277, Patrick Air Force Base, Florida

NEW PRODUCTS AT WESCON

Regulated Power Supply

369

Rated 0 to 10 amp, 0 to 100 v dc



Model ST100-10 transistor power supply is rated at 0 to 100 v dc, 0 to 10 amp continuous duty; the output is continuously variable over the entire range. Vernier control provides about 1 v variation for full rotation. Line regulation is 0.005% for changes between 100 and 135 v ac, and load regulation is 0.01% for changes from 0 to full load. The unit has continuously variable automatic overload protection, programming from a distant point over a narrow voltage range and plug-in sub-assemblies.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

Price & Availability: Price fob Springfield is \$1595; delivery is 30 days.

Booth 2312.

Rack-Mounted Oscilloscope

454

Bandwidth is 500 kc

Model 401BR is a rack-mounted version of Model 401B general purpose oscilloscope. Bandwidth of the scope is 500 kc at 3 db down. Sensitivity is 10 mv per cm with identical X and Y amplifiers.

Allen B. Du Mont Laboratories, Inc., Dept. ED, Clifton, N.J.

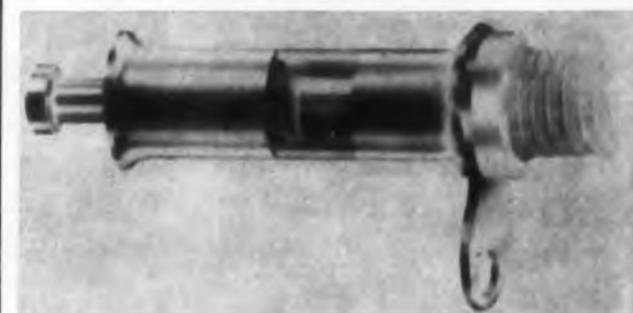
Price & Availability: Price is \$430. Units are available from stock.

Booth 1023-1024.

Trimmer Capacitors

398

For ungrounded operation



The Turret Sealcap series of trimmer capacitors offers low capacitance to ground for applications requiring ungrounded operation. Capacitance

ranges vary from 0.6 to 30 pf. Sealed interior construction protects against atmospheric effects. Tuning resolution is excellent. With glass dielectric, there is no derating at 125 C; with quartz, no derating at 150 C.

JFD Electronics Corp., Dept. ED, 601 16th Ave., Brooklyn 4, N.Y.

Price & Availability: \$3.15 to \$6.75 ea in production quantities. Delivery time is one week. Booth 667.

Scanner

353

Scans up to 100 inputs



Model 701 electronic scanner scans up to 100 inputs, using a true differential, isolated, and guarded input. The measured value is the voltage between the two input terminals independent of the common mode voltage. The unit is internally organized in groups of 10 channels with a maximum of 10 groups. Maximum operating rate is 500 channels per sec.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.
Booth 2810-2811.

Marker Generator

396

Is crystal controlled



Model CM-10 crystal-controlled marker generator is similar to model CM-6, but is a 10-crystal unit and is rack mounted. Frequency range is 2 to 100 mc. In the higher frequencies, up to the 20th harmonic will be visible, and in the lower frequencies, up to the 10th harmonic will be visible. The outputs of the individual oscillators can be mixed with the output of each completely controlled from maximum output to no output.

Jerrold Electronics Corp., Dept. ED, The Jerrold Bldg., 15th and Lehigh, Philadelphia 32, Pa.
Booth 426-427.

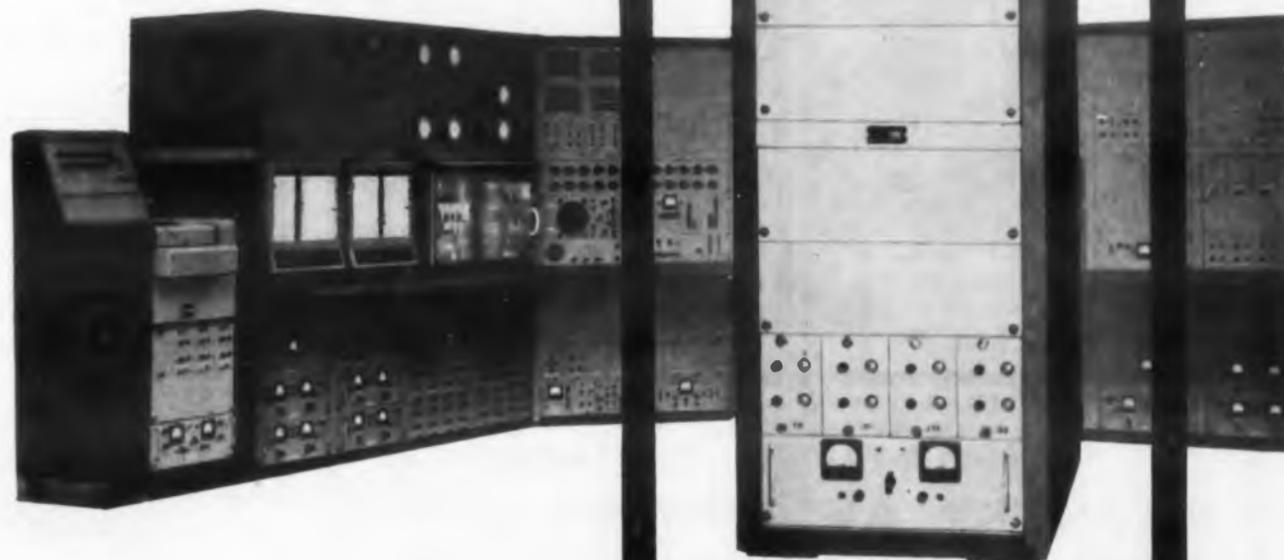
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REAC®

offers a new high frequency,
solid state Electronic Multiplier:

- Static accuracy comparable to the best time division multiplier designs
- Dynamic response far in excess of any other multiplier
- Factory calibrated — requires no field adjustment
- Solid state shaping networks
- Static Multiplier accuracy — to 0.05%

For complete specifications, write for Data File No. 208.



See our display at WESCON — Booths 919-920

MULTIPLIER CONSOLE

1. Eight Independent Products.
2. Expandable to 16 Products with adapter kit.
3. Adequate power for expansion to 16 products.
4. Operational Amplifier for each product.
5. Amplifier Balance Meter.
6. Standard Rack Mounting.

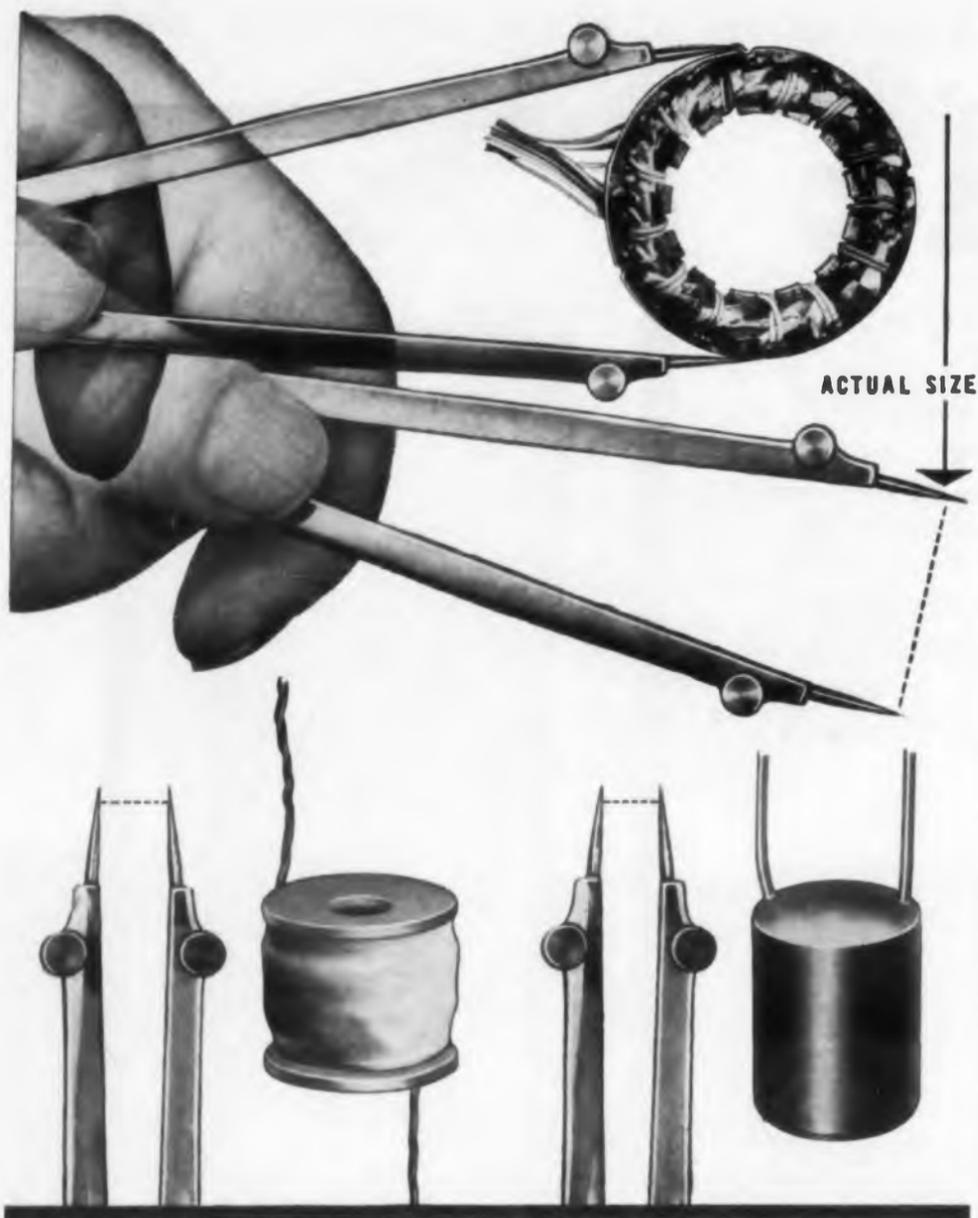
Qualified engineers seeking rewarding opportunities in these advanced fields are invited to get in touch with us.



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INSTRUMENT
CORPORATION**

A Subsidiary of Dynamics Corporation of America
Roosevelt Field, Garden City, New York

CIRCLE 145 ON READER-SERVICE CARD



COILS

INDUCTORS

MINIATURE COILS, EXACTLY AS YOU SPECIFY

...manufactured on a production basis

We have the facilities to produce consistent quality miniature coils, components, and Luxolene molded fine wire coils on a production basis, and engineered to fit your exact specifications.

The Miniature Products Division was founded to furnish electrical and electronic manufacturers with bobbin wound miniature coils—molded fine wire coils—self supported coil assemblies—completed assemblies (plain or encapsulated)—molded inductors—printed circuit board assemblies, etc.

The facilities of the Miniature Products Division are especially designed and equipped to produce up to and including 56 gauge ultra-fine wire coils and other custom built components.

Luxolene encapsulated fine wire coils resist moisture, acids and abrasive conditions.



MINIATURE PRODUCTS DIVISION

Deluxe COILS, INC.

WABASH, INDIANA

CIRCLE 146 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Oscillating Table

393

Angular type



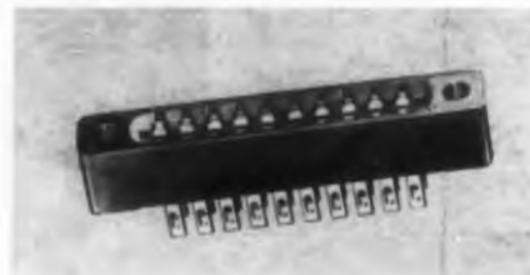
Model 61A angular oscillating table is for frequency-response testing of gyros, accelerometers, and guidance systems. A rate pickoff provides instantaneous rate information for presentation on an oscilloscope or recorder. Input may be from any audio amplifier, dc power amplifier, or shaker amplifier over the range of 0 to 100 cps.

Micro Gee Products, Inc., Dept. ED, Box 1005, 6319 W. Slauson Ave., Culver City, Calif.
Price & Availability: \$4,950 ea; from stock.
Booth 2624.

Printed Circuit Connectors

411

Provides 20 connections



Series 600 printed circuit connectors accept 1/32-in. printed circuit board or tape cable. A double row of 10 contacts with solder lug terminals provides 20 connections for board and circuit wiring on a connector length of 1-7/8 in. Voltage ratings are 650 v rms at sea level, 200 v rms at 70,000 ft. Current rating is 3 amp.

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

Availability: Delivery is about 30 days.
Booth 855-856.

Digital Computer

442

Operates at over 40,000 instructions per sec

Type PB-250 general purpose digital computer operates at up to 41,666 instructions per sec. The unit has a capacity of 1,808 words, which can be adapted for 15,888 words; it has a magneto-

for **CONTINUOUS**
RELIABILITY...
INSTALL Hoyt
PANEL METERS



NEW!
Model 1060
Transparent
Polystyrene

Quality meters on the panel indicate quality throughout—and HOYT Panel Meters are quality in appearance and function... the complete Line of matching AC and DC Meters for original equipment and replacement applications. Get accuracy, readability, and reliability; plus economy. Specify HOYT Electrical Instruments—compatible components for production, research, and test requirements.



Model 647
Black Bakelite

Moving coil, rectifier, and repulsion types available promptly in a wide assortment of sizes, ranges, cases, shapes, and colors; some with parallax-free mirror scales—all with standard mounting dimensions. Or custom designed to the most exacting specifications.



Model 17/3
Black Bakelite



Send for latest fully illustrated brochure with descriptions, engineering data, and moderate prices.

SEE US AT THE WESCON
SHOW—BOOTH 1007

Hoyt
SINCE 1904

**ELECTRICAL
INSTRUMENTS**

BURTON-ROGERS COMPANY

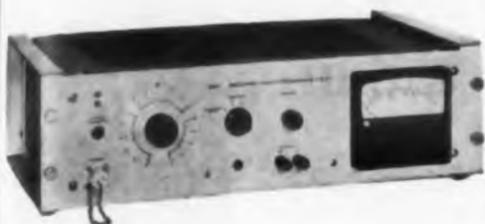
Sales Division—Dept. ED

42 Carleton Street, Cambridge 42, Mass.

CIRCLE 147 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

new, low-cost micro- microammeter



Model 414 offers high performance over 17 ranges for just \$280.00!

● The Keithley 414 Micro-microammeter is today's lowest-cost instrument for low current measurements in production tests, monitoring installations and experiments in the range of 10^{-2} to 10^{-11} ampere. The 414 can be used as the amplifier element in systems, such as reactor controls, thickness gauges, ionization gauge control in high-vacuum equipment. Contact meter models are available for go, no-go production tests, alarm and control systems.

SPECIFICATIONS

Ranges: 17 ranges in 1x and 3x steps, from 10 ma to 0.1 m μ a f.s.

Accuracy: Within $\pm 3\%$ of f.s. to 10 m μ a; $\pm 4\%$ on lower ranges.

Input Voltage Drop: Below 5 mv all ranges with full-scale signals.

Response Time: Below 0.5 sec. all ranges, for any input capacitance to 5000 μ f.

Zero Drift: Below 2% of f.s. per day.

Recorder Output: 5 volts with a 1 ma capability.

Price: Model 414..... \$280.00

For full details, write:

**KEITHLEY
INSTRUMENTS**

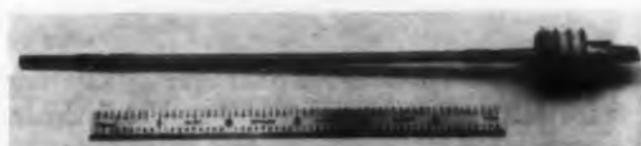
12415 EUCLID AVENUE
CLEVELAND 6, OHIO
CIRCLE 148 ON READER-SERVICE CARD

strictive delay line type memory system. The instrument is designed for 46 different commands. It measures 30 x 19 x 24 in., and will mount in a standard relay rack. Word length is 26 bits plus sign.

Packard Bell Computer Corp., Dept. ED, 1905 Armacost Ave., Los Angeles 25, Calif.

Price & Availability: The unit is priced at \$30,000, and can be delivered in 180 days. Booth 2264.

Traveling-Wave Tubes 368 Amplifiers for test instruments



This series of traveling-wave tubes is designed for test instrument application in the X-band. Type M2201-A is a direct electrical and mechanical replacement for use in the HP494A amplifier unit and operates from 7.0 to 12.4 kmc. The M2201-B is a replacement for use in the Alfred Electronics Model 504 amplifier unit and operates from 8.0 to 12.4 kmc. The tubes use metal-ceramic construction, low-temperature oxide cathodes and ceramic rod-supported helices, providing long life, low spurious modulation and high stability.

Microwave Electronics Corp., Dept. ED, 4061 Transport St., Palo Alto, Calif.

Price & Availability: Tubes, priced at \$850, can be delivered in 2 weeks. Booth 2154.

Tape Programmer 401 Programs 10 lines at a time

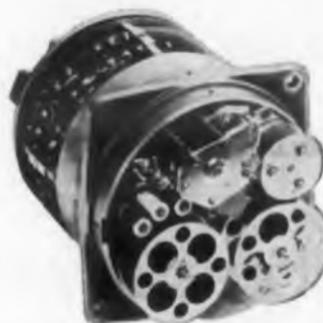


Model 213 tape programmer is able to program tape at one setting for an entire 10-line, eight-hole set of frames, instead of the usual one line at a time. It also alters or adds frames while duplicating tapes. It can punch tape frame by frame as well as line by line.

California Technical Industries, Dept. ED, 1421 Old County Road, Belmont, Calif.

Availability: Immediate. Booth 2631-2632.

5 - POUND PROGRAMMER delivers better than 5 - PARTS - PER- MILLION TIMING ACCURACY in missile applications



MODEL DS-500 PROGRAMMER
5" DIA. x 7"

Only 5 inches in diameter and 5 pounds 2 ounces in weight, the DS-500 Programmer delivers a typical timing accuracy of better than five parts per million. Over a total 15 minute program, it has a measured timing error of only .0045 seconds. This miniature tape programmer offers simultaneous, 6-channel, timing functions... incorporates amplifiers and control circuitry for remote operation control... provides contact closure at extremely precise intervals over the full program period after actuation of the "start time" signal. The programmer meets rugged environmental specifications: vibration -20 g at 5 to 2000 cps; acceleration -30 g; shock -50 g operation, 100 g survival; temperature range -from -25°C to +85°C; altitude -250,000 feet.

For complete information, write for Data File ED-1256-1.

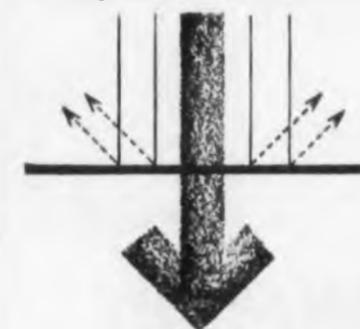


INTERNATIONAL AIRPORT
LOS ANGELES 45, CALIF.

CIRCLE 149 ON READER-SERVICE CARD

NEW 2½-POUND COMMAND RECEIVER

SCREENS OUT NOISE
...PULLS IN SIGNAL
for targets, drones & missiles



MODEL R-400A UHF RECEIVER
260 MC - 400 MC
6.8" L. x 3.5" W. x 3.1" H.

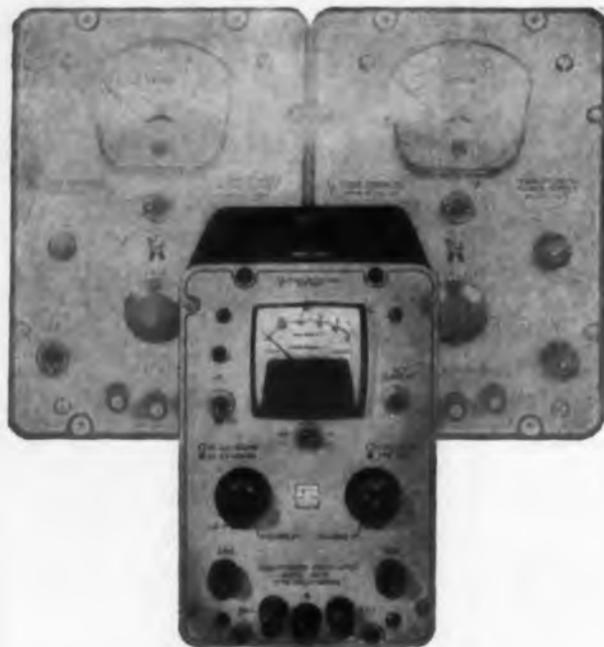
Operating under conditions of highly congested air space and a crowded radio spectrum, this tough, 44-ounce UHF remote receiver maintains excellent selectivity... eliminates spurious short time noise signals through an integrating time delay system. A crystal-controlled receiver, the R-400A operates on a very narrow channel with a stability greater than $\pm .01\%$ of the input frequency over a temperature range of -65°F to +160°F. It offers unlimited application in remote control of targets, drones and missiles where single channel remote control is desired. Selectivity (RF-IF) is: 6 db down, 60 kc \pm 10 kc; 60 db down, 170 kc \pm 20 kc. Sensitivity is better than 2 microvolts. Meets requirements of MIL-T-9790A.

For complete information, write for Data File ED-1257-1



INTERNATIONAL AIRPORT
LOS ANGELES 45, CALIF.

CIRCLE 150 ON READER-SERVICE CARD



CONSTANT VOLTAGE CONSTANT CURRENT

FROM THE SAME TERMINALS!

The Power Designs Inc. Model 4005 Power Supply adds a new dimension to the application of d-c sources for laboratory instrumentation. Truly universal, the Model 4005 may be operated as a constant voltage source, a constant current source, a constant voltage source with automatic current limiting or a constant current source with automatic voltage limiting.

The Model 4005 employs semiconductor devices exclusively in a new proprietary circuit called.....

AMBITROL® is a dual regulator system permitting continuous control of voltage or current with automatic electronic cross-over to either mode of operation.

The supply also features remote voltage programming, dual concentric controls for both coarse and fine adjustment of voltage or current and the HEATRAN® circuit for electronic control of power transistor dissipation.

*TM applied for.

MODEL 4005 SPECIFICATIONS
INPUT: 105-125 volts, 55-440 cycles single phase.
TEMPERATURE: Continuous duty at full load 0-50° C. ambient
POLARITY: Positive or negative output terminal may be grounded
DIMENSIONS: 5 3/4" W x 8 3/4" H x 11 3/4" D.

CONSTANT VOLTAGE

Range: 1-40 vdc, 0-0.5 amperes.

Regulation: .05% or 10 millivolts max. for line or load variations.

Ripple: .001% or 500 microvolts max.

Response Time: Less than 50 microseconds.

Source Z: 0.1 ohms to 20 kc, 0.5 ohms to 1 mc.

CONSTANT CURRENT

Range: 25 to 500 milliamperes.

Voltage compliance: Output current constant to full rated output voltage of 40 volts.

Regulation: .05% or 250 microamperes max. for line or load variations.

Ripple Content: .01% or 25 microamperes max.

Source Impedance: 100,000 ohms approx.



\$143⁵⁰
 F.O.B. FACTORY

WESCON
 BOOTH
 2305

†Prices subject to change without notice.

Power Designs inc. 1700 SHAMES DRIVE WESTBURY, NEW YORK

EDgewood 3-6200 (Long Distance Area Code 516)

CIRCLE 151 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Frequency Converter

354

Sensitivity is 1 mv



Model FC-1 transistorized frequency converter is for use with the firm's FM-6 or FM-7 vhf frequency meters. With these units, it measures and generates frequencies from 10 kc to 1,000 mc. It can be used with other meters. Resettability is ± 10 cps; sensitivity is 1 mv. Accuracy is 0.0001% ± 20 cps from 10 kc to 20 mc and 0.0001% from 20 mc to 1,000 mc.

Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

Price & Availability: \$425 ea; 30-day delivery. Booth 801-802.

Miniature Gearheads

410

Diameter is 1/2 in.



This size 5 gearhead and speed reducer unit weighs only a few grams; it measures 3/4-in. long and is 1/2-in. in diameter. It can have step-up or step-down ratios from 10:1 to 2,025:1. It is designed for satellite applications.

Bowmar Instrument Corp., Dept. ED, 8000 Bluffton Road, Fort Wayne, Ind. Booth 765.

Insulating Tubing

444

Made of rolled glass-silicone

Grade 11556 rolled glass-silicone tubing has a dissipation factor of 0.0015 and arc resistance of 240 sec at temperatures up to 500 F. The tubing, with high tensile strength and impact resistance, is suitable for coil forms, lead insulation and other

NEW...

compact...

small...

light...



CICOIL Super-Flex STRANDED-WIRE FLAT CABLE

for the ultimate in

FLEXIBILITY

CICOIL Super-Flex multi-conductor cable is ideal for use where extremes of temperature, movement and vibration preclude the use of other materials in missile packages, computers, gyro and radar systems. They provide light, reliable and compact harnessing of even the most complex electronic circuitry.

Super-Flex cables are made of stranded conductors, precisely spaced in CICOIL's specially processed silicone rubber base compound. Cables are made in lengths up to 8 feet, and widths determined by the size and number of conductors.

Cable termination can be supplied bare or with commercial or military grade connectors. Special connectors can be molded by CICOIL to meet your requirements.

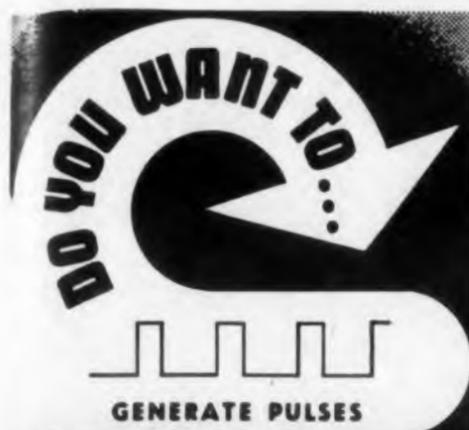
Write for new brochure and complete technical data

CICOIL CORPORATION

13833 SATICOY STREET
 VAN NUYS, CALIFORNIA
 STate 1-3440

CIRCLE 152 ON READER-SERVICE CARD

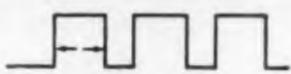
ELECTRONIC DESIGN • August 3, 1960



GENERATE PULSES



DELAY PULSES



WIDEN PULSES



REGISTER PULSES



COUNT PULSES



SUM PULSES



DO BINARY LOGIC



DRIVE TRANSISTOR CIRCUITS

New NAVCOR Series 300—completely transistorized 5" x 6" card modules available from stock to efficiently perform all major pulse generating and programming functions.

Write for
Series 300 Bulletin



CIRCLE 153 ON READER-SERVICE CARD
ELECTRONIC DESIGN • August 3, 1960

fabricated parts. The tubing is available in wall thicknesses from 0.031 to 0.5 in., ID from 0.187 to 6 in., OD from 0.25 to 7 in., and 36 in. lengths.

General Electric Co., Laminated Products Dept., Dept. ED, Coshocton, Ohio.

Price & Availability: Price is \$6.50 to \$10.75 per pound depending on thickness and quantity. Delivery is about 14 days.

Booth 211-B.

DC Power Supplies

373

Supply 5 to 50 v at 225 to 750 ma



The 20-Series Power Supplies (24 models) have an external potentiometer for output voltage adjustment, a removable cover, and either solder terminal or octal plug input and output connectors. Input is 105 to 125 v ac, 60 or 400 cps. Output is from 5 to 50 v dc, 225 to 750 ma, depending on the model. Regulation is within 20 mv. Units, weighing 3.25 lb measure 2-3/4 x 3-3/4 x 5 in. They are protected against overloads and shorts.

Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.

Price: \$115.00, *job Pasadena.*

Booth 1011.

Antenna Multiplexer

376

Greater than 60-db separation



Model MT-395 antenna multiplexer consists of three highly selective band-pass filters and a combining network for isolating transmitters and receivers with low rf loss. General specifications are: frequency range, 225 to 300 mc; isolation, greater than 60 db with 10 mc separation; insertion loss, 0.7 db max; vswr, 1.5:1 max; passband ± 750 kc min.

Rantec Corp., Dept. ED, Calabasas, Calif.

Availability: Delivery is about 60 days.

Booth 2207.

HELIPOT® ...

POTS : MOTORS : METERS

POTENTIOMETERS: The most complete lines of multi-turn and single-turn precision pots... linear and non-linear. Also dials; delay lines; and a complete line of precision trimming pots. Write for data file P712.

SERVOMOTORS: Motor-generators, motors, velocity damps and inertia damps... Sizes 8-11-15 & 18. Beckman® Servomotors feature the most rapid response in the industry... models are available for both 26-volt and 115-volt operation, or anything in between. Write for data file P713.

METERS: Panel meters and expanded scale meters... either commercial or ruggedized and sealed. A full range of sizes in voltmeters, ammeters, milliammeters, microammeters and frequency meters. Write for data file P714.



Beckman / Helipot®

POTS : MOTORS : METERS

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California

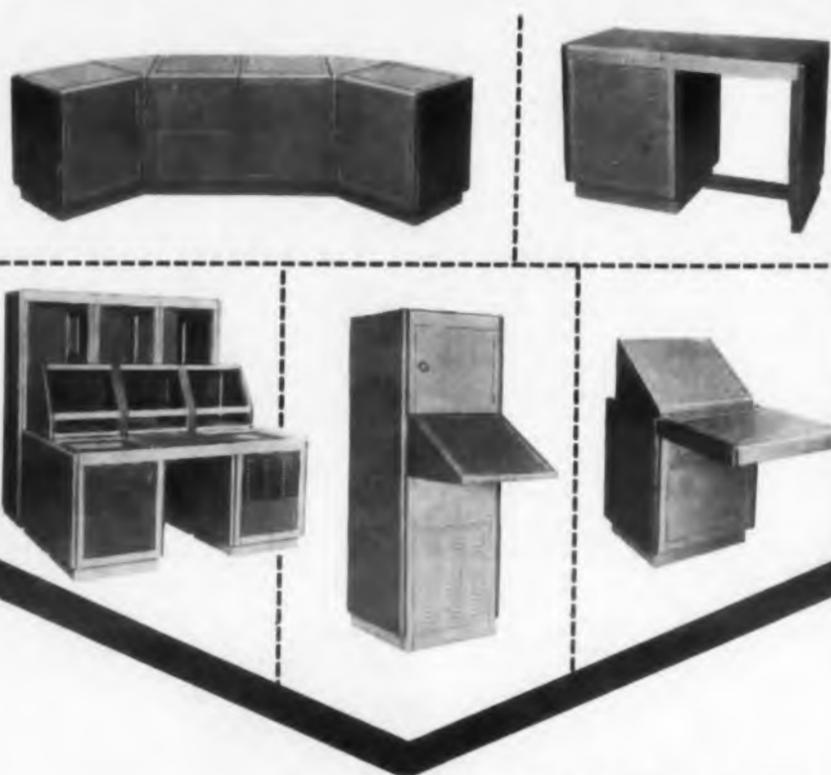


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CIRCLE 154 ON READER-SERVICE CARD

A few of the many unlimited arrangements made possible with the

PREM-O-RAK MODULAR CONSOLE SYSTEM



PACKAGE WITH PREMIER

<p>TR Series</p>	<p>RR Series</p>	<p>PR Series</p>	<p>F Series</p>	<p>FD Series</p>	<p>POR Series</p>	<p>DCR Series</p>	<p>SDR Series</p>
RELAY RACKS		TRANSMITTER RACKS		DESK CABINET RACKS			

Standard

CONSOLES • RACKS • CHASSIS • PANELS • CABINETS • CASES

Shown here are only a few of the many PREMIER STANDARD METAL HOUSINGS which are stocked by leading distributors throughout the country.

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PREMIER METAL PRODUCTS CO.
337 MANIDA STREET, NEW YORK 59, NEW YORK

WESTERN SALES OFFICE: 1485 Bayshore Blvd., San Francisco 24, California
EXPORT DEPARTMENT: EMEC, 127 Grace Street, Plainview, New York
IN CANADA: PREMIER METAL HOUSINGS, Ltd., 5810 Smart Ave., Montreal

SEE THE LATEST ADDITIONS TO THE PREM-O-RAK
MODULAR CONSOLE SYSTEM • WESCON SHOW - BOOTHS 340-341

CIRCLE 155 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Silicon Rectifiers

412

To replace mercury vapor tubes



Types ST-9 and ST-10 silicon plug-in rectifiers directly replace types 8008 and 872A mercury vapor rectifier tubes respectively. The units are rated at 10,000 piv and 1,250 ma dc output. Temperature range is from -65 to +75 C. The rectifiers are hermetically sealed. The ST-9 measures 8.03 in. x 2.13 in. diameter; the ST-10 measures 8.18 in. x 2.31 in. diameter.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.
Booth 2517-2518.

Photoelectric Cells

366

In many shapes and sizes

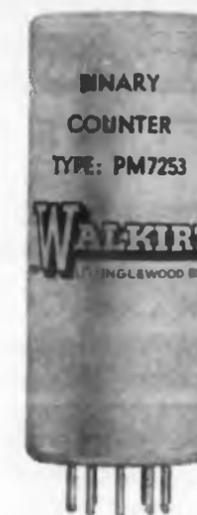


Type 5 self-generating selenium photoelectric cells can be fabricated into various spherical or cylindrical shapes, or into flexible strips which can be twisted into a variety of spiral designs. Sizes range as small as 1/16 in. sq, suitable for reading punched data cards. Convex or concave spherical shapes tend to be omnidirectional or unidirectional without the aid of a lens. Curved and spiral shapes set on a rotating base would be suitable for on-off power functions. Cells have high, stable output and resist mechanical damage.

Daystrom, Inc., Weston Instruments Div., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.
Booth 1037-1038.

BINARY COUNTERS

TRANSISTORIZED



ACTUAL SIZE

7/8" DIA. x 2 1/8" SEATED

IF YOU USE BINARY COUNTERS . . . You should select from Walkirt's big assortment of proved reliability, encapsulated counters. We make NPN and PNP types, Germanium or Silicon, in many physical configurations. We'd like you to compare our circuit performance and our price list with any other counter. For example, compare these brief specifications of the type PM7253 "ECONOMY LINE" binary pictured.

- MAX. FREQUENCY.....Over 800 KC
- RISE TIME.....Less Than 0.25 μ S
- LOAD.....Will Directly Drive 2 Triggered Circuits Per Output Without Emitter Followers
- HAS "SET" AND "RESET" TERMINALS

Write for technical information on DIGITAL and LOGIC circuitry.



SALES OFFICES IN PRINCIPAL CITIES

WALKIRT

COUNTER MANUFACTURERS SINCE 1948
141 W. HAZEL ST., INGLEWOOD 3, CALIF.

CIRCLE 156 ON READER-SERVICE CARD

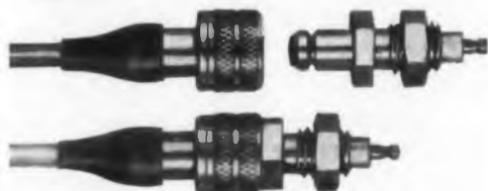
ELECTRONIC DESIGN • August 3, 1960



Well Connected Engineers...

in tight spots turn to EPL Snap-Locking, micro-miniature coaxial connectors for comfort.

Push the plug straight into the receptacle and it locks into place... only a direct pull on the spring-loaded plug collar will release the connection... no twist, no tools, no noise.



Specifications

vibration	up to 10G's at 10-3000 cps
shock	up to 100G's, any axis
temperature range	-70° to +550°F
voltage breakdown	1500v rms minimum at 1 atmosphere
frequency range	0 to 12 KMC
impedance	50, 75, 95 ohms
VSWR	1:1.2 maximum
typical weight, plug	0.10 ounces
receptacle	0.10 ounces

Immediate delivery of a host of standard plugs and receptacles... fast factory modification to your specifications.

Send for EPL Connector Catalog... complete specs, outline drawings, construction details, prices... Snap-Lock and friction-held connectors.

Electro-Physics Laboratories

1900 Walker Avenue
Monrovia, California



division of Marshall Industries

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CIRCLE 157 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

Voltage Comparator 395

Provides dc and rf voltage reference traces



Models VC-12 voltage comparator provides simultaneous dc and rf voltage reference traces on the sweep frequency display. The unit is made up of three sections. A switch contains two spdt, coaxial, mercury relays having a vswr of less than 1.1 from dc to 250 mc. An rf section has a calibrated 1-mc signal that may be varied from 120 μ v to 12 v rms. A dc section has positive and negative outputs of 120 μ v to 12 v.

Jerrold Electronics Corp., Dept. ED, The Jerrold Bldg., 15th and Lehigh, Philadelphia 32, Pa. Booth 426-427.

Clamp Assemblers 443

For rod, tube and pipe structures

These clamp assemblers form rigid joints between rods, tubes and pipes, which can be used to mount switches and instrumentation equipment. An angle clamp to serve as a base or mount is available. Joints may be fixed in 10-deg increments of rotation from 0 to 360 deg. Snap-on clamps and insulated cable clamps are available.

Rotocon Div., Unistrut Products Co., Dept. ED, 933 W. Washington Blvd., Chicago 7, Ill.

Price: Clamps are priced from \$0.66 to \$0.86 each.

Booth 321.

Twin Power Triodes 449

For series-regulated power supplies

Types CK6336A and CK6528 twin power triodes are high current tubes intended primarily for series-regulated power supplies. They are claimed to be extremely rugged, with low internal drops and excellent control sensitivity. The tubes are enclosed in hard glass.

Raytheon Co., Industrial Components Div., Dept. ED, Newton 58, Mass.

Price & Availability: Currently available from stock, the CK6336A is \$19.00 and the CK6528 is \$21.55 in single units.

Booth 2017-2018.

Packaged Blower-Motor Units were required for ground-based radar gear. These Peerless Electric PW-12 Pressure Blowers were furnished, fitted with discharge adapters and intake filters.



Problem: high pressure, big volume air delivery within strict size limits. Solution: This Peerless Electric Direct Drive Blower with space-saver motor.

Twin-blower units were needed to serve in tropical conditions. Built to customer and government specifications, the units have special finishes and insulation to protect against fungus and high temperatures.



How Peerless Electric Solves Electronic Cooling

Peerless Electric experience in engineering air for electronic equipment can go to work for you. Write us about

your cooling problem or send coupon below for specification data sheets on individual units.

PEERLESS ELECTRIC DIVISION

PORTER

H. K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specially alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

PEERLESS ELECTRIC DIVISION, H. K. PORTER COMPANY, INC., Box PF04, Warren, Ohio

Gentlemen:

My cooling problem is _____

Please send pertinent specification data sheets.

NAME _____

COMPANY _____

ADDRESS _____

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SPECIAL SERVICES
FOR DESIGNERS!

I-S short run AND prototype BERYLLIUM COPPER springs

— sample quantities
produced
quickly and
economically!

Hand-made pre-production parts eliminate tooling costs . . . save you time and money. Consult I-S engineers for fast, economical service on your sample orders. Send drawings and specifications for quotations.

After proving correct design in your Model Shop, return to I-S for production quantities. Supreme accuracy, uniformity and long endurance life is assured by I-S precision methods of manufacture.

BERYLLIUM
COPPER
SCREW
MACHINE
PRODUCTS

Prototype and
production parts
from .020" to
1.00" diameter.

"MICRO-PROCESSED"
I-S
BERYLLIUM COPPER SPRINGS
**INSTRUMENT
SPECIALTIES
CO • INC**

270 Bergen Blvd., Little Falls, N. J.
Telephone: CLifford 6-3500

SEE OUR
CATALOG IN
SWEET'S

CIRCLE 159 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Servomotor

403

Size 8



Designated model 8 SM 461, this size 8 servomotor is 0.84-in. long and weighs 1.1 oz. The unit is for 115-v sources. It has a rotor inertia of 0.18 gm-cm² and a stall torque of about 0.22 oz-in., providing acceleration at stall of 86,500 radians per sec². Ambient temperature range is -55 to +130 C; maximum operating temperature is 200 C.

Beckman Instruments, Inc., Helipot Div., Dept. ED, 2500 Fullerton Road, Fullerton, Calif. Booth 2514-2515.

Solderless Terminals

446

Permits rapid component connection

Springclip terminals are designed to be inserted into 3/32-in. holes in insulated boards. A spring arrangement will clamp up to six component wires to the terminal. The wires can be connected and disconnected rapidly without soldering. Contact resistance is less than 0.002 ohms. The terminals are designed for breadboard experimental circuits.

Vector Electronic Co., Inc., Dept. ED, 1100 Flower St., Glendale 1, Calif.

Price & Availability: Terminals are available from stock, priced at 5 to 12 cents each depending on quantity.

Booth 942-943.

DC Power Supplies

374

For laboratory use



Models 62-150 and 62-151 Power Supplies are transistorized, laboratory dc units. Model 62-150

THERE'S A
BETTER
WAY...



Although ice cubes can be used to keep transistors cool enough to operate at full rated load, there are those who maintain that ice cubes serve a better purpose in a long cool drink. This is the school of thought that leans toward Birtcher Heat Radiators for preventing thermal runaway and for getting maximum performance from semiconductor devices. If you would like to investigate before choosing sides in this debate, write for the Birtcher Transistor Radiator Catalog . . . it comes complete with all sorts of test reports and other technical looking papers.

Address your inquiry to: Charles F. Booher, Secretary, There's a Better Way Society of America, Inc.

**THE BIRTCHER
CORPORATION**

Industrial Division
4371 Valley Boulevard
Los Angeles 32, California

Sizes available for every commonly used transistor. If we don't have what you want, we'll probably make one.

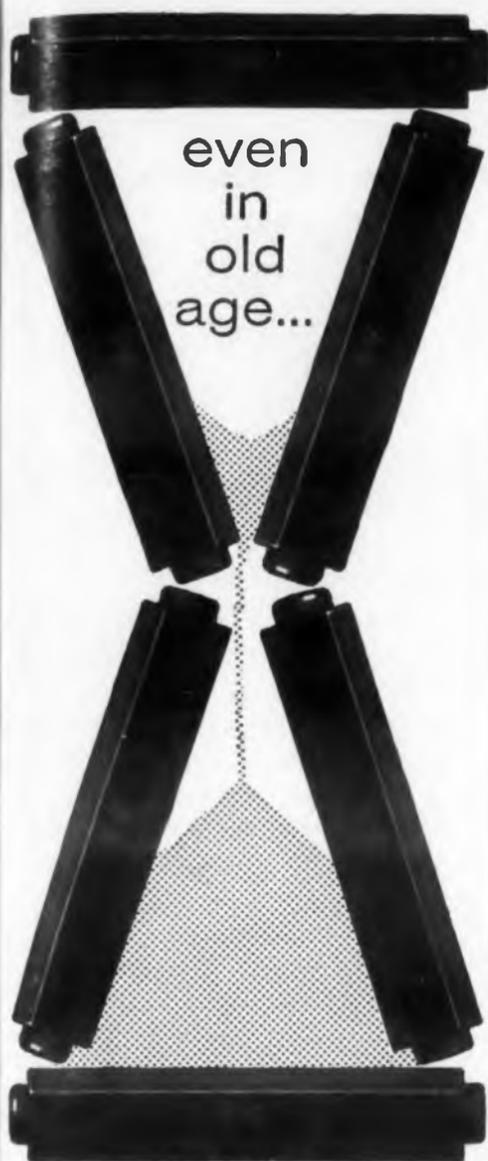


Cool!
Write for
new Transistor
Radiator Catalog

B

CIRCLE 160 ON READER-SERVICE CARD

CIRCLE 161 ON READER-SERVICE CARD



even
in
old
age...

S.S. White

MOLDED RESISTORS retain their values!

S. S. WHITE Molded Resistors retain their original values and never deteriorate due to age!

S. S. WHITE resistors serve dependably in hundreds of commercial... industrial... and scientific applications. They are characterized by low noise level... precision... stability... negative temperature and voltage coefficients. Non-hydroscopic base withstands temperature and humidity. They are compact, have excellent stability and mechanical strength.

For full details, write for our Bulletin 5409. We'll be glad to help you apply these high-quality, "all-weather" resistors to your product. Just drop us a line.

FIXED RESISTANCE VALUES
RANGE FROM 1000 OHMS TO
10,000,000 MEGOHMS!

65X Molded Resistor 1 watt
80X Molded Resistor 3 watts

S.S. White

S. S. WHITE INDUSTRIAL DIVISION
Dept. 28R 10 East 40th Street
New York 16, New York

CIRCLE 162 ON READER-SERVICE CARD

CIRCLE 161 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

has an output of 0.5 to 100 v at 0 to 1 amp; line regulation is 50 mv at 100 v output; load regulation is 25 mv at 100 v output; ripple is less than 1 mv rms. Model 62-151 has an output of 3 to 100 v at 0 to 3 amp; line regulation is 50 mv at 100 v output; load regulation is 75 mv at 100 v output; ripple is less than 2 mv rms.

Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.

Price & Availability: The Model 62-150 sells for \$810, and the 62-151 for \$925, both job Pasadena. Both models are available from stock.

Booth 1011.

Engraved Drum Dials and Verniers 452

Diameters are 1.5 to 3 in.

These precision engraved drum dials and verniers are available in diameters of 1-1/2, 2, 2-1/2 and 3 in. They are black adonized with white filled engraving. Vernier readings are accurate within 6 sec. Mil specs are met.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, L. I., N.Y.

Price & Availability: Prices are from \$45.00 to \$75.00, less 5% in quantities of 101 to 200, less 10% for 201 to 500. Availability is from stock.

Booth 311.

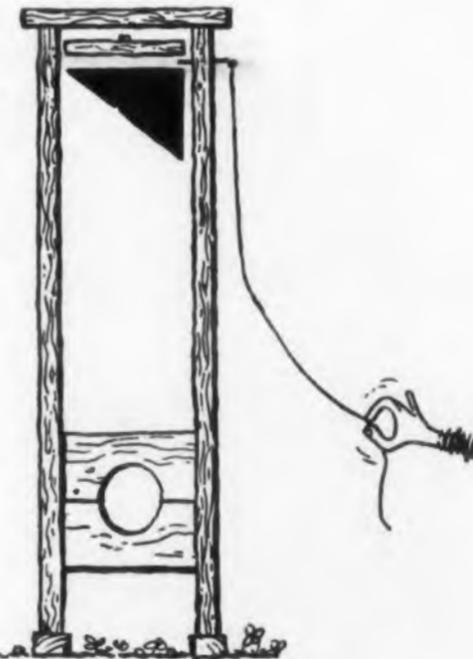
Mesa Transistors 392

Come in 18 types



These diffused mesa transistors come in 18 types, including small signal, medium power, intermediate power, and high power units. The six high-power diffused mesa silicon units have advanced electrical and mechanical characteristics. The four intermediate power diffused mesa transistors are packaged in a 7/16-in. stud-mounted hex package. The small signal units are for low-level, high-voltage switching and amplification; they come in the TO-18 packages. The medium power units have the collector lead isolated from the case.

Transitron Electric Corp., Dept. ED, 168 Albion St., Wakefield, Mass.
Booth 2638-2639.



SIGMA

CAN NOW TAKE CARE OF COMPETITION IN ON-OFF DEVICES

The Great Competitive Game being what it is, drastic measures are often necessary if a new product is to be assured of success. Frequently, one must even resort to publishing better specs than the competitor has announced, and then build a product to meet them. Some companies even go so far as to reverse the order of these events but the procedure is rare in North America.

We used to say the Sigma Series 33 was a sliding current relay and that it would work on 200 milliwatts. Now there is evidence to the contrary: (1) the "33" works best when abruptly energized, and (2) there's a new adjustment coded "VG" that needs only 100 mw for operation. (How's that for being wrong two out of two?)



Series 33 relay

This new subminiature competitor (on the left, next to Dr. Guillotin)



stays within spec and won't open its contacts, energized or not, at 30g to 5000 cycles, under 70g shocks, and over a -65°C. to +125°C. temperature range. Contact form is DPDT, polarized, magnetically biased. This is designated "Form Y" by us and means that the armature occupies one closed position when there is no coil signal, the other closed position when a signal of correct polarity and magnitude is applied, and back to the first position when the signal is removed. On special order, 33VG's can be supplied with dual coils and/or gold alloy contacts for dry circuit work.

One other thing about applications: the VG adjustment of the 33 is good for either on-off or off-on requirements; order device in main illustration only if your application is the former. Series 33 Bulletin and VG supplement on request.

At WESCON—Booth 749-750

SIGMA

SIGMA INSTRUMENTS, INC.
91 Pearl St., So. Braintree 85, Mass.

An Affiliate of The Fisher-Pierce Co. (since 1939)
CIRCLE 163 ON READER-SERVICE CARD

New temperature controlled MICROSTACK® meets

-55°C to +85°C

MILITARY REQUIREMENT



The General Ceramics MICROSTACK, one of the most important advances in memory core packaging, now operates in a temperature range of from -55°C to $+85^{\circ}\text{C}$. Core characteristics remain constant. By maintaining temperature stability inside the MICROSTACK unit, General Ceramics engineers have developed a memory core package that is smaller, more rugged, requires no external cooling or heating, and meets MIL shock and vibration specifications.

For additional information, please write on company letterhead. Address inquiries to Section ED.



APPLIED LOGIC DEPARTMENT
GENERAL CERAMICS

KEASBEY, NEW JERSEY, U.S.A.

TECHNICAL CERAMICS, FERRITE AND MEMORY PRODUCTS
CIRCLE 164 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Thyratron

Peak power is 33 megawatts



Type KU-74 ceramic-metal, hydrogen thyratron is rated at 33 megawatts peak power and is capable of operation at an average anode current of 4 amp at an rms value of 90 amp. The tube is for long-pulse, high-power radars. Internal heat sinks maintain proper operating temperatures of the grid and reservoir. No artificial cooling is necessary under ordinary ambient conditions.

ITT Components Div., Dept. ED, Box 412, Clifton, N.J.

Availability: For immediate shipment.
Booth 2044-2054.

Semiconductor Switches

Voltage ratings to 200 v

The Transwitch series pnpn switching devices are available in voltage ratings up to 200 v. The higher voltage units of these bistable silicon devices are suitable for digital indicating tube applications. The series includes the types TSW-30, TSW-60, TSW-100 and TSW-200 in the TO-5 package, and the types TSW-31, TSW-61, TSW-101 and TSW-201 in the TO-13 package.

Transitron Electronic Corp., Dept. ED, 168 Albion St., Wakefield, Mass.
Booth 2638-2639.

DC Power Supply

For computer applications



The Model RP-10 power supply is a completely transistorized, regulated, 8-amp unit designed for computer applications. Measuring 5-1/4

ELECTRONIC DESIGN • August 3, 1960

397 n. high by 19 in. wide and 11-1/2 in. deep and weighing 38 lb, it will power 320 LE-10 logical element T-PACs operating continuously at 1 mc. Input voltage is 117 v \pm 10%, 60 cps, single phase at 280 w max. Output is -13 to -19 v. It is a rack-mounted unit.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

Price: Approximately \$648.

Booth 561-562.

Navigation Aid Test Equipment 450

Provides rf circuitry for bench testing

398 Type 235-A navigation aid test set provides the rf circuitry required for bench testing and calibrating air traffic control transponders and airborne distance measuring equipment-Tacan navigation systems. The set contains a crystal-controlled rf generator with ranges of 960 to 1049 mc and 1130 to 1219 mc at -10 to -100 dbm, a peak pulse power comparator indicating from 23 to 33 dbm from 960 to 1215 mc, and a wavemeter accurate to \pm 0.5 mc from 1070 to 1110 mc. The unit is designed to be used with Collins Radio's model 578X1 or 578D-1 bench test set.

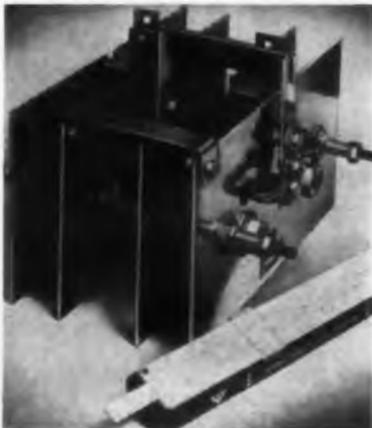
Boonton Radio Corp., Dept. ED, Boonton, N.J.

Availability: Sets will be available from stock in February, 1961.

447 Booth 751-752.

Silicon Rectifier Stack 413

Modular assemblies rated at 750 amp



375 The standard building block of these rectifier stacks is the 2-1-2-D doubler module with an integral paralleling reactor and four 70-amp silicon junction rectifiers mounted on copper cooling fins. Two of these modules may be mounted to form a single-phase bridge (shown) rated at 550 amp. Three stacked modules will provide a 750-amp dc output. The piv rating is 50 to 600 v.

International Rectifier Corp., Dept. ED, 1521 Grand Ave., El Segundo, Calif.
Booth 2517-2518.

FIRST
IN
CLASS

FALCON MISSILE

Playing follow-the-leader at 50 millisecond intervals, three *Super Falcon* missiles rocket ahead of their diamond-shaped supersonic shock waves. Homing in on radar, these deadly air-to-air missiles locate, track, and destroy their prey, with the same killer instinct of the birds they're named after.

Hughes Aircraft, the developer and manufacturer of these missiles and the Armament Control System that triggers them, specified Hitemp magnet and Teflon* wire for their missile, and Teflon wire for its control system.

Hitemp Wires, Inc., the leading specialist in high temperature insulated wires and cables, proudly answers roll call with those developers and manufacturers enlisted in defending our American birthright—*Freedom*.

HITEMP WIRES, INC.

1200 SHAMES DRIVE, WESTBURY, NEW YORK

*Registered trademark for Du Pont fluorocarbon resins.

CIRCLE 165 ON READER-SERVICE CARD



Manufacturer makes unique guarantee for new "EVEREADY" Energizers with cathodic envelope construction

*New Battery Design Makes These Energizers So Reliable They
Can Be Guaranteed Leakproof Up to Value of Device Which Houses Them*

Union Carbide Consumer Products Company, in answer to the growing need, now offers "Eveready" brand Energizers designed especially to meet the requirements of modern transistorized devices.

MORE POWER, LOWER COST

These "Eveready" Energizers (now available in many different sizes) are guaranteed leakproof and provide more power, longer life and lower operating cost than conventional battery construction. They also offer the radio set manufacturer many cost savings such as the elimination of the contacts needed when round cell batteries are used.

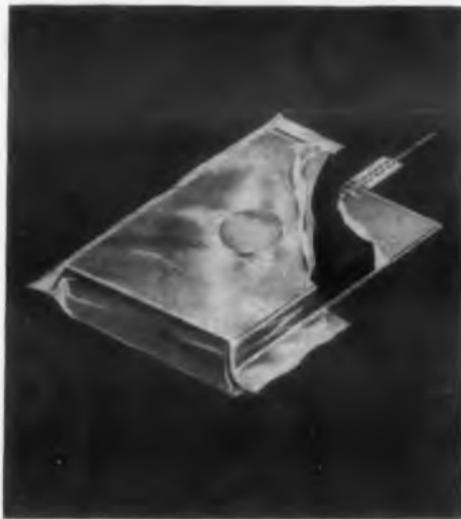
ENERGIZERS NOW GUARANTEED LEAKPROOF

Proof of the complete reliability of these sensational new cathodic envelope batteries can be read in the unprecedented leakproof guarantee which reads: "If this battery is defective through fault of the manufacturer, satisfactory adjustment will be made within the limits of the value of the electronic device"!

Energizers now available in many different sizes →

*Write for complete technical
information on "Eveready" Energizers.*

NEW ADVANCE IN BATTERY DESIGN GIVES NO. 2762 OVER 3 TIMES LIFE OF 6 D-CELLS



Cathodic Envelope design doubles anode and cathode areas to give high current, low impedance required for transistor circuits, provides volume efficiency unknown to other carbon zinc cells with no side penalties for peak performance!

COMPLETE PORTABILITY

New "Eveready" Energizers ideal for radios, marine depth finders, telephone amplifiers, barricade flashers and similar devices. Make countless additional electronic devices truly portable.

DESIGNERS CITE SEVEN MAJOR ADVANTAGES!

1. No instrument damage from leakage.
2. Reduction of tooling and manufacturing cost for mounting batteries.
3. Elimination of corrosion of contacts.
4. Ease of battery replacement — no reversed polarities to damage circuit.
5. More compact design because Energizers give more energy per cubic inch.
6. Easy availability of batteries through any "Eveready" distributor.
7. Outstanding service life.



NEW PRODUCTS AT WESCON

Miniature DC Relays

406

Sensitivity is 25 and 40 mw



Type JSH relays are spdt and dpdt units with sensitivities of 25 and 40 mw respectively. Non-inductive contact rating is 2 amp at 29 v dc or 1 amp at 115 v ac. The relays can withstand vibration of 15 g from 55 to 2000 cps, 0.09 in. double amplitude from 5 to 55 cps, and shock of 50 g without contact chatter. The units weigh 1.1 oz.

Allied Control Co., Inc., Dept. ED, 2 East End Ave., New York 21, N.Y.
Booth 535.

Coil Winder

448

Operates at 5,000 rpm

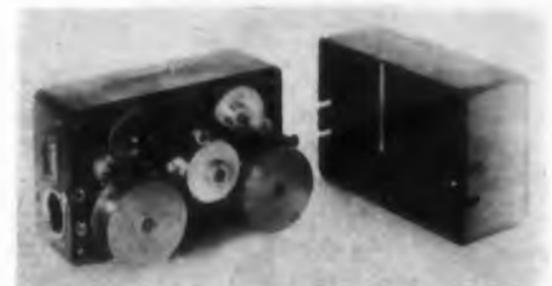
Model 315-AM bobbin-solenoid-repeater-resistor coil winder operates at 5,000 rpm. The traverse rod and wire guide mechanism are rear-mounted. Consistent cam tracking and quick change-over is provided. The OD coil clearance is 5 in. max; coil length is 3 in. max.

Geo. Stevens Manufacturing Co., Inc., Dept. ED, Pulaski Road at Peterson, Chicago 46, Ill.
Price & Availability: Immediately available, the winders are priced at \$700 job Chicago.
Booth 109.

Punched Tape Programmer

371

Time base, 8-channel



The Model TP-860 8-channel, time base punched-tape programmer uses standard teletype punched tape. It has separate motors for forward



"Eveready" and "Union Carbide" are registered trade-marks for products of
UNION CARBIDE CONSUMER PRODUCTS COMPANY • Division of Union Carbide Corporation • 270 Park Avenue, New York 17, N. Y.

CIRCLE 166 ON READER-SERVICE CARD

drive and automatic rewind. Twenty minutes of precision time-base programming at 1 in. per sec are provided. Output is an 8-channel switch closure with common return. The self-contained unit, measuring 5 x 8 x 6 in., stores reels for 100 ft of tape.

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

Price & Availability: Price is \$875 fob Santa Ana, with 6 week delivery.
Booth 2527-2528.

UHF Power Tubes

501

For missiles and aircraft

Types 7650 and 7651 tubes are small, forced-air cooled, uhf beam power types with coaxial electrode construction. Belonging to the Cermolox series of tubes, they have maximum plate dissipation of 600 w, and can be operated at full ratings through 1215 mc. The tubes can be adapted for either coaxial cylinder or parallel line circuits. Type 7651 is designed for pulse operation, and can deliver nearly 40 kw at 1215 mc. The 7650 unit has a plate voltage of 2500 v max and plate input of 1250 w when used continuously as an rf power amplifier and oscillator in class C telegraphy service.

Radio Corp. of America, Electron Tube Div., Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.
Booth 1054-1055.

Noise Source

357

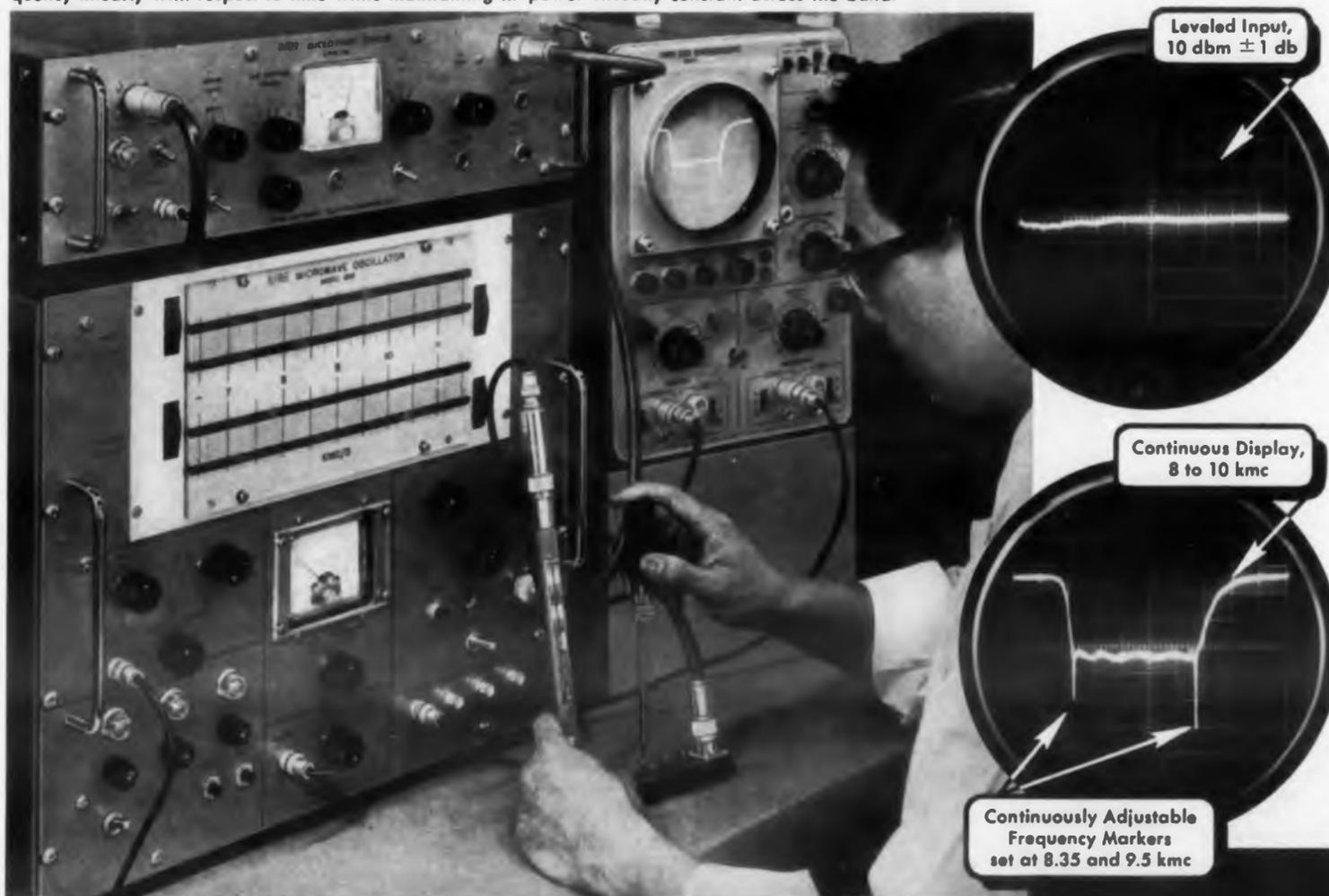
Provides 18.5 \pm 0.5 db



Warranted for 2,000 hr min life, type L-2017 noise source provides an excess noise ratio of 18.5 \pm 0.5 db over the frequency range of 8,790 to 9,190 mc. Similar tubes are available for other frequencies. The tubes are particularly useful in providing continuous radar system performance monitoring because the excess noise ratio is unaffected by changes in ambient temperature or operating current over a wide range of values.

Litton Industries, Electron Tube Div., Dept. ED 960 Industrial Road, San Carlos, Calif.
Booth 2104.

Testing insertion characteristics of X-band filter with Alfred Swept Generator. It consists of Alfred Microwave Oscillator and Alfred Microwave Leveler. This combination electronically sweeps frequency linearly with respect to time while maintaining RF power virtually constant across the band.



Save Test Time, Assure Test Accuracy

with ALFRED'S new SWEPT Microwave Generator.....

The scope patterns tell the story. Top pattern shows constant power input from Alfred Swept Generator to component (filter) under test. With known input, variation in output is due to filter characteristics. Lower pattern is especially significant, showing continuous, flicker-free display, 8 to 10 kmc. Any changes in stubs or irises are immediately reflected. Measurement accuracy is assured at every frequency, not just at selected points.

THIS TECHNIQUE CAN BE USED FOR MOST PRESENTLY KNOWN MICROWAVE TESTING APPLICATIONS. HERE'S WHY IT'S FASTER THAN CONVENTIONAL SIGNAL GENERATORS:

* **Continuous Display** allows immediate measurements — no plotting needed. Trace can be recorded if desired.

* **Sweep Technique** eliminates time-consuming "point-to-point" frequency and power setting methods of conventional signal generators. Sweep range is continuously adjustable with 1% accurate Direct Reading Slide Rule Dial.

* **"Quick Look Readout"** eliminates calculations in setting sweep range.

* **Adjustable Frequency Markers** allow rapid, broadband calibration of scope or recorder trace.

SOME MORE FACTS YOU SHOULD KNOW

* **Frequency Ranges.** The Swept Generator is available in five ranges to 12.4 kmc — 1 to 2, 2 to 4, 4 to 8, 7 to 11, 8.2 to 12.4.

* **Stability.** At any single frequency, stability of the Swept Generator equals that of a conventional signal generator. Spurious modulation is low.

* **Power Output.** Greater than a signal generator: 10 milliwatts as compared to 1 milliwatt.

Key specifications for Signal Generators available for coverage from 1 to 12.4 kmc

Frequency — Controls: Continuously adjustable with direct calibrated dial. Calibration accuracy: 1%. Stability: \pm 0.02%/hr. Residual FM: \pm 0.0025%. **Power Output (Minimum):** 10 mw \pm 1 db. Continuously adjustable from zero to maximum. **Attenuation Range:** Up to 20 db. **Sweep — Selector:** Recurrent Sweep, Single Sweep, Single Frequency, and External on panel switch. Time: 100 to .01 seconds, continuously adjustable. **Monitor Output — Sweep Out:** Positive linear sawtooth, 45 volts peak. Panel BNC connector. **Amplitude Modulation — Internal Square Wave:** RF output is alternately 0 and unmodulated CW value. Frequency 800 to 1200 cps, adjustable by panel control.

FUNCTION OF THE LEVELER It holds power output constant to \pm 1 db over standard frequency ranges, and better than \pm 1 db over narrower ranges. The Leveler serves as a broadband attenuator with up to 20 db dynamic range control, providing constant output over a wide range. It can be used as a general purpose instrument for a wide variety of oscillators and amplifiers.

For more details on the Alfred Swept Generator — please contact your Alfred sales engineering representative, or write direct. Please address: Dept. 36.

ALFRED ELECTRONICS

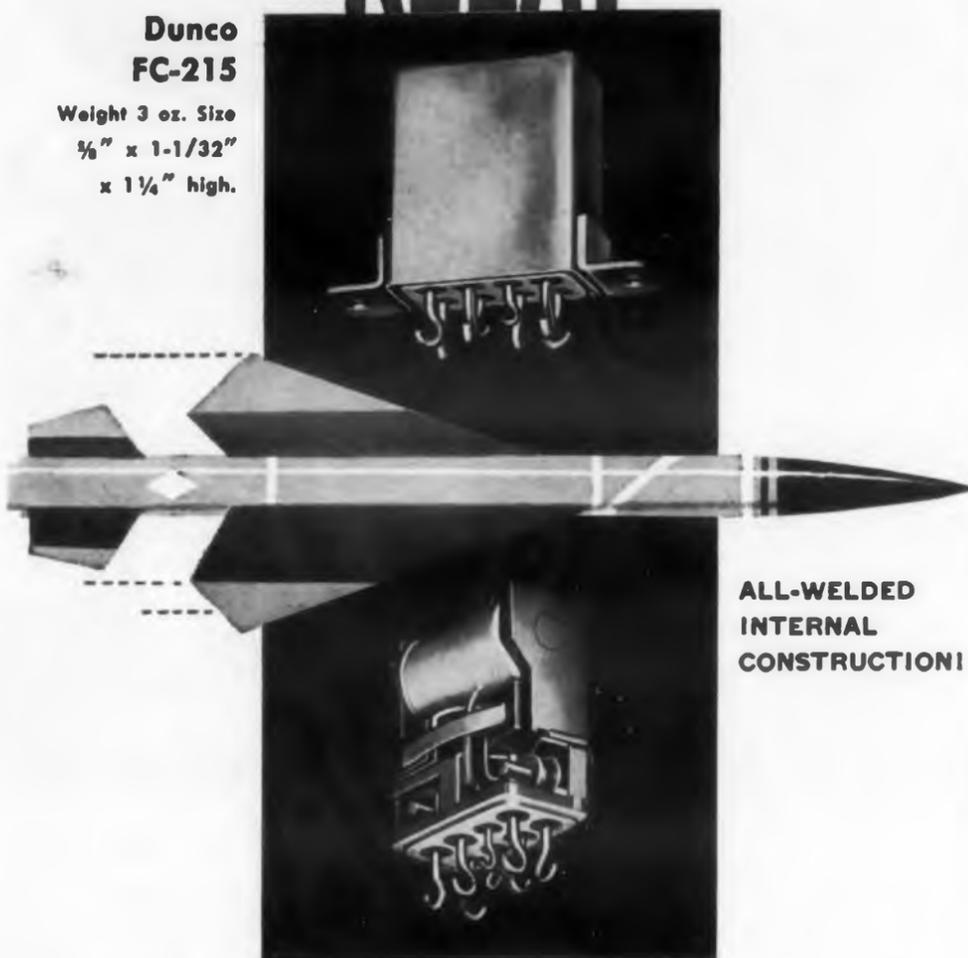
897 COMMERCIAL STREET
PALO ALTO, CALIFORNIA

CIRCLE 167 ON READER-SERVICE CARD

NEW! 10-AMPERE RELAY

**Dunco
FC-215**

Weight 3 oz. Size
3/8" x 1-1/32"
x 1 1/4" high.



**ALL-WELDED
INTERNAL
CONSTRUCTION!**

for missile and aircraft uses

Conservatively rated for 10 ampere DC operation, these solidly built little DPDT units fill a long standing need for dependable heavy duty power relay service under temperature, vibration and shock extremes.

Constructed throughout to meet or surpass MIL-R-575C and MIL-R-25018 requirements. No internal

soldered joints. Withstand 30G vibration to 2000 cycles and 50G shock. Standard coils rated 26.5 Volts DC nominal with 400 ohms coil resistance. Other coils available. Designed for 125° C. operation

Header terminals are 0.2" grid-spaced and can be furnished with hook, long or short wire lead terminals.

WRITE FOR DUNCO BULLETIN FC-215
STRUTHERS-DUNN

World's largest selection of relay types

STRUTHERS-DUNN, Inc., Pitman, N. J.

Member, National Association of Relay Manufacturers



Sales Engineering offices in: Atlanta • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Dayton • Detroit • Kansas City • Los Angeles • Montreal • New Orleans • New York • Pittsburgh • St. Louis • San Francisco • Seattle • Toronto

CIRCLE 168 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

Electronic Housings

524

Use modular packaging



These housings, suitable for electronic circuits, are made in a modular style. The units are designed to provide ease of wiring and installation of equipment, mobility and loading capacity. Rounded corners and proportioned lines are intended to beautify the instrumentation.

Wyco Metal Products, Stantron Div., Dept. ED, 6914 Beck Ave., North Hollywood, Calif.

Availability: Delivery is 30 days.
Booth 523-524.

Chassis Slides

445

Easily pivot and disconnect

QDP Series chassis slides have thin ball-bearing slide mechanisms that pivot 90 deg up and down for chassis servicing. The pivoting section readily disconnects. The slides, constructed of extruded aluminum, meet MIL specs.

Jonathon Manufacturing Co., Dept. ED, 720 E. Walnut St., Fullerton, Calif.

Price & Availability: Slides are \$40 and up in large quantities; delivery is 4 weeks.
Booth 319.

Cooling System

478

For 250-w airborne tubes



The Model E/HT-100, Type 100, cooling system provides a OS-45 coolant heat sink for a

**VENI,
VIDI,**

VECO

...the
name
that leads
all others

in

THERMISTORS

and

VARISTORS

VECO is first in the minds of most engineers whenever—and wherever—thermistors and varistors are needed because VECO can always be relied upon for engineering know-how, quality, and fast reliable service as well as rigid quality control.

Manufactured to MIL-Q-5923 and other applicable MIL standards.

VECO glass enclosed thermistors are not adversely affected by radiation.

VECO, a leader in solid state electronics, also manufactures a variety of electronic controls, gas analysis cells, electronic and thermal instruments, medical and biological instrumentation, experimentors and circuit design kits and temperature sensing devices.

Write for free VECO
Technical Catalog
with data on more
than 650 VECO
stock items.

Visit Booth #948 WESCON SHOW
Aug. 23-26 Los Angeles
Memorial Sports Arena.

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VICTORY
ENGINEERING CORPORATION

108 Springfield Road, Union, N. J.
MUrdock 8-7150

CIRCLE 169 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

±1%

accuracy on all ranges

For the first time, accuracy of ± 1 percent is now available in multi-range Panel-Mounting Electronic Voltmeters (PMEV's)

Metronix offers two such instruments: Model 300-1 for DC measurements and Model 311-1 for AC measurements.



Model 311-1

These instruments, like all Metronix PMEV's, also offer these familiar advantages:

- Continuous monitoring of critical parameters
- Minimum panel space—no larger than the meter itself
- Maximum reliability
- Easy adaptability to special needs

Call, wire or write for data sheets. We welcome inquiries on special voltage monitoring problems.

METRONIX, INC.
a subsidiary of Assembly Products, Inc.
Chesterland, Ohio

Telephone: HAmilton 3-4440
BOOTHS 915-916, WESCON SHOW

CIRCLE 170 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

250-w airborne electron tube. The unit weighs 3.9 lb and requires 95 va under continuous operation. The system provides for coolant expansion, visual coolant inspection, over-pressure and over-heat protection. MIL-E-5400 specifications for Class II equipment are met.

Eastern Industries, Inc., Dept. ED, Box 4372, Hamden 14, Conn.
Booth 2054-2055.

Traveling Wave Tube 529

Noise figure is 7 db min



The Type HA-70 traveling wave tube has a noise figure of 7 db max, a 25-db min gain, a 1 mw saturation power output min, and a frequency range of 2,300 to 3,400 mc. It is focused in a 750 gauss solenoid and has a back attenuation of 70 db min. The tube is 22.4 in. long and has a 1-in. diameter. It is warranted for 1,000 hours.

Huggins Laboratories, Dept. ED, 999 E. Arques Ave., Sunnyvale, Calif.
Booth 820-821.

Rigid Waveguide Components 469

Operate in 4.75 to 11 kmc band



This line of microwave measuring equipment and components operates with the Type D9 double-ridged waveguide in the 4.75 to 11 kmc band. The waveguide cross section and flanges meet the proposed standards of the Electronic Industries Association. The line of equipment includes adapters, tunable detectors, variable attenuators, directional couplers, impedance meters, slide screw tuners, sliding terminals, high-power terminals, 90-deg axial twists (shown), and waveguide tubings.

Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, L.I., N.Y.
Booth 822-823.

3-D's of Electronic Welding



delicate For delicate, demanding or difficult welding applications, Hughes offers you a complete line of welding equipment. One delicate application called for the manufacture of ultra-sensitive thermocouples—cross-wire welding 0.001" platinum wires with unvarying weld results in order to assure uniform electrical characteristics. For this delicate application, Hughes recommended:

The VTW-28, 10 Watt Second Stored Energy Power Supply, which consistently provides the energy required—with no variation. Energy stored repeats exactly—possibility of fluctuation from tubes in charging circuit is eliminated by variable transformer.

The VTA-24, Welding Handpiece, which supplies the necessary, repeatable pressure (from 0.5 to 25 pounds)—releasing the stored energy only when the pre-set pressure is reached.

Write or wire today for full information on Hughes precision welding controls and accessories—available in over 75 different equipment combinations: **HUGHES, Vacuum Tube Products Division, 2020 Short St., Oceanside, Calif.**

For export information, write: Hughes International, Culver City, California.

Cross-wire welding 0.001" platinum thermocouple wires with VTW-28 Power Supply and VTA-24 Welding Handpiece—an unbeatable combination for ultra-miniature precision welding applications!



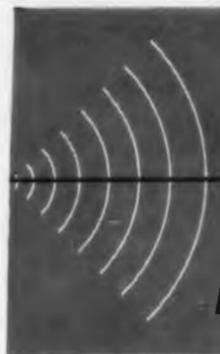
Creating a new world with ELECTRONICS

HUGHES

VACUUM TUBE PRODUCTS DIVISION
HUGHES AIRCRAFT COMPANY

See the complete line of Hughes precision welding controls and accessories in operation at WESCON—Booths: 2826-2827

CIRCLE 171 ON READER-SERVICE CARD



IMPULSE

A DIGEST OF NEW DEVELOPMENTS
IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE DIV. OF ALCOA, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

DEEP PROBLEMS OF THE BRINY DEEP. While outer space and missiles continue to grab the headlines, the Navy has sounded a big blast and challenge to the electronics system designer. Urgently needed are solutions to a seemingly endless series of problems encountered in the area of Anti-Sub Warfare. There are indications that ASW represents such a pressing need that it may soon reach the proportions of the ICBM program. Of the total of nearly \$2 billion earmarked for ASW, some \$25 million will go into electronic equipment, most of it sonar devices. The problem basically breaks down into four major areas: surveillance, localization, classification, and killing. One expert singles out the first as the most perplexing of all, but the Navy is ready for full-steam-ahead on all phases. Good starting point for interested parties is BuShips Form 550.5. So, anchors aweigh! Because ASW is a deep problem and the Navy needs you to cope with it.

INFORMATION SQUEEZE. Do you have time to read all the technical journals and periodicals that bear on your work? Equally important, have you a reliable system for classifying, filing, and retrieving articles you want? No simple problem this, it is being investigated jointly by the Special Libraries Association and the American Library Association. Of course, individuals in many firms also have come up with suggestions. One we saw did a very good job of breaking down the entire electrical field into manageable divisions. Another more complex approach is being tried by the chemical people. They are working with a large computer firm on a system that arranges titles by a method called "Key Word in Context." The computer does the work of evaluating titles of articles and then classifying according to "key words." Printout provides groupings of key words and a detailed bibliography.

DUTCH TREAT. Revival of interest in microwave cooking may be given a boost by an electronic oven developed in Holland. This one is designed to cook prefrozen meals at a rate that could run to 150 an hour. Meals come in one end at minus 25°C and come out at serving temperature of plus 80°C. A total microwave capacity of 10 KW is provided by five magnetron elements. Equalization and isolation zones between each unit prevent the magnetrons from affecting one another. Actual heating time for a meal is one minute, but a total of eight minutes in the oven is needed, the remainder being spent in the equalization and isolation zones.

LAND OF THE NEVER-SETTING SUN. A solar battery with 648 silicon cells is being used to power the warning light on top of at least one Japanese lighthouse. It's been in operation since November and has been so satisfactory that plans call for building six more. The flashes can be seen for nine miles.

CABLEMAN'S CORNER. The subject of cable testing is an important one. This is the phase of production that determines whether or not the cable you are purchasing is in accordance with your standards and requirements. In the field of electronics and automation, cables are required to suit various stringent electrical, mechanical, and/or chemical environments. Many years of study and testing have gone into the design of test equipment to be used for these critical tests. It is not enough to know that a cable has been tested in a manner that is "essentially" the same as the required standard. Slight variations in equipment design or methods of tests can mean the difference between conformance and non-conformance. Make sure the test data you receive gives a true picture of the performance of your cable. When you need cable, call on a cable specialist. Phone Rome 3000, or write: Rome Cable Division of Alcoa, Dept. 1180, Rome, New York.

These news items represent a digest of information found in many of the publications and periodicals of the electronics industry or related industries. They appear in brief here for easy and concentrated reading. Further information on each can be found in the original source material. Sources will be forwarded on request.

CIRCLE 172 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

UHF Isolators

538

Strip transmission line type



This series of uhf strip transmission line isolators are designed for operation from below 300 to above 1000 mc. Models D44J7 and D44PI-5 isolators are designed for J- and P-band operations, respectively, over 10% bandwidths. They have isolations of 10 and 20 db and insertion losses of 1 and 1.2 db for the 400 to 450 and 870 to 990 mc bands, respectively. The isolators measure 1.5 x 3 x 7-37/64 in. and weighs 2-1/2 lb. These units are intended for low power applications up to 10 w cw. Units for higher power applications or wider bandwidths and at other frequencies can be produced.

Sperry Microwave Electronics Co., Dept. ED,
Clearwater, Fla.
Booth 2148-2149.

Precision Miniature Floated Gyro

489

Angular momentum is 300,000 gm-cm² per sec

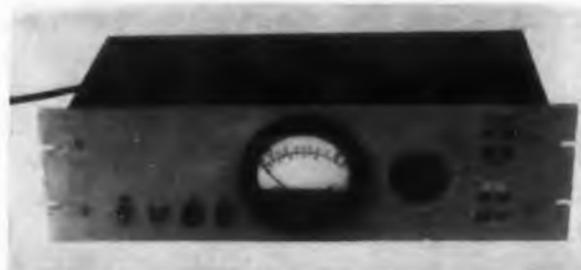
The Zero-One floated gyros are high precision miniature instruments. They have a trimmed drift rate of less than 0.01 deg per hr, an angular momentum of 300,000 g-cm² per sec, and a mass unbalance of less than 0.4 deg per hr per g. The gyro case is 1.8 in. in diameter, and the unit weighs about 1/2 lb.

Reeves Instrument Corp., Dept. ED, Garden City, N.Y.
Booth 919-920.

Audio Volume Level Indicator

491

Range is -40 to +20 db



The Type TR-942-C volume level indicator is a transistorized version of the Series 924 indica-

TOROIDAL COIL WINDER — \$1250 COMPLETE



2-lb. loading capacity

This is the largest of the Harder Toroidal Coil Winders. Its big, 24-inch diameter winding ring will handle coil stacks 6-inches high and 6-inches in diameter. Up to two pounds of wire may be stored in the oversize winding ring. Smaller rings are available when maximum fill is required. This machine is an outstanding buy priced at only \$1250 complete.

Harder Coil Winding Machines are made in five models to handle ring sizes from 3 through 24 inches. This permits the production of coils ranging in size from miniature to heavy duty. The design was developed in Government Laboratories and accepted by the Navy as outstanding in its field. Hundreds in use at leading companies. Write for free booklet. Donald C. Harder Company, 2580 "K" Street, San Diego 2, Calif.

HARDER CO.

CIRCLE 173 ON READER-SERVICE CARD



HARREL

**RELIABILITY
IN HIGH PRECISION
TEMPERATURE CONTROL**

Proportional Controllers

Reliable — Completely solid state. No vacuum tubes, moving parts or relays to wear out.

Precise — Control to a fraction of a degree.

Smooth Control — Furnishes exact amount of steady power to hold temperature to desired value.

High Power — From a few watts to several kilowatts.

Mil Spec. — Meet all applicable MIL specs.

... for close temperature control of floated gyros, delay lines, or other electronic or industrial equipment. Models for 60 cps, 400 cps, or dc operation.

Pure DC Output Models

same proportional control as standard, but output is pure dc for applications such as gyro test tables where noise output of relay or standard proportional controller is objectionable.

Oven Controls

where really precise control of ovens is required. For crystal drawing, fractional distillation, etc. 500 watts to several kilowatts.

Relay Type Controllers

where low initial cost is a prime requirement and close temperature control and extreme reliability of proportional control not needed.

HARREL, incorporated

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Sacramento 2-3683



TEMPERATURE CONTROLS RELAY AMPLIFIERS SINE WAVE SUPPLIES

CIRCLE 174 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

tors. The device measures the level of signals in the power range of -40 to $+20$ db on 600 ohm audio transmission lines. Frequency response is ± 0.1 db from 50 to 10,000 cps and ± 0.25 db from 20 to 20,000 cps. The unit operates from -25 to $+65$ C, and is not affected by line voltage changes of over 10%.

The Daven Co., Dept. ED, Livingston, N.J. Booth 444.

S-Band Circulator

494

Typical unit measures $3/4 \times 2-1/2 \times 7$ in.



This S-band circulator has a typical size of $3/4 \times 2-1/2 \times 7$ in. and weighs less than 2 lb. Characteristics are: 20 db isolation, less than 0.5 db insertion loss, and input vswr less than 1.2 over a 2 mc bandwidth. The circulators can be adapted for use with parametric amplifiers as input-output couplers, or in low-power applications of up to 1 w, avg.

Hughes Aircraft Co., Components Div., Dept. ED, Bldg. 20, Florence Ave. and Teale St., Culver City, Calif. Booth 846-847.

Bowl-Magnet

463

For voltage-tunable magnetrons



This bowl-magnet, designed for voltage-tunable magnetrons, is a compact, light-weight unit that the firm can apply on a custom basis to any of its S-, L- or X-band vtm's. For example, the Type Z-5337 vtm, with a range of 2,900 to 3,100 mc, weighs 1.5 lb, has a diameter of about 3 in. and has a height of less than 1 in.

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

Booth 517-518.

3-D's of Electronic Welding



demanding

 For demanding, difficult or delicate welding applications, Hughes offers you a complete line of precision electronic welding equipment.

A recent *demanding* seam-welding application required the completion of over 3,000,000 welds per day on metal filters of stainless, nickel or bronze screen—ranging in thickness from 0.003" to 0.010". Minimum screen deformation was required to assure uniform rate of flow. For this *demanding* application, Hughes recommended:

The VTW-501 Power Supply—a new half and full-cycle, seam and spot welding AC power supply which delivers the uniform energy output required for high-production applications. It converts to a $1/2$ or 2 to 20 cycle spot welding power supply by the simple flick of a switch. A phase shift control, which accepts from 10% to 100% of the pre-determined wave form, produces stepless energy output. No compromise settings are required—ever!

Write or wire today for full information on Hughes precision welding controls and accessories—available in over 75 different equipment combinations: **HUGHES, Vacuum Tube Products Division, 2020 Short St., Oceanside, Calif.**

For export information, write: Hughes International, Culver City, California.

Seam welding 0.003" bronze filter screens at 120 welds per second with VTW-501. Accurate, unvarying energy output prevents screen deformation.

Creating a new world with ELECTRONICS

HUGHES

VACUUM TUBE PRODUCTS DIVISION
HUGHES AIRCRAFT COMPANY



See the complete line of Hughes precision welding controls and accessories in operation at WESCON—Booths: 2826-2827

CIRCLE 175 ON READER-SERVICE CARD

Dr. Lucius Cuppington introduces . . .



VERNITEL, heart of HOOVER's new FM/FM telemetering system that prolongs the life of FM/FM systems now in use, improving their accuracy by a whole order of magnitude:



Count Vladimir Butts Binswinger shows . . .



HOOVER's new Mixer Amplifier, the palm-sized part of the Vernitel system that helps FM/FM telemetering systems live beyond their income, by prolonging their lives amazingly:



Personalities

at the

HOOVER

ELECTRONICS COMPANY

Booth 2822

Western Electronic Show
and Convention (WESCON)

Sir Joshua Wormwood Scrubbs offers . . .



HOOVER's new Millivolt Transistorized Oscillator that eliminates DC amplification from telemetering, allowing fewer and smaller packages and an end to one source of error:



Dr. Herpes Zoster introduces . . .



HOOVER's new Transistorized Subcarrier Oscillator, for FM/FM telemetering circuits, offering a linearity within 0.3% of band-width and a frequency stability within 1.5%.



See them at WESCON, August 23-26 . . . or ask for literature and specification sheets.



HOOVER

ELECTRONICS COMPANY

SUBSIDIARY OF THE HOOVER COMPANY

110 WEST TIMONIUM ROAD • TIMONIUM, MARYLAND

Field Liaison Engineers
Los Angeles, California

NEW PRODUCTS AT WESCON

Decade Counter Module

461



Resolves pulses at
110 kc

The Model DC-111 miniature, decade-counter modules combine a type BX-1000 Beam-X switch with transistors to resolve pulses at 110 kc. The units, designed as plug-in modules for use in computers, electronic counters, machine control, automation and test equipment, can be cascaded and driven by a 12-v signal. Total power consumption is 2 w. Outputs will operate remote Nixie indicators and printers.

Burroughs Corp., Electronic Tube Div., Dept. ED, P.O. Box 1226, Plainfield, N.J.
Booth 2136-2137.

Power Supply

498

Outputs are -25 and +25 v

Model D3907-01 dc power supply has outputs of +25 and -25 v, both maintained to better than $\pm 0.01\%$. Input power requirements are: 115 v $\pm 6\%$, 400 cps $\pm 2\%$, 3-phase, 5 w, max; 28 v dc $\pm 2\%$, 40 ma max; and 28 v dc unregulated, 7.5 w. The unit weighs 8 lb and measures 8.823 x 7.025 x 4.472 in. Temperature range is -55 C to +71 C.

Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N.J.
Booth 626-627.

Resistor Noise Test Set

527



Has
resistance
range of
100 ohms to
22 meg

Model 315 Resistor noise test set measures the increase in noise generated in a resistor by a dc voltage applied across it. It will test resistors from 100 ohms to 22 meg at voltages from 3 to 300 v.

BENDIX MS-R

ENVIRONMENT RESISTANT
Connectors

Bendix MS-R series are the small, lightweight, more efficient and compatible environment resisting class of connectors as specified in the latest version of MIL-C-5015.

Main joint and moisture barriers at solder weld ends have integral "O" rings. Grommet design of "slippery rubber" is sealing medium for individual wires. This provides easier wire threading and friction-free travel of grommet over wires.

Many other features are described in MS-R Bulletin. Send for your copy today, or

Call your
Avnet
Applications
Engineer

For dependable service

and immediate delivery*

AVNET

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AVNET-5877 Redoe Rd., Los Angeles 16, Cal.-UP 0-6141
AVNET-45 Winn St., Burlington, Mass., BR 2-3060
AVNET-4180 Kettering Blvd., Dayton 39, Ohio-AX 8-1458
AVNET-2728 N. Mannheim Rd., Melrose Park, Ill.-GL 5-8160
AVNET-1262 N. Lawrence St., Sunnyvale, Cal.-NE 6-0300

CIRCLE 177 ON READER-SERVICE CARD

CIRCLE 176 ON READER-SERVICE CARD

SEE IT!



SHOOT IT!



SHOW IT!

...in only

2 MINUTES on Polaroid® Land Projection Film

Just a few minutes from the time you record oscilloscope traces with this new Beattie Oscillotron and Polaroid® Land Film Type 46, you can project a transparency. Also produces 60 sec. paper prints with the new, very fast Polaroid® 3000 Speed Film. Records up to 10 traces on a single frame and offers these many other advantages:

- Direct binocular view of CRT while recording.
- Non-reversed image.
- Camera swings back for easy access to lens and shutter, or lifts off completely. Can be rotated.
- Electric shutter-actuator available.
- Attaches easily to bezel of 5" CRT. Adaptable to other sizes. No special tools.

"Polaroid" ® by Polaroid Corp.

See us at WESCON—Booth 2307

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1000 N. Olive St., Anaheim, California
Branch: 437 Fifth Ave., New York, N.Y.

CIRCLE 178 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

Noise voltages from 0.6 to 1,000 μ v at 1,000 cps are measured. Readings are in microvolt per volt in a decade of frequency.

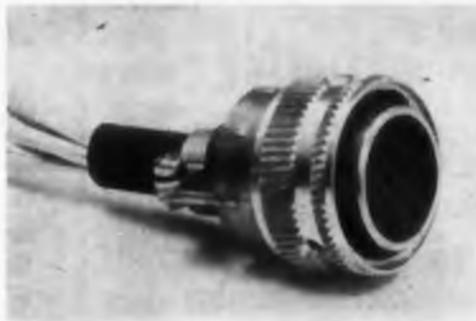
Quan-Tech Laboratories, Dept. ED, Boonton, N.J.

Price & Availability: Units, priced at \$1,550, can be delivered in 6 to 8 weeks.

Booth 1029.

Miniature Connectors 466

Accommodates either ball- or bayonet-lock plugs



The KQ/KR Series connectors consist of Type KRO receptacle, Type KQ ball-lock plug, shown, and Type KR bayonet-lock plug. These crimp-type, miniature plugs have removable snap-in contacts. The receptacle will accommodate either the ball-lock or the bayonet-lock plugs. Plugs with 3 to 55 contacts and ratings from 1250 to 2400 v are available. The series has been tested to 100,000 ft and at 257 F.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

Booth 2836-2837.

Semiconductor Mounts 525

For modular circuits



These modular Tri-Plate semiconductor mounts are suitable for breadboarding in strip transmission line circuits. The holders are available for cartridge, double ended, pill or pigtailed glass packages.

Sanders Associates, Inc., Dept. ED, 95 Canal St., Nashua, N.H.

Booth 929-930.

3-D's of Electronic Welding



difficult For *difficult, delicate* or *demanding* welding applications, Hughes offers you a complete line of precision electronic welding equipment.

Joining 160 components in one cubic inch of space proved to be a *difficult* welding application for a computer manufacturer. Reliable weld-fused joints were required right next to heat sensitive elements. For this *difficult* application, Hughes recommended:

The VTW-13, 250 Watt Second Stored Energy Power Supply—a complete power supply (including controls and pulse transformer) which provides from 1 to 250 watt seconds output in less than 1.5 milliseconds. Instantaneous and complete metal fusion at the weld point is assured without danger of damaging heat transfer.

The VTA-33, Precision Weld Head, which precisely duplicates pressure required to produce uniform, high-quality welds. Adjustable from 0.5 to 25 pounds. Energy releases only when pre-set pressure is reached.

Write or wire today for full information on Hughes precision welding controls and accessories—available in over 75 different equipment combinations: HUGHES, Vacuum Tube Products Division, 2020 Short St., Oceanside, Calif.

For export information, write: Hughes International, Culver City, California.

Electronic welding produces strong, reliable, fused metal joints between nickel ribbon and tinned copper, tinned brass and dumet leads. Absolute control permits close proximity welding with no damage to heat sensitive components.

Creating a new world with ELECTRONICS

HUGHES

VACUUM TUBE PRODUCTS DIVISION
HUGHES AIRCRAFT COMPANY



See the complete line of Hughes precision welding controls and accessories in operation at WESCON—Booths: 2826-2827

CIRCLE 179 ON READER-SERVICE CARD

work in Southern California on the

EAGLE



ADVANCED OPPORTUNITIES FOR SENIOR ENGINEERS

Bendix-Pacific Division, North Hollywood, California, as a member of the Bendix Corporation "EAGLE" Development Team, is a major contributor to the Navy's newest air-to-air Missile "EAGLE." This weapon system is a second generation air-to-air Fleet Defense System and offers challenging design opportunities to the creative engineer.

ADVANCED POSITIONS ARE OPEN TO MEN WITH BACHELOR, MASTER AND DOCTOR DEGREES IN ELECTRICAL AND MECHANICAL ENGINEERING WITH EXPERIENCE IN ELECTRONIC CIRCUIT DESIGN AND MECHANICAL PACKAGING. OTHER HIGH-LEVEL ELECTRONIC ENGINEERING POSITIONS AVAILABLE

Please send resume to

W. C. WALKER,

ENGINEERING EMPLOYMENT MANAGER

Bendix-Pacific Division

NORTH HOLLYWOOD, CALIFORNIA



CIRCLE 901 ON CAREER INQUIRY FORM, PAGE 233

TADANAC BRAND

Special Research Grade

INDIUM

The purity of this specially refined indium is such that no individual impurity exceeds 0.1 ppm. It was developed primarily for use in the production of intermetallic compounds.

Other TADANAC Brand high purity metals or compounds include: Special Research Grade antimony and tin, High Purity Grade bismuth, cadmium, indium, lead, silver, tin, zinc and indium antimonide. Send for our brochure on TADANAC Brand High Purity Metals.

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215 ST. JAMES ST. W., MONTREAL 1, QUEBEC, CANADA . PHONE AVHUE 8-3103

0160

CIRCLE 180 ON READER-SERVICE CARD

new flux discovery!

ALPHA activated liquid rosin flux sets new printed circuit standards!

Even metal surfaces normally resistant to fluxing action can now be soldered quickly and safely with ALPHA's new printed circuit flux; tests prove it.

Subjected to a grueling 42-day, high-temperature, high-humidity trial, this new flux revealed no evidence of corrosion or breakdown. ALPHA fluxes meet government specifications! Write for details and samples.

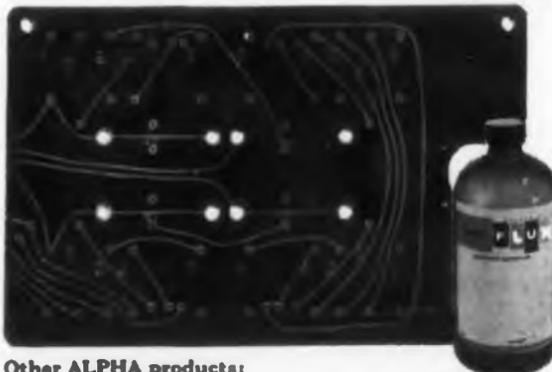
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In Los Angeles, Calif.:
2343 Saybrook Ave.

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58B Water St., Jersey City 4, N. J.

alpha
metals INC.



Other ALPHA products:
Core and Solid Wire Solders • Preforms • High Purity Metals

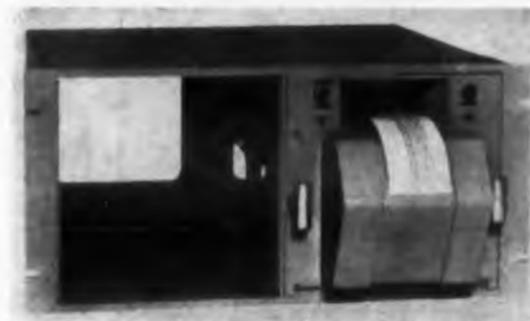
CIRCLE 181 ON READER-SERVICE CARD

NEW PRODUCTS AT WESCON

High-Speed Printer

459

Accepts 1-2-2-4 or 1-2-4-8 binary code



The Model 1453 high-speed printer accepts either 1-2-2-4 or 1-2-4-8 binary coded information. The unit will print 12-digit numbers in either black or red, and is designed to fit into a half-rack of a standard 19-in. relay rack. The instrument is designed to accept information from digital voltmeters and similar equipment.

Berkeley Div., Beckman Instruments, Inc., Dept. ED, 2200 Wright Ave., Richmond, Calif.

Price & Availability: Units will be available from stock in September, 1960, at \$995 each.

Booth 2514-2515.

Tantalum Capacitors

500

Rated at 6 to 100 wvdc

Series TSW hermetically sealed, wet-electrolyte, sintered-anode tantalum capacitors are available in ratings from 6 to 100 wvdc and capacitances from 270 to 4.7 μ f at 85 C. Supplied with or without an insulating sleeve, the bare tube case measures 0.188 in. in diameter, 0.525 in. in length for model TSW1; and 0.282 in. in diameter, 0.720 in. in length for model TSW2.

U.S. Semiconductor Products, Dept. ED, 3540 W. Osborn Road, Phoenix, Ariz.

Booth 2239-2240.

Silver-Zinc Primary Battery

467

Has two sections of 20 cells



The Model P-3000 primary battery has two sections: one section provides 24 to 26.8 amp continuous drainage with 33.2-amp pulses every

ELECTRONIC DESIGN • August 3, 1960

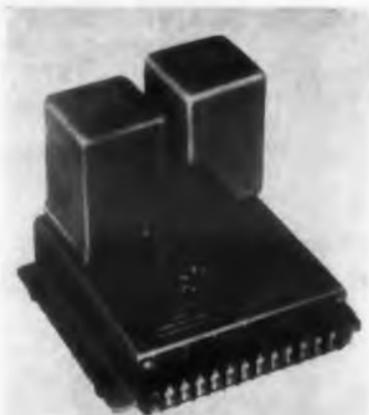
60 sec at 28 v ± 0.7 v for 3.5 min; the other supplies a continuous current of 38.5 to 65 amp with a peak pulse of 145 amp at 27.5 to 26 v for 3.5 min. Each section consists of 20 cells of 3 amp-hr capacity. The unit has a curved shape and is designed for missile applications; it weighs 22 lb, measures 5 x 6 x 15 in.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York, N.Y.

Availability: Units can be delivered in 90 days. Booth 551.

Temperature Detector and Control 488

Detects variations of 0.1 C



The Series 8000 thermistor temperature control consists of a magnetic amplifier relay, a built-in dc power supply, and two legs of a bridge circuit designed to monitor and control small variations in temperature. When coupled to a thermistor and reference resistor, the bridge can detect temperature variations as small as 0.1 C. Model 8001 will handle 1 amp loads, while Model 8002 will switch up to 5 amp.

Sigma Instruments, Inc., Dept. ED, 185 Pearl St., South Braintree 85, Mass.
Booth 749-750.

Volume Resistivity Jig 496

Measures 5×10^7 meg per cm^3

Volume resistivity readings up to 5×10^7 meg per cm^3 can be determined accurately within 10 sec by using this volume resistivity jig with the firm's Megatrometer. The same equipment and technique is applicable to tape, film, and insulating materials. Accuracy of the Megatrometer is 3% in the upper half scale up to 5,000 million meg. Repeatability is better than 0.2%.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

Price & Availability: Volume resistivity jig is \$85 and Megatrometer is \$865. *job Springfield.*
Booth 2312.

D-C Microvoltmeter



Model 1362R [\$575]

ELIMINATES THE POWER LINE FROM LOW-LEVEL MEASUREMENTS IN SENSITIVE CIRCUITS

Totally Isolated and Fully Insulated from Rack and from Power Line.
12 Hours Continuous Operation from Permanent Nickel-Cadmium Battery.
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Reliable Low-Voltage Circuitry

Accuracy $\pm 1\%$ (fs)

Extra-long Mirror Scale [7.2"]



Model 1362 [\$550]

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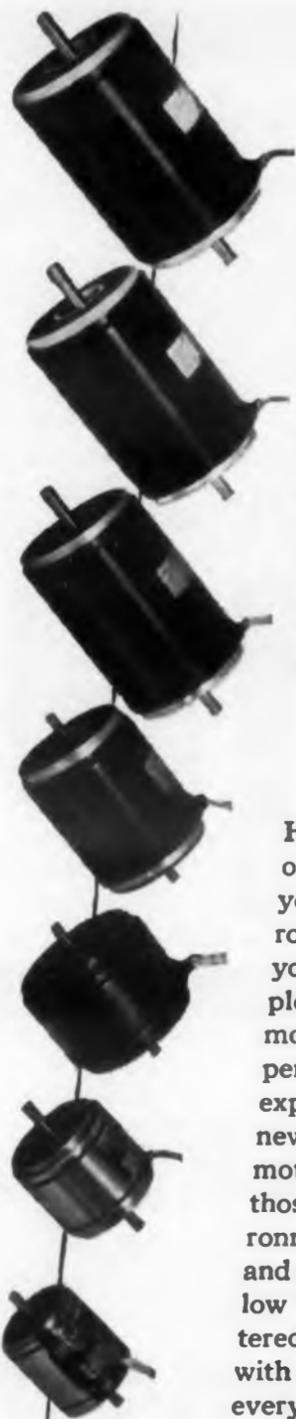
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let's get down to earth about servomotors

Has space exploration caused your servomotor cost to skyrocket? . . . forcing you to pay for protection against environments found only in space . . . not in your applications? If so, the now complete line of DIEHL Instrument Servomotors that give "out of this world" performance at down to earth prices is expressly tuned to your needs. These new epoxy encapsulated, round frame motors were especially designed for those applications where earthly environments such as salt, fungus, moisture, and ambients of -55 to $+55^{\circ}\text{C}$. . . (and low budgets) . . . are normally encountered. And, the line has been developed with sufficient latitude to meet your every rating requirement. Available in sizes 11 and 15, and in larger frames with power outputs from 1 to 20 watts.

All Diehl Instrument Servomotors feature:

- Prelubricated ball bearings
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A World of servo engineering . . . for the servo engineering world . . . The versatile Diehl family of Servo Components.

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Somerville, New Jersey

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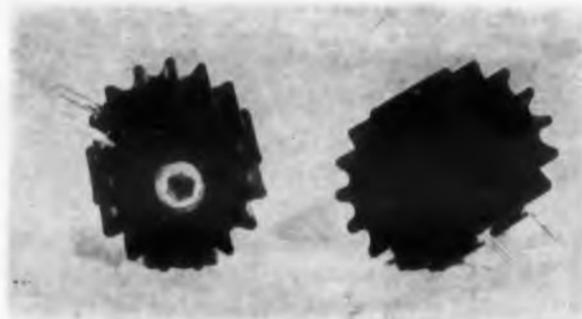
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NEW PRODUCTS AT WESCON

Transistor Heat Radiator 535

For printed-circuit mounting



The Model 3AL-685 radiator, designed to prevent thermal runaway, has an 8-32 tapped-stud hole for mounting all transistors having TO-31 and TO-26 packages. Radiators, designed for mounting on printed circuit boards, have two mounting pins 0.3 in. apart. They are 1/2 in. long with 1/2 in. in diameters. Units have 15 cooling fins for a total of about 4 sq in. of radiating surface.

The Birtcher Corp., Industrial Div., Dept. ED, 4371 Valley Blvd., Los Angeles 32, Calif. Booth 565.

Geared Servo Motor 499

Size 8 unit

Model M-327-001 geared, servo motor is a size 8 unit. Centered-shaft gearheads are available in 28 ratios ranging from 7.62:1 to 1254:1; eccentric-shaft gearheads are provided in ratios ranging from 7.62:1 to 903:1. It operates in ambient temperatures of -54 to $+105$ C. Minimum stall torque is from 1.8 to 20 oz-in. Inertia reference is 0.005 g-cm². No load speed is from 4.7 to 773 rpm, min. The unit weighs about 3 oz.

Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N.J. Booth 626-627.

Tape Programmer 534

For aircraft and missile applications

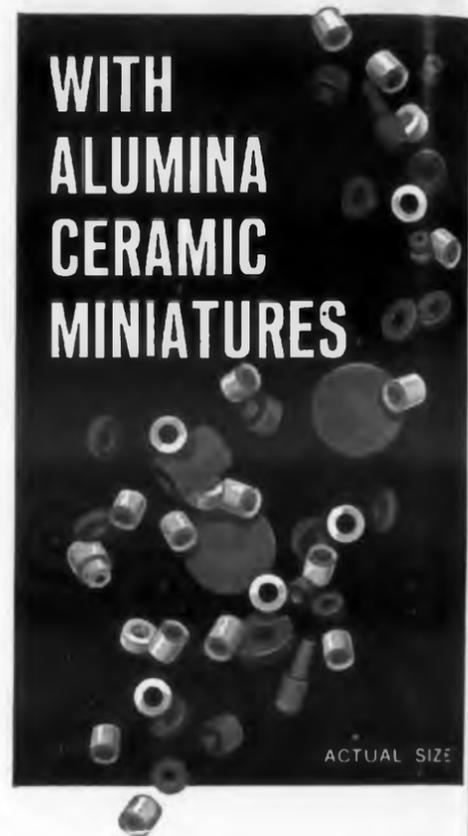


The Type TP-813 tape programmer is designed to withstand severe operating conditions encountered in missile, aircraft and ordnance equip-

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ELECTRONIC DESIGN • August 3, 1960

GUDELACE is engineered for problem-free lacing



It's no accident that Gudalace is the best lacing tape you can buy. Excellence is *engineered* into Gudalace. A sturdy nylon mesh is meticulously combined with the optimum amount of special microcrystalline wax. Careful selection of raw materials and superior methods of combining them give Gudalace outstanding strength, toughness, and stability. Gudalace is the original *flat* lacing tape which distributes stress evenly over a wide area. It is engineered to stay flat; it will not stretch out of shape when pulled. Gudalace's nonskid surface prevents slipping, eliminating the too-tight pull that causes strangulation and cold flow. Durability and dependability make Gudalace your most economic buy—with no cut insulation, fingers, or feelings.

Write for Data Book with specifications on Gudalace and Gudebrod's complete line of braided lacing tapes and dial cords—Temp-Lace, Stur-D-Lace, and Gude-Glass.

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Executive Offices
12 South 12th Street, Philadelphia 7, Pa.

CIRCLE 187 ON READER-SERVICE CARD

ment. It is mechanically and electrically interchangeable with similar units. It has a capacity of 75 ft of 35 mm Mylar tape for a 20 min program at 0.748 in. per sec. Contacts are rated at 0.4 amp. The instrument provides 13 independent timing channels. Programs can be changed quickly. Accuracies are on the order of 1 ppm.

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

Price: \$990 *job* Santa Ana for one to three units.
Booth 2527-2528.

High Speed Ferrite Switch 493

Switching time is less than 0.2 μ sec



This high-speed ferrite switch is capable of on-off or spdt switching in less than 0.2 μ sec. Utilizing Faraday rotation, the switch operates over a 10% bandwidth at X-band without programming the drive current. Characteristics include under 0.7 db "on" insertion loss, 30 db "off" insertion loss or cross channel separation, and power capability of 200 w avg. Typical applications include pulse modulation of cw sources, tr tube replacement in high repetition rate radar systems, and diplexing of two sources into a common waveguide.

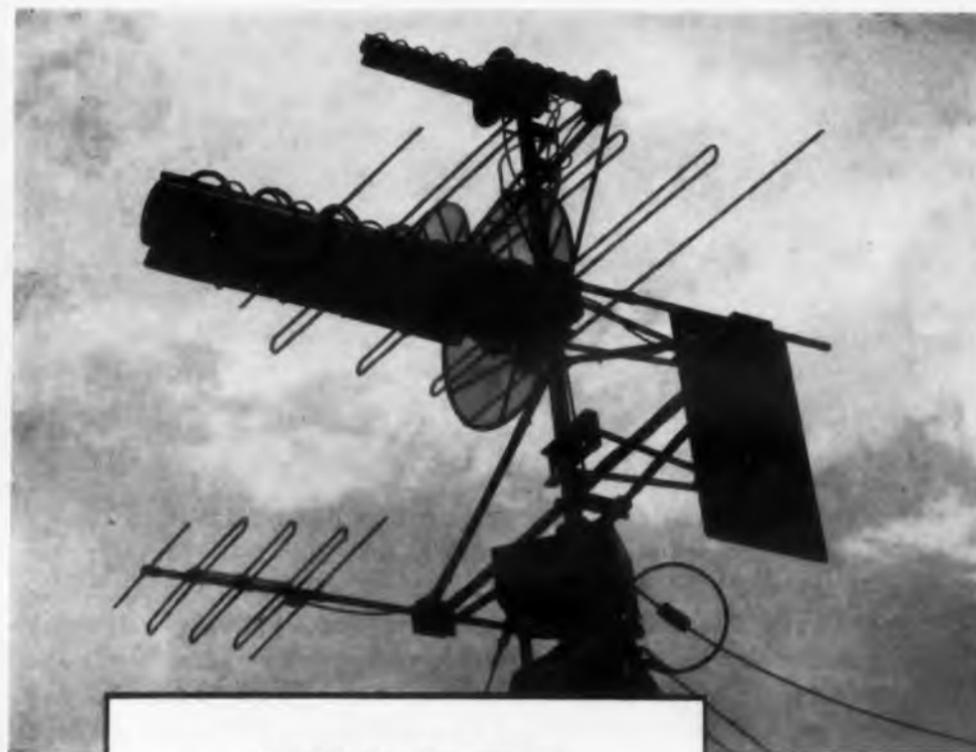
Hughes Aircraft Co., Components Div., Dept. ED, Bldg. 20, Florence Ave. and Teale St., Culver City, Calif.
Booth 846-847.

Electron Tube 495

Tunable oscillator triode

Type 7533 electron tube is a tunable oscillator triode of pencil-tube design. It operates at altitudes of nearly 19 miles without pressurization, and at temperatures ranging from +67 to -67 F. The unit measures about 2.5 in. long and weighs 4/5 oz. Two screws projecting from the side are used to tune the triode to any frequency between 1660 and 1700 mc. The tube is for use in battery-operated radio transmitters of weather balloons.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N.J.
Booth 1054-1055.



First Transistorized Amplifier With Bandwidth From 25 kc to 600 mc

another design problem solved by HRB-SINGER

Need for compact broadband amplifiers with increasingly wider bandwidths has resulted in HRB-SINGER's development of new circuit techniques in transistorized amplifiers.

The 25 kilocycles to 600 megacycles amplifier, no larger than half a cigarette case, covers over fifteen octaves with high gain and high efficiency. It is representative of the outstanding achievements of HRB-SINGER in this field. Reliability, ruggedness and low power consumption make these new amplifiers ideal for applications in airborne receiving equipment, portable receivers and other specialized applications.

This transistorized amplifier is only one of many outstanding amplifier models now available. In addition, HRB-SINGER has the ability and know-how to meet your special requirements, whether for a single amplifier or a complete receiving system. Direct your inquiries to Dept. G-10. A comprehensive series of data sheets describing this capability is yours for the asking.

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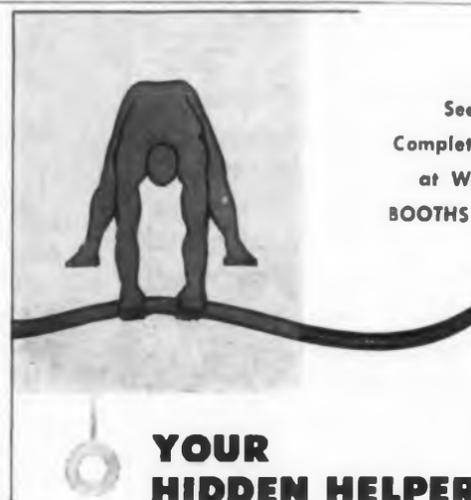
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NEW PRODUCTS AT WESCON

Altitude Control Transducer 543

Intended for expendable applications



The Model 571 altitude control transducer is economically designed for use in expendable target drones or tactical missile and aircraft applications. The unit employs a trapped-air-pressure design to provide an accurate altitude error signal. It operates to 80,000 ft with a dynamic error band of $\pm 2\%$. Functional range is ± 0.5 psi. The unit has a 2-1/4 in. diam and is 4-1/4 in. long.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.
Booth 2250-2251.

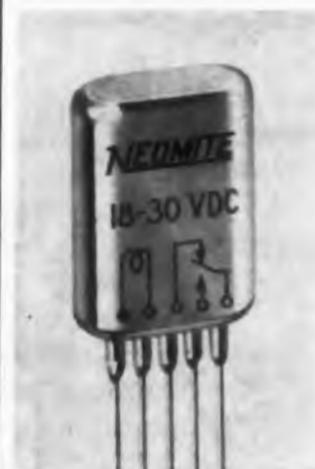
Microwave Diode 497

For K-band applications

Type 1N26C K-band mixer microwave diode meets all military environmental tests. The overall noise figure is 9.5 db max. The unit has a maximum vswr of 1.5, a maximum conversion loss of 7.5 db, and a maximum noise ratio of 1.5.

Sylvania Electric Products Inc., Semiconductor Products Div., Dept. ED, Woburn, Mass.
Booth 2058-2059.

Miniature Relays 530



Encased in transistor can

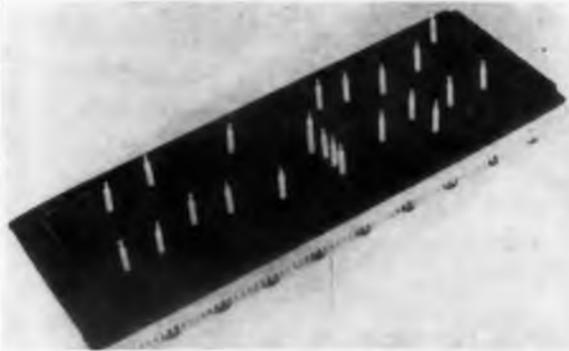
Series NM Neomite relays are packaged in a transistor can measuring 0.53 x 0.392 x 0.196 in. The units have coil resistances from 50 to 2,000 ohms, and require voltages from 4 to 30 v at 7

543

41 ma. Contacts are rated at 0.25 amp at 28 dc. Form C relays have spdt contacts. Units are hermetically sealed and weigh 0.09 oz. Elgin National Watch Co., Electronics Div., Dept. ED, 2435 N. Naomi St., Burbank, Calif. **Price & Availability:** Relays are available as distributor stock items at \$24.00 each. Booth 701.

Computer Programming Pinboards 492

Uses diode pins to form matrix



These programming pinboards consists of two contact strips, one vertical and the other horizontal, drilled and aligned to accept diode pins. Templates placed over the pinboard can indicate proper pin placement, or multiple plug-in connectors can be wired to permit rapid interchange of pre-programmed assemblies.

Beckman Instruments, Inc., Systems Div., Dept. ED, 325 N. Muller Ave., Anaheim, Calif. Booth 2514-2515.

Trimmer Potentiometers 490

Dual units are internally ganged



The Series 309 Squaretrim potentiometer line provides two independent elements internally ganged into one 3/4-in. sq package allowing simultaneous adjustment of two circuits. The units are available in standard resistances from 50 ohms to 50 K. Humidity-proof versions are available in either the standard screw or Allen-head adjustment screw styles.

Daystrom, Inc., Pacific Div., Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif. Booth 1039-1040.



25 MW

100 MW

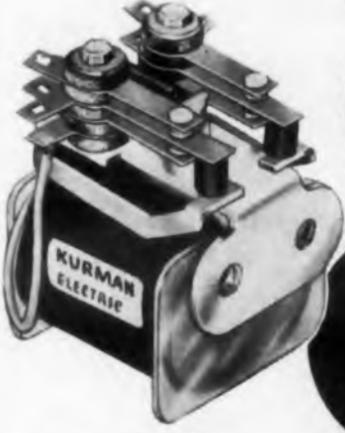
50 MW

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TRULY

SENSITIVE





SERIES
52C
54C



SERIES
5D2C
5D3C
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COIL RESISTANCE up to 20,000 OHMS
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NEW TANSITOR TANTALUM CAPACITORS PROVIDE MORE CAPACITANCE, LESS WEIGHT

Both leads of these new TANSITOR TES-type capacitors emerge from one end. So, only one seal is required, with consequent savings in length.

Welded leads are completely encapsulated too. Hence, soldering can be done close to the end of the capacitor without damaging the welds. Space savings up to 50% are thus possible.

Applications? Printed and transistorized circuits for miniaturized military or commercial electronic equipment are typical.

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Operate at surge temperatures up to 125C with some voltage derating.

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- Neutral electrolyte
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FOR FULL DETAILS on TES plug-in or other types of tantalum capacitors, write Tansitor Electronics, Inc., Dept. 11, West Road, Bennington, Vermont.

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need a critical

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28, 36,
or 75 vdc?

Check Sorensen
transistorized supplies ...
voltage regulation
as close as $\pm (0.02\% + 1 \text{ mv})$

Virtually no maintenance (supplies can't be damaged even by direct short circuit of output); long life; extremely fast response; transient-free, ripple-free output; and wide input frequency tolerance—these are just a few of the major features you get in Sorensen Q and QR Series transistorized supplies.

They're ideal for critical applications like powering computer circuits, strain-gauge bridges, or low-level instrument circuits.

Q Series Supplies: Offered in 15 models with nominal output voltages of 6, 12, 28 vdc (adjustable 2:1, approximately) and up to 220 watts power capacity. Models available for either $\pm 0.25\%$ or $\pm 0.05\%$ voltage regulation (combined line and load). Available in either cabinet or 19" rack-mounting styles (15 and 25 W models can also be provided for dual rack mounting on a single panel).

QR Series Supplies: Feature wide-range adjustable output voltage—zero to rated voltage, continuously, with COARSE and FINE front-panel controls. Two standard models: 0-36 vdc, 4 amps max., or 0-75 vdc, 2 amps max. Output is regulated to within $\pm (0.02\% + 1 \text{ mv})$. Output voltmeter and ammeter. Units are available for cabinet or rack-panel (19" x 5 1/4") mounting.

Get complete specs on these outstanding power supplies. Ask your Sorensen representative or write: Sorensen & Company, Richards Ave., South Norwalk, Connecticut.

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• New Sorensen catalog! Just off the press! 32-page catalog of more than 400 supplies plus valuable application data. Write for your copy today.

NEW PRODUCTS

Microvoltmeter

633



Sensitivity is 1 mv

Model MV-28A high-frequency, linear-scale microvoltmeter has a sensitivity of 1 mv full scale and a minimum voltage reading ability of 300 μv . Accuracy is 5% from dc to 200 mc and 10% from 30 kc to 700 mc. The unit uses a chopper dc polarized amplifier. The carrier-amplifier has eight stages.

Millivac Instruments, Div. of Coahu Electronics, Inc., Dept. ED, Box 997, Schenectady, N.Y.

Price & Availability: \$495 ea; from stock.

DC Power Supply

669

For transistorized devices

Designed to furnish power for transistorized electronic devices, model 1804-0900 power supply operates from an input of 115 v ac $\pm 10\%$, 400 cps, single-phase and furnishes an output of 28 v dc at 1.5 amp max. Temperature range of the unit is -55 to $+71$ C. It weighs about 1.5 lb and measures 3-5/16 x 3-7/8 x 4-1/4 in. Five similar units are also available; four provide 28 v and one, having a regulation of 0.02% provides 9.2 ± 4 v.

M. Ten Bosch, Inc., Dept. ED, 80 Wheeler Ave., Pleasantville, N.Y.

DC Power Supply

737

Outputs are 400 and 285 v



Model V-400 power supply fits into a rack space 5.25 in. high. Made up of models V-401 and V-402, shown, the unit provides outputs of



Time has brought decisive progress in the fight against cancer. Ten years ago one in four persons with cancer was saved. Today it's one in three. But time alone will not conquer cancer. Time plus research will. And research needs your dollars. Send your contribution today to "Cancer," c/o your local post office.





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McLEAN REVERSIBLE FANS

Install in any position as blow or suck, without mechanical change. Ideal for field vehicles or mobile generators.

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44 Page Packaged Cooling Catalog



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CIRCLE 195 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

400 v at 3 amp and 285 v at 3 amp. Model V-401 is a silicon master power supply; model V-402 is a regulator that holds the voltage and current outputs to precise values. No vacuum tubes are used.

Foto-Video Electronics, Inc., Dept. ED, 36 Commerce Road, Cedar Grove, N.J.

Connector

554

Miniature



Type 138 miniature connectors are molded of high-temperature setting-epoxy, polyurethanes, silicone rubbers, and other materials. They are for use with the firm's stranded wire harnesses. All materials used have good dielectric characteristics and withstand a wide range of environmental extremes. A number of sizes are offered, with and without self-locking design.

Cicoil Corp., Dept. ED, 13833 Saticoy St., Van Nuys, Calif.

Availability: Delivery time is 30 days.

Power Supply

620

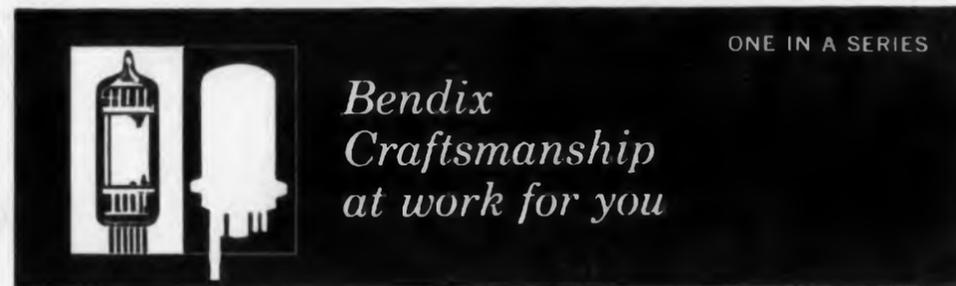
Regulation is 0.25%



This dc-dc power supply has a regulation of 0.25% for combined line, load, and temperature changes. Output is 5 v dc, adjustable to $\pm 5\%$. Current output is rated at 100 mc; the unit can maintain regulation at up to 200 ma. Maximum ripple is less than 0.1% rms and temperature range is -55 to $+100$ C. The input is 28 v dc.

Networks Electronic Corp., Dept. ED, 14806 Oxnard, Van Nuys, Calif.

Price & Availability: \$640 ea; 25-day delivery.



ONE IN A SERIES

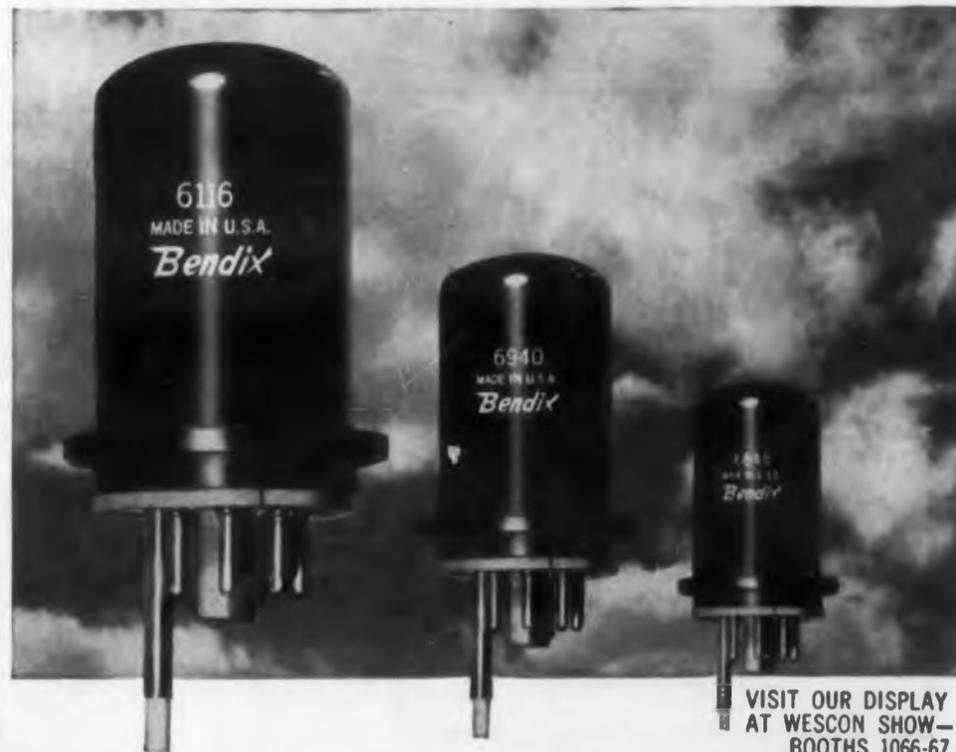
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Craftsmanship
at work for you*

BENDIX RUGGEDIZED REFLEX KLYSTRONS WITH THERMAL TUNING

The 6116/TE-39 Klystron tube combines ruggedized construction and thermal tuning. The combination provides a desirable tube for use in airborne radar and similar applications. Ruggedization makes possible a frequency jitter of less than ± 1.3 MC . . . at vibration levels up to 10 G at 50 cps. Thermal tuning provides a twofold advantage. It permits tuning the tube over its entire operating frequency remotely without mechanical means—and the tube can be

repeatedly cycled throughout its tuning range without damage or deterioration.

These Reflex Klystrons are but one example of how Bendix Red Bank technology can help you meet specialized tube needs. For information on these tubes . . . and on backward-wave oscillators and traveling-wave tubes . . . write RED BANK DIVISION, THE BENDIX CORPORATION, EATONTOWN, NEW JERSEY.



VISIT OUR DISPLAY AT WESCON SHOW—BOOTHS 1066-67.

The 6116/TE-39 ruggedized Reflex Klystron thermally tunes a band of 8500 to 9600 MC by means of a diode within the vacuum envelope. Tuning speed over the required frequency range is 0.7 seconds min. to 3.0 seconds max.

The 6940/TE-58 is identical to the 6116, but has special characteristics limiting spectrum width and spectrum continuity under adverse load conditions.

The 6845/TE-59 is similar in electrical and mechanical characteristics to the 6116 but may be operated under pulsed conditions with minimum frequency modulation.

SPECIAL-PURPOSE TUBES DEPARTMENT

Red Bank Division

EATONTOWN, NEW JERSEY



West Coast Sales & Service: 117 E. Providencia Ave., Burbank, Calif.

Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

Canadian Distributor: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario

CIRCLE 196 ON READER-SERVICE CARD



DC RATE GENERATOR

FOR TACHOMETERS
—AND MOST
SERVO-MECHANISMS

This new design permits perfect brush adjustment to the exact neutral zone. Assures even voltage and r.p.m. with either clockwise, or counter-clockwise motion. Rated at 3 volts per 1000 R.P.M.

Also available as a permanent magnet motor for miniaturized blower, fan or servo motor application. Motor units available from 4-50 volts D.C. Equipped with Alnico V magnets.

All units built to meet any commercial or military specification. Complete with ball bearings or equipped with precision interchangeable sleeve bearings.

Unit illustrated measures 1½" length with a 1¼" diameter. With flange mounting, 1¼" diameter.

A-C rate generator also available.

Designed and Manufactured by

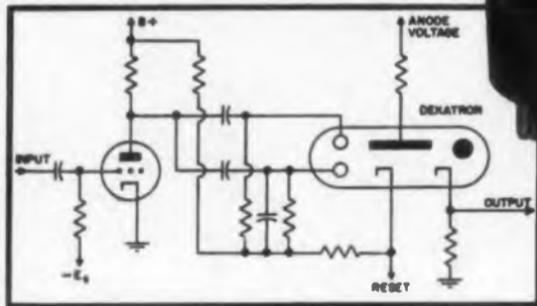


HEINZ MUELLER Engineering Co., Inc.
4735 W. Iowa St., Chicago 51, Illinois
SPECIALISTS IN ROTARY ELECTRICAL EQUIPMENT
CIRCLE 197 ON READER-SERVICE CARD

NOW—Complete Line

dekatron[®]

Electronic Counting Tubes
(up to 20,000 counts/sec.)



Typical Drive Circuit

Now available—only complete "Hand Book of Counting Tubes" in print. Tube specifications, applications, sample circuits, design criteria are included. Available at \$1.00 a copy through Dekatron Tube Section, Baird-Atomic, Inc.

No C. O. D. or purchase orders, please! Cash, check or money order accepted.

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Instrumentation for Better Analysis

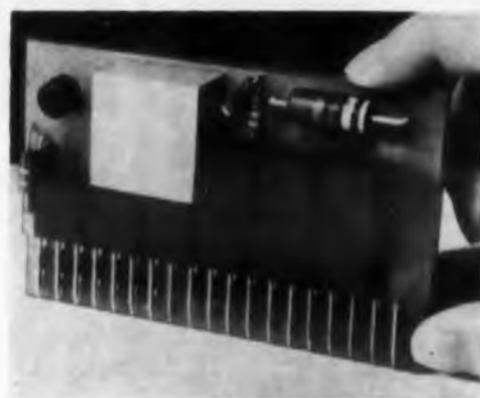
CIRCLE 198 ON READER-SERVICE CARD

NEW PRODUCTS

Magnetic Shift Registers

506

Use one core per bit



These magnetic shift registers, offered in 5-, 9-, and 10-bit modules, use only one core per bit. Each module contains its own shift drive, wide-width gate, and hold-gate circuitry. Model 9TDWW150/U, shown, is a 9-bit unit with a maximum frequency of 150 kc and an input-output pulse of 6 v. Typical applications are in short term storage.

Magnetics Research Co., Dept. ED, 255 Grove St., White Plains, N.Y.

Silicon Transistor

673

Current gain is 4 at 6 mc

Model 2N1660 silicon transistor has a current gain of a minimum of 4 at 6 mc and of 45 at 1 amp dc. Power output is 85 w and operating temperature range is -65 to +200 C. Applications for this npn, diffused silicon power unit include power oscillators, power amplifiers, regulated power supplies and computer core drivers.

Raytheon Co., Dept. ED, Waltham 54, Mass.
Availability: From stock for immediate delivery.

Magnetic Tape Transport

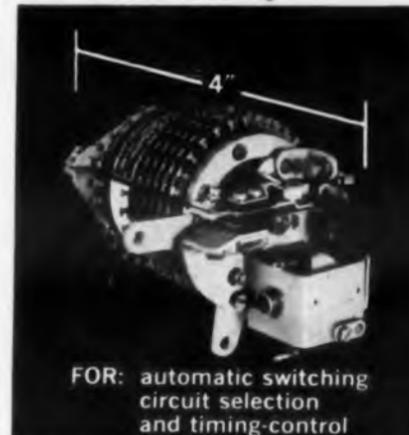
647

Stores 324,000 bits



Model 2966 magnetic tape incremental transport can store up to 324,000 bits of information on a continuous belt of 60-in. tape. The unit is designed for a 4-in. tape providing 54 recording

UNIQUE



FOR: automatic switching
circuit selection
and timing-control

The
Genalex
Miniature
High-Speed
Stepping Switch

FEATURING: 80 steps per second on impulse drive **30** contacts per bank **12** banks maximum **17** oz. lightweight **7** levels sequence switching.

Over 5,000,000 Steps Without Replacements

Write today for complete data — Also, data available on Genalex one-way and two-way stepping switches.



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U. S. AGENTS FOR THE GENERAL ELECTRIC COMPANY, LTD. OF ENGLAND
CIRCLE 199 ON READER-SERVICE CARD

TECHNICAL REPRESENTATIVES

LEAR, INC. has recently formed a new Service Division to keep pace with an increasingly widespread military acceptance of LEAR flight control systems and flight reference systems.

Attractive salary, liberal expense and per diem arrangements. Assignments may require travel or residence at assigned stations. Company orientation prior to assignments.

Qualifications Required:

1. EE, degree or equivalent.
2. Knowledge of servomechanisms, gyros & electronics.
3. Tech. Rep. experience.
4. Must be U.S. citizen.

Send Resume To:
GEORGE E. BROOKS
Manager, Technical Employment



LEAR, INC.
110 Ionia Ave., N.W.
Grand Rapids 2,
Michigan

CIRCLE 200 ON READER-SERVICE CARD
ELECTRONIC DESIGN • August 3, 1960

tracks. The tape can be used in increments of 0.01 in. on signal command or at a steady speed of 10 in. per sec. The unit is adaptable as a component in magnetic tape recording and programming for manufacturing control applications.

Designers for Industry, Dept. ED, 4241 Fulton Parkway, Cleveland 9, Ohio.

Availability: 30-day delivery.

Mercury Switch

555

Has 0.5-in. length, 0.162-in. diameter



Type HG22010 mercury switch measures 0.5 in. in length and 0.162 in. in diameter. Its rating is 0.1 amp. Initially developed as a reversing switch for a portable electric device motor clutch, the unit is suited for use as a miniature on-off switch, and other applications requiring slight force or having a low load or light weight. Switching action is spst; differential angle is 15 deg. The ac load or the dc load at 115 and 230 v is 0.1 amp.

Gordos Corp., Dept. ED, 250 Glenwood Ave., Bloomfield, N.J.

Magnetic Storage Device

643



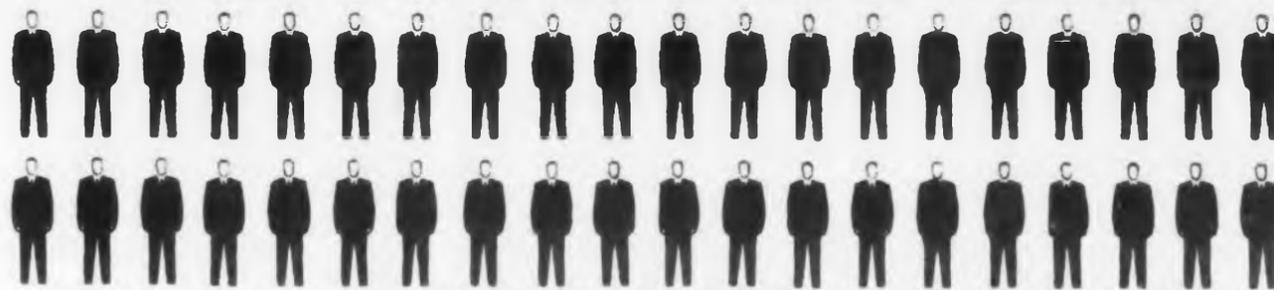
Stores 100,000 bits

Type BD-100 rotating magnetic disc storage device has a 7.5-in. disc diameter, stores 100,000 bits of information on 32 tracks, and operates over the temperature range of 30 to 150 F. The disc is made of magnetic mylar material. The device requires no warm-up and stands severe shock and vibration. It can be used horizontally or vertically.

Laboratory for Electronics, Inc., Dept. ED, 1079 Commonwealth Ave., Boston 15, Mass.

Price & Availability: \$2800 and up; 90-day delivery.

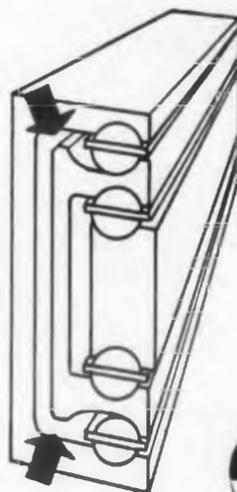
GRANT "SELF-ALIGNING" SLIDES SAVED ONE MANUFACTURER



40 MAN HOURS OF SHIM-TIME!

NOW, you can stop using shims. Time and labor saving Self-Aligning slides compensate for cabinet or chassis construction inaccuracies by an exclusive "built-in" design feature which results in slide action of the same efficient degree as within ordinary, wholly square chassis. All Grant Self-Aligning slides meet military specifications for material and finish. Load ratings on Grant Self-Aligning slides are the same as those for regular Grant slides.

Grant Self-Aligning slides are manufactured under U.S. Pat. No. 2,370,861. We'll be pleased to send you additional data on request.



GRANT INDUSTRIAL SLIDES

Grant Pulley & Hardware Corporation

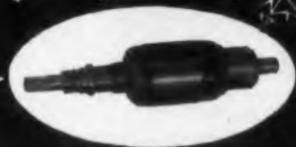
Eastern Division / 21 High Street, West Nyack, N.Y.

Western Division / 944 Long Beach Ave., Los Angeles 21, Calif.

CIRCLE 201 ON READER-SERVICE CARD

furane's EPOXY SOLVENTLESS VARNISHES

for Impregnating
Motors, Transformers
and Wire-Wound
Devices



Resistant to acids, JP fuels and Skydrol, Furane's Epoxy Solventless Varnishes are outstanding dielectric materials that penetrate and insulate. Dimensionally stable, 100% solid Varnishes 3-A and 3-B aid in eliminating fire hazards and allow motors to operate at lower temperatures, with resultant greater efficiency, economy and long life.

Low initial viscosity, ability to gel readily at 150° - 200°F., and a pot life of approximately 30 days make Furane's Solventless Varnishes easy and economical to use. Approved on MIL Specs, they have outstanding resistance to both thermal and mechanical shock.

For concise technical information on these and other Furane Epoxies, call or write for Electrical and Physical Properties Chart. On special problems, request our Application Questionnaire for an exact solution.

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ELECTRONICS JOBS \$6,000 to \$75,000 Still Go Begging

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J. L. Higgins, Manager
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CIRCLE 870 ON READER-SERVICE CARD

BIRD

"Termaline" DIRECT READING RF LOAD- WATTMETERS SERIES 6100



MODEL 612
Models 61 and 611
are identical in
appearance

These popular direct reading instruments measure and absorb power in 50 ohm coaxial line systems through the range of 30 to 500 mc.

They are portable and extremely useful for field or laboratory testing . . . checking installation of transmitters . . . trouble shooting . . . routine maintenance . . . production and acceptance tests . . . transmitter tune-ups . . . measuring losses in transmission lines . . . testing coaxial line insertion devices such as, connectors, switches, relays, filters, tuning stubs, patch cords and the like . . . accurately terminating 50 ohm coaxial lines, and . . . monitoring modulation by connecting phone, amplifier or audio voltmeter to the DC meter circuit.

Power scales for Model 61 Special are made to meet your requirements.

WRITE FOR BULLETIN TW606

See us
at the Wescon
Show: Booths
716 and 717

SPECIFICATIONS

RF INPUT IMPEDANCE: 50 ohm nominal.

VSWR: Standard specification 1.1 to 1 maximum over operating range.

ACCURACY: 5% of full scale.

INTERNAL COOLANT: Oil.

POWER RANGE: Model 611—0-15, 0-60 watts full scale. Model 612—0-20, 0-80 watts full scale.

INPUT CONNECTOR: Female "N".

EXTERNAL COOLING METHOD: Air Convection.

RADIATOR STRUCTURE: All Aluminum.

FINISH: Bird standard gray baked enamel.

WEIGHT: 7 pounds.

OPERATING POSITION: Horizontal.



"ThruLine"
Directional
RF Wattmeters



"Termaline"
RF Load Resistor



Coaxial
RF Filters



Coaxial
RF Switches



BIRD ELECTRONIC CORP.
Churchill 8-1200
30303 Aurora Road, Cleveland 39, Ohio
Western Representative:
VAN GROOS COMPANY, Woodland Hills, Calif.

CIRCLE 204 ON READER-SERVICE CARD

NEW PRODUCTS

X-Band Pulse Power Calibrator 646



For use from 8500
to 9600 mc

Model PCX-9 X-band pulse power calibrator covers the range of 8500 to 9600 mc. It measures the power of pulsed rf signals above the level of 0.5 mw within an accuracy of ± 0.5 db. A reference level is established each time the equipment is used. Some applications of the unit are: calibration of signal generators; measurement of radar power output, cable attenuation, and directional couplers and attenuators.

General Communication Co., Dept. ED, 667 Beacon St., Boston 15, Mass.

Availability: The product can be delivered in six to eight months.

Mica Capacitors 670

For operation at 125 C

Type 210M series of stacked-foil Fabmika capacitors has an epoxy casting process to provide resistance to humidity, moisture, shock and vibration. Standard units range from 300 to 6000 v in capacitance ratings of 0.01 to 1 μ f. They can be used at temperatures up to 125 C in airborne electronic equipment, pulse-forming networks, corrosive atmospheres, and in high-voltage applications in high-powered transmitters and similar devices.

Sprague Electric Co., Dept. ED, North Adams, Mass.

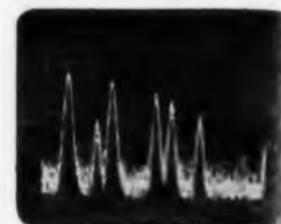
Power Supplies 616

Are convection-cooled



The LA series power supplies, having outputs of 5 and 10 amp at 0 to 34 v dc, are convection-

Discrete signals in noise background are easily detected and measured on SB-7bz display. Automatic high sampling rate (6.7/sec.) speeds measurements.



versatility + economy

Panoramic's ULTRASONIC SPECTRUM ANALYZER SB-7bz 1kc to 300kc



Up to 25 μ v sensitivity and exceptional dynamic range with simple, convenient operation are combined in one compact, low-priced instrument. Standard equipment at military installations and in industry, the SB-7bz is ideally suited for:

- Ultrasonic noise and vibration analysis
 - Communication system analysis—wire carrier and VLF radio
 - FM Telemetry subcarrier channel analysis
 - General Fourier analysis
- The SB-7bz features:**
- Variable sweep width: 0 to 200kc
 - Amplitude scales: 40db log, 20db linear and 2.5db expanded
 - Resolution: variable from 100 cps to 2kc
 - Sensitivity: 250 μ v full scale deflection, calibrated to measure signals as low as 25 μ v
 - Sweep rate: 6.7/sec., synch'd to power line, plus provisions for variable sweep rates when used with accessory units
 - 5" high-persistence CRT Tube
- Write, wire, phone now for detailed specifications bulletin; get on our regular mailing list for the PANORAMIC ANALYZER featuring application data.

Be sure to see us at WESCON



524 Fulton Ave., Mt. Vernon, N.Y.
OWens 9-4600, TWX: MT-V-NY-5229
Cables: Panoramc, Mount Vernon, N.Y. State

Sec. 2900

CIRCLE 205 ON READER-SERVICE CARD
ELECTRONIC DESIGN • August 3, 1960

A familiar shape to DC amplifier devotees



WIDELY
RECOGNIZED . . .
WIDELY ACCEPTED . . .
K2 OCTAL PLUG-INS
FROM PHILBRICK

FAST DC: K2-W is an efficient, foolproof high-gain operational unit for all feedback applications, fast and slow. The K2-W features balanced differential inputs for low drift, high input impedance, low output impedance, and economy of operation. Its range of operation is from d-c to above 100 kc depending on external circuitry. **\$24***

SLOW DC: K2-P gives to other dc amplifiers, such as K2-W and K2-XA, drift stability well under 1 millivolt, long term. This chopper stabilized unit has the same case structure and octal base as the K2-W and sells for **\$60***

HOT DC: K2-XA, a new amplifier of improved reliability, is primarily useful in operational circuits where an output voltage range from minus to plus 100v (at 3 milliamperes) is required. Its pass band extends to beyond 250 kc depending on external circuitry. **\$28***

- * Military equivalents available
- OEM's: write wire or phone for quantity prices
- 24 page Applications Manual available on request



GEORGE A.
PHILBRICK
RESEARCHES, INC.

275 Columbus Avenue, Boston 16, Mass.
Commonwealth 6-5375

CIRCLE 56 ON READER-SERVICE CARD

cooled and use solid-state components throughout. Line and load regulation is better than 0.15% or 20 mv for input variations of 100 to 130 v ac and from no load to full load. All models provide for remote sensing. The 5-amp model weighs 55 lb and measures 3-1/2 x 14-3/8 in. and the 10-amp model weighs 100 lb and is 7 in. high.

Lambda Electronics Corp., Dept. ED, 11-11 131st St., College Point, N.Y.

Price: The 5-amp unit is priced at \$395 without meters and \$425 with. The 10-amp unit is priced at \$510 without meters and \$540 with.

Vaneaxial Air-Mover 739

Will not stall



The non-stall blade of this air-mover, Model BC 1607V-1, eliminates the dip in the pressure-flow curve. The unit has a 3-in. over-all diameter and is 2-5/16 in. long. It weighs 15 oz and is designed for 115 v, 400 cps, although units with other power requirements are available. The air-mover, suitable for cooling compact components in missiles, submarines and aircraft, meets MIL specs for environment and performance.

IMC Magnetics Corp., Dept. ED, 570 Main St., Westbury, N.Y.

Availability: Units can be delivered in eight weeks.

Lamp for Readout Devices 694

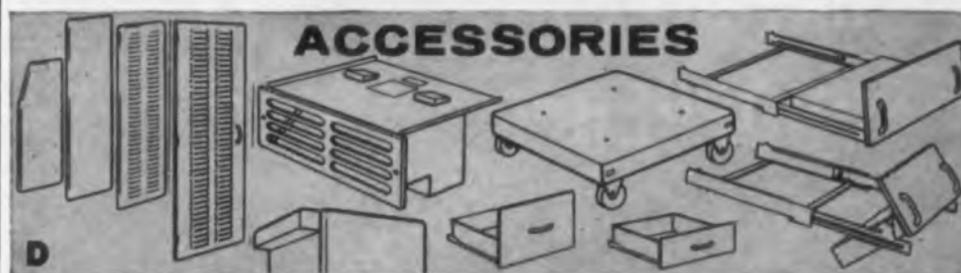
Operates at 4 v, 1.8 amp

Operating at 4 v at 1.8 amp and rated at 2200 K, this lamp is designed to scan punch cards and tapes. It was engineered for use with an input device for instantaneous computation of aircraft position for an air-traffic control system. The spring-tensioned, straight-wire filament offers the single, straight, light source. The filament can be made to withstand repeated 30-g shocks at a 90-deg angle. The lamp can be equipped with a non-reflective, black shield or background.

Chicago Miniature Lamp Works, Dept. ED, 1500 N. Ogden Ave., Chicago 10, Ill.

Price & Availability: Price is \$12 ea; delivery time is 10 days.

THE AMCO MODULAR INSTRUMENT ENCLOSURE SYSTEM



TWO COMPLETELY NEW LINES ADDED IN STEEL AND ALUMINUM TO GIVE 3 COMPLETE MODULAR FRAME LINES IN ONE OVER-ALL SYSTEM

A Amco Custom Line. Removable multi-panels and cowlings based on 19" increments of width. Custom, single-unit appearance for frames mounted in series—ideally suited for complex console arrangements. The 19 1/4" width of frame saves space in series mounting of frames. Constructed of double-channel 16 gauge cold-rolled steel. Conforms to EIA mounting standards.

B Amco Semi-Custom Line. Removable multi-width cowlings provide a semi-custom, single-unit appearance for frames mounted in series. Extra rugged, wide box-type channel frames provide greater internal mounting area. 19" wide panels of any thickness can be recessed—from a flush-mounted position to any desired depth. Box type channel construction of 14 gauge cold-rolled steel. Conforms to EIA mounting standards.

C Amco Aluminum Line. This system of aluminum box extrusions and cast corners allows easy assembly of cabinets in any size from 7" to 20" in height, width or depth. Corners and extrusions

lock together by hand with built-in locking device. All sizes are standard. Ideal for stocking and odd-ball sizes. Cast and hardened corners of 356-T6 aluminum as described in Federal Spec. QQ-A-596a. Extrusions of 6061-T6 aluminum as described in Federal Spec. QQ-A-270a.

D Amco Accessories. A full line of Amco integrated accessories such as blowers, chassis slides and mounts, lighting, doors, drawers, dollies and many more available for A, B and C shown.

Cost savings. All the above—or any part thereof—may be ordered under one combined discount schedule base determined by order dollar value. Orders received at one time with one delivery date may also be combined. Free pre-assembly by Amco provides additional savings in time and installation.

3 week delivery on all standard parts. We welcome inspection of our plant and facilities. Send for your free literature now.

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CIRCLE 57 ON READER-SERVICE CARD

As tall as a
7-story
building...
but it uses
tiny BRISTOL
CHOPPER

More than 40,000 parts, each of which must meet the most stringent reliability standards, make up the U. S. Atlas intercontinental ballistic missile, built by prime contractor Convair (Astronautics) Division, General Dynamics Corporation.

Among these parts is the Bristol Syncroverter* chopper . . . adding to its record of service in U. S. guided missile systems of almost every type since their very beginnings.

Billions of operations. To insure the reliability so necessary in aircraft and missile operations, Bristol Syncroverter choppers are constantly under test at Bristol, with and without contact load. One example: We've had five 400-cycle choppers operating with 12v, 1ma. resistive contact load, for more than 26,000 hours (2.96 years) continuously without failure—over 37-billion operations!

Many variations of Bristol Syncroverter choppers and high-speed relays are available—including external-coil, low-noise choppers. Write for full data. The Bristol Company, Aircraft Equipment Division, 151 Bristol Road, Waterbury 20, Conn.

•••

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



actual size

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER SEVENTY YEARS
CIRCLE 203 ON READER-SERVICE CARD

NEW PRODUCTS

Data-Amplifier Converter

638

Gain stability is $\pm 1\%$



This data-amplifier converter has a high input impedance for use in airborne instrumentation applications requiring the amplification and conversion of millivolt-level ac data signals. Gain stability is $\pm 1\%$ over the temperature range of -55 to $+100$ C. Silicon transistors are used. Applications are in strain-gage data systems, servo-amplifier systems, and synchro position transmitter systems.

The Mira Corp., Dept. ED, 2656 N. Pasadena Ave., Los Angeles 31, Calif.

Price & Availability: \$766.92 ea; 30-day delivery.

Sine Wave Oscillator

731

Distortion is less than 0.1%



Model 401-B oscillator, a source of audio and ultrasonic sine waves, operates with a distortion of less than 0.1% at full output of 20 v, open-circuit. Frequency range is 9 cps to 120 kc, covered in four decade bands. Accuracy is $\pm 2\%$. Output amplitude is controlled by a five-position decade attenuator plus a continuous control; any voltage above 100 mv can be selected. Output amplitude is independent of frequency within ± 0.5 db. The unit measures 8 x 6 x 10.5 in. and weighs 12 lb.

Waveforms, Inc., Dept. ED, 33 Sixth Ave., New York 14, N.Y.

Price: \$160.



No one is
immune
to our
#1 health
problem

Mental illness
hospitalizes MORE
people than polio,
heart, tuberculosis,
cancer—all other
diseases combined.
Outside the hospital
1 in 10 need
psychiatric help.
Next—let's Conquer
Mental Illness!!

Give at
the Sign
of the
Ringling
Bell



CIRCLE 210 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960



tantalum wet slug, porous anode



tantalum foil, silver encased, non-polar



tantalum foil, silver encased, polar



aluminum foil, ceramic and plastic encased



aluminum foil, aluminum and plastic encased, single end

iei SPECIALISTS

In miniature and sub-miniature capacitors

Here's why **iei** is your best source for virtually any type of miniature or sub-miniature electrolytic capacitor:

- For high capacity-voltage product values at low cost in transistorized circuits—tantalum wet slug (porous anode) capacitors.
- Tantalum foil capacitors in ten different case sizes—less weight—save space.
- Wide voltage and capacity range tantalums—3 WVDC to 150 WVDC—capacities to 5000 UF.
- Aluminum foil electrolytics for every application.

Fast, personalized service to assist you in adapting standard capacitors for your special requirements, or in developing entirely new capacitors for your individual needs.

Write for bulletins 81558, 2661 and 2625.
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Box 9036-R, Nashville, Tennessee

WESCON Show
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iei

AN **sps** COMPANY

Where reliability replaces probability

CIRCLE 211 ON READER-SERVICE CARD

ELECTRONIC DESIGN • August 3, 1960

CIRCLE 210 ON READER-SERVICE CARD

Microwave Switch Attenuator 738

For high power levels



This attenuator is designed to be switched on and off without turning off the transmitter. It can attenuate fixed values from tenths of a decibel to over 20 db. With switch de-activated, power loss is less than 0.6 db. This pressurizable unit is available for most frequency ranges and waveguide sizes.

Bogart Manufacturing Corp., Dept. ED, 315 Seigel St., Brooklyn 6, N.Y.

Availability: Unit can be delivered within 90 days.

Diodes 734



Stand 40 kv piv

Series XD-2 diodes include 7131/XD-2 air-cooled type and 7132/XD-2 water-cooled type for rectifier, charging, and shunt-diode service. As rectifiers, they stand a piv of 40 kv at an average anode current of 3 amp. As clippers, they are capable of peak anode currents of 150 amp. These external anode tubes have a thoriated, tungsten filament and have rated dissipation capabilities of 3 and 5 kw for air and water-cooled types, respectively. Uses include high-voltage power supplies.

Central Electronic Manufacturers, 2 Richwood Place, Denville, N.J.

Price & Availability: Delivery is from stock. Price is \$230 per unit, \$172.50 when bought in quantity.

FLIGHT PROVEN

TR-10



(HALF SIZE)

fm telemetry transmitter

The TR-10 is one of a family of transistorized flight proven airborne components used in UED FM/FM and PCM systems and also available to industry. Now in quantity production, the TR-10 is doing service in such missiles as Minuteman, Terrier, Javelin/Journeyman, Sergeant, Hound Dog and in space programs such as Midas, Samos and Pioneer. Outstanding characteristics of the transmitter include:

- Output / 2.5 watts with true FM modulation over complete 215-265 mcs telemetry band.
- Reliability / 99.9% for 500 hours.
- Modulation Frequency Response / ± 2 db from 3 cps to 300 KC.
- Vibration Induced Noise / less than 3 KC deviation at 20 g's from 20 cps to 2000 cps.
- Qualifies to Radio Noise Specification MIL-STD-442.
- Modulation Linearity / less than 1% from straight line at 125 KC deviation.
- Exceeds military environmental specifications including MIL-E-5272.

UED's soundly-conceived and solidly-built systems and components can help solve your design problems. Data sheets, test reports and technical consultation on request. Write or call:

United ElectroDynamics, Inc.
MU 2-1134 SY 9-7161
203 ALLENDALE RD., PASADENA, CALIF.

CIRCLE 212 ON READER-SERVICE CARD

NEW PRODUCTS
AT WESCON

General Purpose
Oscilloscope 422

Rated at 15 mc

Model 160B oscilloscope is a 15-mc general purpose unit built to Mil standards. The device has 24 calibrated sweep rates from 0.1 μ sec to 5 sec per cm. It will accept the Model 166C display scanner, a plug-in unit which provides a permanent recording of a crt trace. With the Model 162A dual-trace amplifier plug-in, maximum sensitivity is 20 mv per cm. The amplifier features differential input and 1-mc electronic chopping.

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

Booth 651-652-653-654.

Power Resistors 415

Rated 2.5 to 210 w

These wirewound resistors are rated from 2.5 to 210 w in a wide range of resistance values. They meet MIL-R-26C specifications in G, V or Y characteristics. Stack mounting, tab terminal and axial lead types are available. The resistors are of vitreous enamel construction.

Ward Leonard Electric Co.,
Dept. ED, Mt. Vernon, N. Y.

Availability: Resistors are available from stock.

Booth 813.

Soldering Tip 430

Will not stick in iron

The Durotherm soldering tip is guaranteed not to stick in any of the manufacturer's soldering irons. Solder will not drip from the tip onto components or work, nor will it creep into the iron to cause damage.

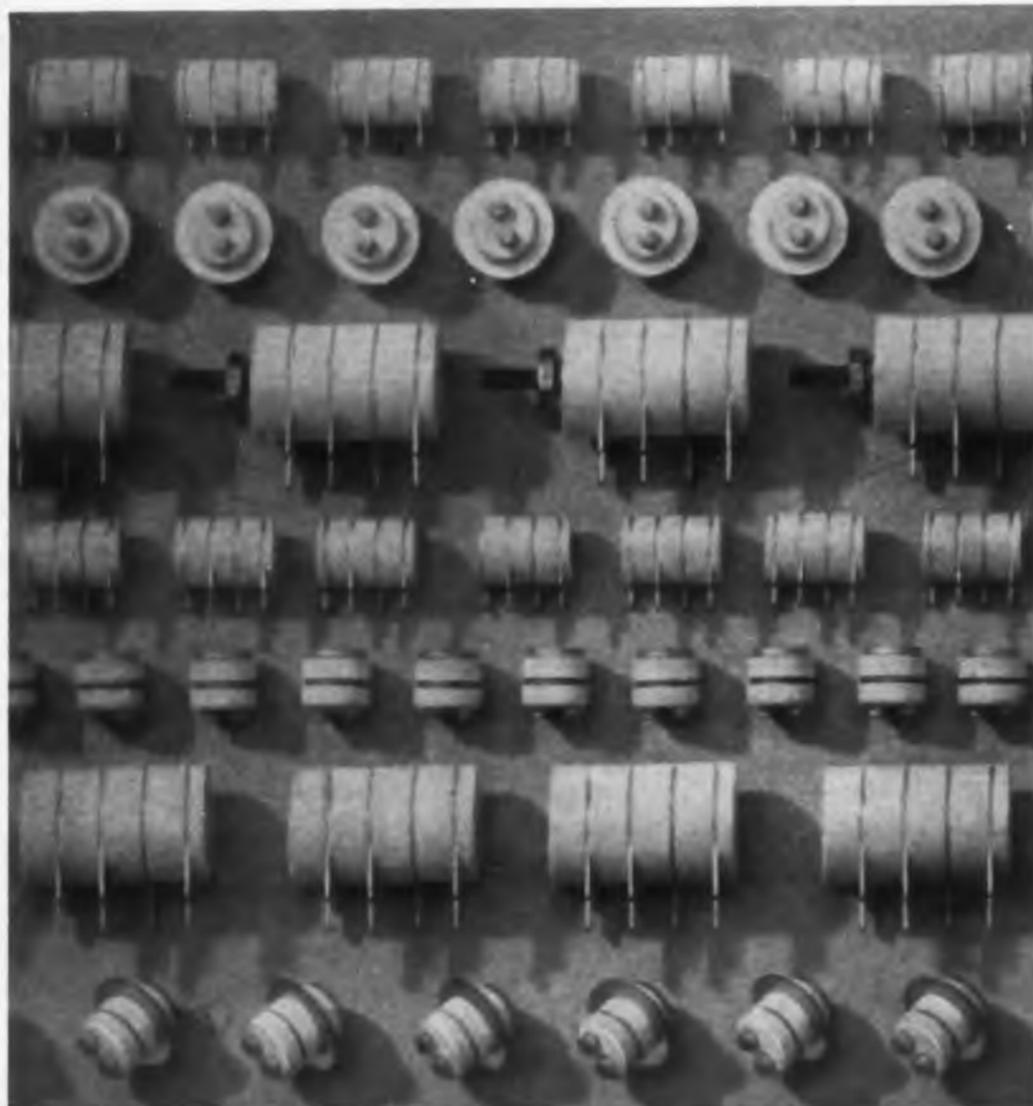
Hexacon Electric Co., Dept. ED,
161 W. Clay Ave., Roselle Park,
N.J.

Availability: Tips are available from stock.

Booth 118.

RELAX! Just select the power output, bandwidth, everything else you need and radiation tolerance..

Telephone today! New York, WI 7-4065.... Boston, DE 2-7122.... Washington, EX 3-3600.... Chicago, SP 7-1600.... Dallas, RI 7-4296..



(ACTUAL SIZE)

7462

RF-amplifier triode

7486

RF oscillator-mixer triode

7296

VHF-UHF low-power triode,
shown with mounting bolt

7625

High voltage-gain triode

7266

VHF-UHF detector diode

Developmental, broadband,
40,000-G_m triode

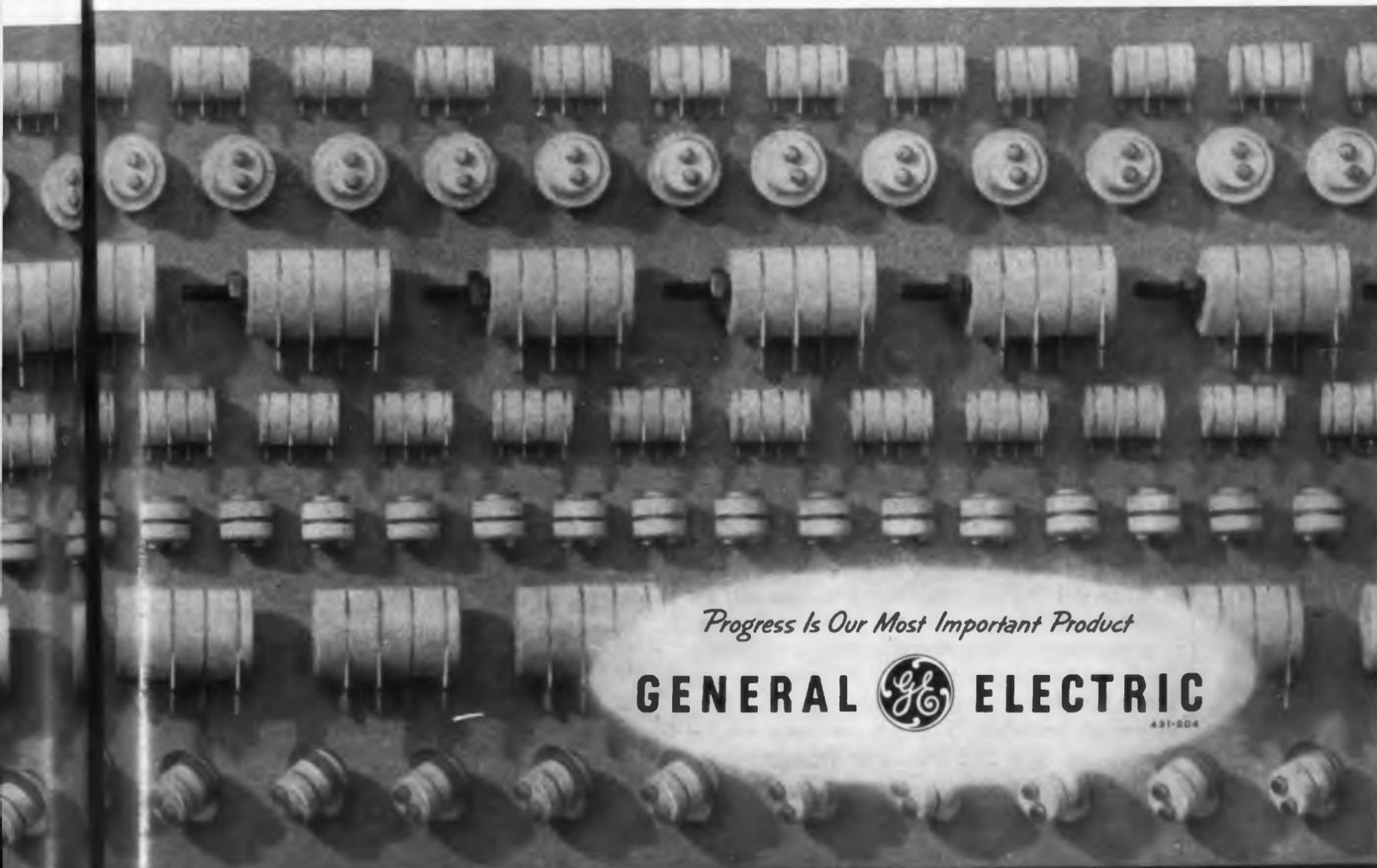
7077

RF-amplifier triode



eright frequency, function,
h G-E Ceramic Tubes have
druggedness...temperature
...high gain...low noise.

Los Angeles, GR 9-7765, BR 2-8566 San Francisco, DI 2-7201 Or call your General Electric Industrial Tube distributor.



Progress Is Our Most Important Product

GENERAL  ELECTRIC

431-204

Miniature Fastener 414

Quarter-turn and pawl types

The receptacle for this miniature quarter-turn fastener measures 0.812 x 0.375 in. and is 0.012 in. thick. It is applicable where space-weight reductions are important. Another quarter-turn fastener is shock and vibration resistant. Its mounting assembly is an aluminum plate to which is bonded a 1/2-in. thick neoprene rubber boss. The No. 48 adjustable pawl fastener requires a 9/16-in. diam. hole to mount the shaft, plus a 0.082-in. hole to receive a stop pin. The pawl position can be adjusted to accommodate frame thickness variations of 1/4 in.

Southco Div., South Chester Corp., Dept. ED, Lester, Pa.
Booth 326.

Precision Gears 423

28 different varieties

These Precision 2- and 3-spur gears are available in stainless steel, passivated, and aluminum, anodized. Precision 3 gears come in the following pitches: 48, 64, 72, 96, 120, and 200, all in 20-deg pressure angles. There are over 28 different varieties of Precision 2 and 3 gears.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, L.I., N.Y.

Price & Availability: Available from stock.

Booth 311.

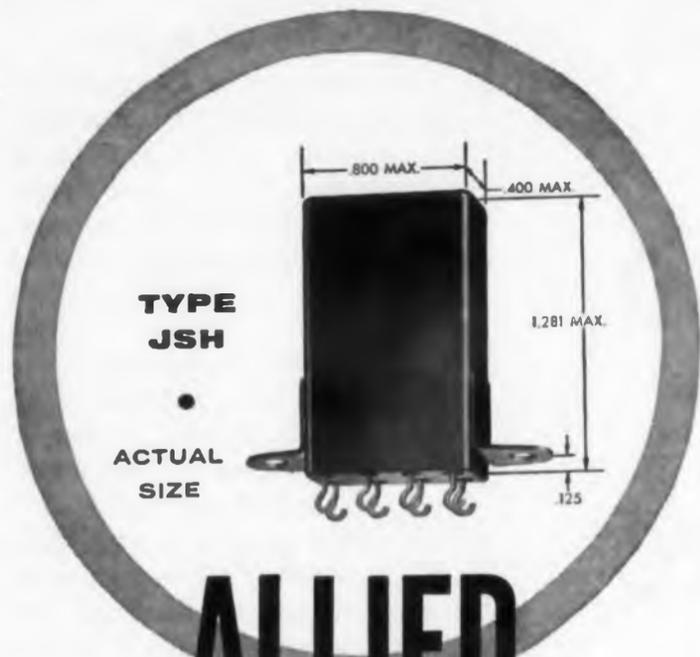
Environmental Test Chamber 425

For temperature coefficient calibration

This temperature coefficient calibration chamber is designed to test and calibrate thermistors and capacitors. The instrument is stable within ± 0.005 C, and can be adapted for stabilities of ± 0.001 C. Temperature range is from -75 to $+250$ C. Instruments for recording chamber operations are available.

Conrad, Inc., Dept. ED, 141 Jefferson St., Holland, Mich.
Booth 1027.

◀ CIRCLE 213 ON READER-SERVICE CARD



ALLIED CONTROL'S NEW

SENSITIVE 2 AMP RELAY
for
***15 g to 2000 cps vibration**

OPERATING CONDITIONS:

AVERAGE PULL-IN POWER:
SPDT 25 milliwatts at 25°C
DPDT 40 milliwatts at 25°C

CONTACT RATINGS:

Non-inductive — 2 amperes at 29 volts d-c
or 1 ampere at 115 volts a-c
Low level contacts are available on request

VIBRATION:

5-55 cps at 0.12 inch double amplitude
55-2000 cps at a constant 15 g
*20 g available on request

SHOCK:

50 g operational

TERMINALS:

0.2 inch grid spaced

WEIGHT:

1.1 ounce maximum

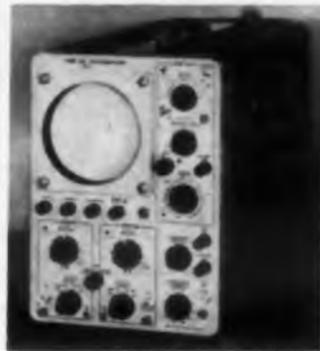
Write for Bulletin JSH #62

ALLIED CONTROL
ALLIED CONTROL COMPANY, INC.
2 EAST END AVENUE, NEW YORK 21, N. Y.
CIRCLE 214 ON READER-SERVICE CARD

NEW PRODUCTS

Oscilloscope

724



Sensitivity is 50 mv per
cm per channel

Type 516 dual-trace oscilloscope for the dc to 15 mc range. Basic sensitivity is 50 mv per cm for each channel with four operating modes possible. Sweep range is adjustable from 0.04 μ sec to over 6 sec per division. Viewing area is 6 x 10 cm. The instrument is suited for bench work. Its dimensions are 13-1/2 x 9-3/4 x 21-1/2 in.

Tektronix, Inc., Dept. ED, P. O. Box 500, Beaverton, Ore.

Price & Availability: \$1,000; immediately available.

Warning System

723



For airborne or ground
support equipment

This multi-channel, illuminated annunciator warning system is designed for airborne and ground-support equipment. It consists of a bank of light boxes, each containing two separately energized nomenclature strips to indicate the emergency status of any piece of equipment. Each strip is lighted by two lamps. The unit measures 3.5 x 2.35 x 3.6 in. and weighs 1.5 lb.

Radar Relay, Inc., Dept. ED, 2322 Michigan Ave., Santa Monica, Calif.

Wheatstone Bridge

668

Stands environmental extremes

Series 301 Wheatstone Bridge is designed for outdoor use in environmental extremes. Housed in a waterproof aluminum case with a removable cover and carrying strap, the instrument measures about 6 x 7 x 9 in. and weighs less than 9 lb, including batteries. It performs every routine bridge and loop test, including Wheatstone re-

another new
exclusive
GRC idea

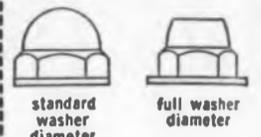


GRC die cast zinc alloy washer base CAP NUTS

GRC makes new exclusive low cost fasteners with Integral Washer Bases for better fastening performance and appearance. Won't mar soft surfaces. Use with over-size or offset holes. Prevents wrench marks. All these advantages at no extra cost to you.

Use standard diameter nuts wherever regular cap nuts would be used alone—full diameter nuts wherever regular cap nuts would be used with separate washers.

Standard thread sizes from #4 through 1/2"—14 hex sizes.
• Rustproof and corrosion resistant
• No tool marks or cut off burrs
• Save assembly time—inventory costs



standard
washer
diameter

full washer
diameter

Both closed end and open end washer base cap nuts available with full & standard washer diameters. In addition GRC has the most complete stock of standard Cap Nuts.

Cap Nuts and Wing Nuts in
widest range of styles and sizes.

Write today for new detailed fastener catalog.

GRIES REPRODUCER CORP.

World's Foremost Producer of Small Die Castings

40 Second St., New Rochelle, N. Y., NEW ROCHELLE 3-8600

CIRCLE 215 ON READER-SERVICE CARD



Gurley Precision Shaft Position Encoder

Read Angles Photoelectrically

- ▶ No friction
- ▶ High accuracy
- ▶ No wear

Gurley Precision Shaft Position Encoder is only 3/8" in diameter...reads 8192 angular positions per revolution...accurate to 2 1/2 minutes of arc...contains amplifiers to give 3 or 10 volt output.

▶ Write for illustrated brochure.

W. & L. E. Gurley

525 Fulton Street, Troy, New York

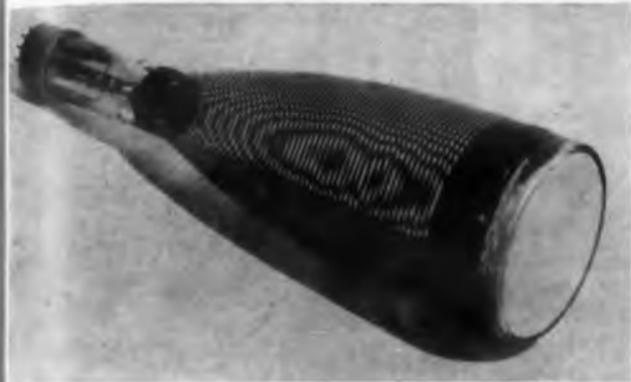
sistance tests, capacitance tests, and Varley, Murray, Hillearn, and Fither loop tests. Accuracy is of $\pm 0.1\% \pm 0.01$ ohms.

The Winslow Co., Dept. ED, 701 Lehigh Ave., Union, N.J.

Cathode-Ray Tube

626

Has 5.25-in. diam



Model K1931 5.25-in. cathode-ray tube is for high-frequency operation for general purpose oscilloscopes and other instruments. The tube has linear post-acceleration for use in low-frequency instruments. It operates at screen voltages of 5,000 v with deflection factors of 25 to 35 v per in. for both sets of deflection plates.

Allen B. Du Mont Labs., Inc., Dept. ED, 750 Bloomfield Ave., Clifton, N.J.

Price & Availability: \$50 ea with P1 or P2 phosphors and \$56.50 with P7 or P11 phosphors. Delivery is in eight weeks for sample quantities.

Direct-Reading Attenuators

622

Cover 3.95 to 40 kmc



Type 101 broadband, direct-reading attenuators come in nine models covering the frequency range of 3.95 to 40 kmc. Attenuation range is 60 db and maximum vswr is 1.15. The units are rotary-vane type. The value of attenuation is determined by the angular position of a resistive film with respect to the waveguide.

PRD Electronics, Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N.Y.

Price & Availability: The units will be available toward the end of 1960 at prices ranging from \$265 to \$490 ea.

NOW— DIRECT VERNISTAT* SERVICE ON WEST COAST



New Los Angeles branch office will provide expanded sales and engineering service

The Vernistat Division of the Perkin-Elmer Corporation has opened a Western branch office to provide direct sales and complete application engineering services in California and the West. Headed by Mr. Lee Pulsipher, a graduate electrical engineer, this office provides for liaison and direct contact between customers and the Norwalk main office.

For prompt attention, all inquiries, quotation requests, and purchase orders should be directed to:

Vernistat Division, Perkin-Elmer Corporation
5670 E. Washington Boulevard, Los Angeles 22, California
Telephone: PArkview 2-4900

We look forward to serving you soon—on all questions concerning Vernistat precision a.c. potentiometers, adjustable function generators, variable ratio transformers, and special components.

*Vernistat—a design concept that unites in one compact device the best features of the precision autotransformer and the multi-turn potentiometer.

vernistat

Perkin-Elmer

Corporation

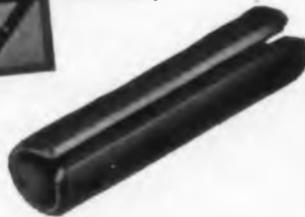
NORWALK, CONNECTICUT, U.S.A.

CIRCLE 216 ON READER-SERVICE CARD

New ROLLPIN APPLICATION DATA!



Esna's latest Rollpin booklet gives you valuable information on where to use and how to install these versatile, all-purpose fasteners. A slotted, chamfered, cylindrical spring pin, Rollpin locks securely in place—yet can be drifted out and used over and over again. Write for it today and see how Rollpins can simplify design and production operations. Address Dept. R55-857.



ROLLPIN

**ELASTIC STOP NUT CORPORATION
OF AMERICA**

2330 Vauxhall Road, Union, N. J.

CIRCLE 217 ON READER-SERVICE CARD

Just
published
by KODAK



If you are working with infrared-actuated devices, you need this new Kodak folder, *Kodak Ektron Detectors*. It tells what you need to know about types and availabilities of these photosensitive resistors.

There are curves for the six different depositions available in Ektron Detectors that give specific responsivity and detectivity (signal-to-noise ratio) against wave length. Also description of physical forms available and a quick summary of basic effects.

To get your free copy, write to Special Products Sales,

EASTMAN KODAK COMPANY
Rochester 4, N.Y.

Kodak
TRADE MARK

CIRCLE 218 ON READER-SERVICE CARD

what makes one
micro-miniature
relay more
reliable
than another?

answer:
**SEALED
CONTACT
CHAMBER**

NEW Couch Relay isolates Contacts from Contamination

Organic material can't contaminate the contacts in the new Couch Type 2M micro-miniature relay. They're hermetically sealed in a separate chamber — and without rosin flux.

Also contributing to reliability is Couch's patented rotary armature, pivoted on two sapphire jewels and virtually immune to present day levels of shock and vibration.

Designs like this, produced within an unusually narrow range of manufacturing tolerances, help explain why Couch relays are being called on to provide reliability in many complex systems.

Write for additional information.

ENGINEERING DATA:

Shock.....	50G Min.
Vibration.....	.30G's to 2,000 CPS
Dielectric Strength.....	1000 Volts RMS Min.
Height.....	.875" max.
Width.....	.800" max.
Thickness.....	.400" max.
Weight.....	.18 ± 1 gram
Contact Arrangement.....	2 form C(2 PDT)



COUCH ORDNANCE, INC.

A Subsidiary of S. H. Couch Company, Inc.

3 Arlington St., North Quincy 71, Mass. Tel.: (Boston) BLuehills 8-4147

CIRCLE 219 ON READER-SERVICE CARD

NEW PRODUCTS

Oscillograph

725

Frequency response is to 125 cps



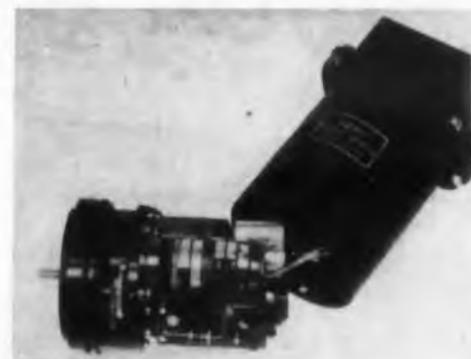
Model 297 two-channel, direct-writing oscillograph recorder is designed for applications in large instrumentation set-ups for monitoring and as a bench-top instrument for field work. Performance features include: frequency response to 125 cps, within 3 db at 10 mm peak-to-peak amplitude; gain stability of better than 1% in spite of 20 C and 20-v power line variations; and maximum non-linearity of 0.2 mm. Chart speeds are 1, 5, 20, and 100 mm per sec. Over-all dimensions of the unit are 10.5 x 16 x 19 in.

The Sanborn Co., Dept. ED, Industrial Div., 175 Wyman St., Waltham 54, Mass.

Servo Repeater

732

Measures 2-5/16 in. in diameter



This 26-v, synchro, servo repeater measures 2-5/16 in. in diameter and 4-7/8 in. in length. The entire assembly includes gear train, motor-tach, control transformer, transistorized amplifier, and power supply. Backlash is zero between the synchro control transformer and output shaft. Static accuracy is 0.25 deg max at a 7-min synchro input, constant velocity is 500 deg per sec per deg, and slew velocity is 30 rpm. Input requirements are 115 v at 400 cps, 7 va. A size 8 synchro transmitter is required. The repeater meets MIL-E-5272B.

Orbit Instrument Corp., Dept. ED, 131 Eileen Way, Syosset, L.I., N.Y.

Availability: Units are made on order and can be delivered in 60 days.

How to Turn a \$500 Raise into a \$1,000 Bonus



WHAT SHOULD HE DO WITH AN EXTRA \$5

He can spend it, of course. But, if he buys a \$25.00 U.S. Savings Bond each month for 40 months with his \$5 a week raise, he is going to have Bonds worth \$1,000.

Wishing won't turn a \$5 a week raise into a \$1,000 bonus, but it's easy to do. If you take that \$5 raise and put it into U.S. Savings Bonds you can buy a \$25.00 Bond a month (cost \$18.75) and have money left over. If you keep buying one of these Bonds a month for 40 months you'll have your big bonus—Bonds worth \$1,000 at maturity.

Why U.S. Savings Bonds are such a good way to save

- You can save automatically with the Payroll Savings Plan.
- You now earn 3¾% interest to maturity.
- You invest without risk under U.S. Government guarantee.
- Your money can't be lost or stolen.
- You can get your money, with interest, anytime you want it.
- You save more than money; you help your Government pay for peace.
- You can buy Bonds where you work or bank.

You save more than money
with U. S. Savings Bonds

The U.S. Government does not pay for this advertising. The Treasury Department thanks The Advertising Council and this magazine for their patriotic donation.



FOR TIMELY DESIGN INFORMATION



In *Electronic Design*, engineers find not only more new products, but all the new products normally encountered in the design of electronic original equipment. 26-time publishing frequency brings this information quickly to the engineer's attention, timed to a fast-moving industry. *Electronic Design* is more up-to-the-minute, more complete, more helpful, and easier to read than any other electronic publication. No wonder more and more engineers read *Electronic Design* first!

ELECTRONIC DESIGN

a HAYDEN publication
830 THIRD AVENUE, NEW YORK 22, N. Y.

Counter-Timer

726

Interval is 10^{-6} to 10 sec



Model 361-R counter timer has a time interval of 10^{-6} to 10 sec; it operates over a period of 10^{-6} to 10^7 sec. It totals random events over any of eight time intervals from 10^{-6} to 10 sec. Frequency is 0 to 10^6 pps or 1 to 10^6 pps. The crystal-controlled clock has an absolute stability of ± 0.3 ppm per week. The count-down chain provides 1-mc crystal frequency sine waves and square waves of 100 kc, 10 kc, 1 kc, 100 cps, 10 cps, 1 cps, and 0.1 cps.

Transistor Specialties, Inc., Dept. ED, Terminal Drive, Plainview, L.I., N.Y.

Silicon Power Transistors

672

Four types offered

Types 2N389 and 2N424 silicon power transistors require only 1.5 v to drive a 1.5-amp collector-current level. They have a higher frequency response than comparable units. Type 2N1470 has a low collector leakage current, low saturation voltage and an alpha cut-off of 1 mc. Type 2N1657 is identical to the 2N1470 but is in the square-power transistor shell.

Raytheon Co., Dept. ED, Waltham 54, Mass.
Availability: From stock for immediate delivery.

Power Supplies

728

Are 1.25 to 1.5 in. wide



These transistor-regulated power supplies are 1.25 to 1.5 in. wide, depending on power output. Depth and length are both 4 in. Designated the 7400 series, the units are rated at 5 to 60 v dc at 200 ma. No load to full load regulation is 0.05% and line change regulation is $\pm 10\%$. Ripple is less than 2 mv.

Systems Research Corp., Dept. ED, Box 251, Northridge, Calif.



ELECTRONIC COOLING UNITS by Peerless Electric

Blower-motor units made to cool radio transmitters involving Klystron tube installations. Peerless Electric meets special dimensional needs with these continuous duty units for unmanned Vortac airline navigation beacons.

BOTH BLOWER AND MOTOR CUSTOMIZED FOR YOU

Do your electronic cooling needs call for air-moving equipment that's unique as to size and performance? Are you looking for a special blower and exactly the right motor to power it? Peerless Electric is your one-source answer for tailor-made blower-motor units. *For specific information, mail coupon below.*

PEERLESS ELECTRIC DIVISION

PORTER

H. K. PORTER COMPANY, INC.

PEERLESS ELECTRIC DIVISION, H. K. PORTER COMPANY, INC.,

Dept. 014, Warren, Ohio

Gentlemen:

My cooling problem is _____

Please send pertinent specification data sheets.

NAME _____

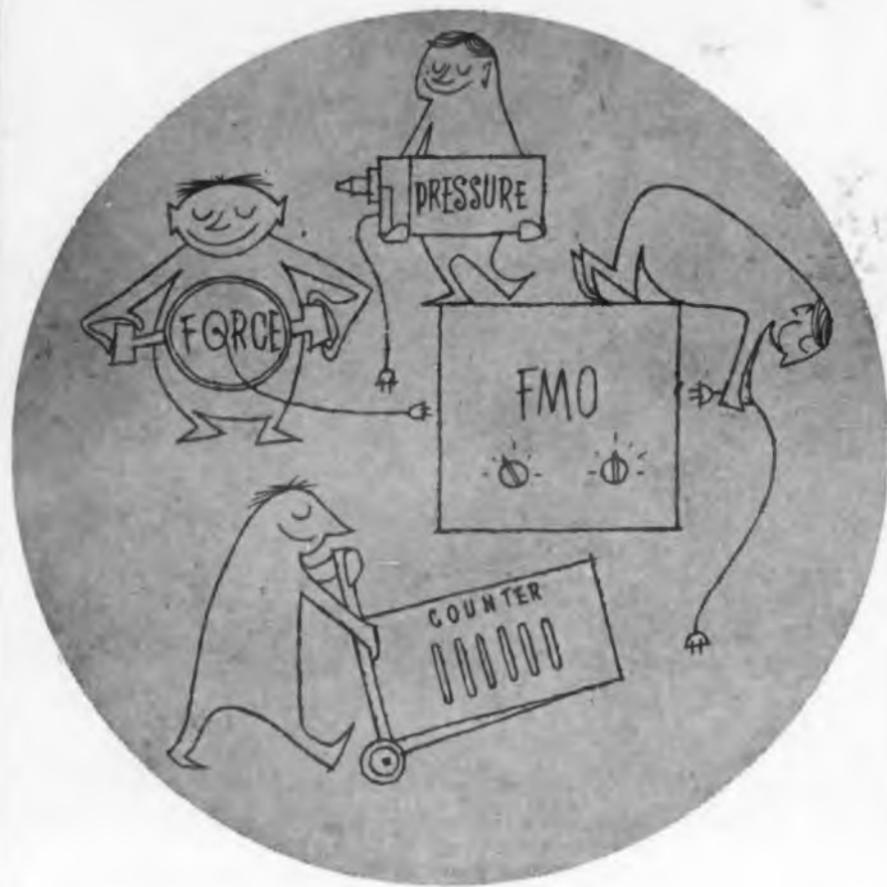
COMPANY _____

ADDRESS _____

CIRCLE 221 ON READER-SERVICE CARD

measurement made easy

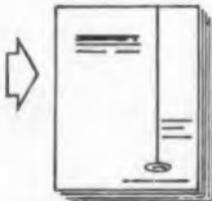
digital precision — direct readout



Wiancko FM building block components make creative "do-it-yourself" systems engineering entirely practical and economical. The compatibility of these components results in long-term system accuracy of ± 0.05 percent, and they are readily assembled for meeting a variety of applications.

Our *Systems Engineer's Handbook* describes these remarkable instruments and discusses numerous applications for them—direct readout for multiplication, summation, time integrals, and ratios of parameters such as temperature, pressure, force, and speed.

Send for it— it's free!!!



PRECISION WITH LASTING RELIABILITY

WIANCKO
ENGINEERING COMPANY



255 North Halestead Avenue • Pasadena, California

CIRCLE 222 ON READER-SERVICE CARD

DESIGN DECISIONS

Featuring the clever and unusual in packaging, appearance design, and circuitry in electronic equipment.

Strobed, Rotating Number Drum Cuts Cost of Digital Voltmeter

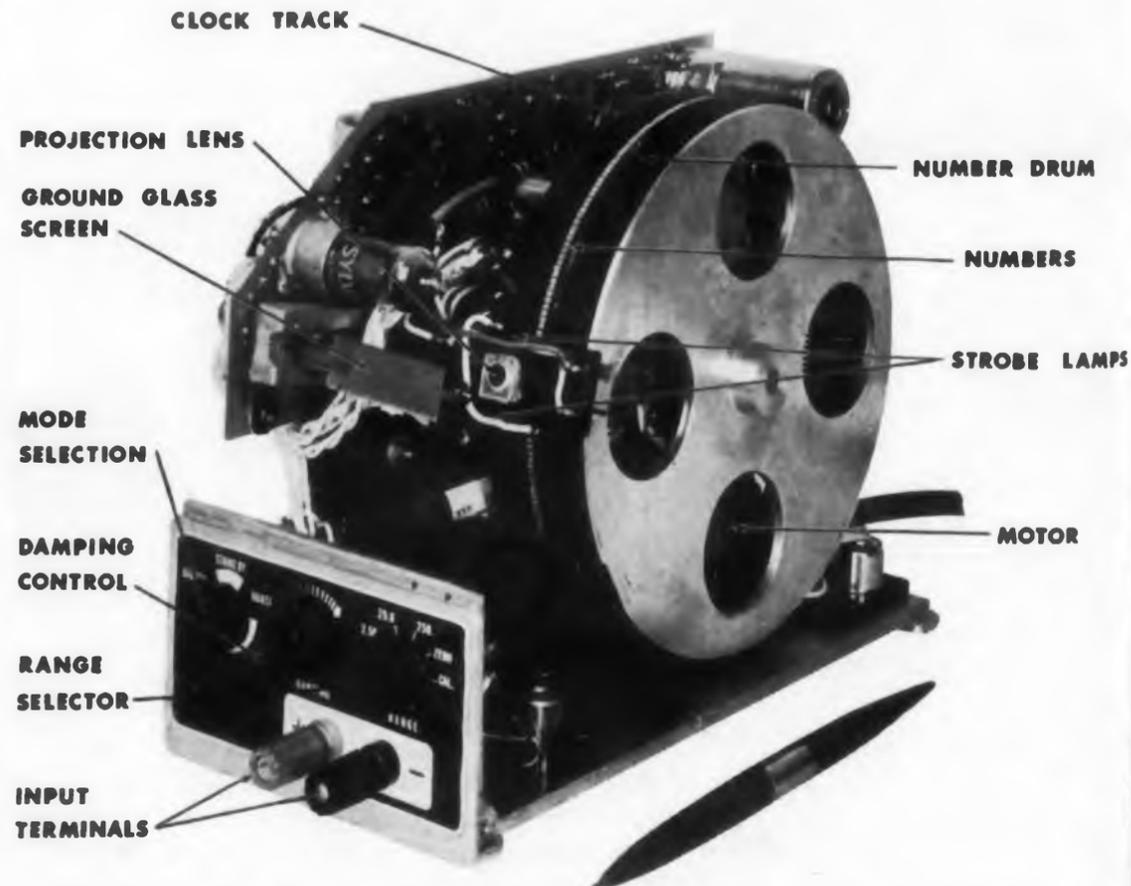
A STROBOSCOPIC readout is the key to the low price (\$295) of Electro-Logic Corp.'s model V-1 digital voltmeter. The DVM uses a rotating potentiometer (on the same shaft with a number drum) to generate a sawtooth sweep.

With the usual ramp voltage technique, George Giel, vice president of Electro-Logic points out, there are two time sources—clock and sweep . . . and feedback is necessary to tie them together. But with the drum and potentiometer on the same shaft, and both

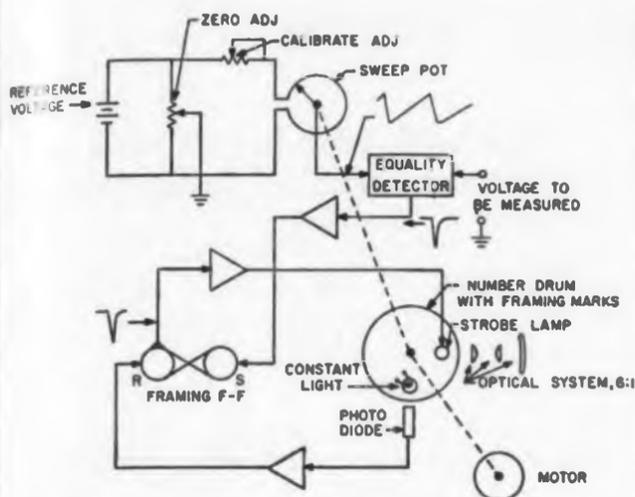
keyed to the strobe lamp, the drum speed (a nominal 1500 rpm) need not be closely regulated, so an 85-cent motor can be used.

On the surface of the drum, there are small rectangular holes corresponding to each of 250 numbers. A light inside the drum shines through these holes, enabling a photodiode to send a series of clock pulses to a flip-flop.

The pulses have no effect on the flip-flop until the nearest hole following equality of sawtooth voltage and unknown is illuminated. Then the flip-flop



Strobe lamps illuminate voltage reading on rotating drum in low-cost digital voltmeter.



When input and sweep voltages are equal, photo-diode triggers flip-flop which flashes strobe lamps which illuminate voltage reading which is optically enlarged.

is reset. The amplified reset pulse fires the strobe lamps which illuminate a number on the drum surface. The number is optically enlarged and projected on a ground-glass screen.

To change from digital to "quasi-digital" presentation, where numbers roll smoothly across the screen, an operator can disconnect the flip-flop with a front-panel control. The strobe lamps then flash as soon as the sweep equals the unknown. This permits interpolation between numbers and lets the operator observe a voltage trend. "It's equivalent," notes Electro-Logic's president, Vincent Van Praag, "to a 70-in. analog scale."

There are only 11 transistors in the 0.5-per-cent accurate DVM, all of them of commercial quality. Transistorized pulse circuitry uses heavy feedback to maintain proper stability. The only close tolerances required are in the concentricity and positioning of the bore for the potentiometer shaft.

The sweep potentiometers are conductive-plastic units, manufactured by Markite Products Corp. in New York City and New England Instrument Co. in Woonsocket, R.I. Life tests of 250 million revolutions confirm the manufacturers' life specifications.

Covered by a patent, the circuit principle in the stroboscopic DVM is applicable to many other devices. Some of these are in the works. ELECTRONIC DESIGN will report on them when they are available to the market.

Availability of this DVM as well as its technical specifications have already been disclosed in the March 30th issue of ELECTRONIC DESIGN.

DOW

Now in magnesium and aluminum

FOUR MAGNESIUM DEVELOPMENTS ANSWER DESIGNERS' PROBLEMS

New Dow developments in magnesium provide solutions to critical problems for aircraft, missile and electronics designers. Among them are: a special bend sheet; new close sheet tolerances; precision extrusions; elevated temperature alloys.



Heated dies are not necessary with Special Bend sheet.

NEW SPECIAL BEND SHEET bends easily on standard bending equipment at room temperature. This AZ31B-O Special Bend sheet can be cold-bent

without cracking through an angle of 90 degrees around a mandrel radius equal to the bend factor times the nominal sheet thickness . . . bend factor for .040" to .100" sheet thickness is 2.0! And tensile yield strength meets the requirements of Federal Specification QQ-M-44.

NEW CLOSE SHEET TOLERANCES can now be obtained on standard gauges when required. For example, on .090" gauge, 48-inch-wide sheet, tolerances can now be held as close as plus or minus .002". Standard tolerances run plus or minus .004". These closer tolerances help to cut down on weight



Magnesium gives greater rigidity for equal weight than other metals.

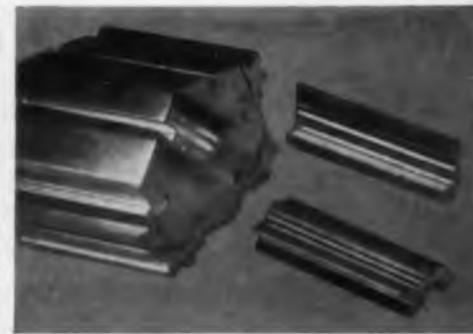
penalty, so important in missile and aircraft design.

PRECISION MAGNESIUM EXTRUSIONS from Dow give you exact-tolerance parts without costly multiple machining operations. Sharp V's, deep notches, thin slots, accurate serrations . . . all can be economically produced in Dow's Madison, Illinois, extrusion plant.

LARGE EXTRUSIONS. A huge 13,200-ton press easily handles large sections, stepped extrusions, combined extrusion forgings and single unit extrusions to replace fabrications. This giant can handle sections of up to a 30-inch circumscribed circle!

ELEVATED TEMPERATURE ALLOYS are available from Dow for extruded and rolled products. These alloys have excellent static and creep properties, some up to or above 700°F. Because of magnesium's high specific heat, it's an excellent heat sink for instruments and components!

Compared pound for pound with other metals, magnesium permits the use of heavier-gauge, more rigid sections for extra structural strength . . . and substantial weight savings!



Dow precision-extrudes magnesium in almost any cross-sectional shape.

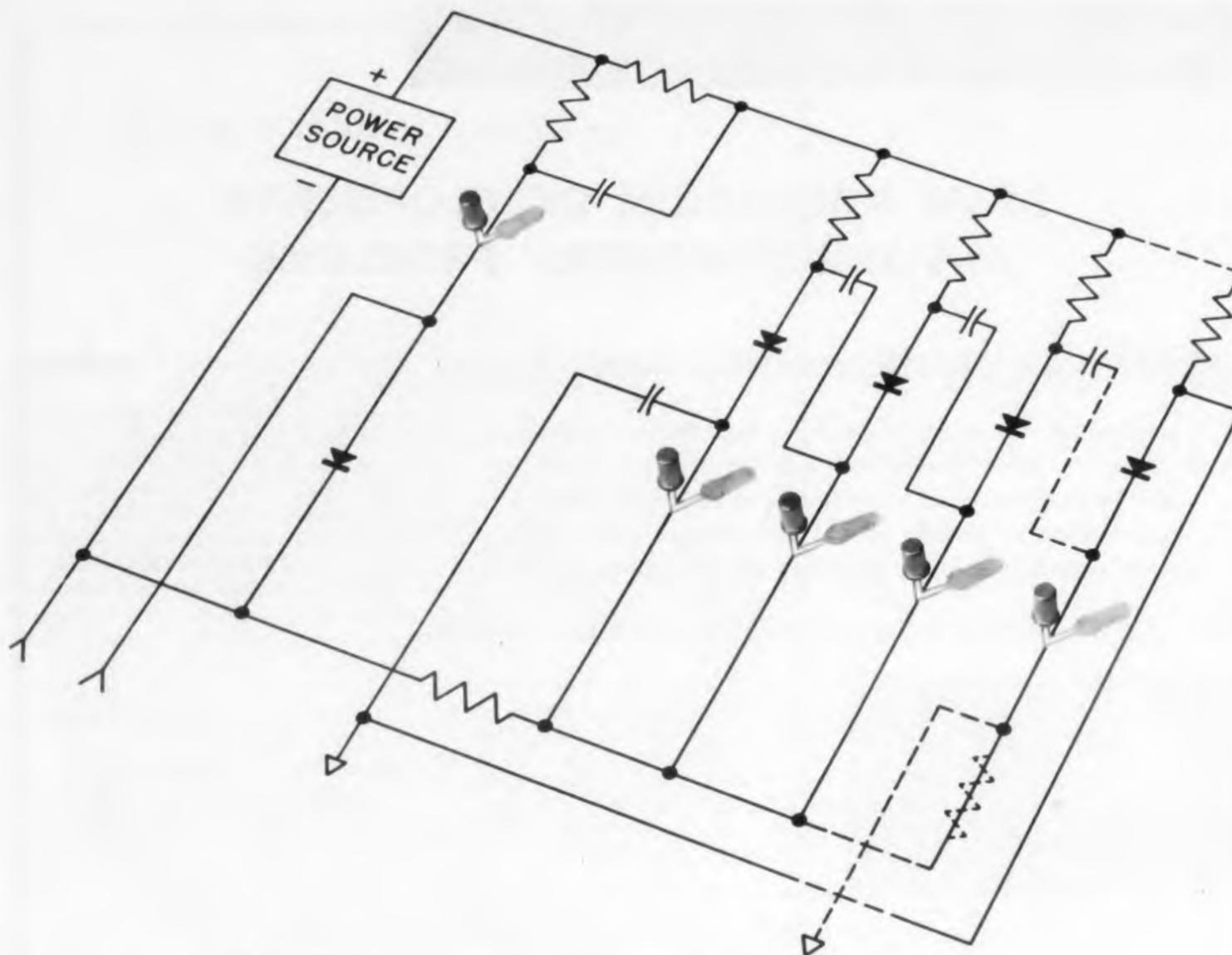
For more information on these products, and on Dow's fabrication facilities for magnesium and aluminum, contact the nearest Dow sales office, or write THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Department 1002BC8-3.



THE DOW METAL PRODUCTS COMPANY

Division of The Dow Chemical Company

CIRCLE 223 ON READER-SERVICE CARD



*SHOCKLEY 4-LAYER DIODES used in typical multiple-stage ring counter circuit.

YOU CAN COUNT ON 4-LAYER DIODES

For counting pulses...for timing...for digital read-out. The diagram shows one of several simplified ring counter circuits using Shockley 4-layer diodes. This silicon semiconductor switch is the key to circuit versatility. Apply appropriate resistors and capacitors, and speeds from less than one pulse per second to several hundred thousand per second may be obtained. At each stage enough power can be handled to operate signal lamps, enough voltage can be supplied to operate Nixie Tubes.

When broad temperature ranges and tough en-

vironmental conditions must be met, the MIL-LINE diode is available. Standard commercial 4-layer diodes are suggested for low cost, non-military applications. If your circuits involve ring counters, consider Shockley 4-layer diodes for faster, more dependable operation. For application notes on ring counters, how to make flip-flops, drive relays, convert DC to AC, pulse magnetrons, or for suggestions about the use of 4-layer diodes in the circuit you are developing now...call or write your local Shockley representative or write Dept. 12-2.

Shockley TRANSISTOR
UNIT OF CLEVITE TRANSISTOR
 STANFORD INDUSTRIAL PARK, PALO ALTO, CALIF.
 CIRCLE 224 ON READER-SERVICE CARD



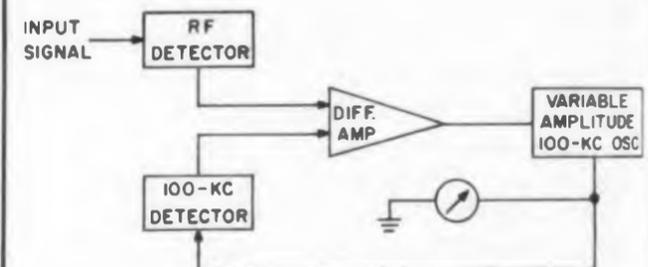
DESIGN DECISIONS

Feedback-Stabilized Probe Uses Replaceable Diode Cartridge

A pair of balanced diodes in a replaceable cartridge provides rf probes with an unusual degree of temperature independence. The diode cartridge fits into any of a number of rf probes for Hewlett-Packard's model 411A RF millivoltmeter.

Probes include a pen type, useful from 5 kc to 50 mc; a vhf type, useful from 500 kc to 250 mc; a type N "Tee" for 10 kc to 1 kmc; a BNC and a TNC, both useful from 500 kc to 1 kmc; and a type N 50-ohm termination for 10 kc to 1 kmc; and a 100:1 capacity divider probe for 10 kc to 1 kmc.

The cartridge uses feedback stabilization to help provide a linear scale readout. One of the diodes in the cartridge rectifies the incoming rf. The other diode rectifies the output of a variable-amplitude, 100-kc oscillator. The output of each diode goes to a differential dc chopper amplifier which amplifies the difference between their dc



Linear readout results from nonlinear detection of incoming rf and 100-kc signal.



Easily replaced diode cartridge obviates time-consuming selection of matching diodes.

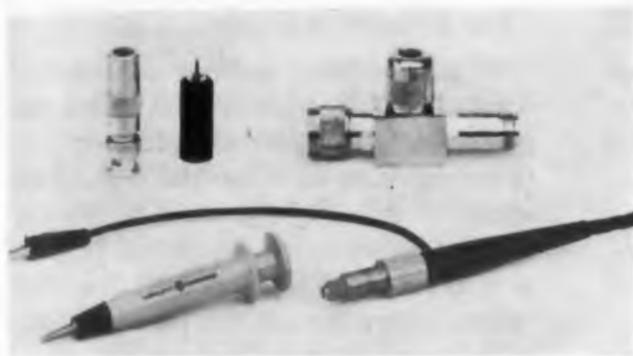
ELECTRONIC DESIGN • August 3, 1960

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levels and controls the amplitude of the 100-kc oscillator. The meter on the 411A measures the amplitude of the 100-kc signal.

Since the oscillator's feedback through the 100-kc detector is nonlinear, just as is the output of the rf detector, the scale readout is linear. Since both diodes in the probe are at the same temperature, the instrument is unusually free from the effects of varying temperature.



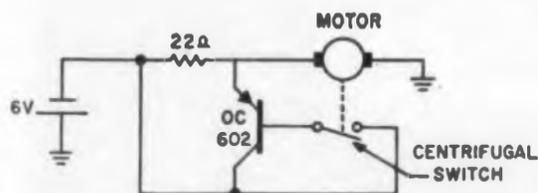
Part of the selection of probes for the 411A RF millivoltmeter.

VARIABLE
AMPLITUDE
100-KC OSC

tection of

Centrifugally Switched Transistor Controls Motor Speed

A power transistor helps maintain constant motor speed in the Niki tape recorder made by the German firm Grundig. In this battery-oper-



Transistor, controlled by centrifugal switch on tape-recorder motor, helps maintain constant motor speed.

ated recorder, a 6-v battery powers the motor through a 22-ohm dropping resistor.

The collector-to-emitter resistance of an OC602 power transistor shunts the 22-ohm resistor. The base of the transistor is shorted to the collector by a centrifugal switch on the motor.

The centrifugal switch is not used to short the 22-ohm resistor directly because the high currents through the switch would reduce its life substantially.

Dr. A. V. J. Martin, Paris, France.

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NEW LITERATURE

Tapes and Adhesives 261

This manual provides comprehensive information on the physical characteristics and typical applications of a full line of industrial tapes, bulk adhesives, coatings, and other pressure-sensitive products. Products are cross-indexed by Armed Forces specification data, tape type, tape function and industrial application. Mystik Adhesive Products, Inc., 2635 N. Kildare Ave., Chicago 39, Ill.

Reference Folder 262

Prepared to be used either as a wall chart or as a desktop reference, this folder contains three tables of information: a temperature table showing conversion from Centigrade to Fahrenheit, or vice versa, from 0 to 3000 deg; a table of decimal equivalents of fractions in increments of 1/64 in., and a table giving the mechanical and electrical properties of high alumina and steatite ceramics. Centralab, Electronics Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Parts Catalog

This 1960 edition of the Green Sheet contains a listing of various electronic equipment available from the company. Among the items listed are transmitting, receiving and special purpose tubes, X-band microwave equipment, test equipment, motors and rheostats, and transformers. Send \$0.25 to Barry Electronics Corp., Dept. ED, 512 Broadway, New York 12, N.Y.

Filter Reference Guide

Printed in three sections of loose-leaf sheets, this reference guide covers the performance characteristics of filters, magnetic amplifiers and toroidal coils. Each group of sheets is organized by type of product. Separate data sheets are jacketed in a cover, which doubles as its own filing jacket, with a die-cut tab providing easy visibility when in a filing cabinet. Write on company letterhead to Components Corp., Dept. ED, 2857 N. Halsted St., Chicago 14, Ill.

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Plastic Products Catalog 263

Plastic products of Teflon, Raylon and Kel-F are described in this 36-page catalog. It contains mechanical and electrical properties plus performance curves. Illustrated are basic shapes, custom-machined parts, thin wall tubing, O and back-up rings, bearings and coatings. Raybestos-Manhattan, Inc., Plastic Products Div., Manheim, Pa.

Refrigeration Systems 264

A variety of miniature refrigeration systems for cooling electronic devices to temperatures ranging from 3.5 K to 200 K is described in this illustrated brochure, four pages. Included are data on closed and open systems for infrared detectors, masers, irasers, parametric amplifiers, and other cryogenic applications. Air Products, Inc., Allentown, Pa.

Synchros 265

Catalog No. 4000, a 16-page, two color brochure, contains definitions of synchro parameters, dimensional drawings, circuit

diagrams, and physical, electrical and mechanical characteristics of the company's basic line of size 8, 10, 11 and 15 synchros for military, industrial and scientific applications. John Oster Manufacturing Co., Avionic Div., 1 Main St., Racine, Wis.

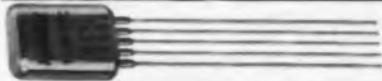
Plastics Catalog 266

This 64-page catalog lists plastic products in sheet, tube, rod, film and roll form. The plastics covered are plexiglas, vinyl, acetate, phenolic, nylon, teflon, kel-f, polyethylene, polystyrene, rexolite, delrin, and fluorglas accessories. Commercial Plastics & Supply Corp., 630 Broadway, New York 12, N.Y.

Silicone Materials 267

This 12-page engineering guide contains technical data and processing information on silicones. It details the important electrical and mechanical properties of the silicones most useful in electronics. Also included are typical applications in various areas of use. Dow Corning Corp., Midland, Mich.

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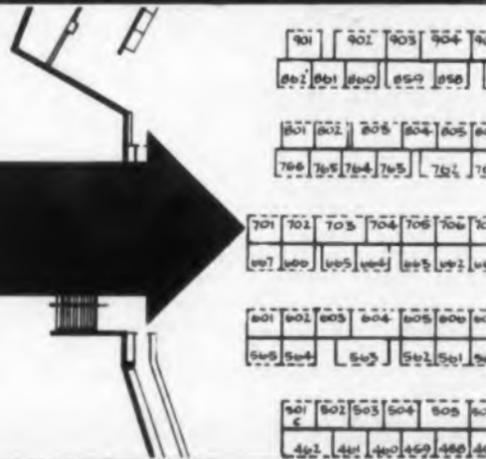
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NEW LITERATURE

Knobs and Handles 268

Specifications, dimension drawings and illustrations of 49 stock designs of molded plastic knobs and handles appear in this eight-page catalog. Groups include ball knobs, oval and tapered knobs, tapered handles, push-pull and lid knobs, knurled and fluted handwheels and knobs, thumb screws and terminal nuts, pointer and instrument knobs, and others. Dimco-Gray Co., 207 E. Sixth St., Dayton 2, Ohio.

Digitalizing Radar Data 269

A description of a system for the digitalizing of radar position data is given in this technical paper on "Precision Data Recording System for Instrumentation Radars." Electronic Engineering Co., Sales Dept., 1601 E. Chestnut Ave., Santa Ana, Calif.

Ultrasonic Filter Cleaner 270

This 38-page technical report describes a hyperintense proximal scanning ultra-

sonic system which uses cavitation to clean filter elements and other equipment. Sections include data on components, operation, installation, input requirements and cleaning limitations. Aircraft Porous Media, Inc., 30 Sea Cliff Ave., Glen Cove, N.Y.

Amplifiers 271

Series USA-4 and K2 operational amplifiers are described in this short-form data sheet, one page. The data sheet contains brief technical data, photographs of the units and price information. George A. Philbrick Researches, Inc., 127 Clarendon St., Boston 16, Mass.

Crystals and Oscillators 272

This 20-page catalog includes specifications for crystals from 400 cycles to 140 mc. Oscillators from 60 cycles and up are shown in detail. Ovens with a stability of 0.003 C are also covered. Monitor Products Co., 815 Fremont, S. Pasadena, Calif.



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Technical Data Catalog

This 1960 technical data catalog is a pocket size edition. It covers the following fields: Power Transmission Machinery; AC Motors and Generators; Electrical Transmissions; AC and DC Electricity; Transformers, Relays and Meters; 5 Place Trig and Log tables; Conversion Tables and others. Send \$1.25 to Lefax Publishers, Dept. ED, Philadelphia 7, Pa.

Antenna Instruments 273

Listed in this 1960 short form catalog is information on various antennas and associated equipment, such as: antenna pattern recorders; antenna positioners; a Fourier computer; remote tuned signal sources; synchro transmitters; model range towers, and wide range receiving systems. Scientific-Atlanta, Inc., 2162 Piedmont Road, N.E., Atlanta 9, Ga.

Semiconductor Exchangers 274

Semiconductor heat exchangers, series 5000, for medium pressure forced air cooling systems using transistors, Zener

diodes and rectifiers, are described in this four-page bulletin, No. 260. A complete description on the material, construction, finish, mounting, and ducting and baffling of the heat sinks is included. Line drawings, illustrations and characteristic curves also appear. Wakefield Engineering, Inc., 7 Broadway, Wakefield, Mass.

Printed Circuit Resistors 275

This one-page data sheet contains data on miniature and printed circuit encapsulated precision wire wound resistors. Specifications include temperature coefficient, wire terminals and tolerances. A table gives physical dimensions and ratings. Dmeter Manufacturing Co., Inc., 68 N. Broadway, Yonkers, N.Y.

Silicon Transistors 276

Bulletin 11-109, one page, offers technical data for types 2N389 and 2N424 high-power silicon transistors. Specifications and illustrations are included. Silicon Transistor Corp., Carle Place, Long Island, N. Y.

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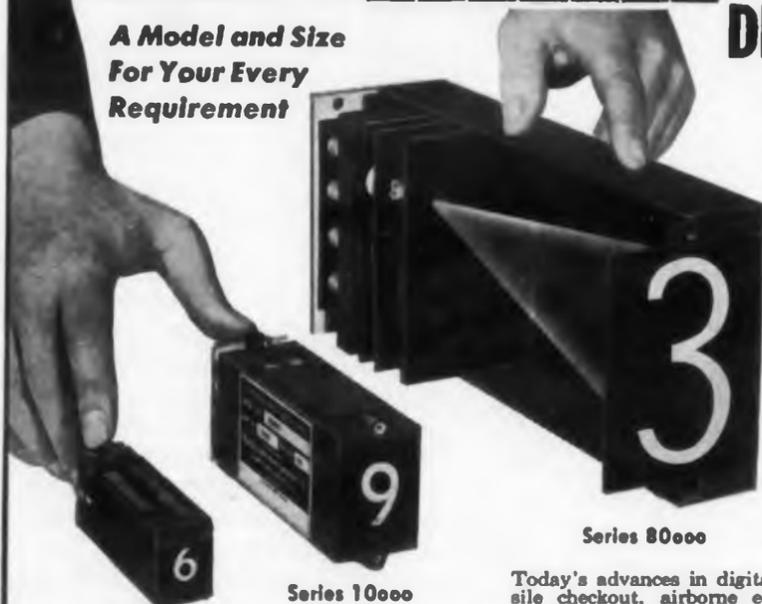
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NEW LITERATURE

Relays 277

This 12-page booklet discusses the complete line of relays for various applications. Relays described include: general purpose, machine tool, mechanically held, pneumatic time-delay and synchronous motor-driven timing. The illustrated booklet, No. GEA-7021, contains wiring diagrams, dimension drawings and tables. General Electric Co., Schenectady 5, N.Y.

Vacuum Gages 278

Heated thermopile vacuum gages are described in this six-page booklet. The illustrated booklet covers pressure ranges for single meter types, twin meter types, battery-operated types, and controllers. Chart and scale ranges of two types of recorders are included. The booklet also describes various accessories. Hastings-Raydist, Inc., Hampton, Va.

Stunt Box Control Device 279

The Teletype 28 stunt box is described in this 20-page, four-color brochure. It is

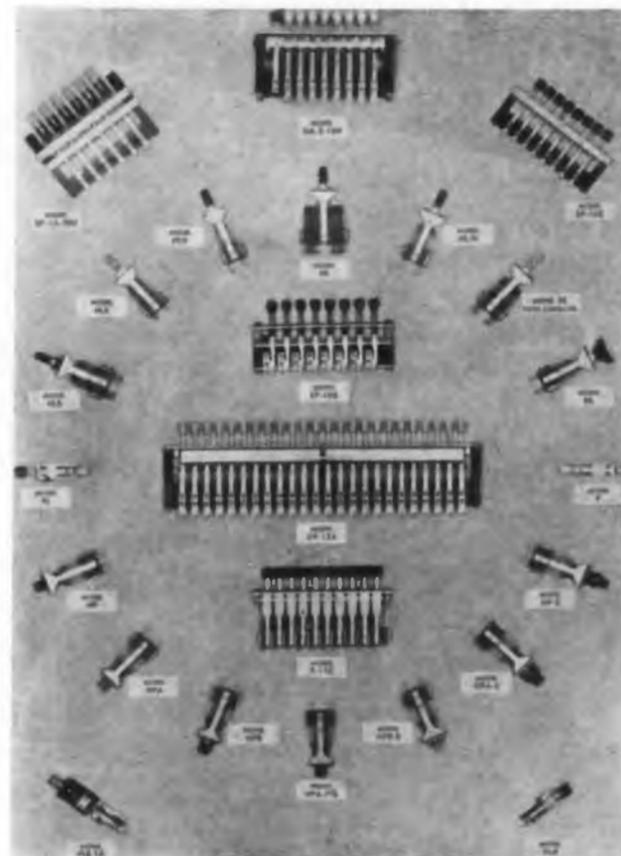
intended to provide users and potential users of Teletype model 28 equipment with data of how model 28 page printers and automatic send-receive sets can be used to maximum capabilities. The illustrated brochure describes functions and function mechanisms. Teletype Corp., Dept. SP-9, 4100 Fullerton Ave., Chicago 39, Ill.

Cold Cathode Tube Manual

The complete line of cold cathode counting tubes is described in this 36-page manual. Included in the manual are specifications, applications, and numerous circuit diagrams and design criteria on all counting tubes, trigger tubes, register and voltage reference tubes offered by the company. Send \$1 to Baird-Atomic, Inc., Dekatron Handbook Section, Dept. ED, 33 University Road, Cambridge, Mass.

Precision Ball Bearings 280

Type HDR precision radial ball bearings are described in catalog No. 60, eight pages. Data covered include: tolerances, internal clearances, materials, shaft



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are adapted to many variations of switching requirements and mechanical arrangements. They are manually operated units, featuring selective control of one or more groups of circuit combinations.

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s, shaft

and housing fits, lubrication, dynamic load ratings, dynamic thrust and combined load ratings and static load ratings. Ball bearings in four standard series of bearing envelopes are described. Split Ballbearing, Lebanon, N.H.

Capacitors 281

This two-color, four-page brochure is intended to aid in the selection of Vitramon capacitors. It contains illustrations and details of axial and axial-radial series and the ceramic microminiature capacitors. Their availability is listed by part number, capacity, dimensions, etc. Schweber Electronics, 60 Herricks Road, Mineola, Long Island, N.Y.

Printed Circuit Drafting Aids 282

Included in this six-page table are all of the pre-cut shapes and sizes of pressure sensitive drafting aids required to make paste-up printed circuit drawings. Illustrations are provided in chart form for cross reference between corresponding donut pad, teardrop pad and twin pad sizes. Actual size illustrations of the

shapes and hole diameters for each are included. By-Buk Co., 4314 W. Pico Blvd., Los Angeles 19, Calif.

Miniature Lamps 283

This pocket-size booklet lists all of the known standard miniature lamps now available, almost 400 of them, and the sources of supply from which they may be obtained. Specifications are given as well as complete lamp nomenclature with drawings of various lamp styles and descriptions of lamp parts. Chicago Miniature Lamp Works, 1500 N. Ogden Ave., Chicago 10, Ill.

Printed Circuits 284

This four-page folder, No. 1159, discusses the use of printed circuits. The types of insulating materials and the current capacity in relation to width of copper conductive pattern are described. The booklet also lists the choice of metals available for the conductive pattern as well as the types of plating recommended to achieve results. Whitney Blake Co., Printed Circuit Div., New Haven, Conn.

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1960 ELECTRONIC DESIGN • August 3, 1960



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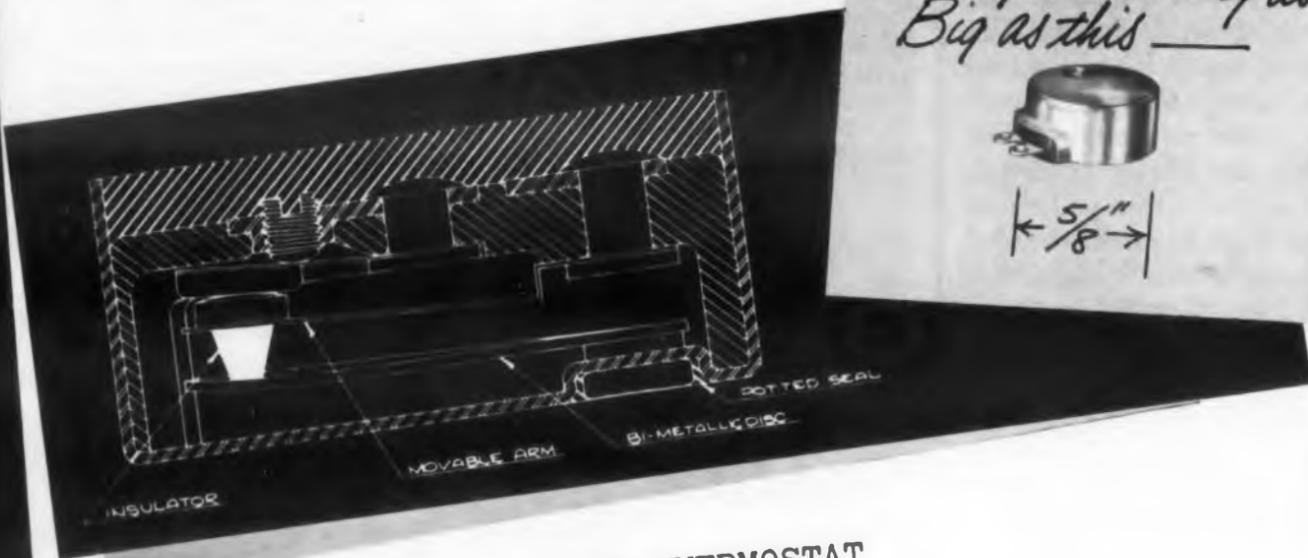
So we've got to have a narrow temperature differential -- like this . . .

And here's my answer --

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Solid-State Relay Varies Operational Amplifier Gain

THE GAIN of an operational amplifier can be rapidly changed by electronically switching different resistors into the feedback loop. Switching is accomplished by using the high forward conductance and high reverse resistance characteristics of silicon diodes. Gain changes can be achieved with dissipations of less than 600- μ w. This compares with the 200-mw a high sensitivity, electromechanical relay would require.

Fig. 1 shows an operational amplifier with negative feedback applied through R_{fb1} . The passive electronic relay is contained in the dotted rec-

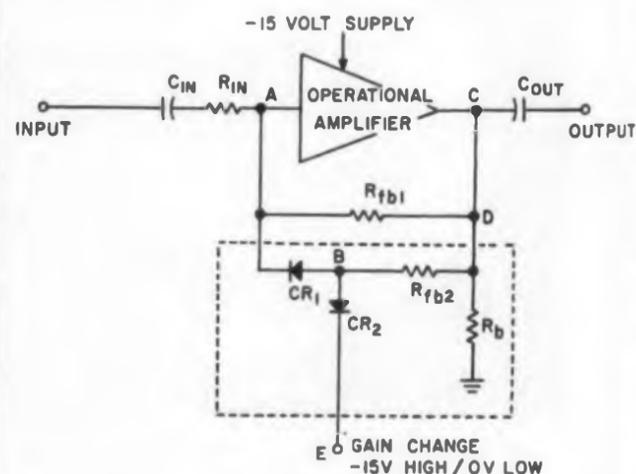


Fig. 1. Operational amplifier gain can be varied by using silicon diodes to switch paralleling feedback resistors in or out.

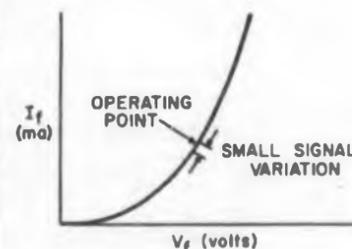


Fig. 2. Small signal operation of diodes keeps their forward resistance almost constant in the operating range.

tangle. The closed loop gain (CLG) of the circuit is given by:

$$CLG = \frac{R_{fb}}{R_{in}}$$

where R_{fb} is the effective value of the feedback resistances.

By varying the bias voltage applied at E , the silicon diodes will switch in, or switch out, resistors paralleling R_{fb1} . Thus, the overall amplifier gain can be changed in step with the voltage at E .

To understand the circuit operation, let us assume that the voltage at A is -6 v. For high stage gain point E is set at -12 v. These voltages forward bias CR_2 via R_{fb2} and R_{b1} , and reverse bias CR_1 . Since the back resistance of these diodes is much greater than R_{fb1} and R_{fb2} , loop BD is effectively open. Gain of the operational amplifier is:

$$CLG = \frac{R_{fb1}}{R_{in}}$$

For low gain, point E is set at 0 v. This forward biases CR_1 via R_b and R_{fb2} , and reverse biases CR_2 . The gain of the amplifier is now:

$$CLG = \frac{R_{fb1}(R_{fb2} + R_{cR1})}{R_{fb1} + R_{fb2} + R_{cR1}}$$

Where R_{cR1} is the diode forward resistance.

Gain-Change Transient Can Be Held Small

The speed of gain change is limited by (1) the diode frequency response and (2) the closed loop amplifier frequency response. With a fast switching diode, the amplifier will be the limiting factor on the speed. However, proper design can make the gain change transient extremely short.

Placing the diodes at the small-signal input of the amplifier minimizes the effect of their non-linear resistance characteristics. This is illustrated by the silicon diode's forward characteristic shown in Fig. 2. Under small signal conditions the variation in slope around the operating point is negligible. This also allows greater freedom in the choice of biasing voltages at A and E . Experiment has shown that the -12 v at E could be as high as -8 v, and the 0 v state could be as low as -3 v with very slight difference in gain from the 12 v/ 0 v levels.

Note that resistor R_b is much smaller than R_{fb} or R_{fb2} . It only serves as a dc biasing path for the two diodes.

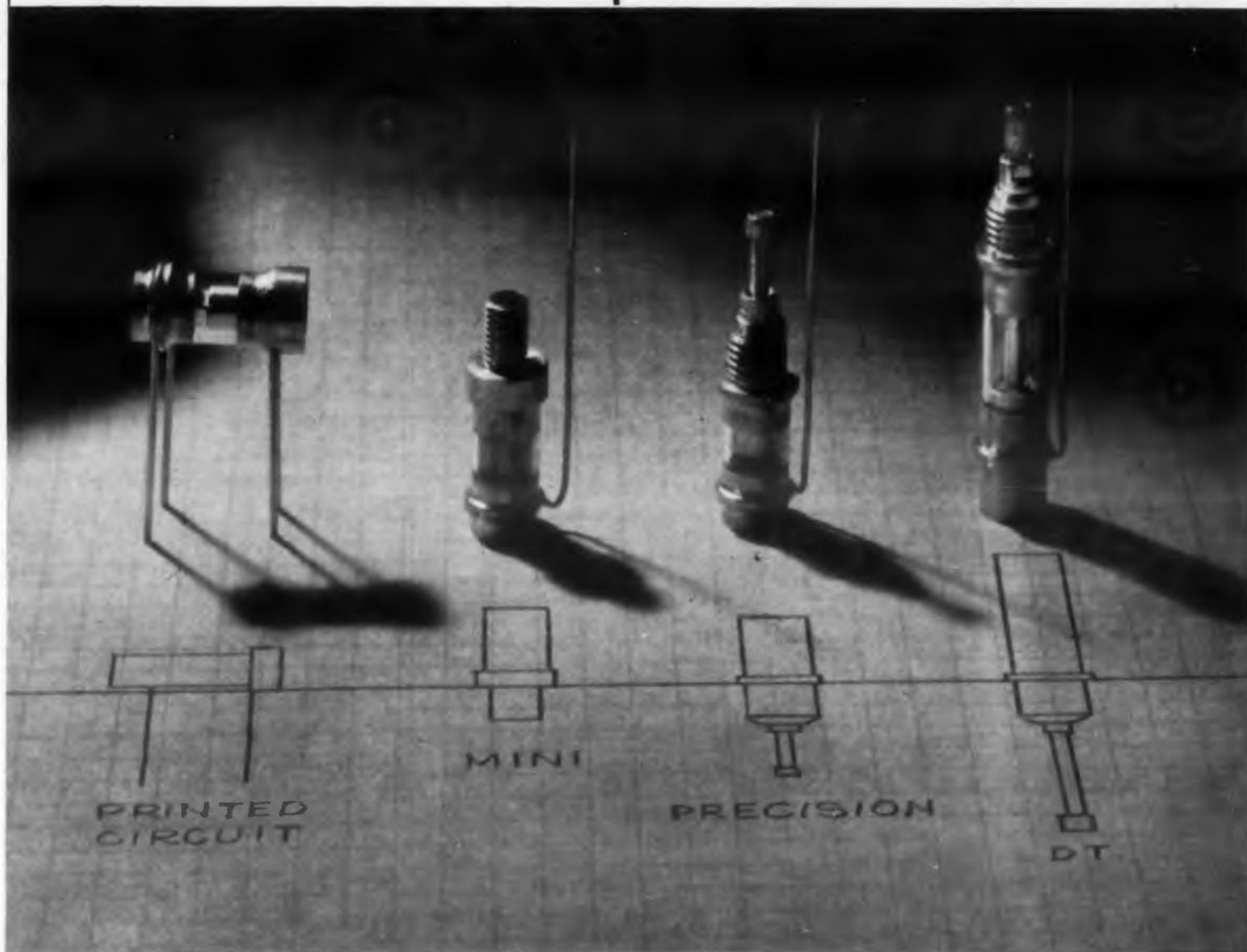
Possible application of the gain switching principle are numerous. Basically, it can be used to electronically change or modulate stage gain as a function of time or some other variable. A suitably programmed voltage can change the gain at speeds up to 5 mc.

George Shaheen, Senior Development Engineer, Bendix-Pacific Div., Bendix Aviation Corp., North Hollywood, Calif.

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Megohms IR	10 ⁶
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	1-12	X	X	X
	1-18	X	X	—
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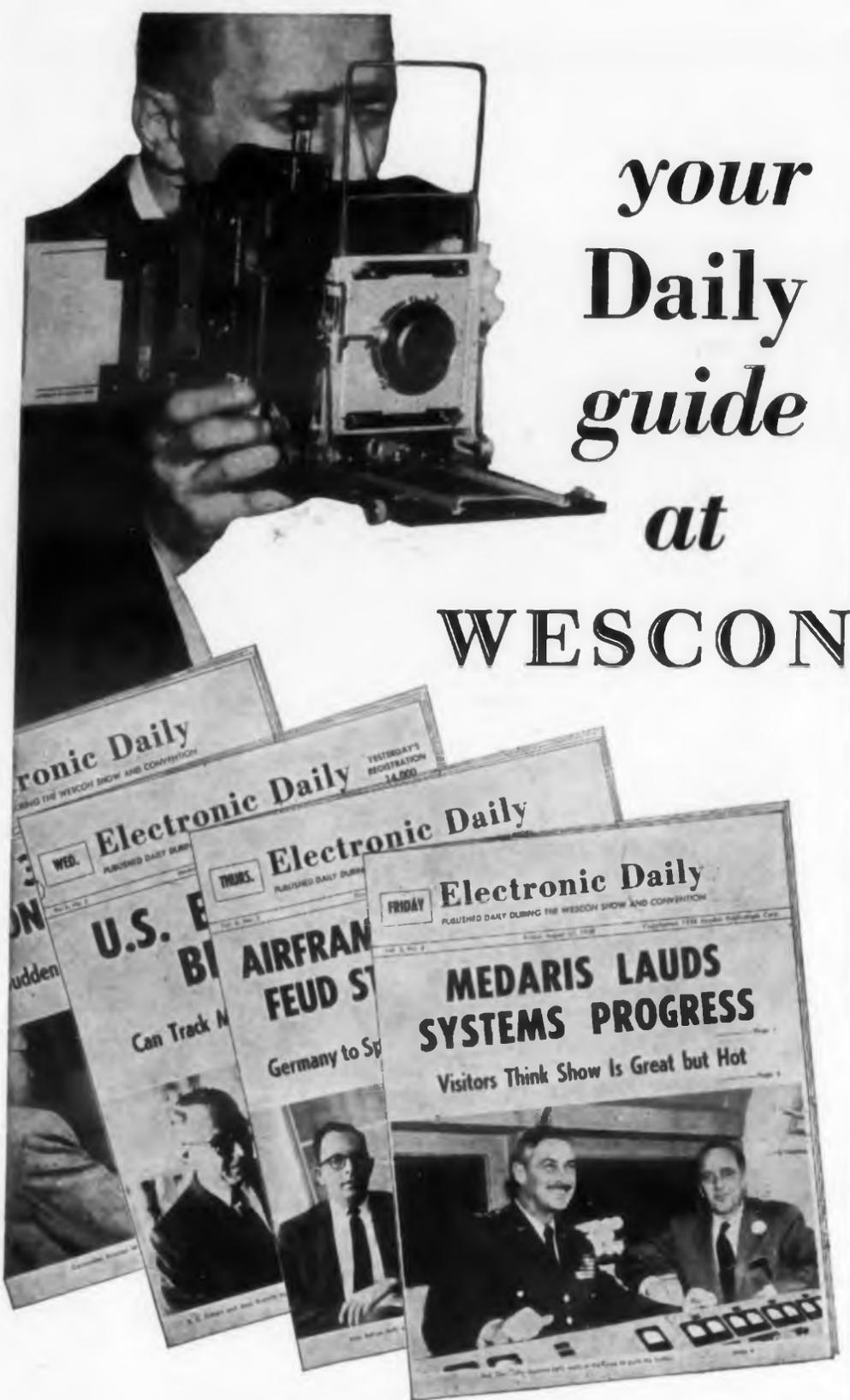
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IDEAS FOR DESIGN

Cut-Off Diode Triggers Fast Output Pulses

Computer control systems often require fast trigger pulses of fixed duration and amplitude generated at a time coincident with the leading or trailing edge of a control pulse. These pulses should not be too dependent on the input signal rise time and should load the input as little as possible.

A capacitor-resistor differentiator is often used for this purpose, but if the trigger duration is to be less than $0.1 \mu\text{sec}$, the pulse source may be overloaded and the trigger output amplitude will depend on the rise time of the input pulse.

The circuit of Fig. 1 generates a negative trigger pulse when the input pulse goes negative. The duration of the trigger pulse is dependent upon the resistor input network and the delay and rise time of T_1 . With the parameters shown, the output pulse duration is only $0.05 \mu\text{sec}$.

The operation of this circuit is as follows: When the input to the trigger circuit is zero volt, trans-

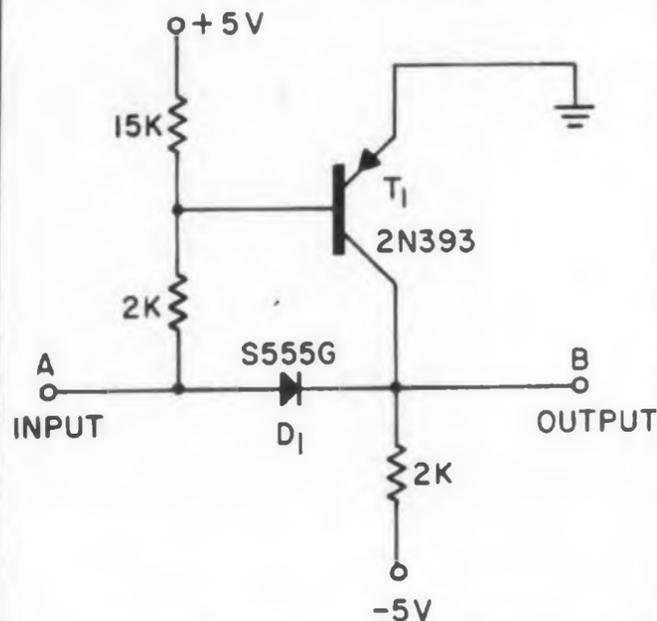


Fig. 1. Fast ($0.05 \mu\text{sec}$) pulses are generated in this transistor-trigger circuit by cutting off the diode with a negative input pulse.

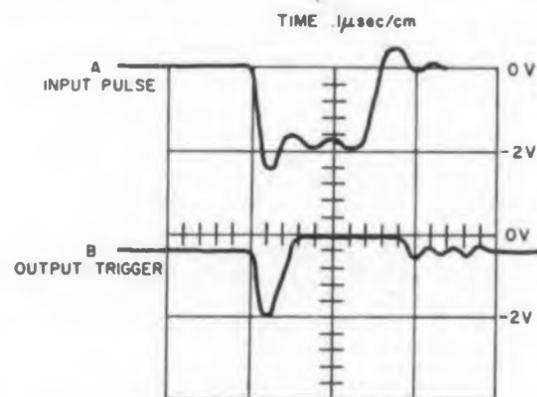


Fig. 2. Sketches taken from an oscilloscope show the $0.2\text{-}\mu\text{sec}$ input pulse (a) and the resultant $0.05\text{-}\mu\text{sec}$ output pulse (b).

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sistor T_1 will be biased off, and diode D_1 will pull the output B up to -0.4 v which is the drop across the diode. When input A goes negative, the 2 K resistor tied to -5 v will pull point B negative several volts, since T_1 has previously been cut off. With A negative, transistor T_1 will soon start conducting and pull B up to -0.1 v, which is the drop across the conducting transistor.

Other transistors and diodes could be used, but the 2N393 micro alloy transistor and the S555G diode were used because of their speed and low voltage drops.

The characteristics of this circuit are shown in Fig. 2. The trigger duration is 0.05 μ sec, and the amplitude is 2 v.

This circuit is also useful for determining the speed of a combination of input network and transistor. The width of the output pulse is the effective turn-on time of this combination.

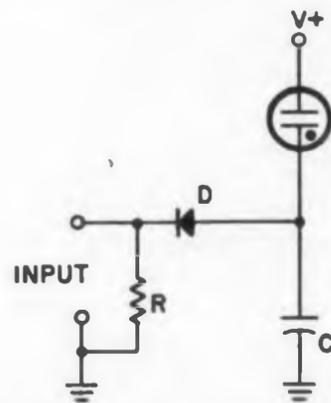
Forrest Salter, Argonne National Laboratory, Applied Mathematics Div., Argonne, Ill.

Holding Capacitors Fires Neon on Short Pulses

By adding a voltage-holding capacitor, neon tube indicators can be used in situations where pulse durations are shorter than the tubes' turn-on time. The capacitor is connected as shown in the figure.

When a fast negative pulse appears, the capacitor C will charge through the diode, D . With the termination of the pulse, the negative voltage is blocked by D and remains on C . If the pulse amplitude is large enough, the tube will fire. After firing, tube current will flow through D and the resistor R .

This idea supports the use of the neon tube indicators as explained by A. Hemel in his Idea for Design "Neon Lamp Matrix Stores Information Visually" (ED, April 27, p 123).



Capacitor C holds the fast input pulse voltage amplitude until the neon tube can fire.

David S. J. Smith, Project Engineer, Stromberg-Carlson Co., Rochester, N.Y.

APPOINTMENTS OF ELECTRONIC ENGINEERS

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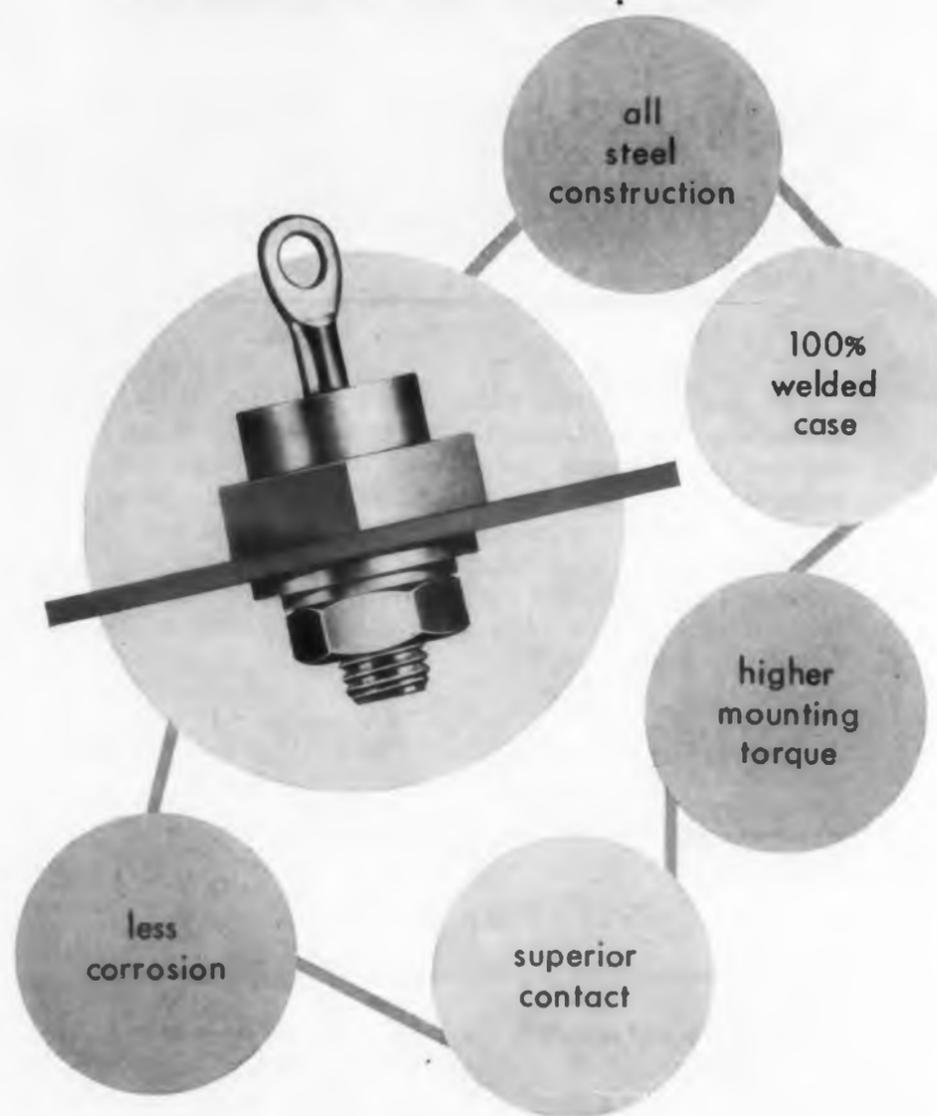
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BOOKS

Control Systems Engineering

William W. Seifert and Carl W. Steeg, Jr., Editors, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y., 964 pp, \$15.00.

With over 950 pages, this volume can well live up to its authors' claim of providing "relatively complete coverage" of the mathematical aspects of modern control-systems engineering as applied in the study of complex, large-scale automatic control systems. It was written to serve as a text for the advanced student, or as a reference book for research workers in industrial and governmental laboratories.

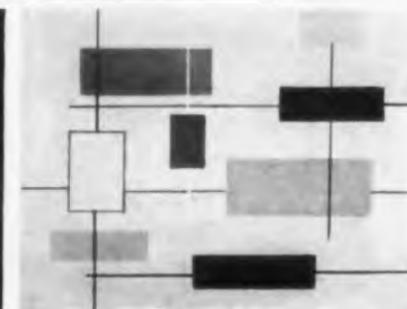
The first two chapters introduce the general subject of control-systems engineering and show the important role

played by models, both physical and mathematical. The remaining 15 chapters are devoted to a systematic development of the theoretical techniques used in the analysis and synthesis of control systems.

The chapters which provide the necessary background for more advanced topics on control systems are directed toward the control engineer rather than the mathematician. Coverage is included on modern control system theory from the trial-and-error procedures which are commonly used in the design of linear systems to the application of game theory in the synthesis of complex systems. The final six chapters in the book contain a large percentage of new material.

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the specialized talents of 11 different contributors, all of whom are former members of the Dynamic Analysis and Control Laboratory at Massachusetts Institute of Technology.

Photoconductivity of Solids

Richard H. Bube, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 461 pp, \$14.75.

A unified picture and interpretation of photoconductivity phenomena in solids is presented with examples drawn from many different kinds of materials. In addition, the text describes the correlation between photoconductivity and other related phenomena in insulators and semiconductors.

Emphasis throughout is placed on presenting a physical description in order to obtain a qualitative understanding of photoconductivity, rather than on detailed mathematical analyses. Basic concepts of photoconductivity are discussed on a level for both the graduate student and the research worker. However, the text

provides more detailed treatment of the current theoretical understanding of the mechanisms of photoconductivity. The chemical preparation and properties of photoconductors are also treated.

An extensive bibliography and a summary of most of the photoconducting materials which have been investigated are included.

Basics of Induction Heating—I and II

Chester A. Tudbury, John F. Rider Publisher, Inc., New York, 132 pp (Vol. I), 133 pp (Vol II), \$3.90 ea.

The fundamental principles underlying the induction heating art are presented using the "pictured text" approach.

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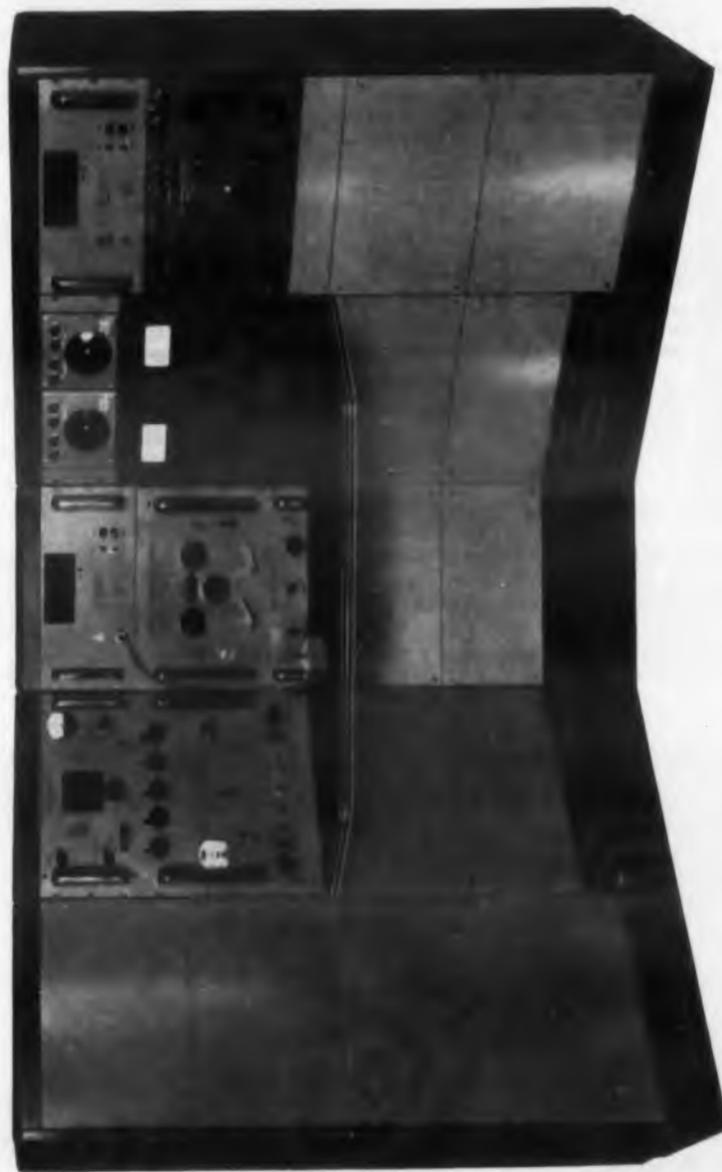
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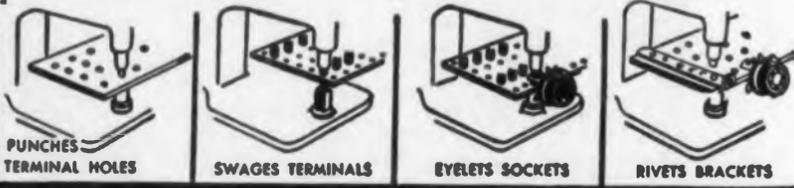
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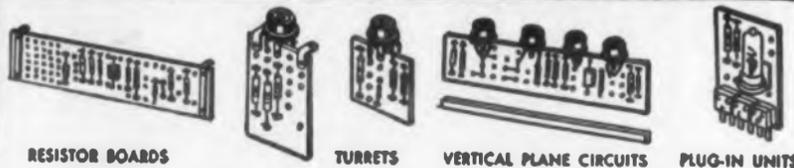


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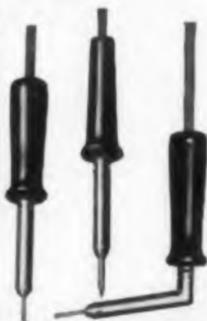


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BOOKS

Transistor Circuit Analysis and Design

Franklin C. Fitchen, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N.J., 356 pp, \$9.00.

The scope and content of this textbook is designed for a one-semester transistor circuits course for electrical engineering students at the junior or senior level. However, it is felt by the author that the practicing engineer, encountering transistors for the first time, will find the analysis and design examples helpful as background for the solution of his specific problems.

It is assumed that the reader has had an introduction to vacuum-tube electronics and has a working knowledge of the fundamentals of both ac and dc circuit theory. The book is introductory and requires no prior knowledge of transistors or of semiconductor physics. The three most important of the many transistor equivalent circuits—the current-generator equivalent tee, the hybrid equivalent, and the hybrid-pi equivalent—are discussed

as well as semiconductor physics, characteristic curves, biasing, and circuit gains.

Introduction to Atomic Energy

William G. Atkinson, John F. Rider Publisher, Inc., 116 W. 14 St., New York, N.Y., 68 pp, \$1.35.

This little volume is designed as a primer for those who have a desire to learn the fundamentals of atomic energy without consulting engineering texts on the subject. It starts with the discussion of the atom, its components, and the necessary physics and chemistry required for understanding the nuclear force, the fundamentals of radioactivity, the various particles, and other components of nuclear radiation. Then nuclear reactions, with special emphasis placed on the fission reaction, are discussed. A number of different types of reactors, as well as the materials that enter into nuclear reactors, are explained. A later chapter explores reactor design problems. The last chapter provides a specification listing of all existing reactors.

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Advances in Cryogenic Engineering, Vol. 5

K. D. Timmerhaus, Editor, Plenum Press, Inc. *Proceedings of the 1959 Cryogenic Engineering Conference*, 227 W. 17 St., New York, N.Y., 584 pp, \$13.50.

Cryogenics—the science dealing with the behavior of materials at temperatures close to absolute zero—has become a practical tool for industry, particularly in the fields of aircraft, electronics, metals, atomic energy, rockets and missiles. The physical properties of materials at very low temperatures differ so vastly from those usually encountered that the engineer cannot rely upon ordinary experience, and so an entirely new and thriving industry has developed.

In order to improve the exchange of information among organizations active in cryogenic engineering, the National Bureau of Standards—Atomic Energy Commission Cryogenic Engineering Laboratory in Boulder, Colo., sponsored the first Cryogenic Engineering Conference in 1954.

The Proceedings of that and all conferences held to date were published to enable scientists to become familiar

with research achievements and the development of new techniques.

This latest volume collects the papers presented at the Fifth National Cryogenic Engineering Conference held at the University of California in Berkeley, Sept. 2-4, 1959.

Section headings in the book include applications and techniques, with a paper discussing cryogenic engineering advances in the space age, missile technology, heat transfer, liquefaction and refrigeration, and fluid phenomena.

1960 Radio Diagrams and Servicing Information

M. N. Beitman, *Supreme Publications*, 1760 Balsam Road, Highland Park, Ill., 192 pp, \$2.50

Collected in this service manual are the schematic diagrams and repair information for the new 1960, and older radios. Included is alignment data replacement parts lists, values of voltage and stage gain, and location of trimmers. Material is given for portables, clock radios, record changers, fm, and automobile sets.

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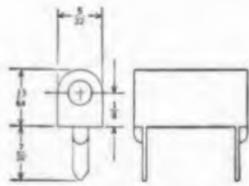
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RUSSIAN TRANSLATIONS

J. George Adashko

Series-Connected Transistors Increase Voltage Switched To Load

USE OF the junction transistor in switching applications can be greatly expanded by connecting two, or more, of the transistors in series. Such an arrangement by-passes the present limitation caused by the transistor's relatively small maximum collector voltage.

To illustrate the design of series-transistor circuits, we will consider a pulse-width modulation system operating into a resistive load. In Fig. 1a two series-connected transistors, T_1 and T_2 , are connected to a load resistor R_L and to a dc source. The average load voltage can be controlled by varying the duration of the positive and negative pulses at the transistor bases.

In discussing the operation of the circuit three conditions must be considered—the transistors are (1) conducting (2) switching and (3) cutoff.

Conducting Transistors Have Essentially Constant Voltage Drops

The voltage drops across the conducting transistors are small and change little with collector

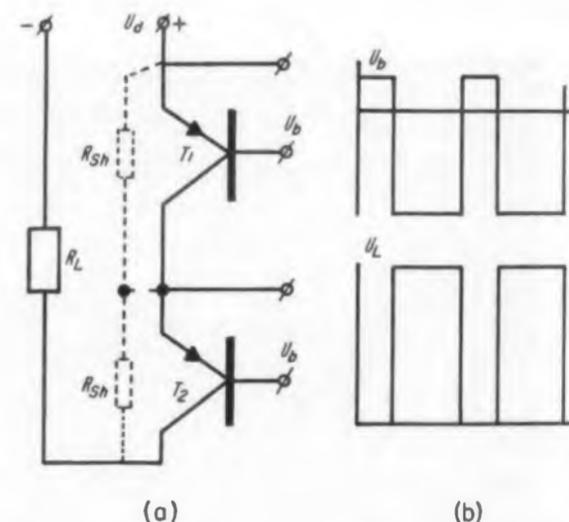


Fig. 1. Voltages higher than the individual transistor's rating can be switched by connecting two transistors in series.

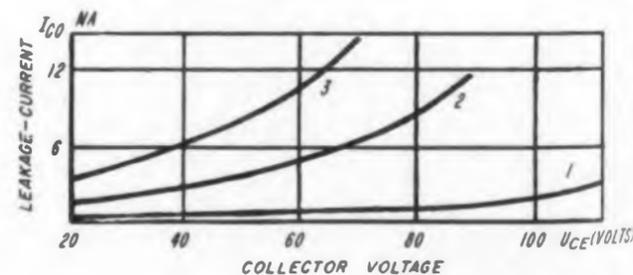


Fig. 2. Since the leakage current-collector voltage relationship varies between units, the source voltage will not divide equally when the transistors are cut off.

current and ambient temperature. Almost all of the power supply voltage appears across the load.

Rapid Switching Required Because of Unlike Characteristics

During switching the operating points of the transistors may not always move "synchronously" along the load lines. This is due to differences in the transistor characteristic, and can lead to an uneven distribution of the potentials across the transistor terminals. For this reason, the switching time should be reduced to a minimum. Switching pulses with sufficiently steep fronts should be simultaneously applied to the transistor bases. These steep fronts can be obtained, for example, from magnetic amplifier circuits having rectangular-hysteresis loop core material.

In designing the circuit, Fig. 1a, it is necessary to know the maximum power dissipated by the transistors. This will help determine the dimensions of any heat-radiating shield, or heat sink. Two powers must be considered: the power dissipated under saturation conditions and the power dissipated during switching.

The first power can be determined from the static characteristics of the transistor. However, calculating the switching power is more difficult. This power is determined from the theoretical or empirical value of the on and off time intervals, t_0 and t_2 .

It can be shown that the maximum value of the switching power is approximately $0.15 P_L(t_0 + t_2)f$, where P_L is the maximum load power, and f is the switching frequency.

Leakage Currents Cause Cut-off Transistors to Divide Source Voltage Unequally

When the transistors are cut-off and there are no shunting resistances, leakage current flows through the series circuit $T_1 - T_2 - R_L$. The source voltage is applied almost entirely to the transistors. It divides across them in proportion to the resistance corresponding to the particular leakage current. For reliable operation this voltage should divide equally between the transistors within the variations of the load and of the ambient temperature. In this connection, it is necessary to analyze the variation of the leakage current of a cut-off transistor, I_{CO} , under different operating conditions.

For example, let us assume that T_1 has characteristic 1, Fig. 2, and T_2 has characteristic 3. Then if the source voltage is 120 v, a simple graphical construction will show that the voltage across T_1 is 108 v and the voltage on T_2 is 12 v. The voltage across T_1 greatly exceeds the maximum collector voltage rating of commonly available transistors (usually 60 to 80 v). This situa-

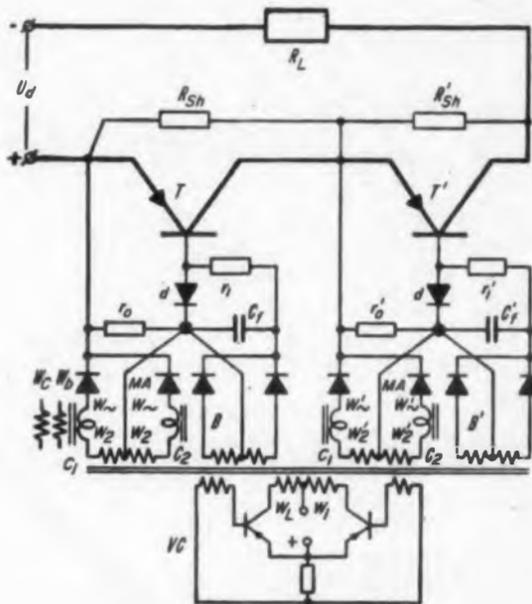


Fig. 3. Control circuit for series-connected transistors has square-wave base pulses supplied by magnetic amplifiers. Shunting resistors R_{sh} , R'_{sh} equalize transistor voltage for cut-off condition.

tion can be remedied by using shunting resistances as shown in Fig. 1a. If R_{sh} equals 2.5 K the voltages across the two transistors become, again under the worst combination of transistor characteristics, 68 and 52 v. With better matched transistors the shunting resistance can be increased to 5 or 10 K and excessive heat rise will be prevented even under difficult temperature conditions.

Complete Control Circuit Uses Series Transistors Fired by Output From Magnetic Amplifier

Fig. 3 shows a complete control circuit, with series transistors, proposed by the author. The voltage converter VC serves as the supply to the magnetic amplifier MA and generates a rectangular voltage output. The blocking potential in the base circuits of the series connected transistors T and T_1 is produced by isolated supply sources (rectifiers B , B' on the secondary side of the voltage converter) and by means of diodes d , d' . The magnetic amplifier serves to switch the power transistors. Its distinguishing feature is that each of its cores has two ac windings w and w' , which are connected to individual secondary windings w_2 and w_2' of the voltage converter. Thus, the parallel electric circuits of the magnetic amplifier are independent, permitting individual control of the power transistors. Since the magnetic circuit is common, simultaneous switching is insured. By varying the saturation angle of the magnetic amplifier from π to 0, the duty cycle of the signal can be changed from 0 to 1, thus changing the average load voltage.

Translated from *Series Connection of Switching Transistors*, O. A. Kossov. News, Academy of Science of the USSR—Power and Automation #1 Jan.-Feb. 1960 pp 169-172.



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GERMAN ABSTRACTS

E. Brenner

One-Mc Parametric A

MOST PUBLISHED data dealing with parametric amplifiers are concerned with circuits whose pump frequency is of the order of tens of megacycles or higher. The circuit of Fig. 1 uses a pump frequency of 1 mc. The signal frequency is 100 kc and the nonlinear reactance is a Zener diode, biased in the reverse direction, with the capacitance-voltage characteristic shown in Fig. 2.

The circuit operates as a linear amplifier for small signals, Fig. 3. The voltage gain-bandwidth product is constant, Fig. 4. The experimental results are in general agreement with published data cited in the American literature. However, because of the lower pump frequency used, the pump voltages had to exceed the diode bias to obtain substantial power gain. As a result, the capacitance was driven into the conducting state. The attending losses are not accounted for in the conventional calculations. At higher pump frequencies lower pump voltages suffice, since the negative conductance presented to the signal circuit is proportional to frequency.

Abstracted from an article by R. Elsner, L. Pungs, and K. H. Steiner, Frequenz, Vol. 14, No. 2, Feb. 1960, pp 59-67.

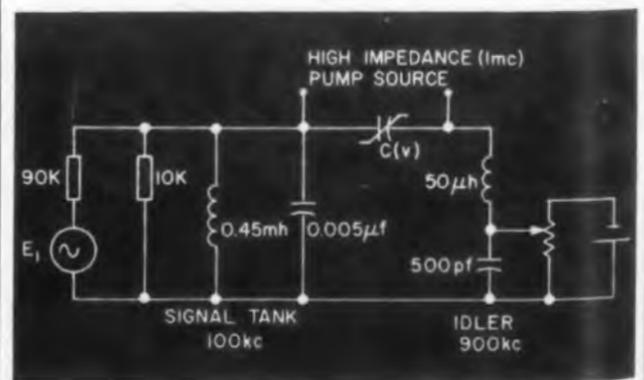


Fig. 1. One-mc parametric amplifier uses the nonlinear reactance of a Zener diode.

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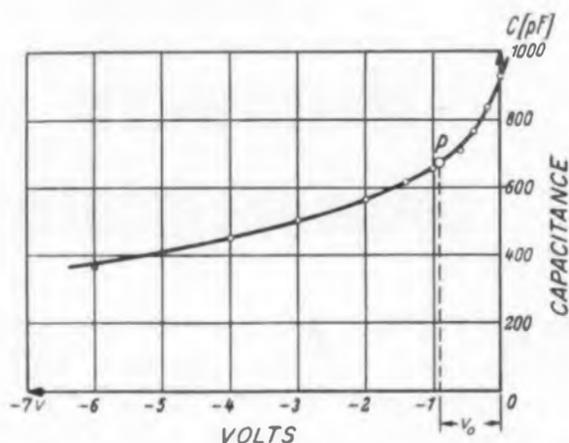


Fig. 2. Zener diode capacitance-voltage characteristic.

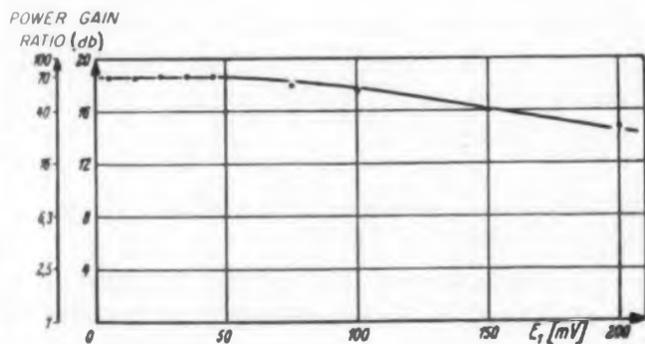


Fig. 3. Power gain as a function of input voltage.

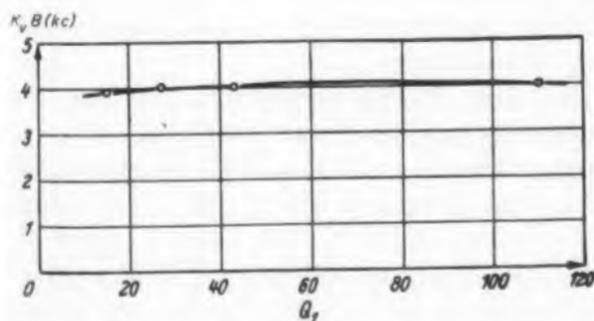


Fig. 4. Gain bandwidth product as a function of signal tank Q.

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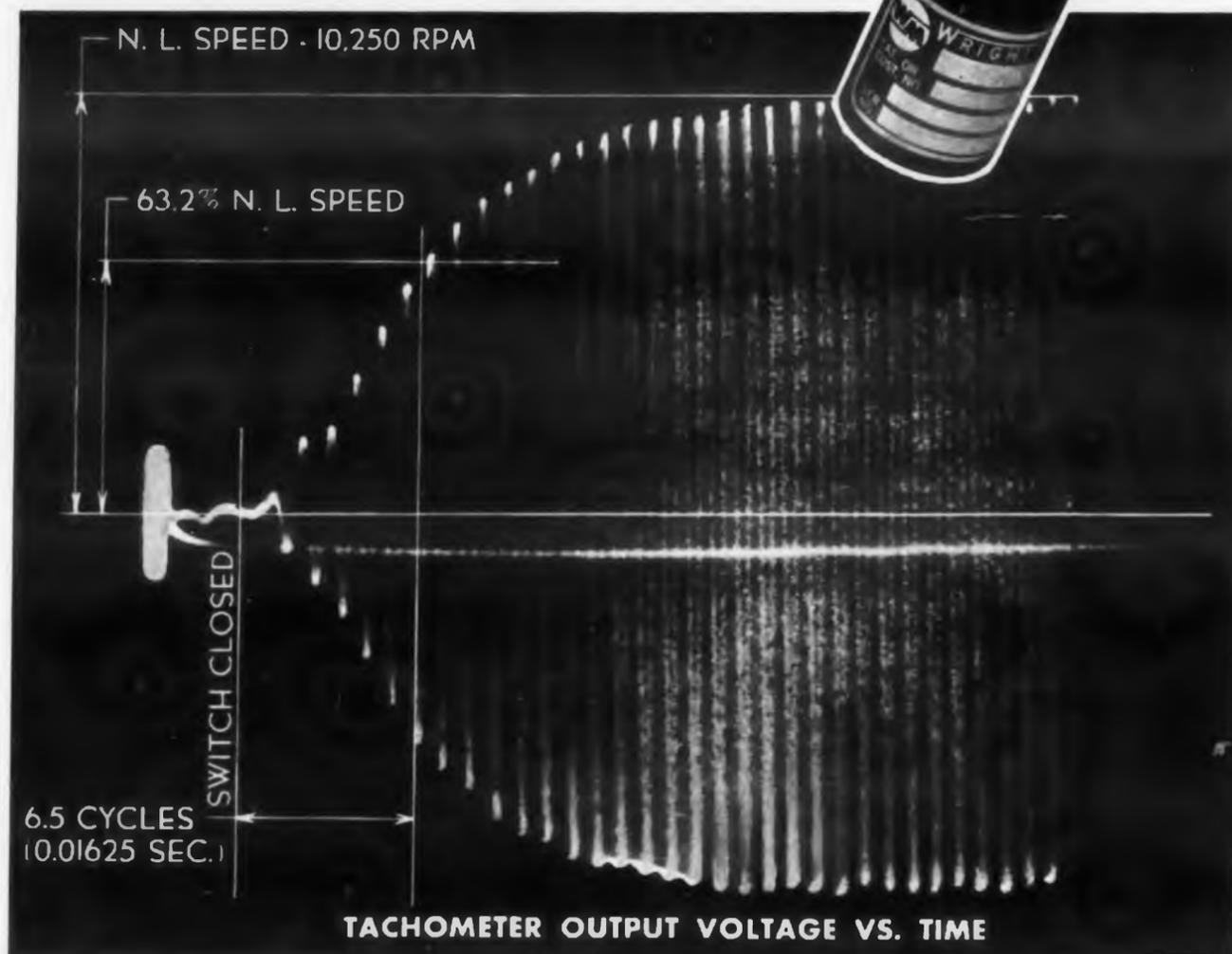
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Signal Flowgraphs Simplify Microwave Measurements

MICROWAVE measurement techniques can be simply analyzed by using signal flowgraphs to describe the networks in the measuring system. The flowgraphs of the individual networks are then combined to represent the entire system. Reviewed here are the methods for setting up flowgraphs of microwave networks and the rules for their solution. An example of the method is then given for a system which measures the reflection coefficient of a load with a directional-couple reflectometer.

Simple Signal Flowgraphs Represent One and Two-Port Networks.

The signal flowgraph is used to represent a set of equations. In the flowgraph the variables are replaced by points and the interrelations are replaced by directed lines. These combine to give a direct picture of signal flow. Fig. 1 shows some simple flowgraphs used as building blocks for more complicated networks.

In Fig. 1a the general two-port network is shown as specified by its scattering matrix coefficients. Here a_1 and a_2 are the complex-entering-wave amplitudes, while b_1 and b_2 are the outgoing-wave amplitudes at ports 1 and 2 of the network. These are represented in the flowgraph as points or "nodes." The "nodes" are related to one another by directed lines (signal flow) marked with appropriate coefficients. These are the scat-

Fig. 1a. Two-port network

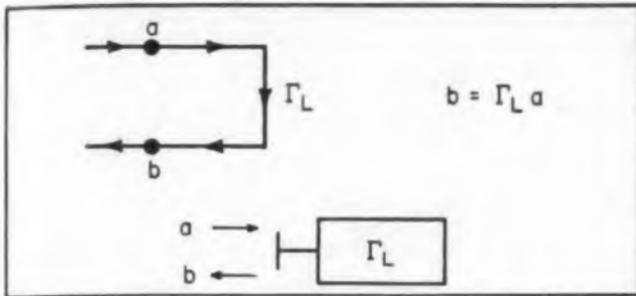
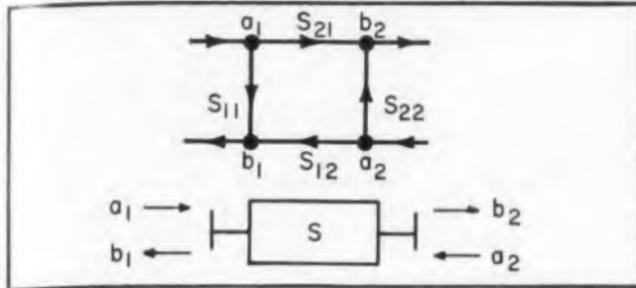


Fig. 1b. Load

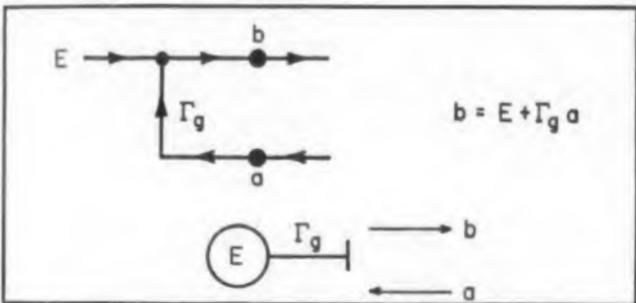


Fig. 1c. Generator

tering coefficients S_{11} , S_{12} , S_{21} , S_{22} . Their meaning is derived from the equations:

$$\begin{aligned} b_1 &= S_{11} a_1 + S_{12} a_2 \\ b_2 &= S_{21} a_1 + S_{22} a_2 \end{aligned} \quad (1)$$

Here S_{11} is the reflection coefficient, b_1/a_1 , at port 1 when port 2 is terminated in a matched load ($a_2 = 0$). S_{22} is the reflection coefficient b_2/a_2 at port 2 when port 1 is matched ($a_1 = 0$). S_{21} is the transmission coefficient b_2/a_1 from port 1 to port 2 when port 2 is matched ($a_2 = 0$). In all reciprocal networks $S_{12} = S_{21}$. The value of each node in the flowgraph is the sum of all signals entering it, each signal being the value of the node from which it comes multiplied by its path coefficient. The independent variables a_1 and a_2 in the equations represented by the flowgraph are characterized by signal flow which is directed into the graph.

Fig. 1b depicts a termination or load whose reflection coefficient is Γ_L .

Fig. 1c shows a mismatched generator. Here E

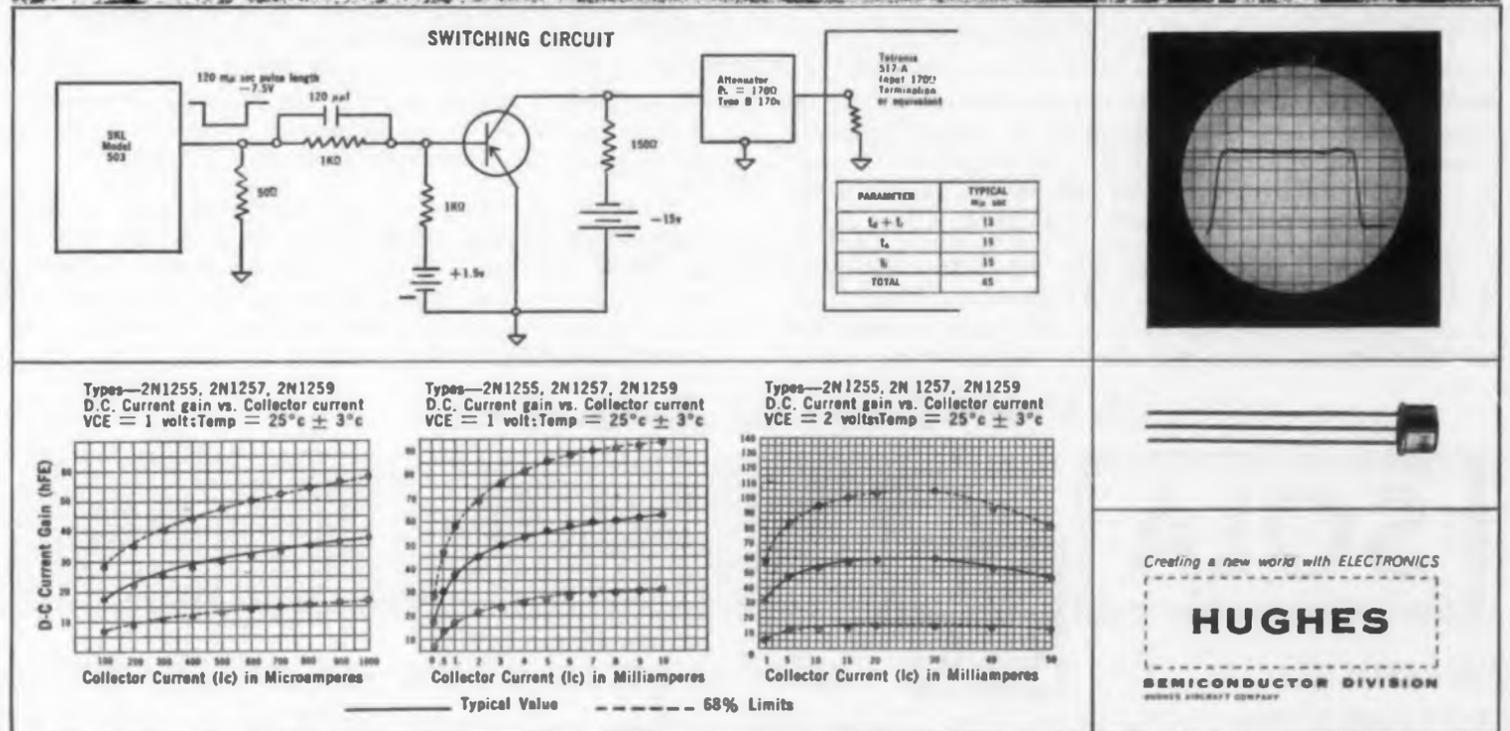
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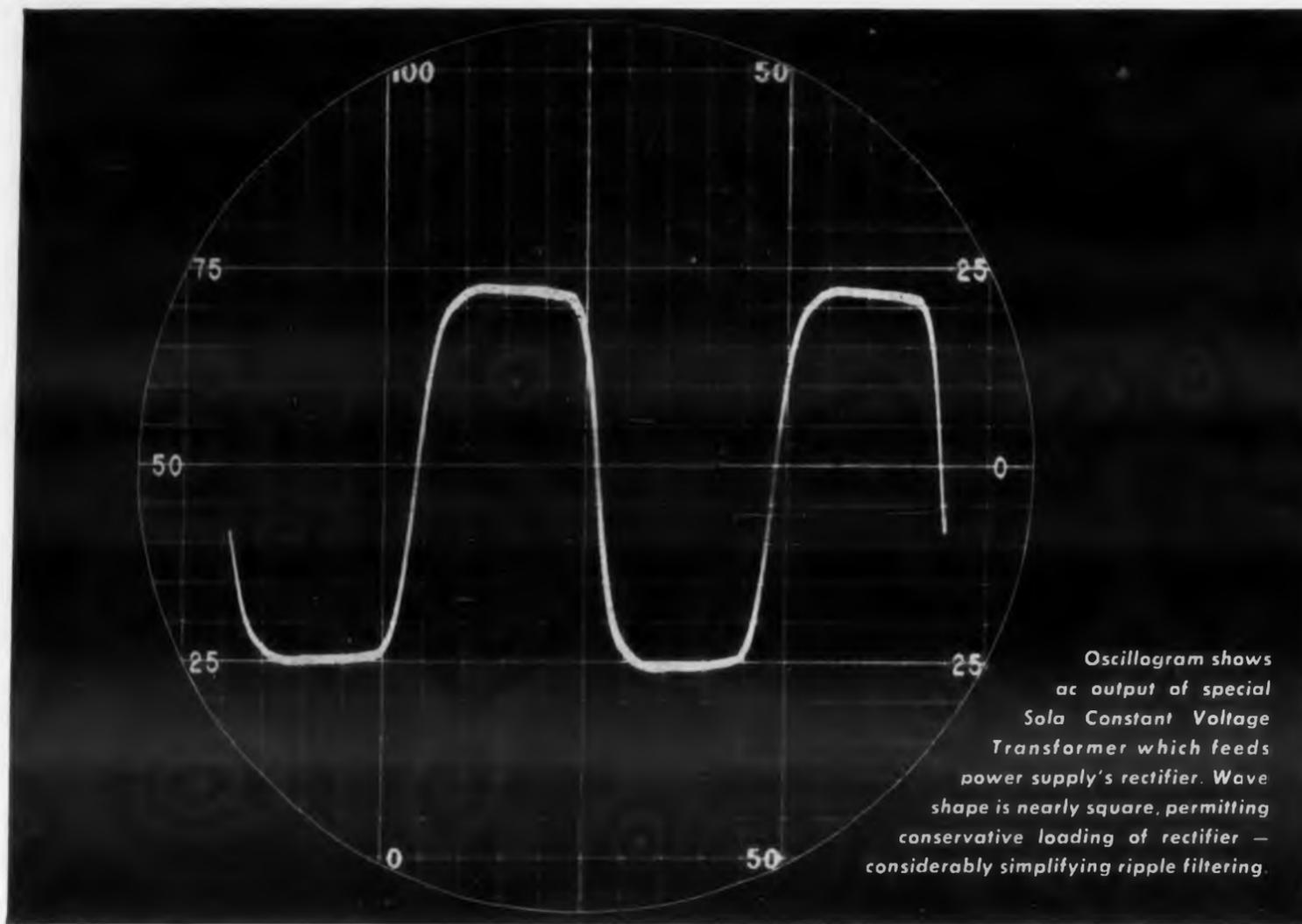
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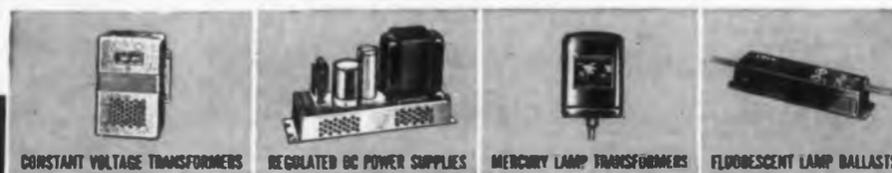
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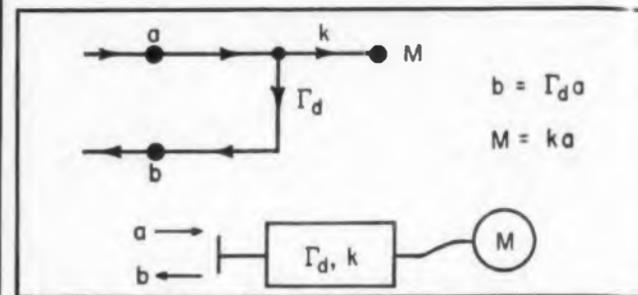


Fig. 1d. Video detector

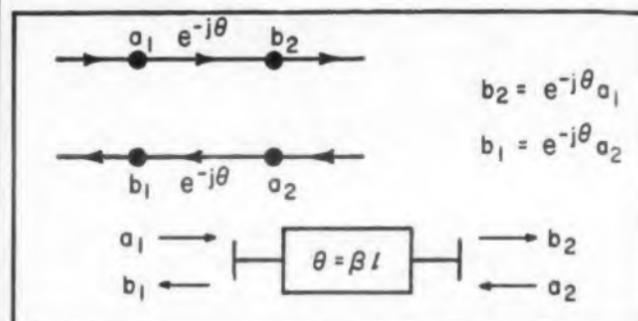


Fig. 1e. Lossless-line length

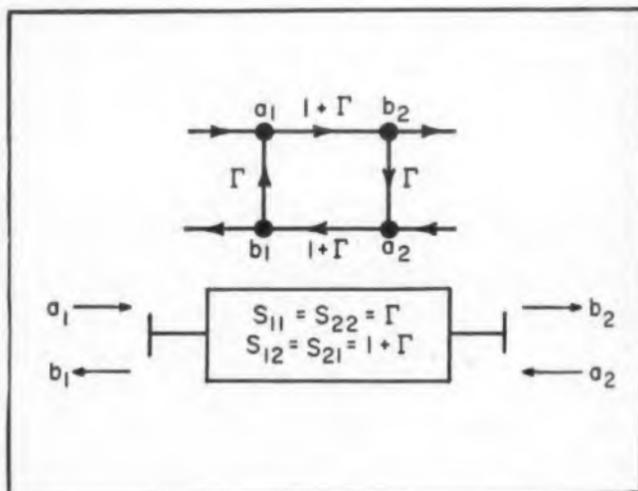


Fig. 1f. Shunt admittance

is the wave amplitude at the port when the generator sees a matched load ($a = 0$), and Γ_0 is the reflection coefficient looking into the port when E is zero.

Fig. 1d shows a video detector (such as a crystal or a barretter mount). Γ_d is the detector reflection coefficient at the port, and k is a scalar conversion efficiency relating the incoming-wave amplitude to a meter reading M . It is assumed that this meter is calibrated to take account of the de-

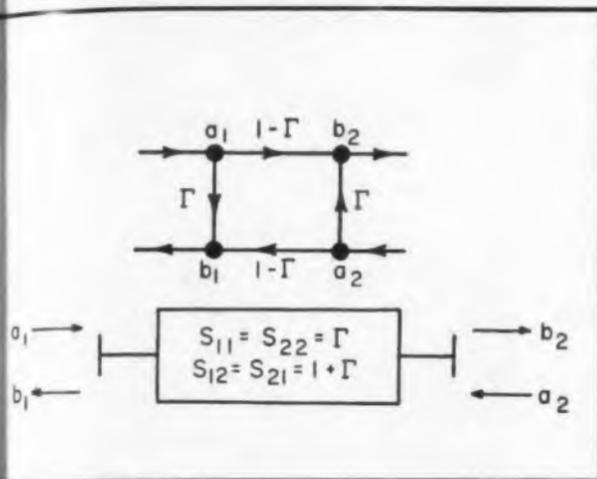


Fig. 1g. Series impedance

factor law, so that k is independent of signal level. It is also assumed that Γ_d is independent of signal level. (Both these conditions are satisfied very nearly with detectors used in reflectometer systems in their proper operating range.)

Fig. 1e represents a length of lossless transmission line.

Fig. 1f is a shunt discontinuity, such as a junction between two lines, or a probe which can be considered as a shunt admittance. The coefficient $S_{11} = S_{22} = \Gamma$ is the reflection coefficient which would be measured if the discontinuity were followed by a matched load. The coefficient $S_{12} = S_{21} = 1 + \Gamma$ follows from the fact that the net wave amplitudes on either side of the discontinuity must be equal. The coefficient Γ is related to the normalized shunt admittance Y by

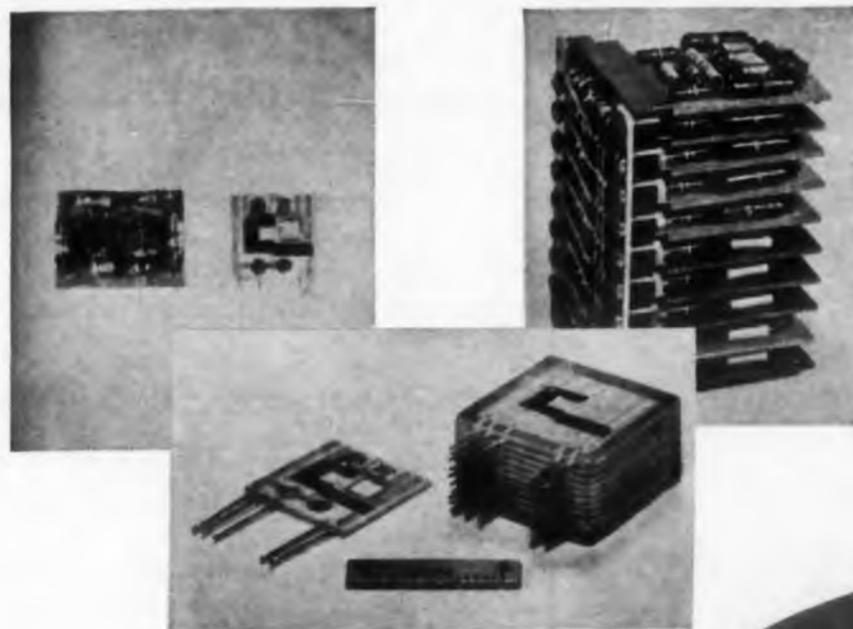
$$\Gamma = -\frac{Y}{Y+2} \quad (2)$$

Fig. 1g is a lumped series impedance. Here the coefficient Γ is related to the normalized series impedance Z by

$$\Gamma = \frac{Z}{Z+2} \quad (3)$$

Cascaded Flowgraphs Form More Complicated Networks

When networks are cascaded, it is only necessary to cascade the flowgraphs, since the outgoing wave from one network is the incoming wave to the next. This is shown in Fig. 2 where a network is placed between a generator and a load. The system now has only one independent variable,



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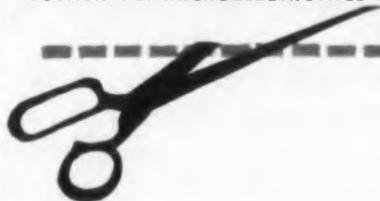
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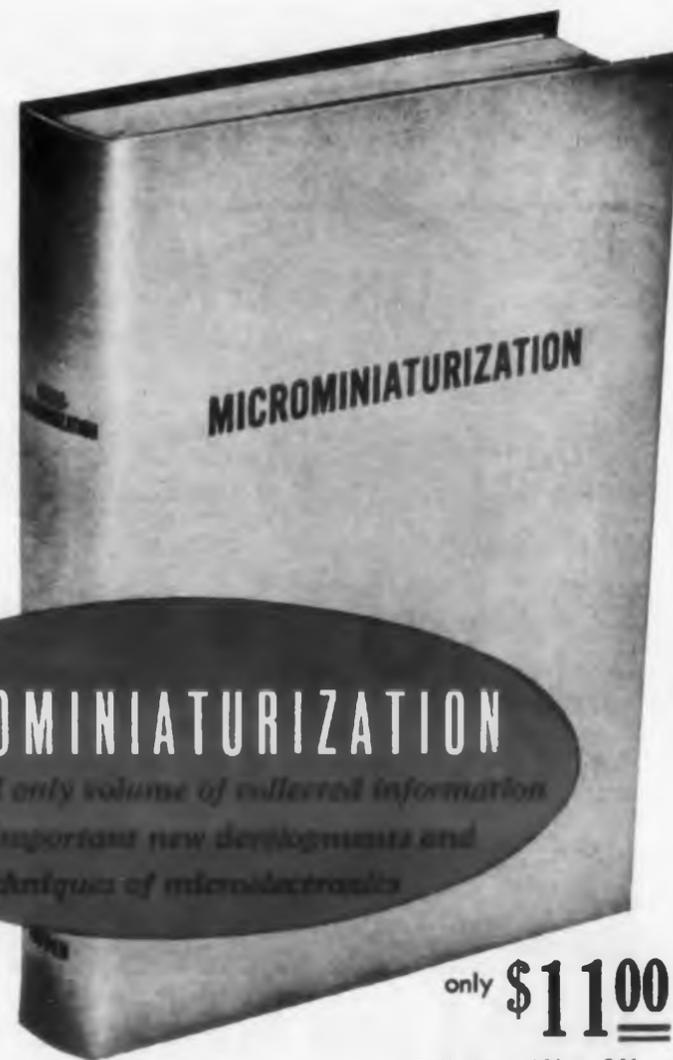
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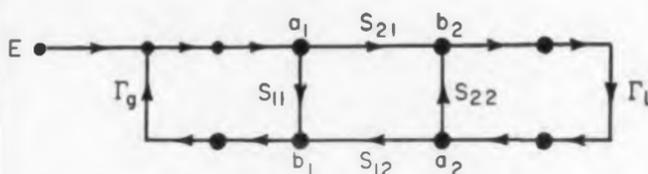


Fig. 2. When a network is placed between a load and a generator, the flowgraphs are cascaded.

the generator amplitude E . The flowgraph contains paths and loops.

A "path" is a series of directed lines followed in sequence and in the same direction so that no node is touched more than once. The value of the path is the product of all coefficients encountered en route. In the figure there is one path from E to b_2 . It has a value S_{21} . There are two paths from E to b_1 , namely S_{11} and $S_{21}\Gamma_L S_{12}$.

A first-order "loop" is a series of directed lines coming to a closure when followed in sequence and in the same direction with no node passed more than once. The value of the loop is the product of all coefficients encountered en route. A second-order loop is the product of any two first-order loops which do not touch at any point. A third-order loop is the product of any three first-order loops which do not touch, and so on. In Fig. 2 there are three first-order loops, namely, $\Gamma_g S_{12}$, $S_{22}\Gamma_L$ and $\Gamma_g S_{21}\Gamma_L S_{12}$ and there is one second-order loop $\Gamma_g S_{11} S_{22}\Gamma_L$.

A flowgraph is "solved" by applying the "non-touching rule" which written symbolically is:

$$T = \frac{\left\{ \begin{array}{l} P_1(1 - \Sigma L(1)^{(1)} + \Sigma L(2)^{(1)} - \Sigma L(3)^{(1)} + \dots) \\ + P_2(1 - \Sigma L(1)^{(2)} + \Sigma L(2)^{(2)} - \dots) \\ + P_3(1 - \dots) \end{array} \right\}}{1 - \Sigma L(1) + \Sigma L(2) - \Sigma L(3) + \dots} \quad (4)$$

Where $\Sigma L(1)$ is the sum of all first-order loops, $\Sigma L(2)$ is the sum of all second-order loops, and so on. $\Sigma L(1)^{(1)}$ is the sum of all first-order loops which do not touch path P_1 at any point, and so on.

P_1, P_2, P_3 , etc., are the values of all the various paths which can be followed from the independent-variable node to the node whose value is desired. Thus, each path is multiplied by the factor (in brackets) which involves all the loops of all orders which that path does not touch. T is a general symbol representing the ratio between the dependent variable of interest and the independent variable. This process is repeated for each independent variable of the system, and the results are summed.

As examples of the application of the rule, the transmission, b_2/E , and the reflection coefficient, b_1/a_1 , are written as follows:



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$$\frac{b_2}{E} = \frac{S_{21}}{1 - \Gamma_0 S_{11} - S_{22} \Gamma_L - \Gamma_0 S_{21} \Gamma_L S_{12} + \Gamma_0 S_{11} S_{22} \Gamma_L} \quad (5)$$

$$\frac{b_1}{a_1} = \frac{S_{11}(1 - S_{22} \Gamma_L) + S_{21} \Gamma_L S_{12}}{1 - S_{22} \Gamma_L} \quad (6)$$

Note that the generator flowgraph is unnecessary when solving for b_1/a_1 , and the loops associated with it are deleted when writing this solution. Also second- and higher-order loops can quite often be neglected while writing down the solution, if one has orders of magnitude for the various coefficients in mind.

Flowgraph for Three-Port Network

The flowgraph of the general three-port network with the third port terminated by a detector is shown in Fig. 3a. The equations described by the flowgraph are:

$$\begin{aligned} b_1 &= S_{11}a_1 + S_{12}a_2 + S_{13}a_3 \\ b_2 &= S_{21}a_1 + S_{22}a_2 + S_{23}a_3 \\ b_3 &= S_{31}a_1 + S_{32}a_2 + S_{33}a_3 \\ a_3 &= b_3 \Gamma_d \\ M &= kb_3 \end{aligned} \quad (7)$$

(note also the $S_{12} = S_{21}$, $S_{13} = S_{31}$, $S_{23} = S_{32}$ for reciprocal networks).

Since only two rf ports are available with this combination, the flowgraph can be simplified con-

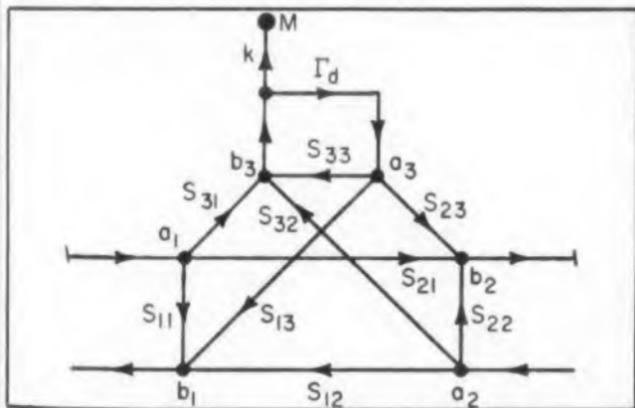


Fig. 3a. Three-port network terminated by a detector.

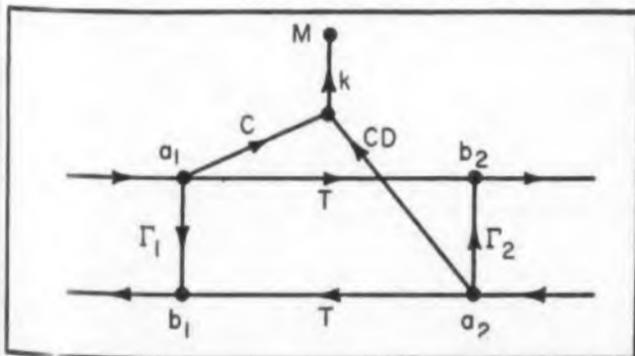


Fig. 3b. With only two available rf ports, network flowgraph can be simplified.

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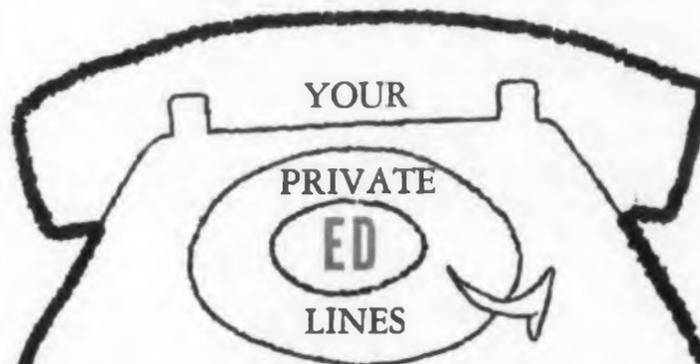
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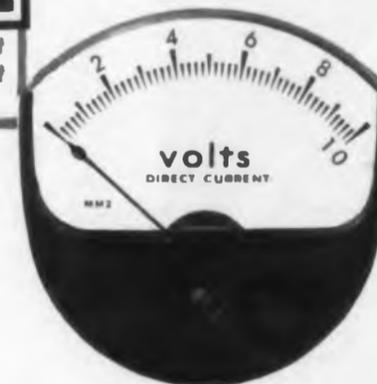
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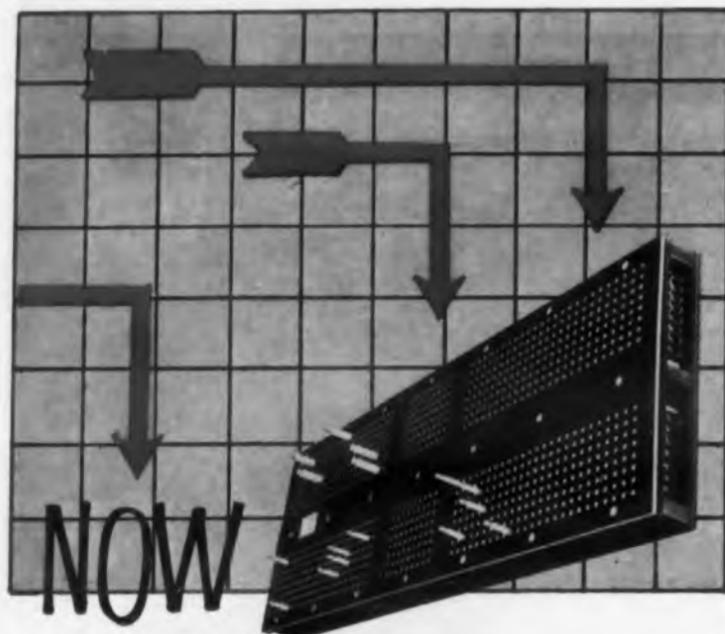
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siderably. Fig. 3b shows this simplification. The symbols for the coefficients are chosen with a directional coupler-detector combination in mind. The directional coupler is assumed to have a built-in termination in one end of its secondary arm, and the other end of the secondary arm is the third port which is terminated by a video detector. The relationships involved are:

$$\begin{aligned} b_1 &= \Gamma_1 a_1 + T a_2 \\ b_2 &= \Gamma_2 a_2 + T a_1 \\ M &= k (C a_1 + C D a_2) \\ \Gamma_1 &= S_{11} + \frac{S_{13}^2 \Gamma_d}{1 - S_{33} \Gamma_d} \\ \Gamma_2 &= S_{22} + \frac{S_{23}^2 \Gamma_d}{1 - S_{33} \Gamma_d} \\ T &= S_{21} + \frac{S_{13} S_{23} \Gamma_d}{1 - S_{33} \Gamma_d} \\ C &= \frac{S_{31}}{1 - S_{33} \Gamma_d} \\ D &= \frac{S_{32}}{S_{31}} \end{aligned} \quad (8)$$

These relationships are written directly through application of the non-touching loop rule, Eq. 4. Note that the path a_1 to M is the main coupling direction involving an effective coupling coefficient C , and the path a_2 to M is the residual coupling direction involving the coupling factor and effective directivity coefficient D . For a direc-

tional coupler, the coupling factor as usually defined is $20 \log |(1/S_{31})|$, while the directivity is $20 \log |(S_{31}/S_{32})|$.

Applying Flowgraphs to Measure Reflection Coefficient

A reflectometer system for measuring the reflection coefficient of a load is shown in Fig. 4. In this arrangement a single directional-detector is used with two slide-screw tuners, one at each end of the coupler. These tuners are for cancelling residual signals, which can cause a measurement error. They consist of a probe of adjustable penetration projecting into the line through a slot along which the probe position can be varied.

In the flowgraph of the system the generator tuner reflection is lumped together with the generator reflection as Γ_g' , and the load tuner is represented as a general two-port network with coefficients Γ_{t1} , Γ_{t2} , and T_t . It can be shown that Γ_g' can be made equal to any arbitrary value by proper adjustment of the generator tuner (although E varies with the adjustment), and Γ_{t1} can be made any arbitrary value by proper adjustment of the load tuner.

The solution for the meter reading M is

$$M = C k E' \frac{(D + T \Gamma_{t1}) + \Gamma_L (T T_t^2 - T \Gamma_{t1} \Gamma_{t2} - D \Gamma_{t2})}{\left\{ \begin{aligned} &(1 - \Gamma_g' \Gamma_{t2} - \Gamma_g' \Gamma_{t1} T_t^2 - \Gamma_1 \Gamma_{t1}) \\ &- \Gamma_L (\Gamma_g' T_t^2 T_t^2 + \Gamma_1 T_t^2 \\ &+ \Gamma_{t2} - \Gamma_g' T_t^2 T_{t1} \Gamma_{t2}) \end{aligned} \right\}} \quad (9)$$

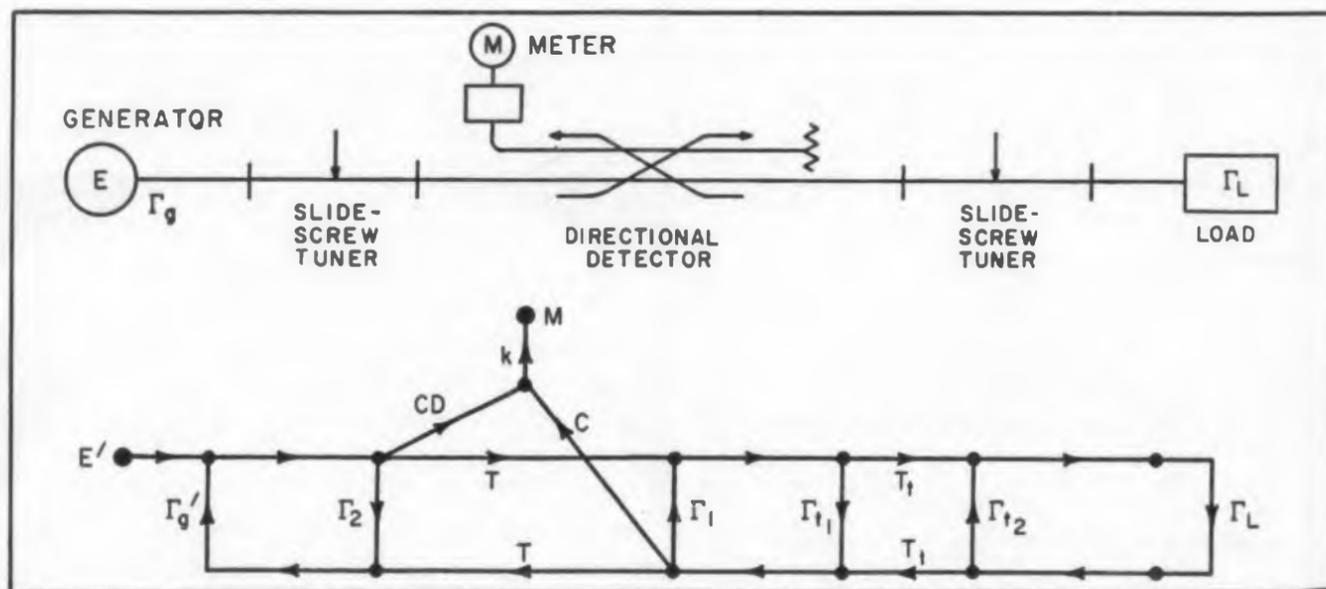


Fig. 4. Equivalent flowgraph of a single-coupler reflectometer used to measure load-reflection coefficient.

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T_i^2
 $T_{t1}\Gamma_{t2}$

(9)

This assumes that connector or flange joint reflections are lumped within the tuner networks, and that the coupler coefficients Γ_1 , Γ_2 , D are small compared to unity. All third- and higher-order loops are negligible, and second-order loops involving Γ_1 or Γ_2 are also negligible. These approximations are quite valid for practical systems and simplify the algebra considerably. Since the meter reading M is not directly proportional to Γ_L , the reflectometer system as it stands cannot give an accurate result.

Procedure

The procedure for achieving the accurate relationship is as follows:

(1) Adjust the load tuner.

Terminate the system with a low-reflection phaseable load. The Γ_L term in the denominator is then negligible by comparison with the constant term, whereas the Γ_L term in the numerator is comparable to the constant term. As the load is moved, the meter reading will vary. By adjusting Γ_{t1} so that no variation occurs, the constant term in the numerator can be brought to zero. This means $\Gamma_{t1} = -(D/T)$.

(2) Adjust the generator tuner.

The system is now terminated with a phaseable short circuit. As this is moved, the meter reading varies as a result of the beating between the Γ_L term and the constant term in the denominator. By proper adjustment of Γ'_o the Γ_L term can be made zero. That is,

$$\Gamma'_o = \frac{\Gamma_1 T_i^2 + \Gamma_{t2}}{T^2 \Gamma_{t1} \Gamma_{t2} - T^2 T_i^2} \quad (10)$$

With this adjustment no variation in M occurs as the short is moved.

(3) The meter reading is now directly proportional to Γ_L . That is, $M = K\Gamma_L$. The meter reading is adjusted to the reference value of unity by adjustment of a gain control. If now an unknown load is connected to the system the meter will accurately measure the magnitude of its reflection coefficient. In a practical case it may be necessary to apply corrections to the meter readings to take account of small deviations of the detector law from the meter law.

Material taken from Analysis of Microwave Measurement Techniques by Means of Signal Flowgraphs, J. K. Hutton, Hewlett-Packard Co. The complete article appeared in Hewlett-Packard Application Note 38—Microwave Measurements for Calibration Measurements.

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VLF Antennas

The problems involved in applying helical top-loading techniques to large, high-power antennas for the vhf range were studied. Electrical design and performance parameters are calculated for a 15-kc antenna and a 1/10 scale model. *Low- And Very-Low-Frequency Antenna Data, ITT Labs., Nutley, N.J., Oct., 1957, 76 pp, Microfilm \$4.50, Photocopy \$12.30. Order PB 137694 from Library of Congress, Washington 25, D.C.*

Transistor Logic

Discusses the design of a logic module employing junction transistors. This package is designed as a standard module for logical operation in a digital computer, and employs "NOR" logic in place of the usual "AND," "OR," and "NOT" functions. In addition, the principle of threshold operation for the "NOR" circuit is introduced; this characteristic increases the versatility of the logical operation. The worst-case design philosophy was employed in the design technique. The circuit analysis of this module includes the various input and output loading conditions. A small-signal equivalent circuit for saturation operation is also presented. *Investigation of High-Frequency Transistor Logic Circuit for Digital Application, Thomas Wong, Naval Ordnance Test Station, China Lake, Calif., 1 Aug. 1959, pp 104, Microfilm \$5.70, Photocopy \$16.80. Order PB 145166 from Library of Congress, Washington 25, D.C.*

Thermionic Emission

Surveys the various materials which may have low electron affinities. More promising materials include MgO, carbides, nitrides, the halides of the alkali and alkaline earths, and ionic compounds of the rare earths. "Hot electron" emission has been obtained under dc operation from silicon diodes after a cesium surface treatment. *Thermionic Emission Studies, G. A. Morton, A. H. Sommer et al., David Sarnoff Research Center, Princeton, N.J., Oct.-Dec. 1958, 22 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 145236 from Library of Congress, Washington 25, D.C.*

Broad-Band Transistor Amplifiers

Analysis, comparison, and design of broad-banded, low-pass transistor amplifiers are discussed in this report. The configurations by which broad-banding can be achieved, are common-emitter stages with resistive, series-peaked, or shunt-peaked interstages, and common-emitter stages with a parallel RC network in the emitter

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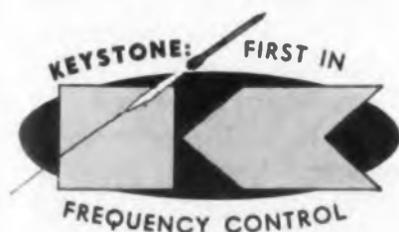
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lead. *Shunt-Peaked Transistor Amplifiers*, R. S. Pepper and D. O. Pederson, *Electronics Research Laboratory, University of Calif., Berkeley, Calif., April 1959, 27 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 145696 from Library of Congress, Washington 25, D.C.*

Transistor Equivalent Circuits

Through the use of simpler transistor equivalent circuits a great deal of modern network technology can be easily applied to the study and design of transistor circuitry. In this report, certain of these simple equivalent circuits are investigated and/or clarified. In particular, two topics are given most attention: the problem of excess phase and the incorporation of the depletion layer capacitance to obtain a dominant pole response. *A Note on Simplified Transistor Equivalent Circuits*, D. O. Pederson, *Electronics Research Laboratory, University of Calif., Berkeley, Calif., Feb. 1959, 16 pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 145496 from Library of Congress, Washington 25, D.C.*

Junction Transistor Standards

Sets forth measurements and circuits required for the specification and evaluation of junction transistors. The report covers the basic measurements required on most transistors, and specific techniques and circuits for vhf and uhf devices. A sample outline of a portion of a transistor specification is given to demonstrate the acceptance electrical tests. *Junction Transistor Measurements and Practical Standards*, Bernard Reich, *Army Signal Research and Development Laboratory, Fort Monmouth, N.J., Feb. 16, 1959, 24 pp, \$0.75. Order PB 161469 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D.C.*

Printed Circuit Switch

Full details of a printed circuit switch design are shown and examples of various forms of application demonstrated. The switch can be used where printed wiring boards are employed for mounting and interconnecting the component's electrical parts. Included are concentric shaft and multiple decking arrangements. A kit form of the switch is suitable for general experimental use in the laboratory, and the applicability to mass production and automatic assembly methods is stressed. *A Versatile Printed Circuit Switch for Application in the Laboratory and in Production*, W. H. Hoffmann, Jr., *Army Signal Research and Development Laboratory, Fort Monmouth, N.J., Aug. 1958, 31 pp, \$1.00. Order PB 161458 from OTS, Washington 25, D.C.*

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NEWS AND NOTES

Most companies rely on the engineer to decide for himself what information he can use on subsequent jobs with other concerns. However, the engineer and his new employer often have been sued for using information gathered at the previous job.

This was the conclusion of a study by the Engineers Joint Council of "Employer Practices and Expectations Concerning the Safeguarding of Proprietary Rights."

The study was based on a survey of 206 companies that employ engineers. The responses indicated that wide use is made of agreements that protect the current employer.

Nearly half the companies said they make contracts with engineering employees to restrict their use of "company-acquired" knowledge either during or after the period of employment.

More than half the companies said their "trade secrets" are defined for engineering employees at some time during the employment period.

However, 68 per cent of the concerns said they did not review with the employee, at the time of his leaving the firm, the information that is considered restricted, or a definition of restricted information for his future guidance.

The Martin Co. in Baltimore will send a man to Johns Hopkins University every year to perpetuate the name of the nation's first space program—Project Vanguard.

Under the terms of the Project Vanguard Annual Graduate Fellowship, the recipient must be a candidate for a bachelor's or master's candidate in engineering or the physical sciences. He may be a citizen of any of the 61 nations that participated in the International Geophysical Year from July, 1957 to December, 1958.

Of the \$5,000 included in the fellowship, \$3,000 will be given to the Fellow and \$1,200 will be applied to his tuition. The remaining \$800 will go to the university for administrative purposes.

The Martin Company was the prime contractor for the rockets used in Project Vanguard, under which three artificial satellites were placed in orbit around the earth.

The president of the American Rocket Society has called on engineering professional societies to stimulate creativity.

H. S. Seifert, at the recent ARS meeting in Los Angeles, made the following suggestions to the societies:

- Attract young researchers into society activities by establishing, for example, mixed panels of junior and senior engineers.

- Arrange summaries of the "state of the art" to alleviate confusion on the part of young researchers in new, broad fields.

- Program "free-forum" sessions where any member can make a 15-minute presentation of his work without review or necessity for publication in any but abstract form.

- Support youth programs and adequate secondary teacher training to encourage young persons to enter technical fields and receive proper education.

- Encourage philosophical papers that deal with the future to direct young persons to promising research goals.

- Arrange informal meetings between engineers and scientists in different fields.

Companies should give more consideration to increasing the individual engineer's productive rate, according to Lynn C. Holmes, director of engineering operations for Stromberg-Carlson, Rochester, N.Y.

Many companies, he said, try to increase their engineering output by using more engineers or by increasing the time spent on a project. He suggested, however, that greater output could also be obtained if the "rate factor" were increased.

Companies could improve their engineers' productive rate, he said, by providing more training, better supervisors, adequate wage incentives, and a good working environment.

Two factors that determine the engineer's rate were beyond the company's control, Mr. Holmes said. They were the man's inherent ability and his "individual drive."

Mr. Holmes made his remarks in a talk on "More Output From Fewer Engineers" at a conference on "Utilization of Engineering Manpower" at Garden City, N.Y.

Engineering education today is being pulled simultaneously in opposite but necessary directions, according to Robert F. Goheen, president of Princeton University.

The need to replace the "traditional approach"

of emphasizing specialized training with "an engineering education that emphasizes ideas, generalizations, concepts, and principles" exists, he said, alongside the need to broaden engineers' humanistic education.

The latter, however, "must be acquired with little or no diminution in the competence of the engineer to handle technical facts and scientific data," Dr. Goheen told the recent graduates of the Newark College of Engineering, Newark, N.J.

He said the engineering profession may eventually require four years of liberal-arts education as a preface to professional training.

Design engineers these days often "don't know" what they have done until they speak to a public-relations man.

For the benefit of those engineers who haven't had time to think about it, they were involved in the following phases of industrial development (according to the "Engineer's Lexicon" of the Auburn Manufacturing Co., Middletown, Conn.):

STRICT QUALITY CONTROL IS NOW BEING EXERCISED—We fired the girl who was dropping hairpins in the gunk.

MODERN PRODUCTION EQUIPMENT HAS BEEN INSTALLED—The old machine fell apart and we had to buy a new one.

A CONTINUING EXPANSION PROGRAM—Last year we installed a new sink in the washroom and the year before the president put up a shelf in his closet.

HIGH ACCURACY—The joints meet.

FIELD TESTED—The lab was too crowded.

EXTENSIVE DEVELOPMENT WORK LED TO THIS NEW ADHESIVE—While working on another project, this stuff spilled on the floor and we still haven't been able to clean it off.

ADVANCED DESIGN—The advertising copywriter couldn't understand it.

EXCITING NEW PRODUCT—This sold miserably for the past 11 years so we have added some chrome and repackaged it.

AFTER PAINSTAKING ENGINEERING WORK—We really goofed around on this for about three years and finally hired a competitor's engineer to get the secret.

MORE THAN SATISFIES NAVAL REQUIREMENTS—The Swiss Navy, that is.

The complete course in deciphering the P man is available from Auburn free of charge.

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