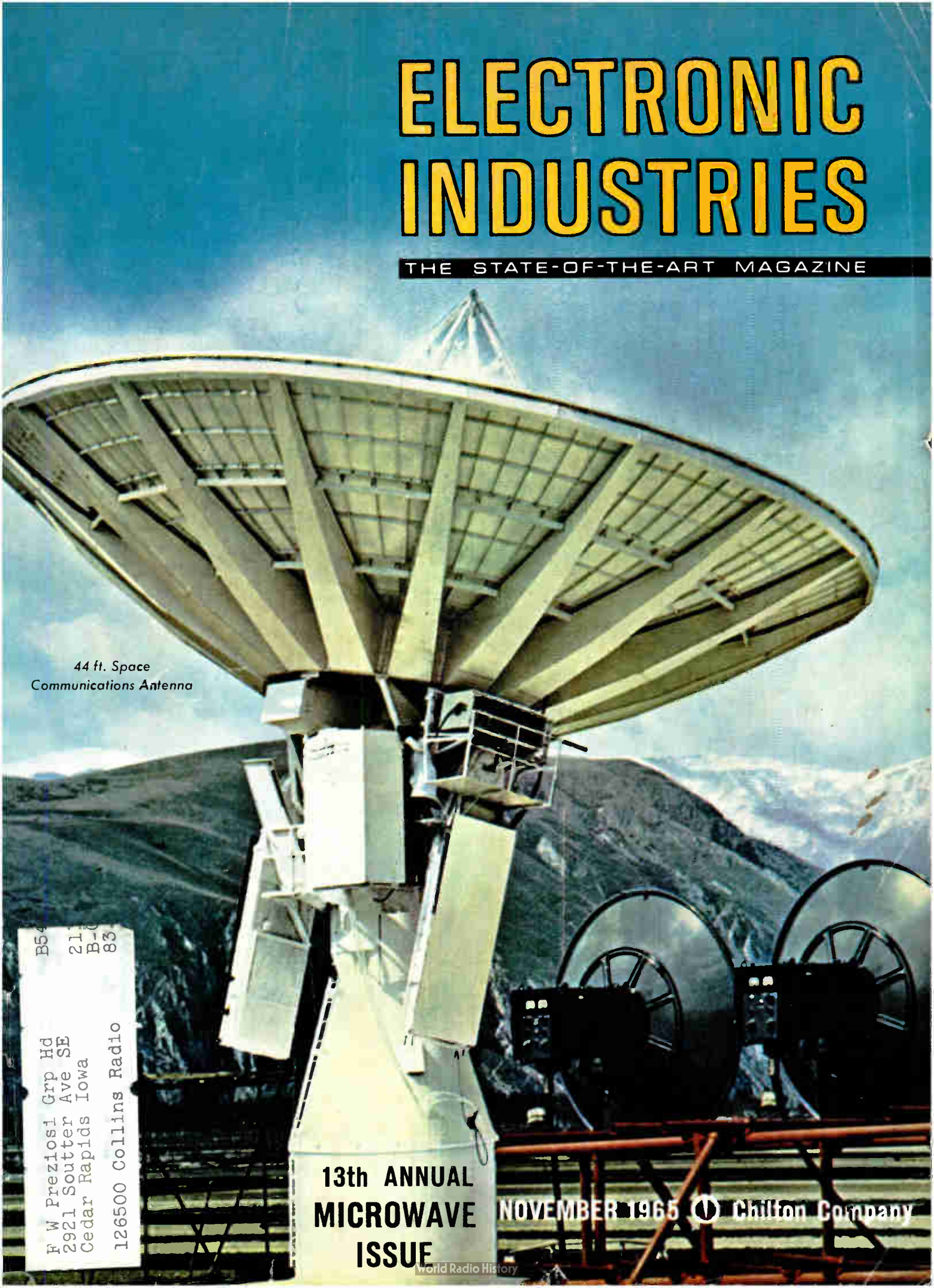
ELECTRONIC INDUSTRIES

THE STATE-OF-THE-ART MAGAZINE



44 ft. Space Communications Antenna

13th ANNUAL MICROWAVE ISSUE

NOVEMBER 1965 ⓒ Chilton Company

UTC
PIONEERS IN MINIATURIZATION

TOMORROW'S PRODUCTS TODAY...

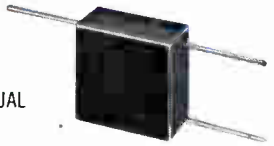
TRANSFORMERS
INDUCTORS
TOROIDS
ELECTRIC WAVE FILTERS
HIGH Q COILS
MAGNETIC AMPLIFIERS
SATURABLE REACTORS
REFERENCE UNITS
PULSE TRANSFORMERS

Design and application engineers with unique requirements have utilized UTC's advanced research and design capabilities for over 30 years. These engineering services are supported by the most complete manufacturing facilities for military and commercial production. Both stock and special custom built iron core components are available in long and short run quantities.

SUBMINIATURE AUDIO TRANSFORMER

ACTUAL SIZE

Plug-in and weldable transistor type audio transformer hermetically sealed to MIL-T-27A, Grade 4, Class R, Life X. Leads spaced on .1 radius circle to conform to "TO-5" cased semiconductors and micrologic elements. Primary impedance: 10K CT ohms; secondary impedance 2K CT ohms. Size: 5/16 dia. x 3/8" h; weight: 1/15 oz.



ACTUAL SIZE

SUBMINIATURE MOLDED AUTOTRANSFORMER

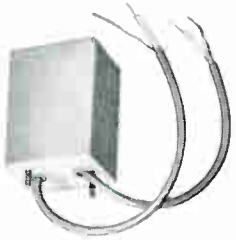
Specially designed for application where space requirements were limited to a slot less than ¼" high. Molded unit with straight pin terminals.
Designed to MIL-T-27A for 6400 cycles, 250 ohms to 1K ohms. Size: 17/32" square x 7/32" tall; weight: 0.1 oz.

ACTUAL SIZE

SUBMINIATURE PULSE TRANSFORMER

Unique subminiature PIP construction to MIL-T-21038 type TP6SX4410CZ with weldable and solderable gold plated Dumet leads. Used for transistor blocking oscillator applications. Pulse width .05 μsec, 3 windings. Size: 5/16 dia x 3/16" h; weight: 1/20 oz.

CHOPPER TRANSFORMER



Has magnetic plus electrostatic shielding. Electrostatically shielded for voltage isolation of 2 x 10^4. Shielded cable leads. Frequency range 60 cycles to 500 cycles. Primary impedance 200K ohms CT to within .1%. Secondary impedance 50K ohms.

BAND PASS FILTER

Designed to MIL-F-18327A in a flat construction for use in printed circuits. Unit has a source and load impedance of 600 ohms. Attenuation ratings are: 100 cycles to 3 KC, ± 0.5 db; 60 cycles and 4 KC, 3 db; 4800 cycles more than 30 db. Size: 4 x 4 x 7/8" h.

THREE PHASE HIGH VOLTAGE POWER TRANSFORMER

Primary jumper hardware for easy conversion from delta to wye inputs. Made to MIL-T-27A specifications. Primary: 440 V 60 cycles delta or wye 3 phase input. Secondary: 2100 V line to line or 1215 V line to line @ 242 ma. Full load voltage ± 2% maximum regulation 5%. Electrostatically shielded to give 20:1 ratio per MIL-T-27A test @ 20 KC. Maximum ambient 70°C, temperature rise 35°C. Size: 10 x 10 x 6"; weight: 66 lbs.

...THROUGH

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ELECTRONIC INDUSTRIES

The State-of-the-Art Magazine

3-G Computers

Dear Reader:

It seems like only yesterday that "second generation" computers were the talk of the industry. But here we are today well into the "third generation" types. These "3-G" computers have much more to offer than their predecessors. And that brings us to next month's issue of E.I.—which will feature computers and related equipment.

State-of-the-art reports on 3-G computers, modern memory devices, optical character recognition, display equipment and one of the "hottest" subjects—time-sharing—will supply answers to many oft asked questions. The impact that these techniques and equipment have had, and will have, on the industry is emphasized.

Recent trends toward multiprogramming and integrated circuits will be discussed. Thin-film, cryogenic, semiconductor and other memory devices will be reviewed with respect to their application to present and future memories. How time-sharing will benefit the user, and how it operates, are covered.

Optical character recognition, while commercially available for almost 10 years, has yet to enjoy widespread use. But recent developments may change this. These new trends are outlined and their significance discussed.

Then, there is the question of computer software—those programs that make computers "tick." Can they be protected by patent? By copyright? One of the articles next month covers the basic legal approaches for protecting rights in software. As the importance of computer software is constantly increasing—investment in this area having now passed the billion dollar mark—this article is particularly timely.

We believe you will find the December issue both interesting and stimulating. We shall be glad to provide you with extra sets of tearsheets for those articles in which you have a special interest.

Sincerely,
The Editors

1965-1966 EDITORIAL FEATURES

DECEMBER	• Switches, Part 1, Specification Chart • Memory Devices for Modern Computers • Some Thoughts on Time-Sharing • Annual Index of Articles
JANUARY	• 1966 Review & Forecast for the Electronic Industries • Potentiometers, Part 3, Specification Chart—Trimmers
FEBRUARY	• Switches, Part 2—Push-button • The Expanding Role of SCR's
MARCH	• 1966 IEEE Show Coverage • Potentiometers — General purpose
APRIL	• Special Purpose Tubes, Part I • Switches—Rotary & Stepping
MAY	• Switches—Slide & Snap Action • Special Purpose Tubes, Part II

ELECTRONIC INDUSTRIES
The STATE-OF-THE-ART Magazine

Expanding Microwave Markets

THE MICROWAVE INDUSTRY is on the threshold of an evolution in technology, applications and markets! The past two years have been difficult for manufacturers, but now, things are looking up. Statements from industry authorities, starting on page 72 in this, our 13th Annual Microwave issue, promise an exciting future.

New government contracts are stimulating the industry's business. Several contracts for Nike-X systems have recently been awarded to Western Electric. This major anti-missile system is providing many sub-contracts which include development of phased antenna arrays and related equipments. In addition, our aerospace program has produced contracts for satellite microwave communications systems. Most promising is a dual communications and tracking system utilizing S-band microwaves.

In commercial communications, a forerunner of things to come is the aptly-named Early Bird Satellite system sponsored by COMSAT. It promises the expansion of the electromagnetic spectrum from 5 to 30GHz,—five times the present bandwidth.

Microwaves are steadily moving into industrial areas. More devices are being used for electronic cooking and baking. Precision controlled heating and drying of materials is another promising industrial application.

International markets are being expanded on two different fronts. Microwave systems, for example, are helping many underdeveloped nations to build up their telecommunications almost overnight. Moreover, many developed countries in Western Europe are refining their telecommunications and color-TV systems through the use of microwave communications.

As new microwave devices are developed, associated test and measuring apparatus must also become more sophisticated. Greater stability, higher accuracy and broader bandwidths are among requirements being placed on new instruments. The emphasis is on swept-frequency measuring equipment and designs that provide continuous display of wideband response. Spectrum analyzers and spectrometers also are in increasing demand.

Technologically, the biggest inroads on electron tubes are being made by the new solid-state microwave devices in the low power ranges. (See solid-state devices chart starting on page 77 in this issue.) These units cost less, weigh less, are smaller and are more reliable. And these devices can perform some operational functions that previously could not be done with tubes.

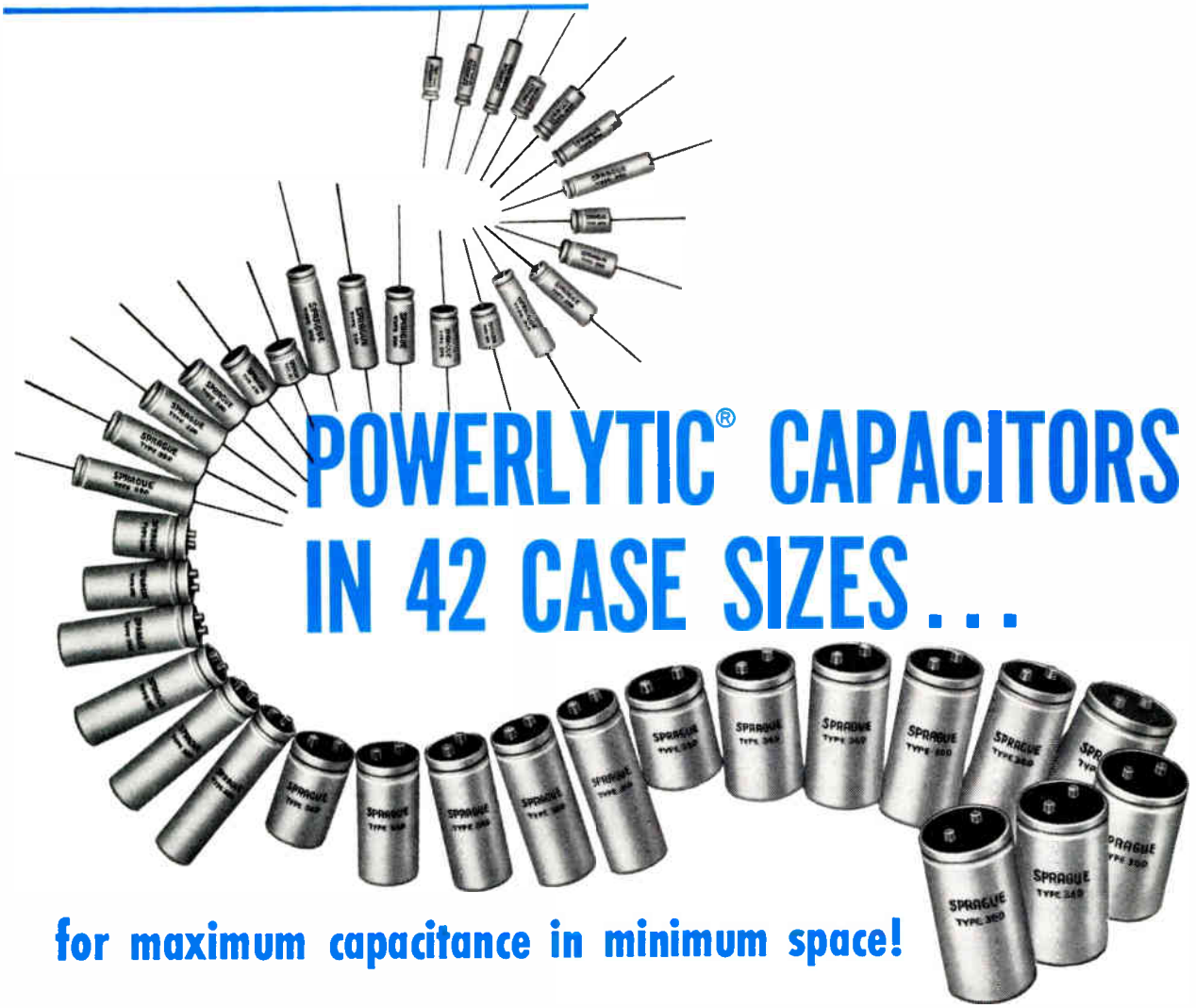
Obtaining substantial power from solid-state devices at microwave frequencies continues to be a problem, but there have been improvements. Recently CW powers up to 5 watts at S-band and 1 watt at X-band have been demonstrated. It has been estimated that these powers will easily be doubled within the next two years. Also, there will be many solid-state integrated circuits which will combine two or more functions in each "building block."

Even radar systems are undergoing an evolution. A most significant development is the portable, electronically-scanned radar. Soon there should be solid-state microwave radars that will incorporate no tubes, except in the display devices.

The recent past has been a trying period for microwave manufacturers but the future now looks much more promising for this important segment of our industry.

Bernard F. Osbahr

Now from Sprague!



POWERLYTIC® CAPACITORS IN 42 CASE SIZES . . .

for maximum capacitance in minimum space!

Type 36D Cylindrical Case

Designed specifically for space economy, in applications such as computer power supplies, industrial controls, high gain amplifiers, etc. Case sizes from 1 3/8" x 2 1/8" to 3" x 5 5/8". Improved temperature capabilities—may now be operated at 85 C. Low equivalent series resistance, low leakage current, excellent shelf life, high ripple current capability. Superior seal employs molded cover with recessed rubber gasket. Reliable safety vents. Solder lug or tapped terminals. Standard ratings from 3 to 450 VDC, capacitance values to 270,000 μF.

Type 39D Tubular Case

Smaller companion to proven 36D capacitor, possessing same outstanding performance. Case sizes from ½" x 1 1/8" to 1" x 3 5/8". Designed for operation at temperatures up to 85 C. Unique construction—anode and cathode terminals are welded—no riveted or pressure connections—prevents open circuits, even in microvolt signal range. Improved molded phenolic end seals contribute to unusually long life (expectancy, 10 years or more). Low effective series resistance, low leakage current. Standard ratings include capacitance values to 18,000 μF, voltages from 3 to 450 VDC.

For complete technical data on Type 36D or Type 39D Powerlytic Capacitors, write for Engineering Bulletins 3431B and 3415, respectively, to Technical Literature Service, Sprague Electric Co., 233 Marshall Street, North Adams, Mass. 01248.

Popular ratings are now available for fast delivery from your Sprague Industrial Distributor.

SPRAGUE COMPONENTS

CAPACITORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
TRANSISTORS	INTERFERENCE FILTERS	PACKAGED COMPONENT ASSEMBLIES
RESISTORS	PULSE-FORMING NETWORKS	BOBBIN and TAPE WOUND MAGNETIC CORES
INTEGRATED CIRCUITS	TOROIDAL INDUCTORS	SILICON RECTIFIER GATE CONTROLS
THIN-FILM MICROCIRCUITS	ELECTRIC WAVE FILTERS	FUNCTIONAL DIGITAL CIRCUITS

4SC-5131

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THE MARK OF RELIABILITY

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NOVEMBER 1965, Vol. 24, No. 11

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART* Magazine

COVER: Transmitting and receiving system at the Fucino, Italy earth station was designed, manufactured and installed by Societa Generale di Telefonia ed Elettronica S.p.a. of Milan, Italian subsidiary of General Telephone & Electronics Corp. Smaller dishes connect the station with Rome and European communications networks.

*STATE-OF-THE-ART: up-to-the-moment capability in each area of electronic technology

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ELECTRONIC INDUSTRIES

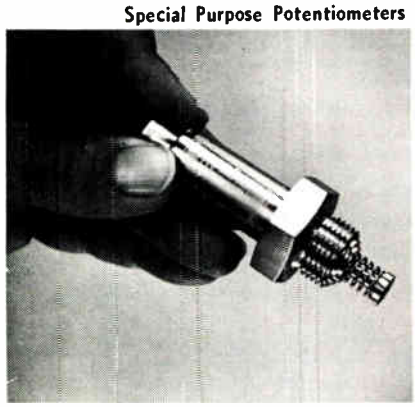
HIGHLIGHTS

Microwave Component Market

Microwave Semiconductors

Photoconductive Detectors

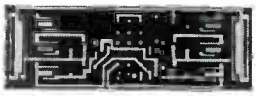
Special Purpose Potentiometers



• A REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department, 56th & Chestnut Streets, Philadelphia, Pa. 19139

Did you know Sprague makes...?

UNICIRCUIT® RCTL INTEGRATED CIRCUITS



(8x actual size)

Sprague Series US-0100 . . . a complete line of monolithic digital building blocks featuring low power consumption (2 mW typ.)

Circle 2 on Inquiry Card

UNICIRCUIT® RTL INTEGRATED CIRCUITS

TO-5 CASE

Types US-0708 through US-0721 . . . Fully interchangeable mW digital building blocks featuring power consumption of 4 mW/node and propagation delay of 40 nanoseconds.

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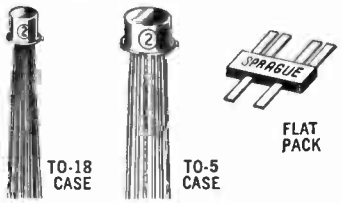
DIFFERENTIAL AMPLIFIER TRANSISTOR PAIRS



TO-18 CASE

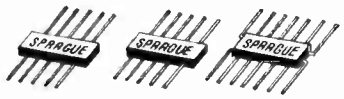
TO-5 CASE

FLAT PACK

NPN or PNP • Matched characteristics.
h_{FE} = 10-20%. ΔV_{BE} = 5-20 mV.
ΔV_{BE}/Temp = 5-20 μV/°C.

Circle 4 on Inquiry Card

MULTIPLE TRANSISTORS (NPN-PNP PAIRS/QUADS)

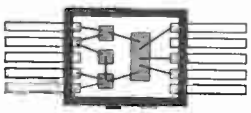


AMPLIFIERS SWITCHES CHOPPERS

Pairs	Quads
2 NPN	4 NPN
2 PNP	4 PNP
1 NPN—1 PNP	2 NPN—2 PNP

Circle 5 on Inquiry Card

UNICIRCUIT® CUSTOM HYBRID CIRCUITS



Combine monolithic silicon circuits with Ni-Cr alloy resistors. Close resistance tolerances, low temperature coefficient, ±2% resistor matching.

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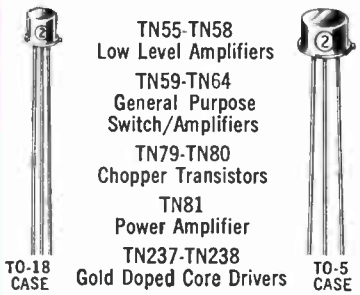
LOW-COST HERMETICALLY-SEALED PLANAR TRANSISTORS



TO-18 CASE

TN55-TN58
Low Level Amplifiers

TN59-TN64
General Purpose Switch/Amplifiers

TN79-TN80
Chopper Transistors

TN81
Power Amplifier

TN237-TN238
Gold Doped Core Drivers

TO-5 CASE

Circle 7 on Inquiry Card

SILICON ALLOY REPLACEMENT TRANSISTORS

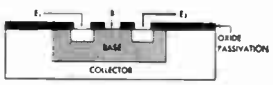
FULL PLANAR RELIABILITY

2N327A	2N945	2N1026
2N328A	2N946	2N1469
2N329A	2N1025	2N1917

Sprague makes 82 standard high-emitter-voltage full planar silicon alloy replacement types.

Circle 8 on Inquiry Card

DUET* HIGH-VOLTAGE DUAL-EMITTER TRANSISTORS



New Type 3N123 low-cost transistor with 25-volt rating now available.

• • •

Sprague makes more dual-emitter chopper transistors than any other source.

★Trademark

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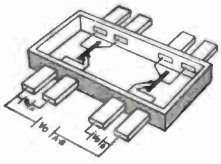
TWIN DUET* DUAL-EMITTER TRANSISTORS IN FLAT PACKS



Sprague leads again with two dual-emitter chopper transistors in one flat-pack case, with tight V_{OFF} matching of both devices.

★Trademark

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For complete technical data on any of these products, write to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts 01248.

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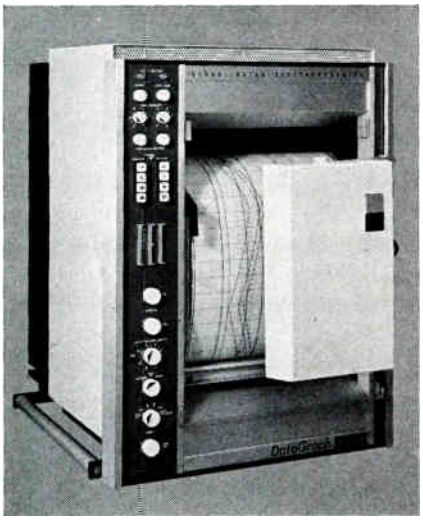
The most advanced oscillograph is now available with the DataDigit T.M. Character Generator



5-133 – BENCHMOUNT CONFIGURATION

CEC's 5-133 DATAGRAPH® has long been accepted as the world's finest recording oscillograph for those applications where no compromise is acceptable.

However, the state-of-the-art is constantly changing. As a result, a companion instrument has been perfected which gives the 5-133 an additional capability undreamed of a short while ago. And that is . . .

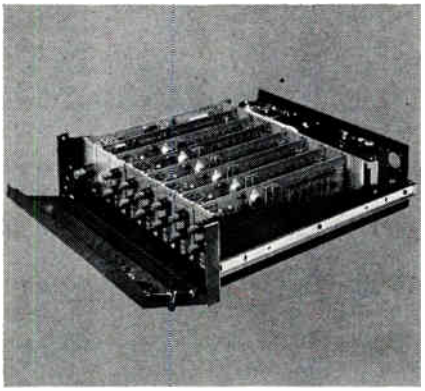
DataDigit—the new Datagraph Accessory

When used with the 5-133 or any CEC oscillograph, the new DataDigit Accessory literally provides a new dimension in data recording. Speed, accuracy and flexibility that were previously unattainable can now be realized even at moderate and slow paper speeds.

The DataDigit is virtually a quantum jump in recording technique, combining the features of the fastest digital printer and an analog light beam oscillograph in *one* instrument. And, being a completely self-contained accessory, this instrument can be used with existing oscillographs *without modification.*

Fundamentally, this accessory generates the necessary waveforms to print decimal data on standard photographic papers. Up to 26 columns can be printed at speeds to 1600 lines-per-second. So economical is this instrument, it soon pays for itself in paper savings alone.

Compared to the best previous methods, recording capabilities with DataDigit become impressive indeed.



DATADIGIT TM CHARACTER GENERATOR

Specifications:

Print-Out — 0 thru 9 • **Input Data Format** — 10 line decimal • **Input Voltages** — Select command + 5 v min. to + 70 v max. • **Input Impedance**—Select command signal 20 k ohm resistive min. • **Print Command** — rise time 1 μsec; duration 2 μsec min. — 400 μsec max.; voltage + 5 v min. to 25 v max.; input impedance 550 pf • **Power Requirements** — voltage 90 — 135 v or 180 — 270 v; frequency 48 — 420 cps; wattage 120 max. • **Physical Characteristics** — 5¼" H x 19⅜" D x 19" W. Mounts in standard EIA rack, slide rackmount available.

	Conventional	DataDigit
Accuracy	1.5% to 2%	0.01% or better with digital techniques
Frequency Limit	15 kc	1 mc with digital techniques
Channel Separation	Visual	Digital identification
Channel Capability	52	Unlimited
Timing	Paper speed	Digital clock
Data	Continuous	Continuous or multiplexed

Other important accessories:

The Remote Control Unit operates the 5-133 from distances up to 1000 feet. Complete remote *control* of all electrical functions is possible – including all *speed selection*, power ON/OFF and recording lamp ON/OFF.

The Latensification Lamp Assembly uses four 8-watt cool white fluorescent lamps to latensify slow-speed recordings. A readable record is immediately available when recorded at low speeds up to 4 ips.

The Ambient Light Shield permits recording with no latensification, allowing the record to be chemically processed for maximum contrast needed for oscillograms of archival quality.

For complete information on DataDigit, plus the 5-133 and its other accessories, call your CEC Sales and Service Office, or write for CEC Bulletins 5133-X9 and 30100-X4.

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ELECTRONIC INDUSTRIES RADARSCOPE

Developments and trends affecting the State-of-the-Art of technologies throughout the electronic industries

SPACE ANTENNA

Engineer Edgar R. Bourke examines inflatable antenna developed by Raytheon Company for use in space programs. Antenna is carried aloft in collapsed form only 2 ft. in size. In use it is inflated to 8 ft. inside and 10 ft. outside diameters. Weight of this prototype C-Band Cassegrain model is less than 8 pounds.

COLOR TV DEMAND is exceeding the industry supply according to RCA. It is estimated that by Christmas the demand will exceed the industry supply by about 350,000 sets. The sale of color TVs is expected to be at least 2.5 million for 1965. Last year's sales were 1.3 million.

MASER has been operated by Westinghouse Aerospace Div. without the usual dc magnetic field about the crystal. Aluminum nitrate was used as the active material. The aluminum nitrate was used in single crystal, polycrystaline, and powder forms. Experiments showed a power gain of 25 db. The experimental maser operated at 9.35 GHz. Not using the magnetic field reduces the maser's size.

PARAFFIN WAX is being used by Sperry Rand for producing modules. In assembling cordwood welded modules the parts are temporarily encapsulated prior to welding. After welding, the paraffin is melted for removal and a permanent encapsulant used. Using the paraffin and pre-cutting parts leads has reduced packaging costs about 40%.

COSMIC NOISE is being used by ITT for measuring the noise figure of DEW Line ionospheric scatter propagation receivers. Every day the antenna patterns of the northernmost communication stations sweep through the center of the galactic plane. Knowing the noise level in the 40 MHz band, an estimate of the receiver noise figure was made to detect deterioration. In the Arctic, a cosmic noise measured by a 40 MHz receiver in a 600 Hz band has a median value of 0.04 microvolt into a 50 ohm impedance.

SHARPENING THE MEMORY of a spacecraft attitude control system for NASA is the object of a study being made by Douglas Aircraft. The study is to find ways of improving operation of the attitude system so that it will learn from its past performance in the changing environment of space. The concept is based on electronic intelligence methods and seeks to develop a system which not only adapts to changes, but also learns from them.

CONTINUOUS SOLID STATE LASER beam operating at a power level in excess of 40 watts has been achieved by Union Carbide's Linde Div. The laser crystal used is a neodymium-doped ytterium aluminum garnet (YAG). The CW laser wavelength was 1.06 microns.

A DIGITAL COMPUTER is being used by scientists at The Jet Propulsion Laboratory to help refine and improve the photographs of Mars relayed by the Mariner IV spacecraft. A Digital Equipment Corp. PDP-7 computer is reworking the transmissions in a variety of ways. For example, values of the 40,000 dots that make up each photo are juggled so that contrasts will stand out more clearly.

PRODUCTION DESIGN STUDIES for an all-weather landing system for the 158-ton C-141 StarLifter aircraft have been completed by engineers of the Lockhead-Georgia Co. Sponsored by the Air Force and Federal Aviation Agency, the studies were aimed at enabling the StarLifter to land at zero-ceiling and zero-visibility. Current FAA regulations require a pilot to have ½-mile visibility and 200-ft. ceiling to continue an approach for a landing. Studies are for a system for ¼-mile visibility and 100-ft. ceiling. Lockheed's design uses, within the landing system, a device called a "vertical navigational computer." This would assist the pilot during periods of low visibility at airfields which aren't equipped with electronic aids. A feature of the proposed system is a provision for manual back-up of the automatic system. Current systems don't coordinate manual back-up with automatic operations.

AMPLIFICATION as well as variable delay of microwave signals by a miniature device is closer to reality due to work done by physicists at Sperry Rand Corp. Company physicists recently demonstrated net gain amplification of delayed signals in an experimental C-band solid state delay line operated at room temperature. Net gain of 15 db as high as C-band was generated.

SMALL COMPUTER is used to monitor information from aircraft controls. This is in a system being made by Elliott Brothers Ltd. of London, England. Data is then projected, in the form of symbols, onto a reflection glass, focused at infinity, in the pilot's line of vision. Thus, "suspended" in space in front of him, it allows him to keep his head up while reading it. The "Head Up" unit relieves the pilot of some of the stress of watching complex instrumentation systems.

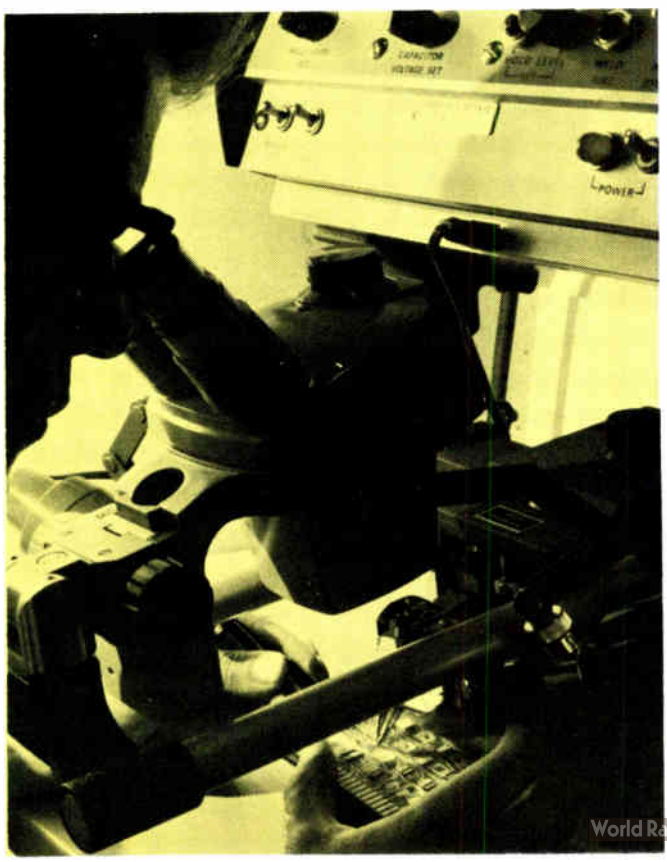
SONAR SYSTEM developed by the Pacific Division of The Bendix Corp. is to be used by the state of Alaska to solve one of its chief problems—that of counting salmon as they swim upstream to spawn. The salmon industry contributed $86 million to the state's economy in 1964. So it can be seen why proper regulation is important. The system can operate unattended. It was designed on the idea that the air bladder of a salmon is a good target for a sonar beam.

PROBE DETECTS FAULTS

Intermittent faults in almost any kind of equipment, from microcircuits to the tubes shown here in this oscilloscope, can be detected by this new RF probe built by Honeywell, Inc. Engineer Patrick O. Harvey taps the tubes with a rod and listens to the signals transmitted to his earphones from the pick-up in his right hand.

SPEEDS PRODUCTION

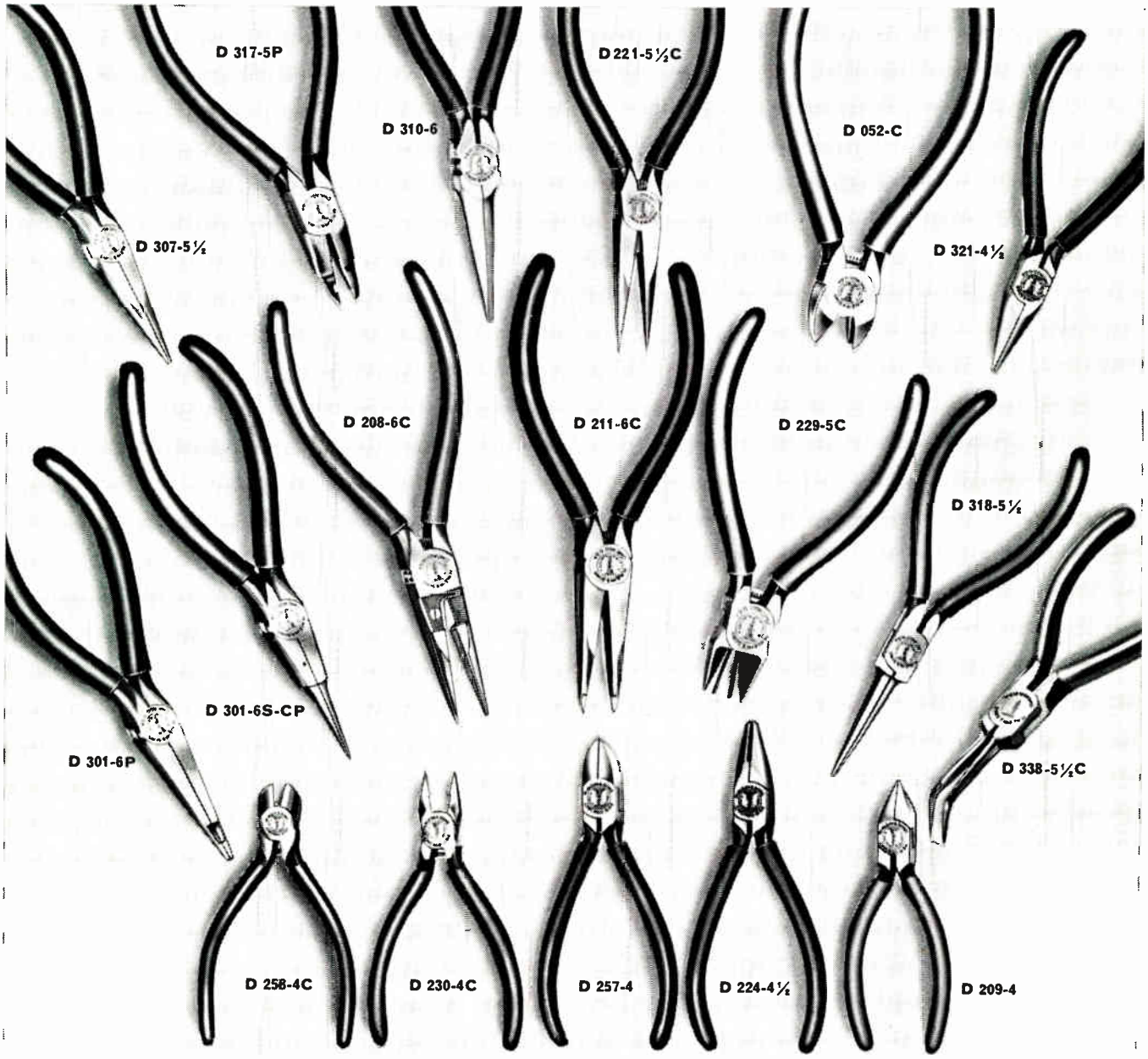
New technique developed by Sylvania speeds production of printed circuit cards. Technique combines a standard welding process and precise, microscopic pre-positioning of components. Here, a tiny component is positioned on an adhesive card. Components are then welded to form a "virtually indestructible" circuit card.



MICROELECTRONIC WELDING is being done with a laser. An automatic system for laser welding of integrated circuit modules uses a tape-controlled micropositioner developed by Arvin Systems, Inc. This is mated with a Westinghouse laser welder. The connection is automatically positioned and the laser beam is triggered. The developmental laser at Westinghouse Defense and Space Center in Baltimore now makes welds at a rate of 20 per minute. Work is being done to increase the firing rate.

CONTINUED RESEARCH on a new method which converts dozens of laser light frequencies into a narrow single frequency beam capable of transmitting signals more clearly than any existing method is the object of an Air Force contract awarded to Sylvania. The method, known as the "super-mode laser" was developed by Sylvania. It preserves and exploits all of the original power.

IC CORE MEMORY series with an operating speed of 1 microsecond full cycle and access time of less than 500 nsec. has been developed by Computer Control Co. The coincident current, random access core memory is 5¼ inches high. It permits word capacities to 16,384 and fits into a standard relay rack.



Midgets and specials for electronic assemblies

A cutter that cuts clean and holds the crimped end . . .

One that cuts and crimps wiring on a printed circuit for efficient dip soldering . . .

A trimming plier, flush cutting . . .

A needle nose plier that reaches deep into miniature assemblies . . .

These and dozens of other pliers are available from stock in the complete Klein line. In fact, here you will find pliers exactly designed for any electronic system where clean cutting accuracy, crimping and bending are necessary in extremely confined space.

The Klein line of specially designed electronic pliers offers a plier exactly designed for each specific job—saving time, speeding assemblies, assuring a better product. For complete information write for the Klein catalog on electronic pliers.

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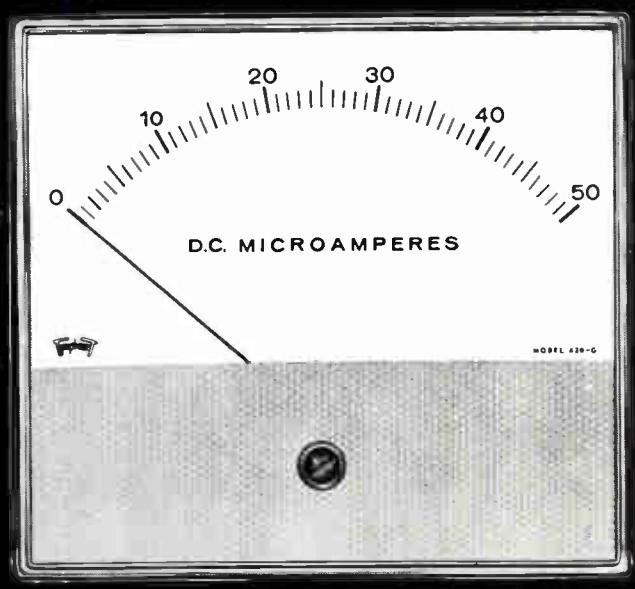
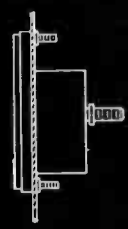


now you see it

now you don't



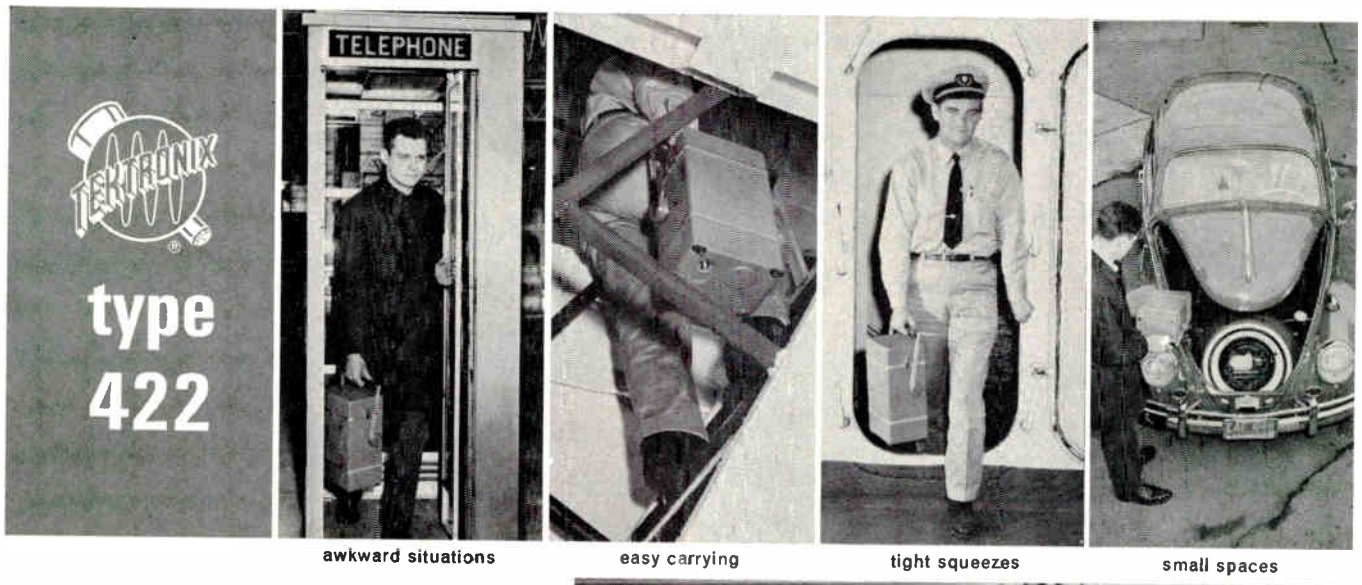
THE PANEL INSTRUMENT WITH BUILT-IN FLEXIBILITY

New Triplett G-Series Panel Instruments offer a modern design that features a greater degree of flexibility and interchangeability. **1** Two types of mounting are available—conventional flush type or behind-the-panel with a bezel for modern picture window appearance. **2** The insert shield on the front of the meter can be custom painted or printed to meet customer's requirements. **3** Triplett's famous self-shielded Bar-Ring magnet, with one-piece die-cast frame, all DC and DC suspension type instruments.

Available in three popular sizes: 2½", 3½" and 4½" models with black molded dustproof cases and clear molded plastic fronts.

TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO



awkward situations | easy carrying | tight squeezes | small spaces

portability

The Type 422 is dimensionally proportioned for comfortable portability and on-the-job convenience.

Small Size — with maximum overall dimensions of 6¾" high x 10" wide x 17⅛" deep, including panel cover and handle, making it easy to carry anywhere, even through a revolving door.

Light Weight — ~21 pounds, with panel cover and included accessories.

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Storage (without batteries)	—55°C to +75°C, to 50,000 ft.
Operating (without batteries)	—15°C to +55°C, to 15,000 ft.
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Operating (with batteries)	—15°C to +40°C, to 15,000 ft.

No fan used. Runs cool and stays clean.

Versatile Performance—with bandwidth of dc-to-15 MHz, sensitivity to 10 mV/div, sweep speed of 0.5 μsec/div to 0.5 sec/div, and dual-trace operation in a compact instrument. Ch 2X10 to 1 mV/div (AC only).

Sharp, bright displays—even under high ambient light conditions. Rectangular 4" CRT provides 8 X 10 div display area (0.8 cm/div).

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Type 422 Oscilloscope (AC only) $1325
Type 422 Oscilloscope (AC-DC) $1750
(Includes set of 20 NiCd cells)

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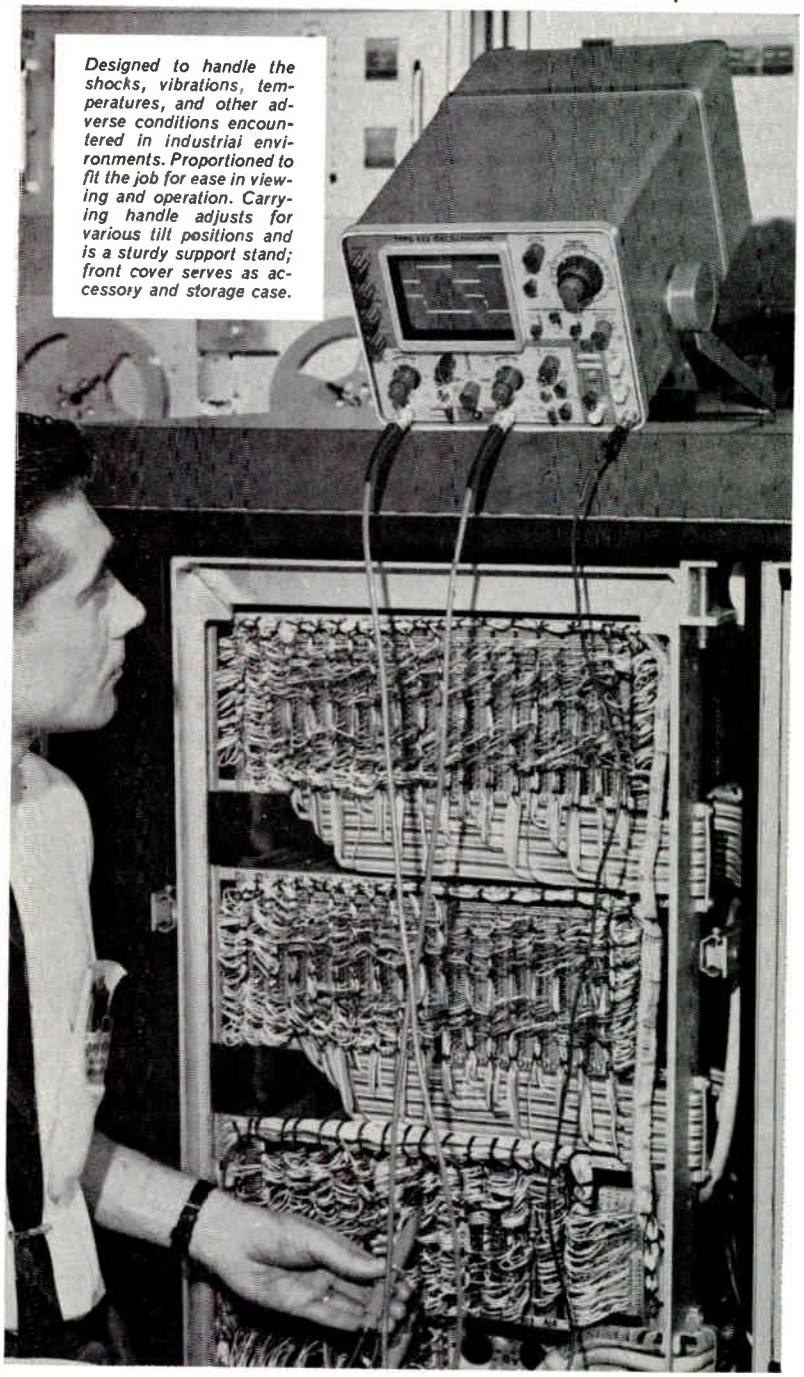
Tektronix, Inc.

Designed to handle the shocks, vibrations, temperatures, and other adverse conditions encountered in industrial environments. Proportioned to fit the job for ease in viewing and operation. Carrying handle adjusts for various tilt positions and is a sturdy support stand; front cover serves as accessory and storage case.



These slim PC Correed* terminals have "I-Beam Strength"

They make AE's new printed circuit dry reed switches easier to insert...and keep electrical contacts positive.

For extra strength and rigidness, the terminals are "ribbed" like an I-Beam.

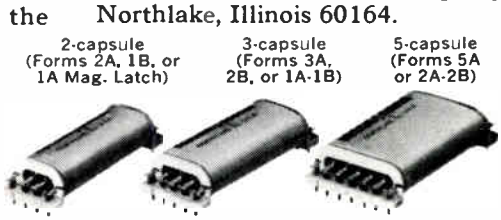
Why? Because new PC Correeds are specifically designed for direct insertion into standardized grids. Terminals are spaced in multiples of 0.200 inches—for compact wiring pads and high packaging density. Magnetic shields surround the coils, preventing interaction. Diodes can be soldered directly to the upper side of terminals.

*U.S. patent applied for.

And for an extra measure of moisture resistance, AE uses glass-filled plastic bobbins. It's a practical way to prevent electrical failures.

What's more, the terminals in PC Correeds are separate from the leads. They're welded to the leads—not soldered. This takes the strain off the glass capsules.

Want some helpful information? Get fully detailed data on new AE Printed Circuit Correeds. See how they meet the needs of modern electronic circuitry. Simply write to the Director, Electronic Control Equipment Sales, Automatic Electric Company, Northlake, Illinois 60164.



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COMING EVENTS

November

Nov. 16-18: 4th Annual Symp. on Physics Failure in Electronics, ITT Research Institute, Rome ADC; Chicago, Ill.

Nov. 16-19: Annual Conf. on Magnetism & Mag. Materials, AIP, IEEE; Hilton Hotel, San Francisco, Calif.

Nov. 18-19: Mid-America Elect. Conf. (MAECON), IEEE; Continental Hotel, Kansas City, Mo.

Nov. 22-23: Int'l Conf. on UHF Television, IEE, IEEE, IERE; London, England.

Nov. 30-Dec. 2: Fall Joint Computer Conf., IEEE ACM; Convention Center, Las Vegas, Nev.

December

Dec. 1-3; 1965 Ultrasonic Symp., IEEE; Hotel Kenmore, Boston, Mass.

Dec. 2-3: 16th Vehicular Commun. Conf., IEEE; Sheraton Park Hotel, Washington, D.C.

'66 Highlights

IEEE Int'l Conv., Mar. 21-24; Coliseum, New York Hilton, New York, N.Y.

WESCON, Western Electronics Show & Conv., Aug. 23-26, WEMA, IEEE; Sports Arena, Los Angeles, Calif.

Nat'l Electronics Conf., Oct. 3-5, IEEE; McCormick Place, Chicago, Ill.

January 1966

Jan. 25-27: 12th Annual Symp. on Reliability, IEEE, ASQC, et. al; Sheraton Palace Hotel, San Francisco, Calif.

Jan. 30-Feb. 4: IEEE Winter Power Meeting, IEEE; Statler-Hilton Hotel, New York, N.Y.

Jan. 31-Feb. 2: Int'l Symp. on Information Theory, IEEE; UCLA, Los Angeles, Calif.

February

Feb. 2-4: 7th Western Conv. on Aerospace & Electronic Syst., IEEE; Los Angeles, Calif.

Feb. 9-11: Int'l Solid-State Conf., U of Penna., IEEE; Univ. of Penna., Sheraton Hotel, Phila., Penna.

March

Mar. 2-4: Scintillation & Semiconductor Counter Symp., IEEE; Shoreham Hotel, Washington, D. C.

Mar. 21-24: IEEE Int'l Convention, IEEE; Coliseum & New York Hilton Hotel, New York, N.Y.

April

Apr. 4-5: Rubber & Plastics Industries Tech. Conf., IEEE; Sheraton-Mayflower Hotel, Akron, Ohio

Apr. 12-15: 4th Quantum Elect. Conf., IEEE; Towne House, Phoenix, Ariz.

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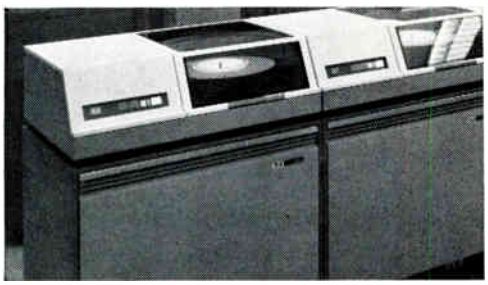
WHATEVER YOUR NEEDS MAY BE . . .

FORMICA MAKES A LAMINATE TO MEET NEARLY EVERY PRINTED CIRCUIT 'SPEC'

Basic properties of three of the most-used FORMICA® brand copper clad laminates are shown on the chart. We have seven other grades, with a wide range of electrical and mechanical properties. Chances are that your "special" application can use a standard grade of FORMICA®. We're printed circuit pros, and we welcome every opportunity to prove it.



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FORMICA® FR-45 glass-epoxy laminate	FORMICA® FR-200 paper-phenolic laminate	FORMICA® XXXPN-36 paper-phenolic laminate
A single material which does the job of 4, eliminating quadruple stocking, purchasing, record-keeping. Flame retardant.	Flame retardant version of grade XXXPN-36. Flame retardant. Punching grade laminate at no premium price.	Allows plating in alkaline (cyanide) bath and 500° F. soldering with high bond strength. Transluscent for ease of registration.
Available copper clad or unclad.	Available copper clad or unclad.	Available copper clad or unclad.
Meets MIL-P-18177, type GEE & GEB; MIL-P-13949C, type GE, GB, GF, GH (copper clad).	Meets MIL-P-3115C, type PBE-P (natural color only); MIL-P-13949B, type PP (copper clad).	Meets MIL-P-3115C, type PBE-P (natural color only).
Meets property requirements of NEMA G-10, G-11, FR-4, FR-5.	Meets property requirements of NEMA FR-2.	Meets property requirements of NEMA XXXPC.
Insulation resistance: avg. value 1,000,000 megohms.	Insulation resistance: 500,000 megohms.	Insulation resistance: 500,000 megohms.
Flexural strength 1/16" length (flatwise): 75,000 psi.	Flexural strength 1/16" length (flatwise): 21,500 psi.	Flexural strength 1/16" length (flatwise): 15,000 psi.
Thickness: 1/32" to 1".	Thickness: 1/32" to 3".	Thickness: 0.015" to 1/2".
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Finish: semi-gloss.	Finish: semi-gloss.	Finish: semi-gloss.
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What this brand new catalog won't tell you...

this brand new calculator will.

BOTH FREE

Between the new Daven catalog on precision wire wound resistors and networks... and the new Resisto-Dial... you've got the most complete, concise, *usable* data published today. Both are designed to provide just the information you want, just the way you want it—fast!

The 16-page catalog is the "Bible" on precision resistors... high reliability, encapsulated, subminiature, printed circuit, fuse, power, instrument grade, high frequency, and unencapsulated resistors. Also covered: DAV-Pak Prepackaged Networks.

The Resisto-Dial *instantly* calculates resistor styles based on requirements; calculates failure rate based on unit hours at a given confidence level; and many other computations.

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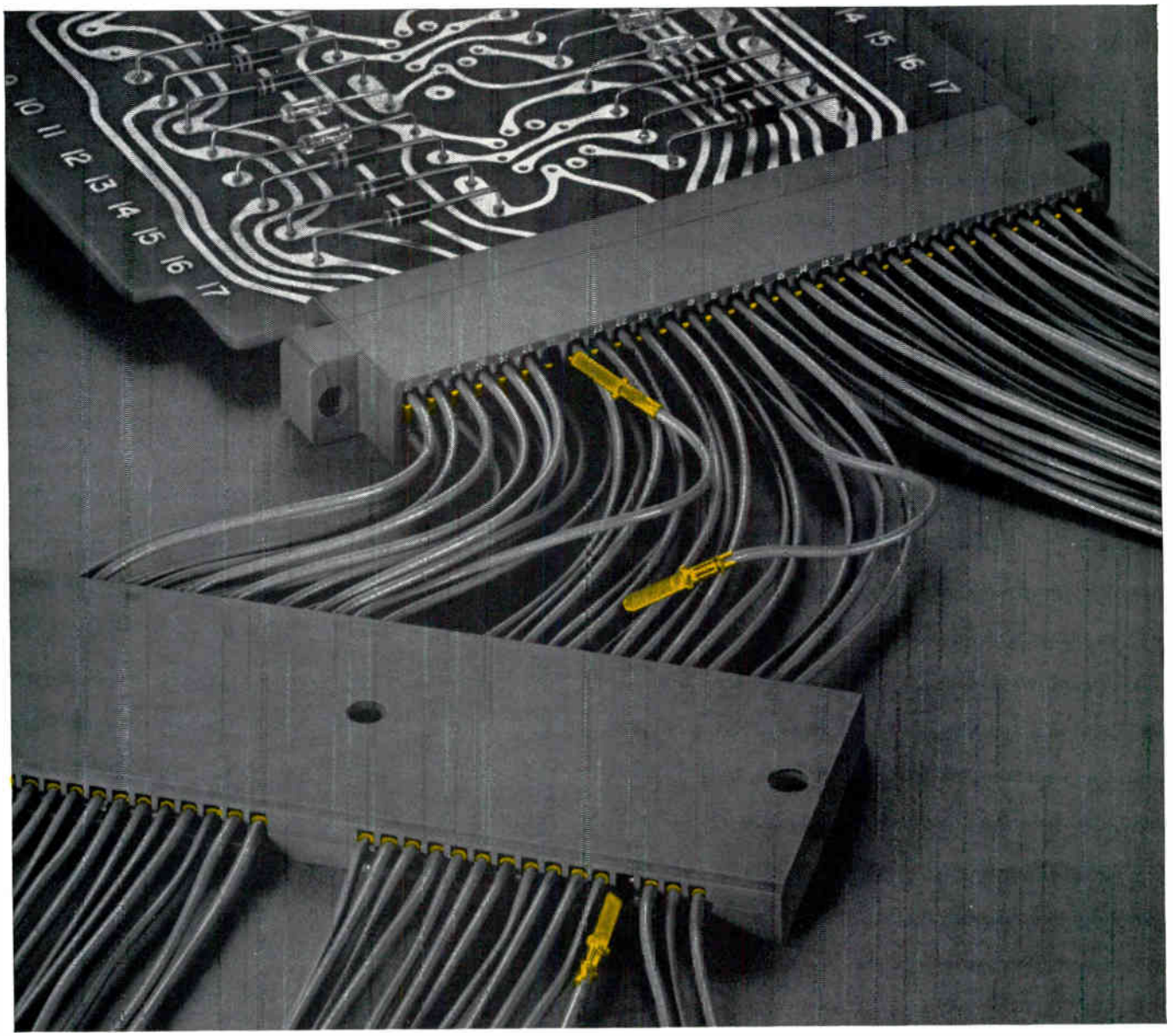

Keep tabs on the ins and outs of wiring

Now you can modernize your wiring . . . use only tab terminals on your leads. Employ harnessing techniques using tab terminals on each end; snap one end to our AMP-TAB★ Printed Circuit Board Connector, the other to the AMP-TAB Feed-Thru Block.

Our new Feed-Thru Block was designed as a companion to the popular AMP-TAB Printed Circuit Connector. By using the same contact on both ends of the wire, you can assemble your racks at the lowest installed cost. And . . . you need no insertion tools to do it! Gold-over-nickel plated tab terminals are not only hand insertible, they require only one-third the space of other terminals.

It all adds up to one of the most practical ways we can think of to solve your wiring problems. And . . . look at these bonus features:

- Hand inserted contacts—no insertion tool required
- One tool crimps entire wire range
- High density—.100″ mounting centers
- "Egg crate" housing design eliminates need for contact sleeves
- Built-in keying slots for stacking blocks
- Contacts available in strip form for high production

Whether you are commoning, distributing or simply feeding-through your leads, let our Feed-Thru Block pick up the tabs. Write today for complete information.

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INDUSTRIAL SALES DIVISION

A-MP★ products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

Circle 67 on Inquiry Card

SLOW CHANGE TO METRIC SYSTEM—Congress saw no need for haste in 1965 in converting to the metric system. A bill providing for a study of the problems likely to result from a change from inches to meters has been laid aside until 1966. Secretary of Commerce John Connor has urged that such a study be started without delay. With the decision of Britain to "go metric" within 10 years, the U.S. will be the last major hold-out of the inch-pound-gallon school of measurement.

ELECTRONICS AND GRAPHIC ARTS—"Growth of electronic communications is overtaking conventional methods of printing." What's likely to emerge is a new "communications industry" that will include all existing forms of publishing and broadcasting. These predictions come from Elmer Brown, president of the International Typographical Union (ITU). "Eventually, the entire field of communications—graphic arts, radio frequency, electronics, electrostatics, and the application of other energies—will come under the same business control," he believes.

U.S. ALLIES BUY SURPLUS—Our allies have purchased $9,200,000,000 worth of U.S. military surplus equipment since June 1961. Defense Secretary McNamara points out that disposal of this surplus equipment (including electronic) to our allies permits them to buy at low prices, while U.S. manufacturers gain by selling new equipment to DOD. Germany and Britain account for more than $6,100,000,000 of the total. About $930,000,000 worth is sold to Canada, Australia, New Zealand, and Japan. The balance is sold to allies scattered throughout the world.

EDUCATIONAL TV FOR PUERTO RICO

One of 1,800 educational TV sets ordered by Commonwealth of Puerto Rico from GE. Specially designed sets are now installed and being used by P.I.'s Department of Education in an effort to improve the quality of education by offering a richer curriculum to more students.

SMALL FIRMS, MORE CONTRACTS—Smaller manufacturers are now being awarded more contracts than they were a year ago. The Defense Dept. says smaller companies received $5,305,000,000 in prime contracts in the year ended June 30, which is $463 million more than in the previous year. Enforced set-asides of defense contracts to smaller firms was of measurable help. Such contract awards rose from $643 million (1959) to $1,642 million (1965).

TRITIUM RULES RELAXED—Use of tritium on dials and pointers is to be exempted from government licensing. Atomic Energy Commission is proposing the exemption. Basis of the proposal is a petition from Canrad Precision Industries, Inc., New York, N.Y. Interested parties should submit written comments to the Secretary, Atomic Energy Commission, Washington, D.C. 20545, by Nov. 17.

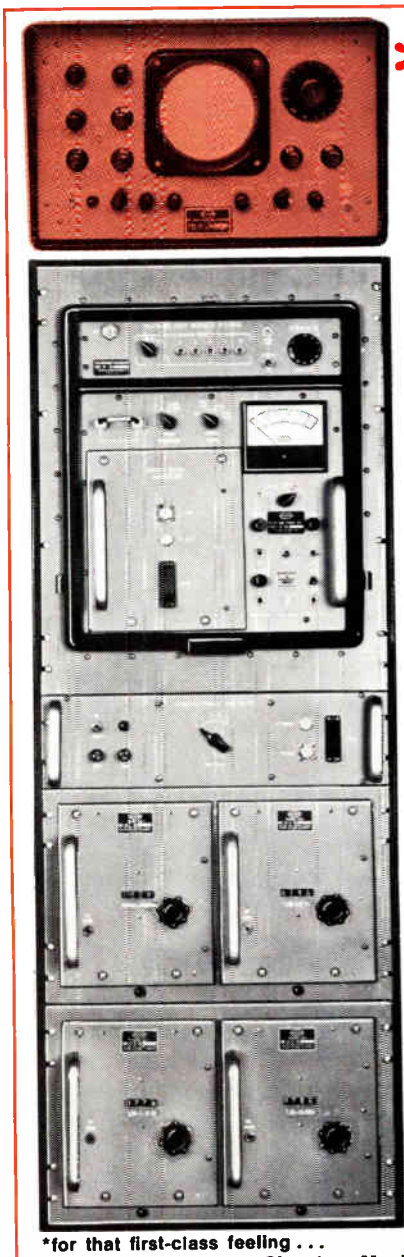
BAN ON CATV PROGRAMMING—National Association of Broadcasters urged FCC to prohibit community antenna television (CATV) systems from originating any kind of programming and from extending their signals by artificial means. NAB asserts that CATV should be limited to receipt and retransmission of broadcast signals without any "insertions or deletions" of any kind. Such a policy, it said, would be consistent with CATV claims that the system is merely a "master antenna service."

LAG BLURS WORLD TV—U. S. officials are uneasy over lack of action by the 13-member international consortium which controls all activity involving the proposed global communications system. So far, the failure of the group to do much more than talk hasn't slowed progress—but U. S. officials are beginning to wonder if agreements will come when they are needed. First approval will be needed within a year for the launching of the first Pacific Early Bird satellite scheduled to give Hawaii its first live TV coverage.

WHERE THE BUSINESS IS—California has moved into a still-larger share of military prime contracts. A Defense Dept. study shows that 22.1% of prime contracts are placed in California—up from 21.0% a year ago. New York is second, with 9.6% of primes, down somewhat from the 10.00% share of a year earlier. In terms of dollars, this means that $5.1 billion is spent in California; $2.2 billion in New York, $1.4 billion in Texas, and $1.1 billion each in Connecticut and in Massachusetts. Georgia, a fast comer, pushed out Washington State for its first appearance among the top 10 states.

While you weren't looking...

We just converted your **Polarad CFI RI/FI Meters and TR Receivers** into dozens of fully-automated, 1.0-21.0 GC Spectrum-Signature/Surveillance Systems...or into push-button all-band spot-frequency (or sector-scan) production test sets ...or into spectral-energy-distribution recorders...or into whatever else we can mutually cook up; and it's all done with a trio of inexpensive Adaptor/Control/Interface Modules. Think of it—overnight we've converted what used to be merely the world's finest **Solid-State Receivers & RI/FI Meters into Microwave & RFI Systems.** How? It's simple—like All really good ideas. Here's how...



Model DM-1

Mount your CFI or TR basic unit in this Adaptor Panel (CFI-AM or TR-AM)

Then add this Switching Module (CFI-SM or TR-SM)

finally, add one, two, or three of these Tuning Unit Adaptor Modules (CFI-TUM or TR-TUM)... **plug in your tuning units, and you're on the air!**

*for that first-class feeling... add a DM-1 Spectrum Signature Monitor!

WHAT? You don't own a CFI or a TR? *Good Grief*, don't waste another moment! Call (212) EX 2-4500 for immediate relief—from a demonstration to delivery, from *(naturally!)* the busiest production line in the industry.

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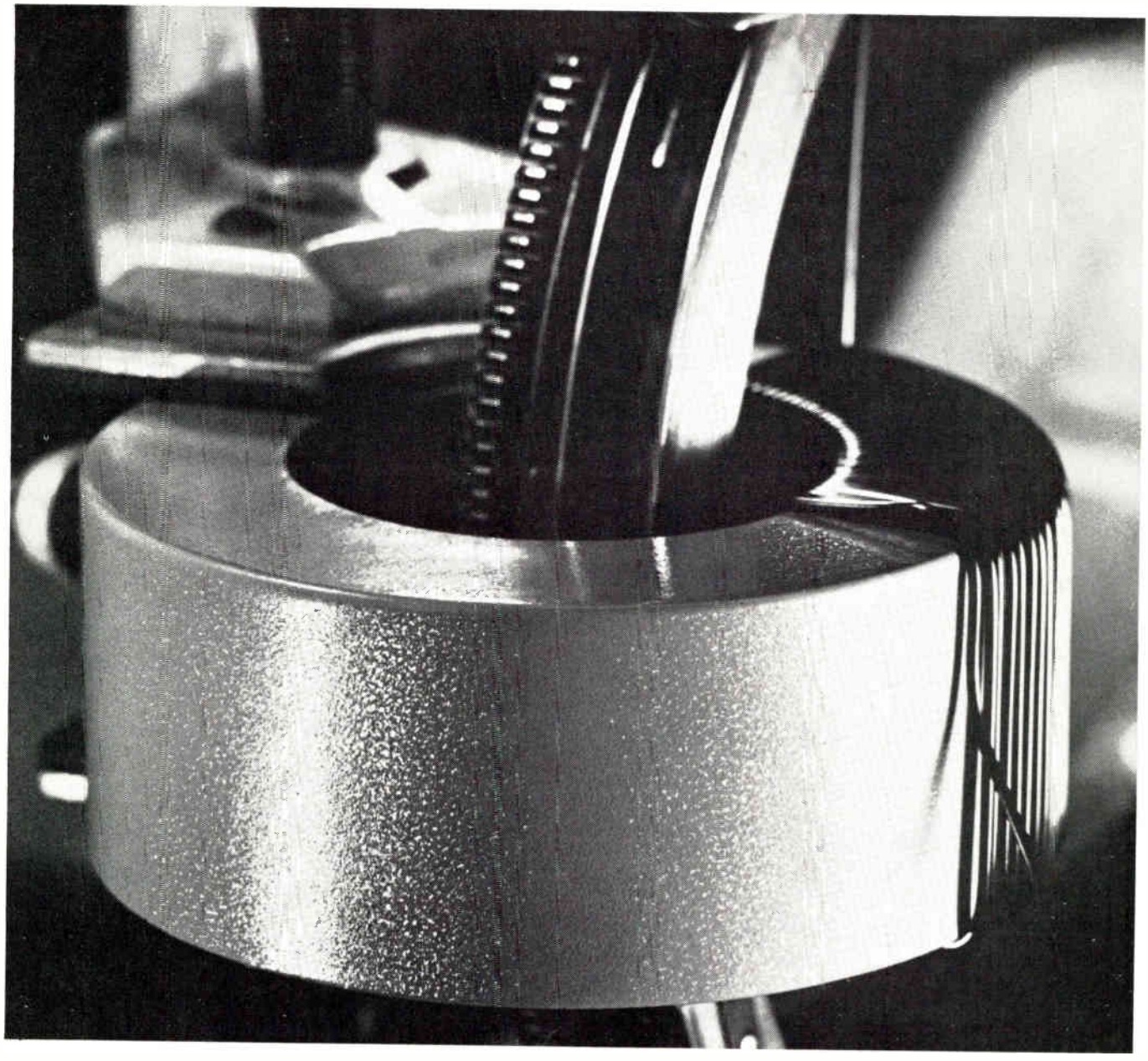

ROUGH WITH A REASON

Unique GVB finish cuts core winding costs

GVB encased cores mean fewer production delays because GVB does much more than seal the core box against potting material. Its matte finish provides a resilient, non-slip base for winding, and the tough epoxy skin prevents the wire from cutting through to the core box. Guaranteed not to fail, even when wound with heavy #6 wire, GVB surface also eliminates abraded wire problems. No prior taping of the core is required, so another winding operation is wiped out.

Magnetics doubles the normal guarantee on core box finishes by expressing it in this unique way: The guaranteed voltage breakdown (GVB) finish seals the box and is capable of withstanding at least 1,000 volts at 60 cycles *between a bare winding and the aluminum case.* Quality control monitors the application and curing of GVB to assure dimensional and voltage breakdown fidelity. Performance characteristics are maintained between —65 and 200 degrees C.

To reduce production costs on your winding operations, try Magnetics' tape wound cores with GVB. Eight material types, in a wide range of sizes from 0.375″ to 4.0″ inside diameter, are stocked for immediate delivery. More information? Write *Magnetics Inc., Dept. EI-27, Butler, Pa.*

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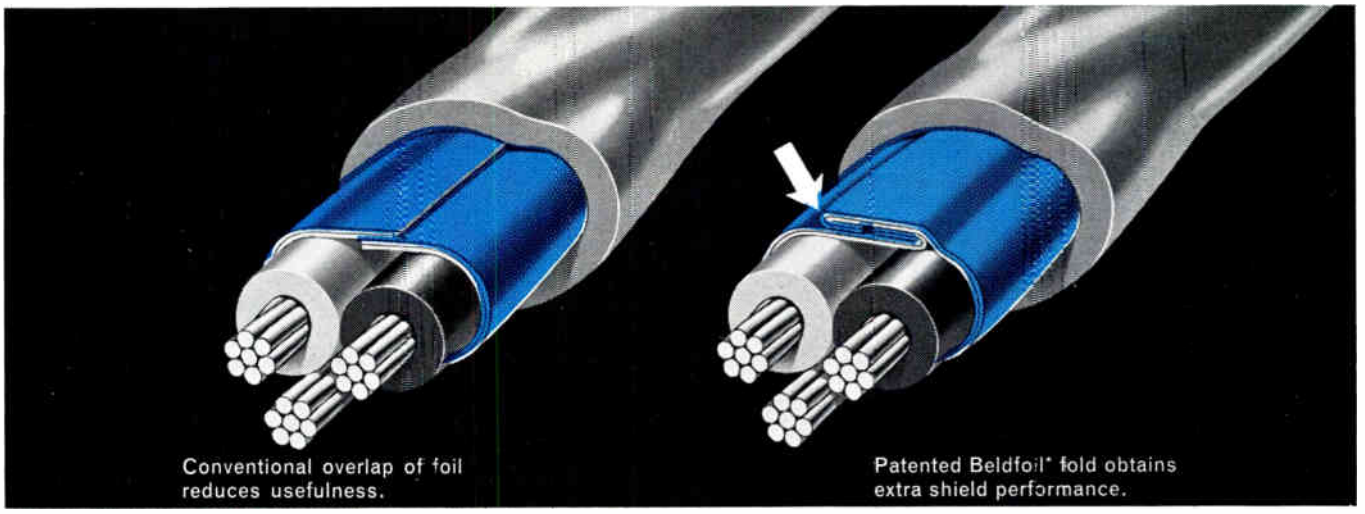


It's in the fold!

By Frank Timmons, Chief Engineer, Electronics Division, Belden Manufacturing Company

There are a number of cables on the market today which utilize Mylar† Aluminum Shielding to eliminate noise, hum and cross-talk. These cables have been developed to meet the needs of equipment engineers who have found that standard braided and spiral shields are inadequate in reducing pick-up and transmitted noise.

There is a big difference in the various cables available . . . and the big difference is in the manner by which the Mylar Aluminum Shielding is applied to the cable. The cable which does the most effective job of eliminating noise, hum and cross-talk uses a unique, patented wrapping process that "folds back" one or both edges of the Mylar Aluminum Shielding. It provides "total shielding" and was introduced in 1957 by the Belden Manufacturing Company under the trade name, "Beldfoil."

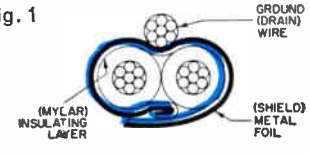
It is evident that many interested persons do not completely understand the manner in which Mylar Aluminum Shielding is used in the manufacture of Beldfoil cable. Therefore, Frank Timmons, Chief Engineer of the Electronics Division at Belden's Richmond, Indiana plant answers some of the more frequently asked questions, and points up some of the more important benefits offered by Beldfoil.

Q. *You talk about a patented process wherein the Mylar Aluminum Shielding is folded back . . . on one or both edges. Just how is this done?*

A. First, let us define Mylar Aluminum Shielding . . . it is a lamination of Mylar insulation film from 0.0005" to 0.001" thick and aluminum foil of .00035" to .001" thickness, applied spirally around the shielded conductor or conductors to give 100% shield coverage.

In some instances the wires are wrapped with the metal foil on the outside as shown in the cross-sectional drawing Fig. 1.

Fig. 1



Note the heavy black line showing the foil edge folded back so that a full layer of Mylar "bonus insulation" is provided between the conductors and the foil shield, increasing the reliability of the cable.

Cables to be used at radio frequencies, or sensitive to radio frequency interference, may need the fold shown in Fig. 2. This fold creates a metal-to-metal connection which eliminates any possible inductive effect, and makes the shield the electrical equivalent of a solid aluminum tube.

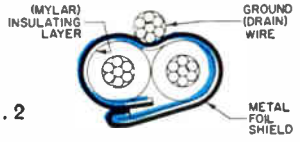


Fig. 2

Shields shown in Fig. 1 and 2 are used for cables with one pair of conductors.

For cables carrying multiple pairs of conductors, a different technique is used. On each pair, the aluminum foil is placed on the *inside*, with the Mylar layer on the *outside* (See Fig. 3). This is important because if the aluminum surface were on the outside we would have random metallic contact between the shields on the different pairs of wires. This would permit the voltages existing on one shield to generate currents in the adjacent shield, creating a transfer of energy or cross-talk between circuits.

Note that the outer edge of the shield is folded to tuck the edge of foil out of the way where it cannot short to the adjacent shield.

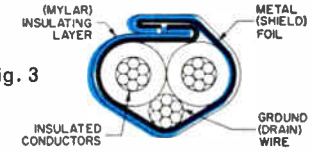


Fig. 3

The inner fold again provides the electrical equivalent of a solid aluminum tube. Belden calls this combination of two folds in one shield a "Z" fold because an end view of the unwrapped tape looks like the letter "Z".

Q. *How much signal isolation results between pairs, when aluminum foil is on the inside, and Mylar layer outside?*

A. This type of construction obtains isolation of more than 100 db between pairs, per thousand feet of cable, at 10 Kc. The short-circuited tape shield makes the cable quite suitable for use at frequencies ranging from audio to RF.

Q. *Do any contact-resistance problems arise between the drain wire and the aluminum foil shield on Beldfoil?*

A. No. Belden design and field service experience on millions of cable-feet in wide service environment have proved this point of reliability.

Q. *Can Beldfoil shields be used over small single conductors as well as over large complex cables?*

A. Yes. Belden applies it on groups from .050" to 1.25" OD.

Q. *Design engineers are constantly faced with miniaturization problems. What about the size of Beldfoil shielded cables?*

A. Beldfoil definitely reduces the diameter of multi-conductor cables . . . in some instances by as much as 66⅔%. The small diameter provides design engineers with extra conduit space, extra raceway, extra console and rack space.

Q. *How can I determine which type of shield I should choose for a given cable?*

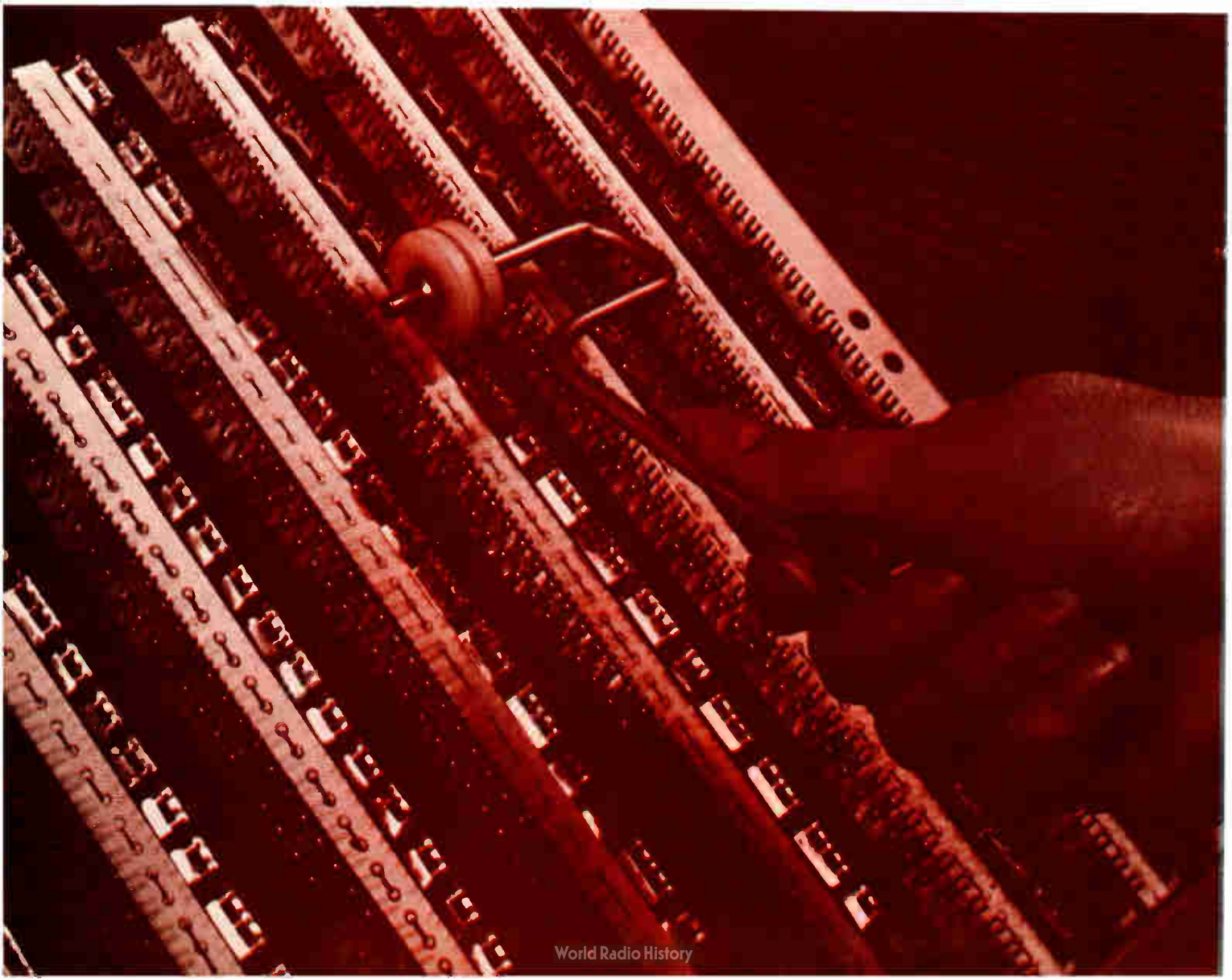
A. Belden application engineers are available for engineering assistance. Or, you can obtain preliminary printed information by writing to Belden Manufacturing Company, Advertising Department, P.O. Box 5070-A, Chicago, Illinois 60680.

▲ **BIG BULGE FOR NAVY SONAR**

Acoustical "window" for a bow dome that will be mounted below the water line on bow of Navy destroyer Willis A. Lee to house sensitive sonar equipment. Window, made by B. F. Goodrich, has acoustical properties similar to sea water.

ELECTRONIC SNAPSHOTS

The Changing STATE-OF-THE-ART In the electronic industries

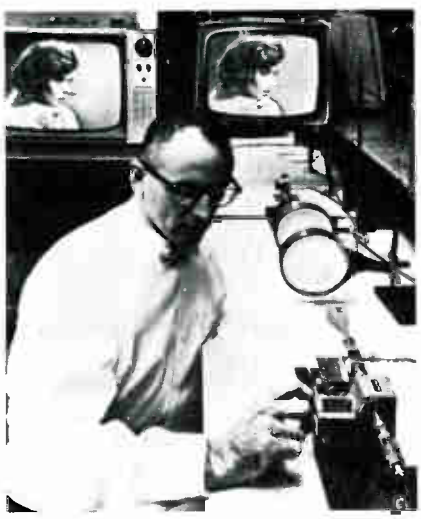


▲ **BEAM DEFLECTOR**

Photo shows path of an electron beam being aimed by Consolidated Vacuum Corporation's new beam deflection system. Path of beam is controlled by deflection coils and separate controls permit easy aim of beam spot.

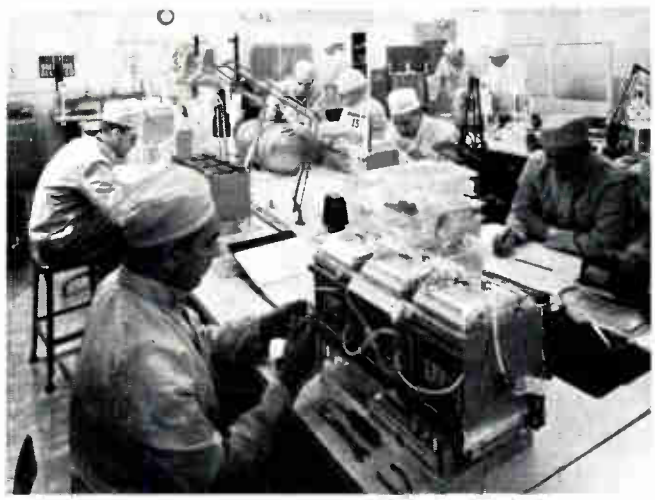
▲ **COMPACT COMPUTER MEMORY FOR ROCKETS**

Baseball-size experimental computer memory—"one of most compact ever developed"—designed by IBM to store data for rocket and missile guidance. Device, produced for aerospace use, has only one moving part and can hold 600,000 separate bits of data.



▲ **TV BANDS ON MM WAVE**

Entire radio frequency channel of a TV station superimposed on millimeter-wave signal by semiconductor device called injection modulator developed by GT&E Labs. Dr. Richard Harrison adjusts small mm-wave system.

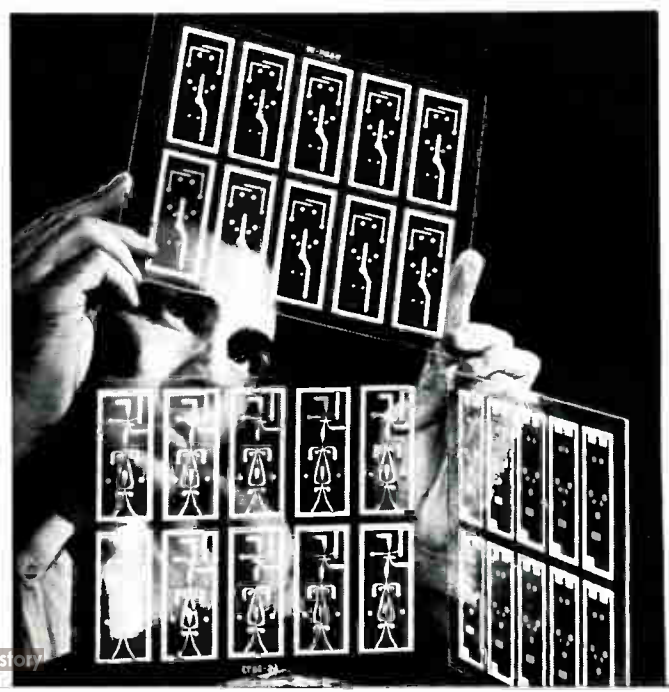


◀ **FUEL CELL BATTERIES**

Final assembly of GE fuel cell batteries includes careful check-out of individual fuel cell modules shown here before being enclosed in their cannisters.

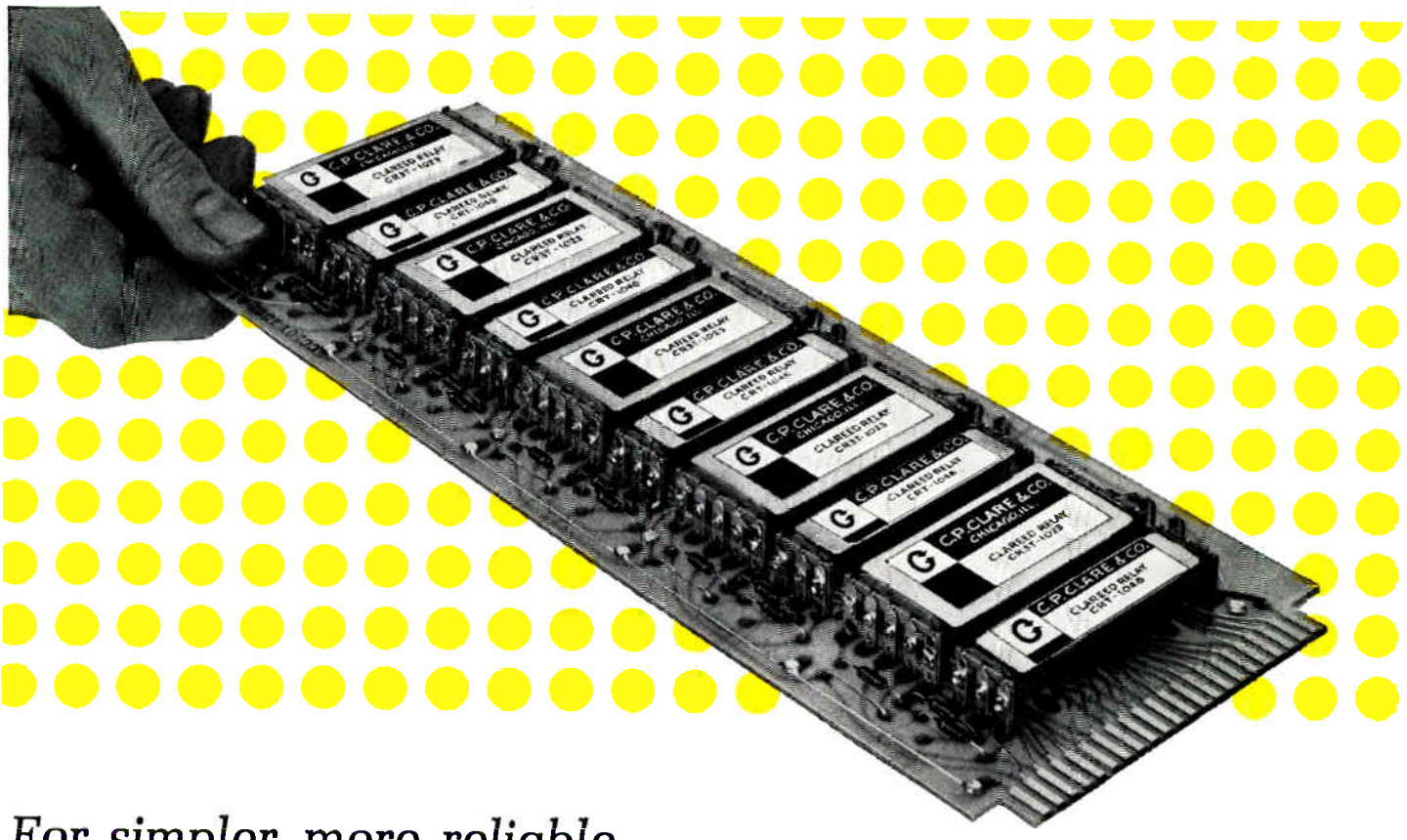
◀ **CRIMPER FOR LOGIC BOARDS**

New production technique used at Bunker Ramo Corp. Following diagrams on special aluminum "fingers" between terminal pins on logic board, assembler crimps pre-cut bus into place with special roller.



FLUID BINARY COUNTERS ▶

Four glass plates (photosensitized and etched) when stacked and sealed, make up 10 identical four-layered binary counters. Fluid amplifiers are used to recognize instruction signals in counting or switching systems.



For simpler, more reliable digital control circuits... **CLAREED®**

CONTROL MODULES

pre-packaged counting, selection and logic devices

■ Counting, selection and logic switching problems are readily solved with Clareed Control Modules. Pre-packaged (or custom-designed if your problem is a new one), these modules combine speed, simplicity, and reliability ...at lower cost than comparable solid state circuitry, and without unnecessary design delay.

Counting. Pre-packaged printed circuit board modules in wide variety, for assembly to perform as decimal ring counters, radix (n) counters, bi-directional counters, shift registers, etc. Typical applications include scanning systems, digital clocks, data tracking and data transmission systems.

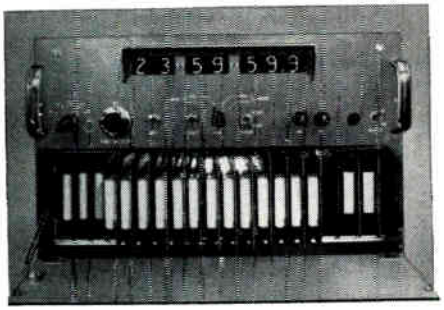
Selection. Pre-packaged printed circuit board modules in wide variety, for interconnection to perform as selection matrices. Typical applications include more versatile equivalents of traditional cross-bars, selection matrices capable of individual memory, and check-out matrices which can be operated with all contacts either normally open or normally closed. (Combining these Selection Modules with Clareed Counting Modules, the designer can readily provide a wide variety of scanners.)

Logic. Pre-packaged units for printed circuit board assembly in custom-designed logic modules, which efficiently perform such logic functions as AND, inclusive OR, exclusive OR, NAND, NOR, exclusive NOR, etc. These standard Clareed units, in Clare-customized systems, provide master control circuitry which greatly reduces complexity and cost of digital control systems.

Take a look at these Clareed advantages! You'll see how this versatile switching concept can fit into your plans for industrial or commercial systems.

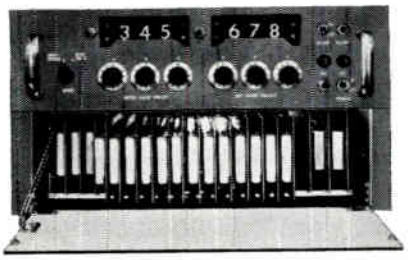
- *multiple input and output capabilities, making possible logic at both input and output*
- *switching capabilities from low level up to 15 va, ac or dc, automatically available at all points without additional output circuitry*
- *complete isolation between input and output. The output is the contact closure*
- *immunity to transient and external noise*
- *data handling speeds up to 120 bits per second, 250 bits as special*
- *modular printed circuit board construction compatible with modern electronic assembly techniques...meets the requirements of almost any application*

TYPICAL CLAREED CONTROL SYSTEM APPLICATIONS



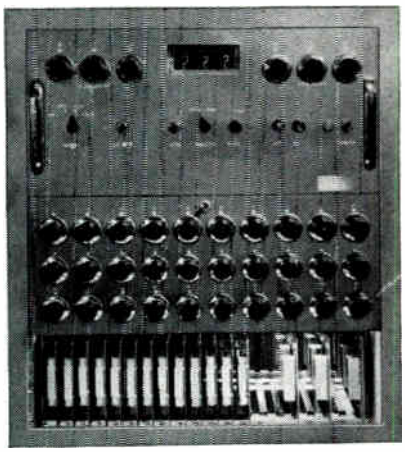
Digital Clocks using Clareed Control Modules as ring and binary counters, illustrate a variety of solutions for basic counting circuits in application for timed events, testing and systems control. Counting is performed by flux operated flip-flop elements; switching in the high-rate counter is done by Clare mercury-wetted contacts. This design provides:

- Greenwich time output
- elapsed time output
- local and/or remote visual readout
- local and/or remote control
- 7 digit capability



Industrial Preset Counters demonstrate production counting and control applications which provide a wide range of switching functions. Clareed flip-flop Modules are the basic switching elements used to provide this more versatile control. This design provides:

- low-cost anti-coincidence circuit for multi-channel operation
- preset 3 digit or 6 digit capability
- multi-channel input
- batch mode operation
- preset unit and batch operation
- special packages available to meet NEMA general purpose, explosion-proof, gas-tight, and water-tight enclosure requirements



Scanners exemplify flexible sub-systems for instrumentation sampling, data logging and control systems requiring multiplexing. In the example shown, the driver is a three-decade counter composed of Clareed flip-flops; the control section uses flux and contact logic to control the driver and provide strobe drive to the matrix. A broad range of scanning options is possible:

- scan rate up to 100 crosspoints per second
- any number of crosspoints
- any number of poles per crosspoint
- special crosspoints for low level scanning
- contact forms A, B, C, or D at any crosspoints
- sequential scan with stop and recycle modes
- random scan of any 10 points in any sequence

Clareed Control Modules can be applied to the switching requirements of most systems. Proven Clareed solutions span many completely different application areas, including:

- machine tool numerical control
- engine test cell scanning systems
- process counting and recording
- telephone peripheral equipment
- psychological testing equipment
- missile checkout systems
- supervisory control and alarm annunciator systems

What's more important is how can Clareed Control help with your switching problems? Take another look at the Clareed advantages. Then, ask your Clare engineer how these plus features apply to your system. Write for Manual 400, Clareed Control Modules, or ask for specific data on Clare Industrial Preset Counters, Digital Clocks and Scanners. C. P. CLARE & CO., Group 11D4, 3101 Pratt Boulevard, Chicago, Illinois 60645.

CLARE®

relays and related control components

HEAVY INCREASE REPORTED IN COMPONENTS INDUSTRY

Value-added-by-manufacture in the 1963 electronic components industry amounted to $1.4 billion, an increase of almost 93% over the value-added for 1958, according to a preliminary report of the 1963 Census of Manufacturers just issued by the U. S. Dept. of Commerce, Bureau of the Census.

"Value-added . . ." approximates the value of the products shipped less the cost of the materials used to manufacture the products.

Manufacturers shipments of electronic components and accessories (not elsewhere classified) were valued at $2.46 billion in 1963, an increase of 98% over 1958, last previous year of the Census.

Most significant increase was in components and accessories other than capacitors, resistors, coils, transformers, reactors, and chokes for electronic applications, not elsewhere classified. Shipments in that category increased from $608 million in 1958 to $1.42 billion in 1963.

HOLLAND EXPORTS SCORE 19% GAIN FOR 1964

Holland's exports of electrical and electronic products in 1964 advanced by nearly 19% over 1963, it was revealed by the Institute of Dutch Electrical Engineering Works at the Hague.

In 1964, the monetary total of Dutch electrical exports throughout the world reached $605,300,000 as compared to $509,500,000 for the preceding year.

Radio and TV equipment and accessories outpaced all other categories of electrical products in exports. The total value of such shipments abroad in 1964 stood at $233,556,000 as against $185,361,000 in 1963.

Electron tubes, photocells, transistors and similar products took second place in 1964 with an export total of $98,150,000. The 1963 export volume in this area came to $78,945,000.

TAPE RECORDERS IN JAPAN MAY HIT 7.5 MILLION OUTPUT

Japan's tape recorder industry has increased production rapidly, and the demand for such items, especially in Japan, during 1965 is expected to reach 7.5 million units. Of this, about two million recorders will in all probability go to the home market, as reported in the magazine "Japan Electric Industry."

Production of tapes in 1964 held value at $8,106,300, and exports amounted to about $830,600.

ACTIVE COMPONENTS FORECAST

(In Millions of Dollars)

SEMICONDUCTORS	1965	1969
Transistors	$333	$221
Diodes	123	84
Rectifiers	95	96
Microwave Diodes	14	19
Zener Diodes	42	45
Tunnel Diodes	2	2
SCRs	32	53
Selenium Stack Assemblies	18	8
Integrated Circuits	60	170
Other	16	23
Total	$735	$721
VACUUM TUBES		
Receiving Tubes	255	140
B & W Tubes (excl. Rebuilts)	150	74
Color Tubes	260	489
Power & Trans.	250	165
Total	915	868
TOTAL ACTIVE	$1,650	$1,580

(Source: Sylvania Electronic Components Group)

BILLION-DOLLAR MART SEEN FOR U. S. IN SCANDINAVIA

The stable and prosperous economics of Scandinavia offer attractive opportunities for U. S. exporters, reports an officer of a New York bank.

John Fox, international department, Meadow Brook National Bank, noted that Scandinavian countries (Denmark, Norway, Sweden, Finland) have one of the world's highest standards of living and that their rates of economic growth show a relatively steady upward trend. The gross national product of all four countries increased 5% or more (at constant prices) last year.

"The industrial progress of Scandinavia," Fox observed, "has created substantial markets for sophisticated equipment and products of the type produced in the U. S."

He listed the following among U. S. products with market opportunities in Scandinavia; scientific and industrial instruments; electronic apparatus, instruments and systems; automation control equipment; traffic and safety equipment; industrial chemicals; industrial training aids; packaging machinery; and home appliances.

BETTER FORECASTS NEEDED, SAYS BATTELLE ECONOMIST

Executives, though reluctant to admit it, need forecasts of technology. However, such forecasts must be improved to be of real value, reports William L. Swager, Battelle Memorial Institute.

In a paper delivered during a symposium of the Engineering Economy Division of the American Society for Engineering Education, he said, "Today, few executives in American industry acknowledge clearly and specifically their need for forecasts of technology."

Mr. Swager, associate manager of the Department of Economics and Information Research at Battelle's Columbus (Ohio) Laboratories, said that, fewer are willing to admit that such forecasts may be of practical value. Still fewer recognize that every investment decision made by industry is made with an assumed or estimated, conscious or unconscious, good or bad technological forecast.

Misleading forecasts have stemmed, he commented, from estimating advances in one technology and ignoring advances in another. Forecasters have ignored such pertinent questions as: "What technologies should be forecast?," "What specific areas of these technologies deserve closest scrutiny?," "What are the competing technologies and what changes will occur in them?," and "Do all technologies need to be forecast in the same detail?"

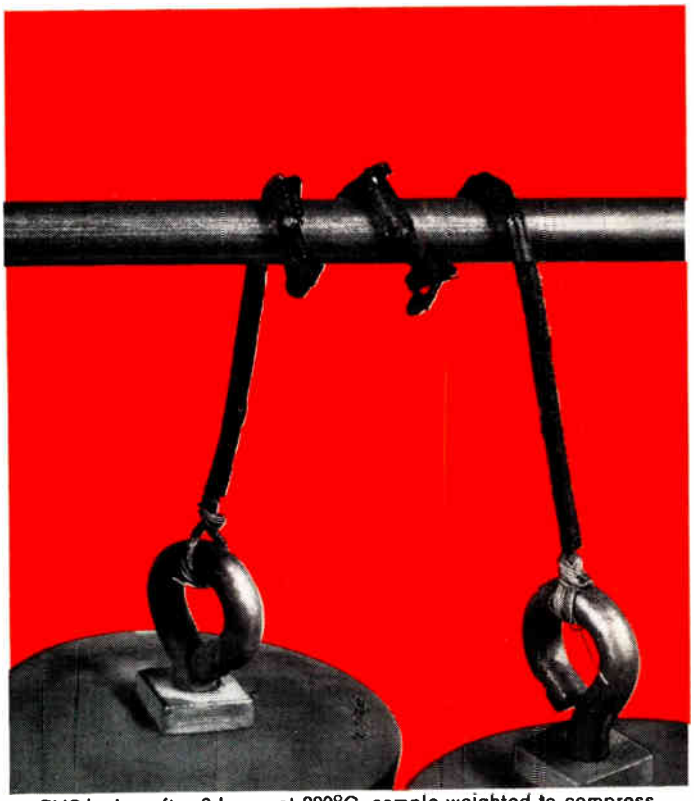
"My thesis," Mr. Swager explained, "is that technological forecasting will be practical and will have a major impact on business when we place somewhat more emphasis on the question: 'What should be forecast?' and somewhat less on 'What methods should be used for forecasting?'."

He pointed out that by answering the question "What should be forecast?," forecasters can limit the options from which valid decisions are possible. The answers guide forecasters in the selection of methods to be used for forecasting and provide a foundation for communicating the decisions and the logic to both nontechnical executives and to research scientists and engineers.

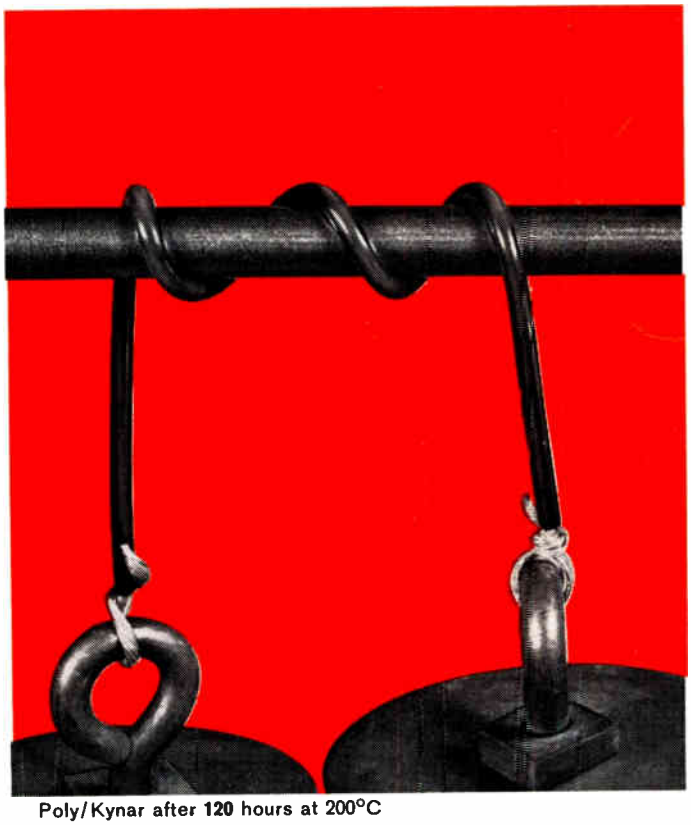
MARKET LOOMS IN MEXICO FOR SOPHISTICATED GEAR

A market for the more sophisticated of electronic equipment has been reported growing in Mexico. According to a report from the U. S. Commercial Attache in Mexico City, this new market should provide opportunities to U. S. exporters.

As the report states, proximity of U. S. suppliers is a favorable factor. Prices for sophisticated equipment apparently are not a great determinant, as compared to prices for simpler electronic items, especially consumer products. The report warns that vigorous competition can be expected from other nations interested in this new market.



PVC/nylon after 9 hours at 200°C, sample weighted to compress insulation and tense conductor per MIL-W-81044.



Poly/Kynar after **120** hours at 200°C

Vinyl goes to pieces, Poly/Kynar* looks like new

Heat, abrasion have little effect on tough new MIL-W-81044 aircraft wire

High-temperature capability—Poly/Kynar wire is rated at 135°C for continuous operation. Each lot is acceptance-tested for six hours at 225°C, followed by stringent bending and dielectric tests. The self-extinguishing, nonflowing insulation and jacket are radiation cross-linked for maximal high-temperature form stability, which imparts Poly/Kynar's unique resistance to soldering iron damage.

Poly/Kynar is absolutely nonwicking, since it contains no glass or nylon braid. And the tough Kynar jacket is highly resistant to abrasion, cut-through, solvents and fuels—including Skydrol and jet fuels.

Its light weight and smaller diameter make it ideal for airborne and space applications.

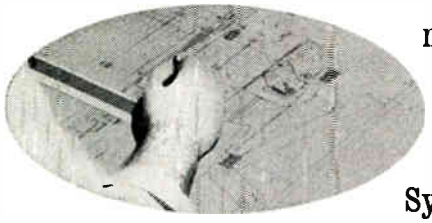
Four types are available: Types 1 and 2 for 600-volt, heavy-duty aircraft and hookup work; Types 3 and 4 for lightweight hookup, instrumentation, black boxes. Want details or engineering samples? Write Dept. EI, ITT Wire and Cable Division, International Telephone and Telegraph Corporation, Clinton, Massachusetts. In Canada, write or call ITT Royal Electric Company (Quebec) Limited, Pointe Claire.

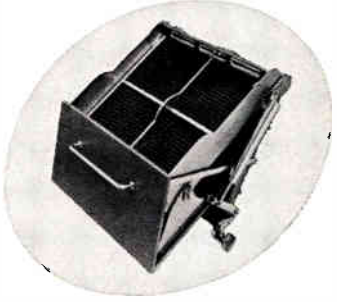
*Kynar is a Pennsalt Chemical Corp. trade name.

wire and cable division ITT

MAC Panel Plugboard Programming Systems are total engineered

MAC Panel's total engineering guarantees that the system specifications meet all of your requirements for circuits, space limitations, environmental conditions, signal levels, frequency range, and reliability. From the precise handwork necessary for contact spring placement to the silk-screening of general purpose or multi-color special legends, you are assured of receiving only top quality, precision products. MAC Panel offers eleven standard sizes of Plugboard Programming Systems and a wide variety of standard Plugwires. We can also provide custom designed systems and wires for special applications. Find out how MAC Panel can give you a reliable, low-cost method of flexible program control in your equipment. See your MAC Panel representative or write today.





MAC

O.E.M. Division

MAC PANEL COMPANY, High Point, North Carolina

Representatives Throughout the World

Once you take the measure of Helipot trimmers, you'll use them as a rule

Here are some of the rules for measuring

What do you look for in trimming potentiometers? Probably the same things that Helipot has established in 20 years of leadership in precision pots. By almost any standard of measure, you get more in the broad line of Helitrim® trimmers. If force of habit has caused you to overlook the important facts below, take a minute to brush up. You'll be doing yourself a favor.

Measure for Mounting Styles. Sizes and shapes to meet any application. Leads, pins, solder lugs and various panel mounts. All pin configurations, too, so they'll fit anywhere any other trimmer will.

Measure for Resistance Range. From 10 ohms to 2 megohms in every model, widest range in the industry. Rugged cermet resistance element, too, that has it all over wirewound or carbon elements. The cermet element is immersible, shock resistant, free from sudden failure and offers essentially infinite resolution.

Measure for Price. Helitrim trimmers stretch to fit any requirement and price, from military models to commercial trimmers priced *below a dollar* in quantity. They're *all* priced competitively or *below* trimmers you may currently be using.

While you're measuring, don't forget availability. Helitrim trimmers are available from stock in large quantities, and there are 32 Helipot sales offices to serve you. Ask one for the new Helipot trimmer catalog.

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Circle 26 on Inquiry Card

LETTERS

to the Editor

Reprint Permission?

Editor, ELECTRONIC INDUSTRIES:

I would like to request permission to reprint 35 copies of the article entitled "A Survey of Commercial Semiconductor Photosensitive Devices" by R. D. Kaus, which appeared as IBM Technical Report 07.062. I understand you have purchased copyrights to this article from Mr. Kaus, who is an IBM employee at our Rochester, Minnesota facility. With your kind permission we would use this article as a hand-out in an upcoming Engineering Education class at IBM Kingston.

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We Like Him . . .

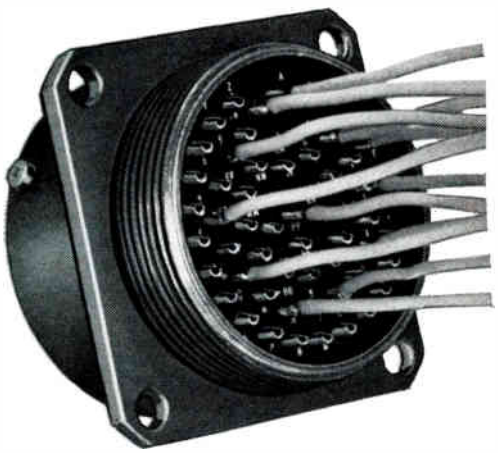
Editor, ELECTRONIC INDUSTRIES:

I have just received my copy of the September issue of your magazine and I find that the Wire & Cable Reference Chart which you included is an outstanding compilation, in fact the best that I have seen of this nature. I consider it so good that I would like to be greedy enough to request up to 50 reprints from you so that I can distribute them to all the electrical engineers and certain key mechanical engineers in our Division of McDonnell Aircraft Corporation.

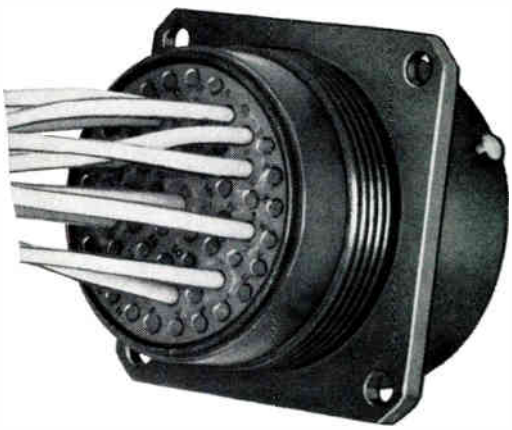
Let me express my thanks now for the valuable magazine which you publish. Within it we are greatly assisted in keeping up with the state of the art, and sometimes just a little ahead of that. As a matter of fact, in my opinion the greatest means of an engineer continuing his education lies in the magazines such as you publish.

J. Spruce White, Supv.
Materials and Process Corp.
Dept. 957, Bldg. 101B
McDonnell
Electronic Equipment Div.
Box 516
St. Louis, Mo. 63166

MS-3110
MS-3112
MS-3114
MS-3116
MS-3118
MS-3120
MS-3122
MS-3124



Solder Terminals



Crimp Terminals

26482 CONNECTORS

Methode "Midgets" are available in all standard shell sizes and insert configurations with solder or crimp type terminals.

Removable and replaceable one piece contact retention clips have been proved reliable in over 10,000 insertions and withdrawals.

Methode's unique contacts provide positive contact sooner upon entry of pin; lower insertion force and higher retention without millivolt drop variation.

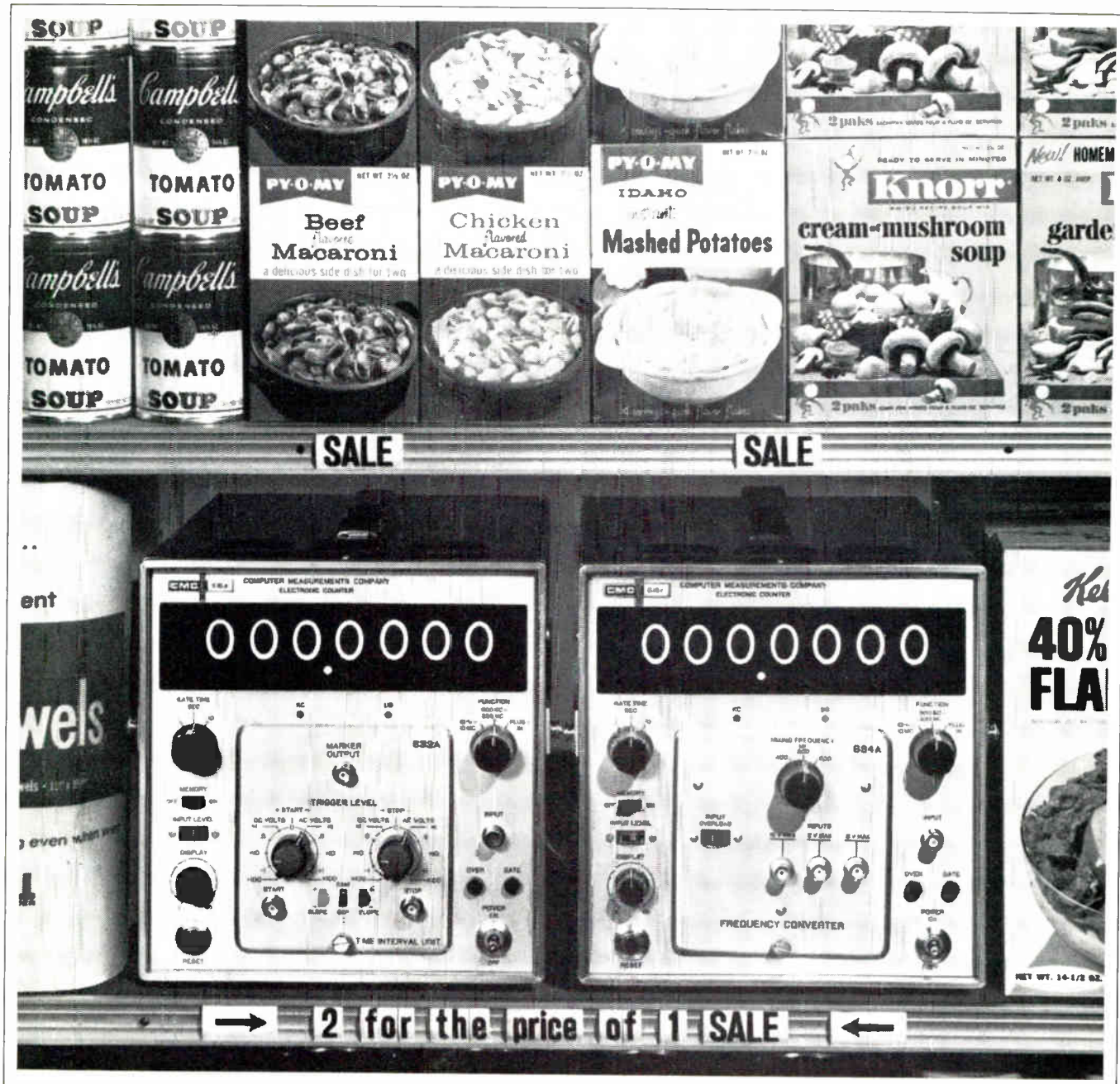
Methode can provide complete assembled connectors with solder pot terminals or unassembled connectors or will supply contacts only.

Specials? Try us.

Write for catalog 482-A and crimp contact folder right away.

Methode Electronics, Inc.

7447 W. Wilson Ave. • Chicago, Illinois 60656 UNderhill 7-9600



No, it's not the start of a price war. We're simply demonstrating that our new solid-state Model 616A frequency meter costs about half the price of any other comparably performing instrument now available. But, since the 616A is so versatile, who needs two of them anyway? This clever little instrument, with all silicon semiconductor insides, gives you direct frequency measurement through the entire 225 Mc telemetry band, and as high as 12 gigacycles with one plug-in. That's because we cunningly built in the prescaler.

But Hewlett-Packard and Beckman didn't. Theirs is a plug-in to a counter, and the total cost is twice that of our 616A. Then they sell you a second plug-in to measure above 400 Mc. Speaking of plug-ins... the 616A comes well equipped! Slip in a frequency converter or other special CMC frequency extender plug-ins, and your frequency measurements can soar to 1,000 Mc, 3,000 Mc, and even a phenomenal 12 gigacycles! Or, with our time interval plug-ins, measure time from .1 μsec. to 1 sec., or 1 μsec. to 10 sec.

Not only is the Model 616A half the price, but notice, it's half-rack size too! One reason is because, like others in the 600-Series, it features an advanced "mother board" technique. Lost are excess size, weight, and components; gained are new shape, reliability, and ease-of-maintenance. Button it up with its front cover and this rugged 28-pound wizard goes right out in the field.

All this for just $2,185. Interested? Then send now for the complete specs. And, if you're new at comparing our specs to high-powered H-P and big, bad B, you can earn a glorious Crusading Engineers' medal which reveals to everyone that you had the guts to look at somebody else for a change. It's also a great conversation opener for sweet young things you want to dazzle at your next T. G. I. F. party!

CMC

12976 Bradley · San Fernando, California · Phone (213) 367-2161 · TWX 213-764-5993

COMPUTER MEASUREMENTS COMPANY IS A LEADING DESIGNER AND MANUFACTURER OF ELECTRONIC INSTRUMENTATION TO COUNT, MEASURE, AND CONTROL.

You have no idea of the many uses in which Allen-Bradley permanent magnets are doing "a better job!"

For instance, **HAMILTON BEACH** uses Allen-Bradley MO5C oriented ceramic magnet material in the motor of their new electric knife, which has "taken the country by storm." It made possible a reduction in the size of the motor, enabling an improvement in styling and "balance" of the knife.

CONTROLS COMPANY OF AMERICA specified the toroid size and shape, along with the desired magnetic force for the biasing magnet in their new Model 84 low voltage thermostat. Allen-Bradley was able not only to furnish a ceramic permanent magnet to fit these exact specifications, but also provide greater consistency than obtained with the metallic magnets previously used.

BRIGGS & STRATTON'S new ignition system greatly improved coil, plug, and point life. Allen-Bradley MO5B permanent magnet material met all the requirements for magnetic strength, coercive force, and temperature coefficient.

BADGER sanitary meter for liquid foods employs a magnetic drive consisting of permanent magnets on either side of the chamber wall, which eliminates the need for a packing gland. Allen-Bradley ceramic permanent magnets provide the required long service life.

Allen-Bradley ceramic permanent magnet materials cover such a broad range of specifications, that they should be able to satisfy new and unusual design problems that may be baffling your engineers. Oriented, as well as nonoriented materials, are available. And of these, you'll find the new MO5C permanent magnet material especially interesting.

MO5C is an oriented ceramic permanent magnet material that can open entirely new areas of permanent magnet applications. Outstanding is the fact that it can be produced in shapes previously limited to nonoriented materials. It also has a high energy product—2.6 times that of nonoriented materials. Then, too, there's a high coercive force and high residual induction. With these properties, this MO5C material has given engineers a new design flexibility—and an economic edge—with the permanent magnet motors which they have developed.

Allen-Bradley engineers will gladly work with your designers in the selection and application of the exact magnetic material for your project. For more complete information, please write: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ont. Export Office: 630 Third Ave., New York, N.Y., U.S.A. 10017.

Allen-Bradley ceramic permanent magnets are available in a wide range of sizes and shapes.

A-B QUALITY

ALLEN-BRADLEY

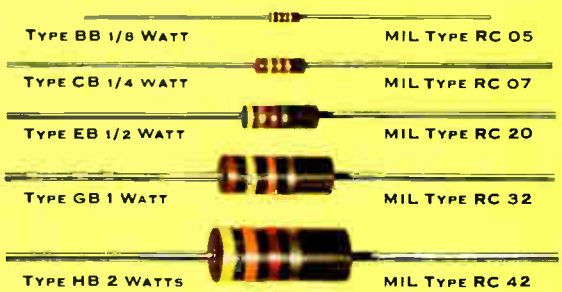
QUALITY MOTOR CONTROL
QUALITY ELECTRONIC COMPONENTS

ALLEN-BRADLEY Type BB ⅛-watt and Type CB ¼-watt hot molded resistors **shown approximately 4 times actual size**

Here are two resistors that are ideally suited for your miniaturized circuits—the Allen-Bradley Type BB ⅛-watt and the Type CB ¼-watt units. While extremely small, both have integrally molded insulated bodies and are full-fledged members of the Allen-Bradley hot molded resistor family.

This is made possible by employing the same exclusive hot molding process as used for the higher ratings of A-B resistors. The use of special automatic machines removes the element of human error, assuring complete uniformity of physical and electrical properties from one resistor to the next—from one billion to the next. And catastrophic failures are absolutely unheard of with Allen-Bradley hot molded resistors.

Be sure you have full specifications on both of these A-B hot molded resistors on hand. Please send for Technical Bulletin 5050 on the Type CB and Technical Bulletin B5005 on the Type BB: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ont. Export Office: 630 Third Ave., New York, N.Y., U.S.A. 10017.



HOT MOLDED FIXED RESISTORS are available in all standard EIA and MIL-R-11 resistance values and tolerances, plus values above and below standard limits. Shown actual size.

A-B QUALITY

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

49-07-5E

NEW COAXIAL SWITCH CONCEPT

THE HIGH-COST, LONG-DELIVERY annoyance normally associated with custom bladed-type switches is gone, thanks to a new method of coaxial switch construction developed by Amphenol RF Div., Danbury, Conn. Now design engineers can receive extremely prompt delivery of an almost infinite variety of bladed-type switches.

Called "Dynaform," the new switch line uses standard modules to produce hundreds of different combinations. Special designs that required extended delivery time are now, in effect, standard items with off-the-shelf delivery. Modular construction of the units permits tighter control over tolerances and necessary adjustments which contribute to the switch's ultimate electrical performance. This same degree of control and resulting performance would require most conventional switches to be manufactured as precision devices at higher cost.

The switches feature completely-enclosed dust-proof construction with rigidly-mounted coil terminals extending through the cover. They are uniform in size and appearance no matter what terminations and operating coils are used. Excluding connector and coil terminal projections, SPDT and transfer types form ¾ x 2⅜ x 1 11/16 in. rectangle. DPDT types are ¾ x 2⅜ x 3½ in.

The switches are designed and tested to exceed the requirements of classes B2b and B3b of Mil-S-3928B. Their operating temp. range is —55° to 100°C. Depending on type of connectors, terminations, and operating freq., switch VSWR ranges from 1.03 to 1.35. Insertion losses range from 0.06db for shorting SPDT types operating up to 0.5GC to 0.50db for resistor terminated SPDT's in the 3.0 to 6.0GC range. RF power rating varies from 500 w. CW (5 kw peak) at 0.5GC to 50 w. CW (2kw peak) from 3.0 to 6.0GC. RF voltage rating for all units is 1000v. peak. Mechanical life rating is a minimum of 1 million cycles.

Standard module produces hundreds of different combinations.

SELF-RENEWING CONTACTS ON NEW MERCURY RELAY

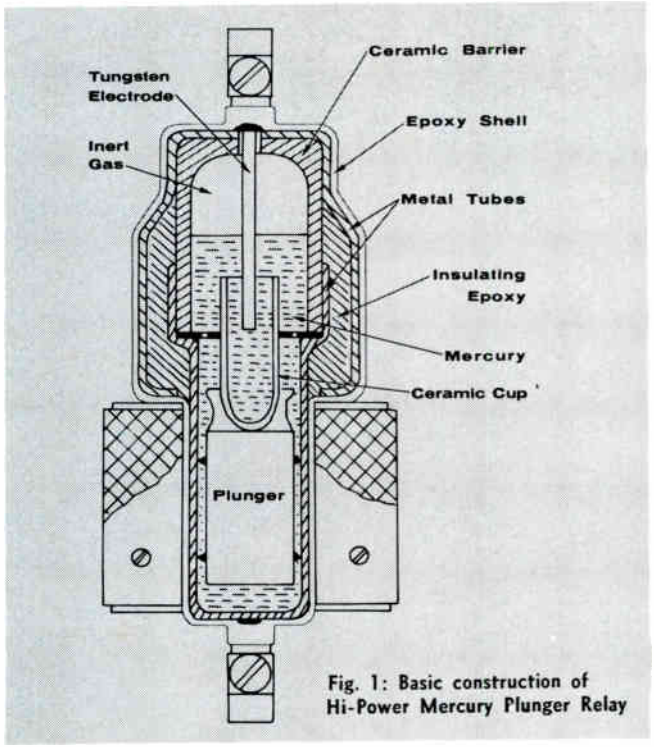


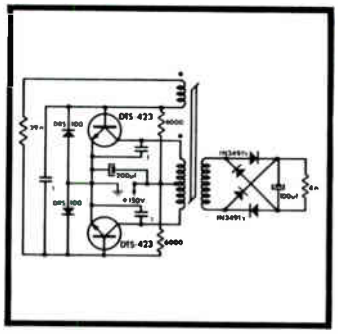
Fig. 1: Basic construction of Hi-Power Mercury Plunger Relay

A NEW LINE OF MERCURY PLUNGER-TYPE RELAYS is designed for maximum reliability through a technique whereby the contacts renew themselves each time a contact is made.

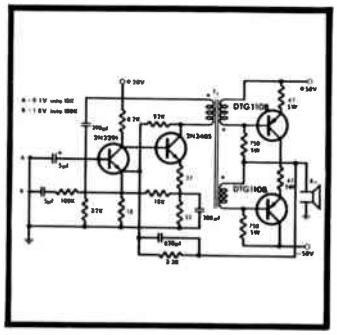
When the coil is energized, the magnetic field pulls the floating plunger into the lower pool of mercury. The displaced mercury flows up into the upper contact chamber and joins with the mercury in the ceramic cup, completing the circuit. When the coil is de-energized the plunger moves up, allowing the mercury level to drop, breaking the contact. The liquid mercury-to-mercury contact continuously renews itself on each make, thus eliminating the major causes of relay failure—contact deterioration or sticking and change in contact resistance.

The relays are housed in non-contaminable hermetically sealed steel shells, with the two electrode chambers electrically isolated by a specially formulated, high dielectric epoxy barrier. Fragile glass-to-metal seals are thus eliminated.

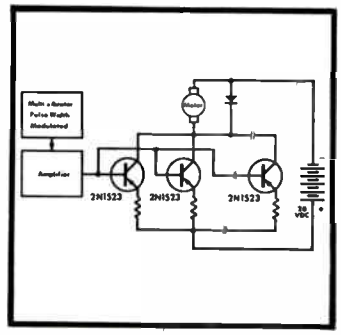
A complete catalog of the Hi-Power line of relays is available. Manufacturer is Ebert Electronics Corp., 130 Jericho Turnpike, Floral Park, L.I., New York.



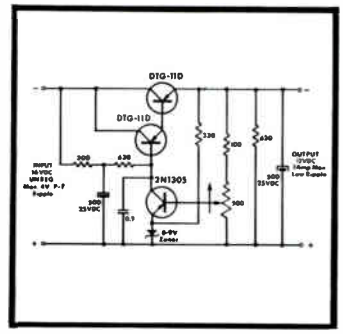
HIGH EFFICIENCY DC-DC CONVERTER



100-WATT AUDIO POWER AMPLIFIER



PULSE-WIDTH MODULATED SPEED CONTROL

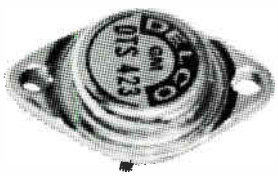


LOW-COST VOLTAGE REGULATOR

Delco's got the solution for every one of them.

HIGH VOLTAGE SILICON TRANSISTORS.

These 400-volt Vceo-rated semiconductors come at less than 3 cents per volt even in sample quantities, have fast switching speeds, good current gain and high power dissipation. You operate them directly from rectified line voltage. They come in TO-3 packages for video deflection output (vertical and horizontal), audio output, inverters and converters, low frequency R. F. amplifiers, fluorescent light inverters, high voltage regulators, and other applications.



HIGH POWER GERMANIUM NU-BASE TRANSISTORS.

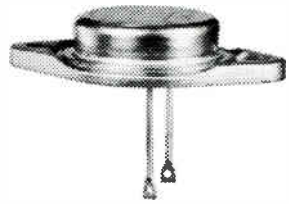
This is the family of Delco transistors to consider if you need high betas, high power dissipation and very good high voltage high current sustaining characteristics. Vcex ratings up to 325V with low thermal resistance. Very rugged and they come in the solid copper TO-3 package. Among applications are auto ignition systems, video horizontal and vertical deflection systems, high efficiency inverters and converters, fluorescent light inverters, voltage and current regulators, and high current control circuits.

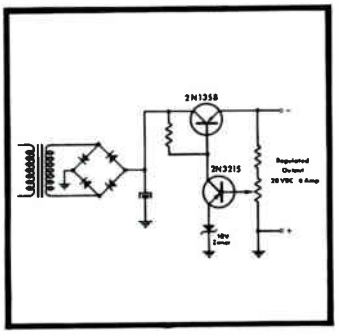
HIGH CURRENT GERMANIUM TRANSISTORS.

Delco makes them available to you in 25-, 35- and 50-ampere ratings, and with a minimum beta of 12 at 50 amperes. Vceo-rated to 60V with low saturation and thermal resistances, high power dissipation and in the TO-36 package. Pulse-width modulated speed control is one application. Others you'll consider them for are: high power DC to DC converters, power conversions from low voltage sources, high current control circuits and general switching circuits.

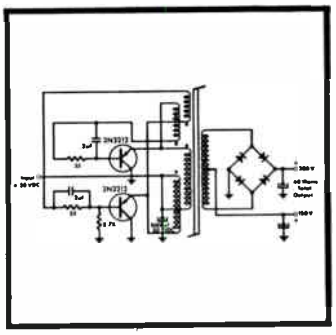
MEDIUM POWER GERMANIUM ALLOY TRANSISTORS.

Very high beta ratings with proven reliability and low cost. These germanium alloy transistors also have linear transconductance and low thermal resistance features, are available in the TO-3 package. The Delco resident engineer in your nearby field sales office will be happy to talk over such applications as hi-fi audio amplifiers, audio output, voltage regulators, medium power inverters and converters, video vertical deflection, medium current control circuits.

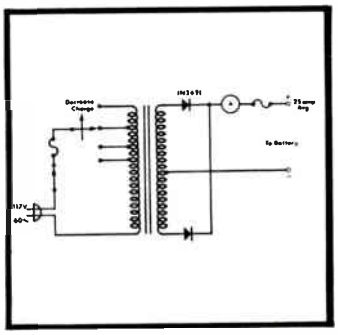




MEDIUM CURRENT HIGH RELIABILITY REGULATOR



40-WATT DC TO DC CONVERTER



MEDIUM CURRENT BATTERY CHARGER

HIGH POWER GERMANIUM ALLOY TRANSISTORS.

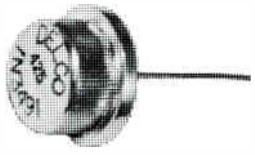
This extremely reliable family of semiconductors comes in the TO-36 package with many beta and voltage ratings (up to 100V). You get 15-ampere switching capability, high power dissipation, low saturation resistance. Consider them when you're working on designs for high efficiency inverters and DC to DC converters, voltage and current regulators, single-ended audio output, control and switching circuits and high power communications modulators.

MEDIUM POWER GERMANIUM NU-BASE TRANSISTORS.

Need fast, high voltage switching capability in a small package? This family of Delco transistors brings you both at low cost. Plus high current ratings and good beta to 7 amperes. Get them in TO-37 packages for use in 40-watt DC to DC converters with high efficiency, print-out hammer drivers, portable fluorescent light supplies, audio drivers and output stages, regulator circuits, light flashers, and many others.

RECTIFIERS.

Here's a family of extremely rugged, low-cost rectifiers. They come in either negative or positive, press-fit or stud packages. Half-cycle surge current is rated at 300 amperes with average current ratings to 18 amperes. Uses? A few are auto AC generators, battery chargers, high current bench supplies, general purpose high current rectifying, polarity protection applications. And maybe that problem that came into your office this morning.



DELCO RADIO

DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA

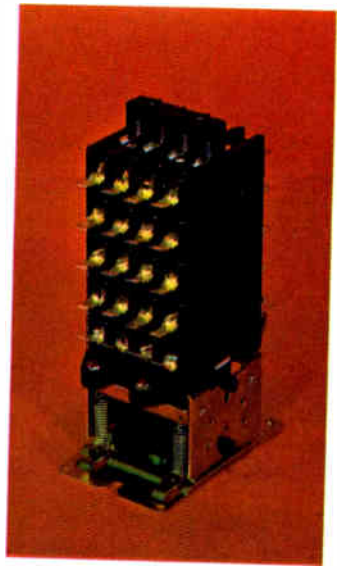
Our customers report that Delco power semiconductors have performed exceptionally well in all of the applications listed. For an economical solution to your circuit problems, call or write our nearest sales office. They'll provide you with detailed data, prices and applications assistance.

General Sales Office: 700 E. Firmin, Kokomo, Ind., (317) 457-8461—Ext. 500. **Detroit:** 57 Harper Avenue, (313) 873-6560. **Syracuse, N.Y.:** 1054 James St., (315) 472-2668.

A resident engineer and field lab are ready to work for you in:

Union, N.J.: Box 1018, Chestnut Station, (201) 637-3770. **Chicago:** 5151 N. Harlem Ave., (312) 775-5411. **Santa Monica, Cal.:** 726 Santa Monica Blvd., (213) 870-8807.

NEW PRODUCTS



TWENTY-POLE RELAY

Multi-pole relay provides 15a. at 250vac and 10a. at 100vdc.

Type FEB provides contact configurations up to 20 poles. Contactors are supplied with any ac coil voltage from 6 through 550v. Standard coils are 24, 110-120, 208-240, 440-480, and 550v., 50/60 CPS. Standard dc voltages are 15, 24, 28 to 30, 48 to 50, and 60v. The Rowan Controller Co., Box 306, Bethel Rd., Westminster, Md.

Circle 140 on Inquiry Card

AUDIO TRANSFORMERS

Measures 5/16 in. dia. x 3/16 in. high and weighs 1/20 oz.

The PIL-50 is metal encased, hermetically sealed, and manufactured and guaranteed to Mil-T-27B by full environmental testing. The DO-T type structure used overcomes inherently poor electrical characteristics found in miniature audio transformers. Units are subjected to a 500v dielectric strength test, instead of the usual 100v, for higher safety margins and reliability. These ruggedized units, with a complete rigid cylindrical bobbin, eliminate wire movement and stress. The turns are circular, effecting uniform wire lay and eliminating corner stress. United Transformer Corp., 150 Varick St., New York, N. Y. 10013.

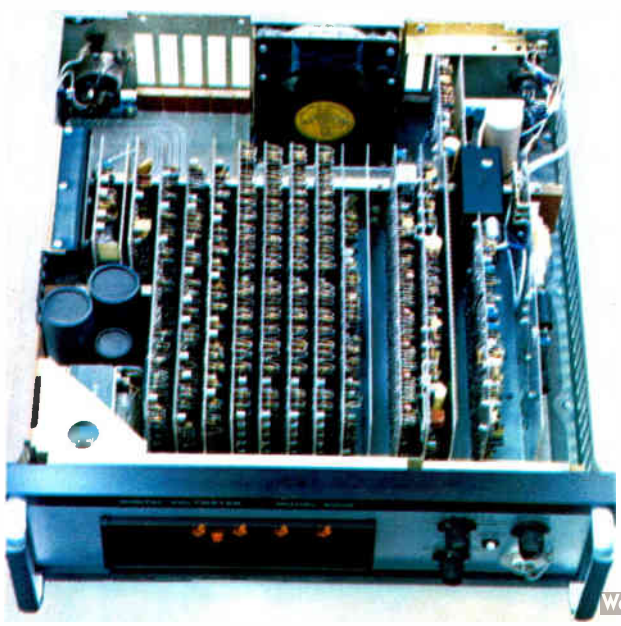
Circle 141 on Inquiry Card

FOUR-DIGIT VOLTMETER (below)

Constant high impedance; accuracy of ±0.01% of full scale.

Model 4000 is an integrating-type DVM which provides controllable, fast readings from 10 readings/sec. to 15 sec./reading. It operates without stepping switches, high precision resistors, and few reed relays. Stability results from a unique freq.-to-voltage comparator. By checking the correlation of the output freq. of the VCO with the input voltage, the freq.-to-voltage comparator corrects for any degree of nonlinearity, and for both short- and long-term drift. Hughes Aircraft Co., Vacuum Tube Products Div., 2020 Oceanside Blvd., Oceanside, Calif.

Circle 142 on Inquiry Card



WIREWOUND RESISTORS (above)

Finned aluminum housing contacts the chassis next to hot spot.

This expanded line of PH housed wirewound resistors adds a 50 watt (PH-50) model, and makes two single-termination, non-inductively wound models (PH-10-5 and PH-25-8) available for specialized applications. Three termination methods are provided. Model PH-10-1 has axial spade terminals; models PH-25, PH-50 and PH-100 have side-by-side terminals. Models PH-10-5 and PH-25-8 have a single terminal with one side of the resistor common to the grounded case. The latter termination method cuts assembly time and provides a non-inductively wound low-reactance resistor. This is useful in applications such as high-speed core memory systems. Power rating is 10 to 100w.; resistance range, 0.1Ω to 95.2KΩ; operating temp. range, −55°C to +275°C; tolerances, 3, 1, 0.5, 0.25, 0.10, and 0.05%; temp coefficient, ±50, ±30, and ±20 ppm, dependent on resistance value. Dale Electronics, Inc., P. O. Box 488, Columbus, Nebr.

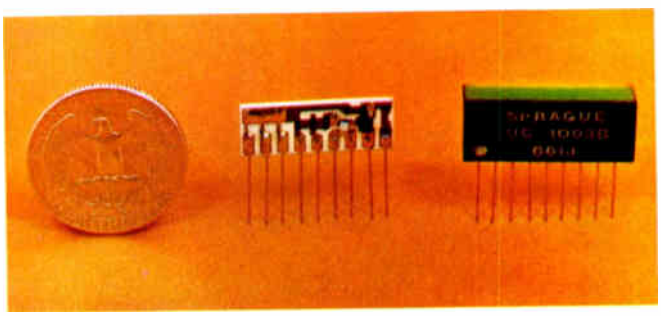
Circle 143 on Inquiry Card

TWO AXIS ACCELEROMETER

Acceleration-measuring for low-cost inertial guidance systems.

The C70 2414 001 accelerometer is a fluid-damped 2-axis device which measures accelerations up to ±50G. It has a threshold of less than 10^{-6}G, and a linearity error of less than 2 x 10^{-5}G/G². The sensitive element is a pendulum which displaces less than 10 microradians/G of acceleration input. This feature contributes to negligible cross-coupling errors. A novel Hooke's joint flexure precisely defines the pendulum's pivotal point, has low creep and hystersis effects, and provides good bias stability. General Precision, Aerospace Group, 1150 McBride Ave., Little Falls, N. J. 07424.

Circle 144 on Inquiry Card



DTL NETWORK

This Ceracircuit DTL logic network is one of a line of 5MC logic modules all housed in a case 1 x 0.4 x 0.2 in. It uses small epoxy-encased transistors and miniature glass diodes bonded to the screened basic circuit with screened passive elements. Sprague Electric Co., No. Adams, Mass.

Circle 145 on Inquiry Card

LIGHT-WEIGHT OSCILLOSCOPE

Uses less than 15w.; has 0.75μsec. trigger delay; flat 3 in. CRT.

The Knight® KN-5005 has a dc response of dc to 6MC (±3db) at 2 divisions amplitude. At 4 divisions the response is dc to 3MC. AC response is 10 CPS to 3MC at 4 divisions; 10 CPS to 6MC at 2 divisions. The rise time is 0.75μsec. at 2 divisions; 0.1μsec. at 4 divisions. The horizontal system sweep speeds are 1μsec./div. to 100msec./div. in 6 steps. Accuracy is within 3%, 1μsec. to 50msec./div.; within 10% from 100-500msec. Allied Radio Corp., 100 N. Western Ave., Chicago, Ill.

Circle 146 on Inquiry Card

X-RAY MASS INSPECTION

NASA is using an instrument to detect faults in relays, capacitors, semiconductors, and other components. Called Searchray, it eliminates the slow and costly X-ray film methods previously used. The new system uses a special vidicon which picks up the X-ray image directly. Because the film and fluorescent screens are eliminated, the picture on the TV monitor is instantaneous and clearer. The Searchray is made by Philips Electronic Instruments, 750 So. Fulton Ave., Mt. Vernon, N. Y.

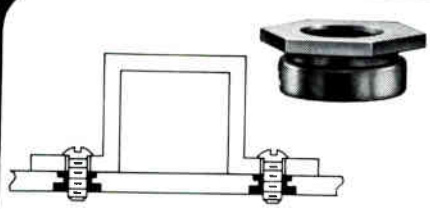
Circle 147 on Inquiry Card

Permanent Threads Resist Pull Out, Push Out, Torque Out!

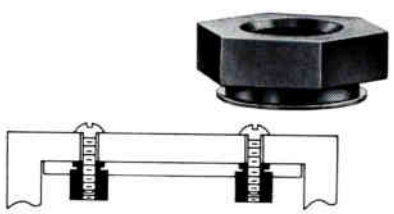
National Captive Hardware can improve designs, simplify assembly, and enhance the appearance of your finished product.

Hex-head design resists torque. Recessed cavity accepts cold-flow of parent material. Result: They never push out, pull out, or torque out of the parent material. They can be installed easily without special tools, even in cramped chassis locations. (Just drill hole, insert hardware, and press in . . . even with an arbor press.) They provide permanent threads for otherwise soft and easily-stripped materials. They are inexpensive.

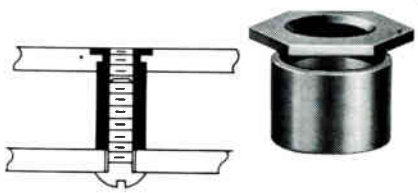
National Captive Hardware is **the** answer to your fastening or assembly problems. Shown below are just nine possible applications for National Captive Hardware, but many others exist. Why don't you investigate the many uses available?



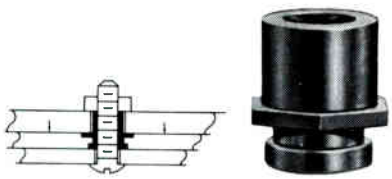
Back of panel inaccessible, no extensions allowable: Type 1 National captive nut fits flush on both sides. Can be used for mounting bracket or component or in cases when top and bottom are closed.



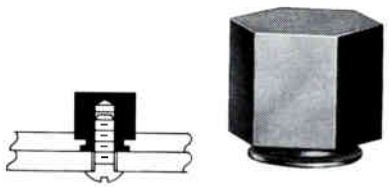
Extra threads required, or possibly to stand off compression load: Type 2 National captive nut extends hex-head above parent material, gives extra holding power for thin materials.



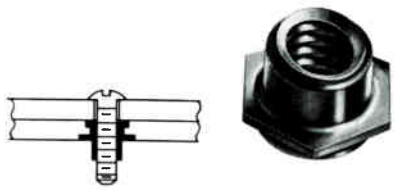
Tensile load spacer needed: National's Type 3 meets several requirements with cylindrical barrel which projects from parent material.



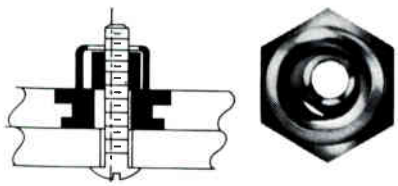
Compression load stand-off required, need orientation guide for second plate: Type 4 National captive nut meets these requirements while it provides extra threads.



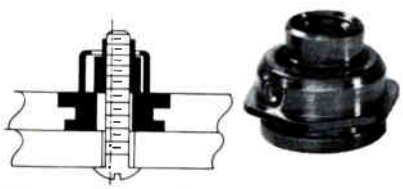
Need water-tight or short-circuit-proof nut: National's Type 5 do not have through taps, but end in a blind hole, preventing water seepage or shorting of chassis components. Can also stand off compression load.



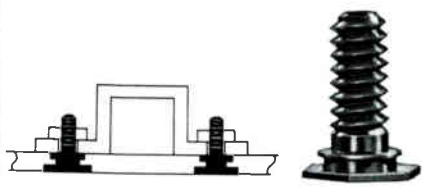
Components subject to vibratory or cyclic motion: Type 6 self-locking National captive nut has an oval-shaped extension that **holds**, yet is easily installed. Meets MIL-N-25027.



Holes in two materials misaligned: Type 7 National floating captive nut will adjust to correct misalignments of as much as .031". Low profile. Simple installation.



Holes misaligned, vibration present: Type 8 self-locking version of National's floating captive nuts answer both problems, yet offer strong threads in weaker materials. Type 8 **combines** the features of 6 and 7. Locking feature meets MIL-N-25027.

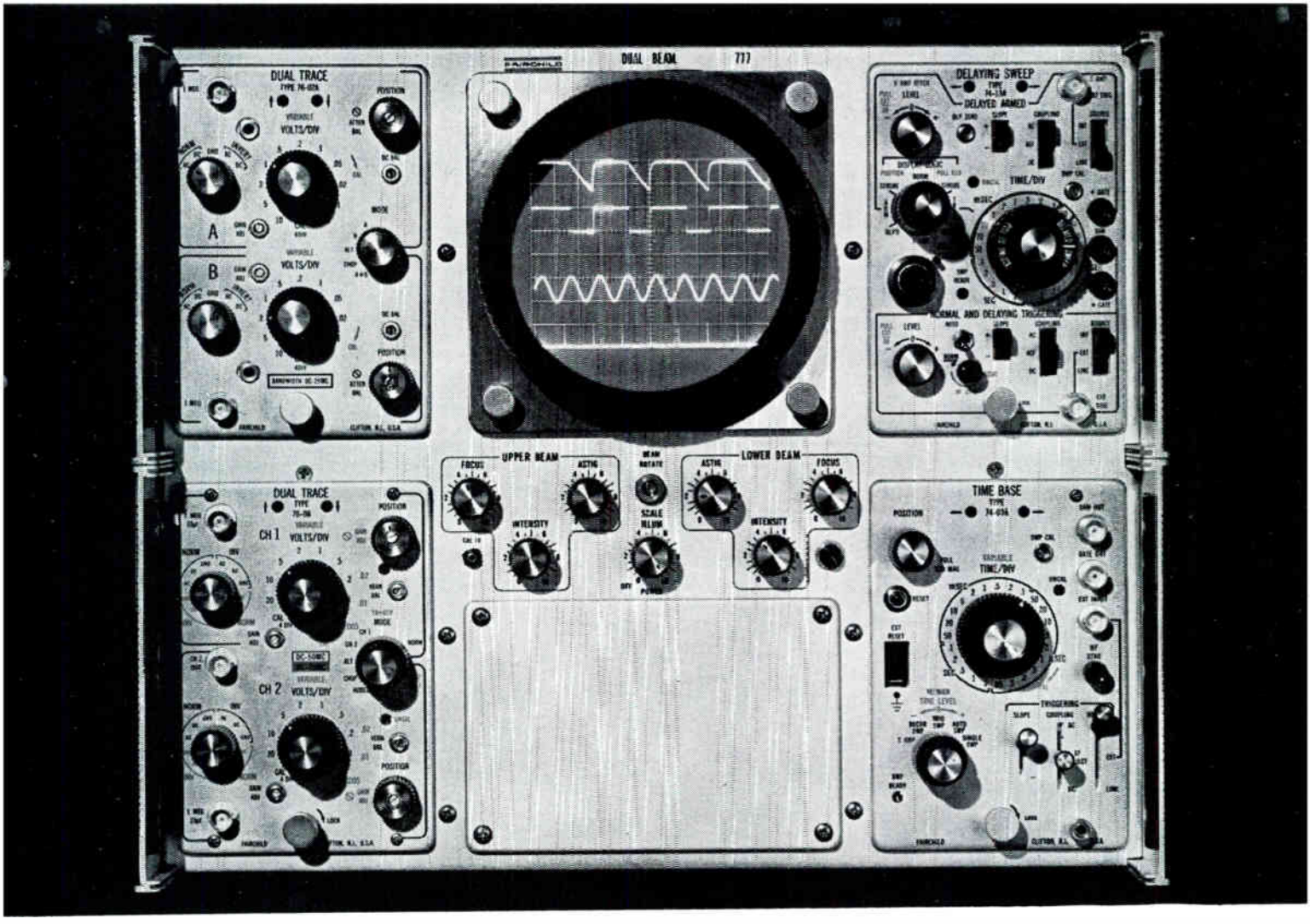


No extensions permitted on panel, but threads required: National's captive stud fits flush with parent material. Wide range of standard sizes and threads, with many others available on special order.

Is your application here?

National Radio Company, Inc.

37 Washington Street, Melrose, Massachusetts 02176 Telephone: 617-665-4800, TWX: 617-665-5032



HOW MANY SCOPES CAN THIS ONE REPLACE?

A sizable number, depending upon the range of applications. For this is the Fairchild 777—the most versatile of all industrial scopes. The 777 is a dual beam, dual trace scope in which any four of 22 plug-ins are completely interchangeable in both X and Y cavities. These same plug-ins fit all Fairchild 765H Series scopes. They include DC-100 mc bandwidth, spectrum analyzer and raster display capabilities, sensitivity to 500 μv/cm, risetime to 3.5 ns.

Other features of the 777 include 6 x 10 cm display area for each beam with 5 cm overlap between beams for optimum resolution... unique 13 kv CRT with four independent deflection structures... solid state circuitry (with all deflection circuitry in the plug-ins)... light weight (44 lbs.)... environmentalized for rugged applications. Price (main frame): $1,600 f.o.b. Clifton, N.J.

BEAT T.O. WITH FAIRCHILD

The 777 illustrates the Fairchild concept of value through versatility. One scope doing many tasks is only part of it. Future state-of-the-art capability is equally important because it helps you curb the high cost of Technological Obsolescence. And finally, service. Fairchild has more service centers than any other scope manufacturer.

Ask your Fairchild Field Engineer for details on this and other new generation Fairchild scopes. Or write to Fairchild Instrumentation, 750 Bloomfield Ave., Clifton, N.J.

*Technological Obsolescence

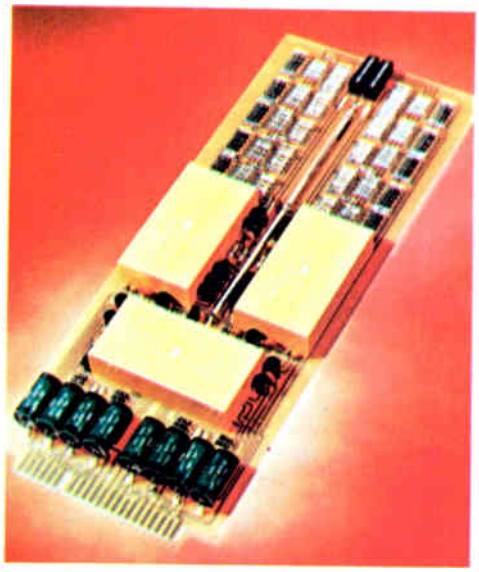
FAIRCHILD
INSTRUMENTATION
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

FREQUENCY STANDARD

60-cycle standard has bi-metallic tuning fork operating at 960 CPS.

This standard has 4 stages of binary division which count down to 60 CPS. The higher freq. tuning fork provides greater stability with changes in temp., attitude, and supply voltage and is more immune to vibration. Output is either an 8v. peak-to-peak square wave, or 3v. RMS sinewave into a 10K load with a 12v. supply. Case is 1½ x 1½ x 2 9/16 in. high with an octal plug connector. Four accuracy ranges are available from 0.2% over a temp. range of −25°C to +85°C ($69) to 0.015% from +15°C to +35°C ($114). Sinewave output is $15 extra. Fork Standards, Inc., 211 Main St., West Chicago, Ill. 60185.

Circle 148 on Inquiry Card



ANALOG MULTIPLIER

Analog multiplying, dividing, squaring, and sq.-root extraction.

Model 502A is a quarter square multiplier. Inputs required are +X and+Y and an inverter on the card gives complementary values. Where the complements are available externally, the inverter need not be used. Max. error is less than 50mv for both inputs within the range of ±100v. The 2 independent squaring networks may be used independently with max. error of 20mv. The multiplier can be externally programmed to function in any of its operating modes without circuit alteration. Zeltex Inc., 2350 Will Pass Rd., Concord, Calif.

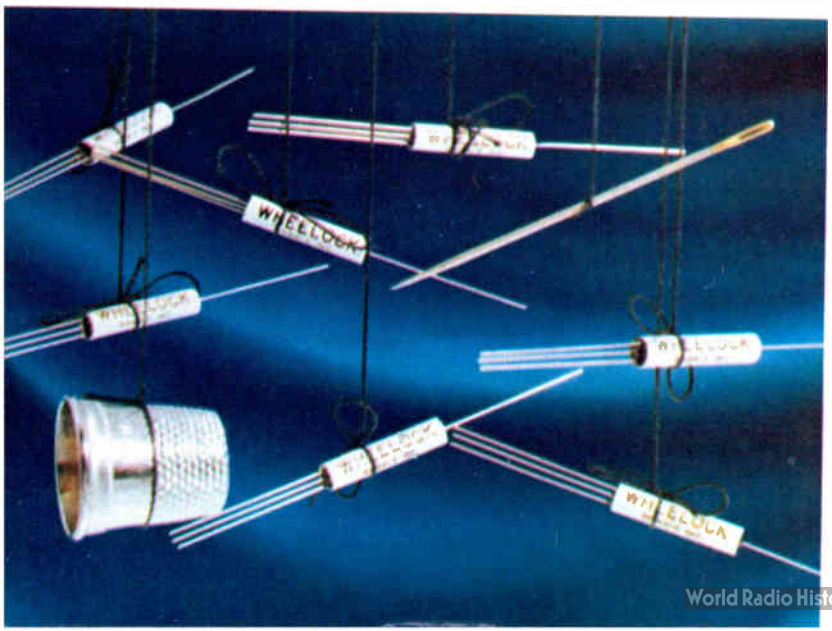
Circle 149 on Inquiry Card

VOLTAGE MEASURING SYSTEM

Provides direct reading 11.111110. Accuracy is 5 ppm.

The Model 1045A voltage measuring system provides direct-reading measurement of dc voltage to 11.111110v. full scale on 3 ranges. Seven decade dials provide 1μv resolution on the lowest range. The system combines a direct-reading potentiometer, a direct-reading standard cell comparator, a guarded voltbox and 2 independent null detectors for state-of-the-art accuracy. A simple checking procedure allows the operator to verify the accuracy of the measurements. Electro Scientific Industries, Inc., 13900 N.W. Science Park Dr., Portland, Ore. 97229.

Circle 150 on Inquiry Card



MINIATURE NEEDLE RELAY

Occupies a volume of 0.02 cu. in.; its dia. is 0.19 in.

The series 370 miniature needle relay has nominal coil voltages of 6 and 12v. with nominal rated coil power of 50 or 60mw, respectively. Contacts are rated at 125ma, 4w., and 10 x 10^6 operations at rated load can be expected. Max. operate time is 0.40msec. The low profile of the relay permits close stacking of PC boards. Application areas include aerospace, integrated circuits and miniaturized instrumentation circuits. Wheelock Signals, Inc., 273 Branchport Ave., Long Branch, N. J. 07740.

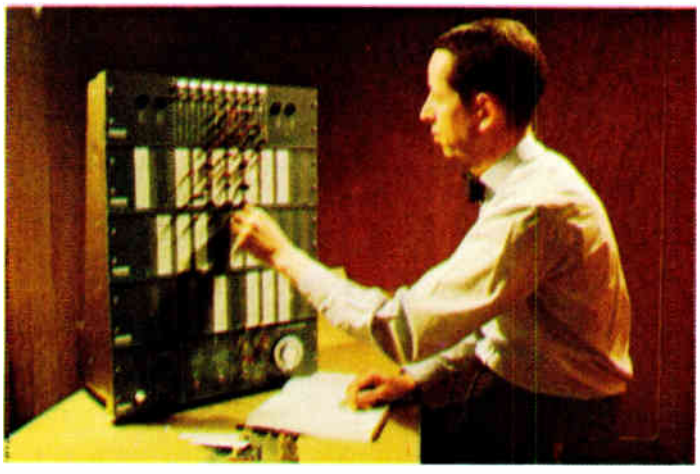
Circle 151 on Inquiry Card

SWITCH/DISPLAY MATRIX

For customized keyboards and control panels. Offers flexibility.

Keyboards comprised of bench-assembled switches and indicators can be arranged by units in any pattern of squares, rectangles and rows. A "KB" unit is ¾ in. sq.; a ½ unit is ¾ x ⅜ in.; a 1½ unit is ¾ x 1⅛ in.; and a 2-unit is ¾ x 1½ in. Units may be assembled into a variety of strong, yet light, rows or matrix configurations. The rigidity of mounting hardware eliminates extensive panel reinforcement. Selective external connections are used for direct encoding, which eliminates intricate wiring. Micro Switch, Freeport, Ill.

Circle 152 on Inquiry Card



LOGIC LABORATORY

Helps newcomers learn logic or it can be used as a breadboard.

The Logic Laboratory is a training device and design tool. It contains a power supply, pulse generators, controls, indicators, mounting hardware, and logic modules. All hardware is entirely flexible and expandable. Those learning logic can construct operating logical systems. When used as a breadboard, full scale computer elements or test systems can be built. Digital Equipment Corp., Maynard, Mass.

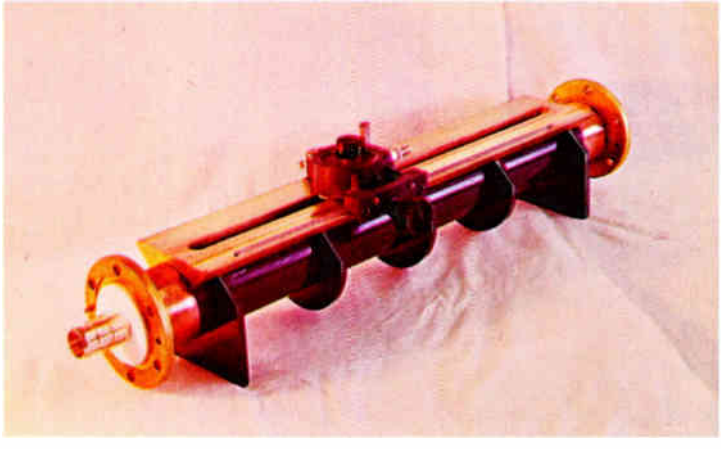
Circle 153 on Inquiry Card

SLOTTED LINE

Measure impedance of large size coaxial devices in their own dia.

These slotted lines come in 3 different diameters. The 1⅝ in. slotted line has a freq. range of 300-3000MC. Freq. range of 300-1350MC is reported for the 3⅛ in. model; and 300-900MC for the 6⅛ in. slotted line. Characteristic impedance is 50 (±0.15)Ω for the 2 smaller dia. units and 75 (±0.22)Ω for the larger. Residual VSWR is less than 1.010. Lower freqs. and other impedances are also available. Phelps Dodge Electronic Products Corp., 60 Dodge Ave., North Haven, Conn.

Circle 154 on Inquiry Card

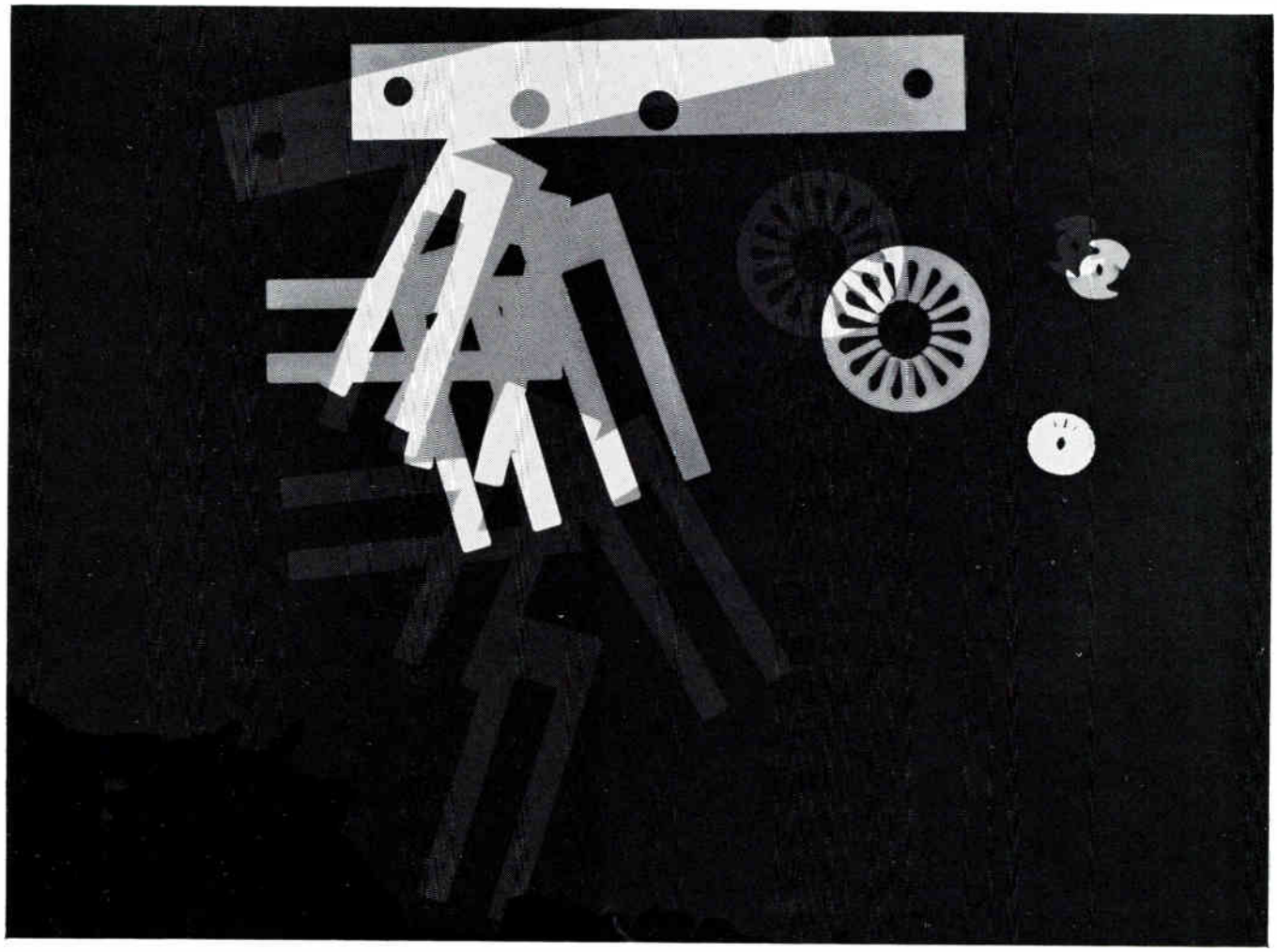


MINIATURE DATA SYSTEM

Gives 50KC data throughput with 12- or 15-bit resolution.

The Multiverter® replaces 3 or more chassis normally needed in the analog front end of data systems. It combines an integrated circuit multiplexer, an advanced sample and hold amplifier, and an analog-to-digital converter. The system provides 12-bit data throughput at 50KC or 15-bit at 30KC. Each multiplexer card accommodates 16 input channels. The sample and hold amplifier has a 100nsec. aperture time and settles in 4nsec. to 0.01% accuracy. Raytheon Computer, Santa Ana, Calif.

Circle 155 on Inquiry Card



Cut energy loss, core size, and weight with Armco 48 Ni and 48 Ni-R Nickel-Iron Magnetic Alloys

Armco 48 Ni and 48 Ni-R magnetic alloys offer you a wide range of magnetic properties, thicknesses, and costs. They enable you to select core material to achieve the most effective design for high quality audio and instrument transformers, specialty motors and generators, communications, computer, and other high frequency equipment.

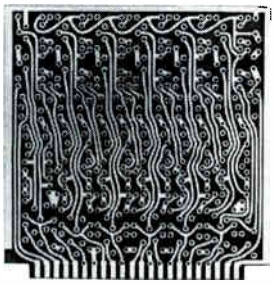
Armco 48 Ni is produced in thicknesses of 14, 10, 6, 4 and 2 mils. Precise control of processing assures low hysteresis loss. Armco 48 Ni has exceptionally high permeability at low and moderate inductions. Its initial permeability is approximately twice that of the oriented silicon steels. Extremely low coercive force enables you to minimize core losses for a wide range of frequencies. In the low and moderate range, H_c for 48 Ni is only 10 to 30% of that for silicon steel.

Armco 48 Ni-R is produced in thicknesses of 14,10, and 6 mils. Processed to produce small grain size and uniform magnetic properties in all directions, it develops higher permeability with a lower temperature anneal than 48 Ni. These special characteristics make it ideal for rotor applications in communications equipment, guidance systems, and sensing devices. Many satisfied customers have reported that Armco 48 Ni-R is superior to any other rotor grade offered in the industry.

For full information on Armco 48 Ni and 48 Ni-R magnetic alloys, call your local Armco Sales Office. Or write Armco Steel Corporation, Dept. E-3395, P. O. Box 600, Middletown, Ohio 45042.

ARMCO STEEL ARMCO

Photocircuits can solve your PRINTED CIRCUIT PROBLEMS



Here are the solutions to some typical problems we have recently received.

CONCERN OVER MULTILAYER CAPACITY

PROBLEM: A system we are designing requires over 40 multilayer boards. We anticipate a production schedule of five systems per month. Our initial vendor surveys indicate this quantity is too large for the multilayer capacity of local suppliers. Is ours an unusually large multilayer requirement?

SOLUTION: Not for the larger printed circuit manufacturers who have been supplying multilayers for a number of years and have noted the increasing demand for this versatile product. As an example, five years ago Photocircuits was able to fill all customer multilayer requirements with a capability of 50 average size parts per month. Two years ago we had to increase our capacity to 500 parts per month. The newest multilayer facility at our Glen Cove plant is capable of producing over 5000 parts per month. If your boards are typical of those we have made for other systems use, only 5% of our total multilayer capacity would be needed to meet your requirements.

BOARD BREAKAGE

PROBLEM: We are presently using XXXP base material for the printed circuits in our equipment. Production line handling and power driven assembly tools result in cracked and broken boards which have to be scrapped. We can't afford G-10 or epoxy paper. Are there any available low cost materials with high impact strength?

SOLUTION: Photocircuits' new CC-4 additive printed circuit process allows the use of new and unique base materials which are not available as foil-clad laminates. One which seems particularly well suited for your application is a low cost, polyester glass mat material, GL-52R, which was specially developed for use with the CC-4 process. This new material has electrical and mechanical properties superior to XXXP and epoxy paper. Although GL-52R is no more expensive than XXXP, it has an impact strength almost ten times greater. Commercial users have found that breaking, cracking and crazing during assembly and manufacturing are greatly reduced with this material.

SLOW PRICE AND DELIVERY QUOTATIONS

PROBLEM: We often need a quick price and delivery quotation on a number of types of circuit boards for a new application. The time cycle involved in sending out prints to manufacturers and waiting for their reply is often too long for our schedule. How can we get price and delivery information faster?

SOLUTION: Our Standard Circuit Division was set up to help medium quantity users of printed circuits eliminate red tape and delays in quoting and procurement. By only manufacturing boards to a limited number of choices in such areas as base materials, platings and tolerances, the paperwork and communication problems of buying a custom-made component are drastically reduced. The Standard Circuit concept simplifies design and procurement to the point where boards can be ordered from a catalog. The published prices and fixed delivery schedules included in the Standard Circuits catalog should solve your problem. Write us for a copy.

ARTWORK FOR MULTILAYER CIRCUITS

PROBLEM: We've always prepared the master patterns for our printed circuit boards. We have our first application for multilayers and wonder if there are special or unusual requirements for the artwork?

SOLUTION: It would be wise to talk to an Applications Engineer from a reliable printed circuit manufacturer with multilayer experience before beginning the artwork. In addition to requiring much more stringent tolerances and tooling symbols, multilayer artwork almost always requires special attention because of the particular manufacturing process used. Since the artwork for one board may require individual patterns for as many as 15 layers, cost-cutting opportunities should be carefully investigated. Photocircuits' Master Circuit System, for example, uses automatic equipment to produce photographic glasswork for each layer with perfect registration and can save as much as 50% over regular drafting techniques.

(If you have a problem in printed circuitry, let us hear from you.)

Photocircuits
CORPORATION
Glen Cove, New York • Anaheim, California

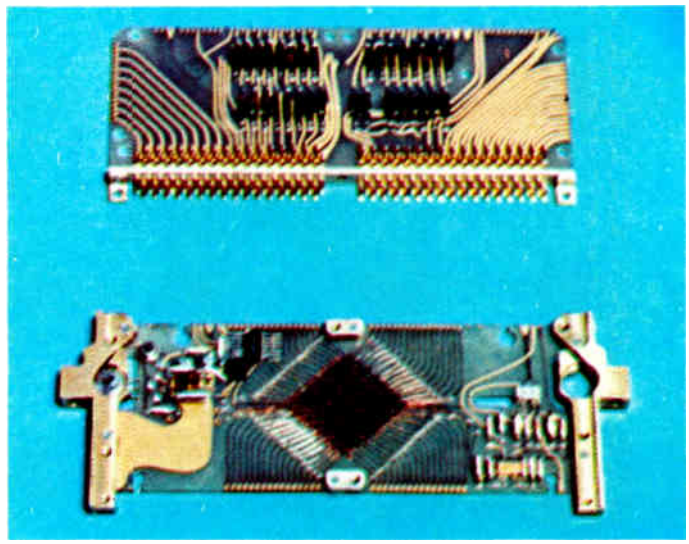


Fig. 1: Diode matrix module (top) and basic memory module (bottom).

The packaging system described here provides for the compatible use of integrated circuits, thin film circuits, and conventional components in spaceborne digital command and data handling equipments. Design of this system allows for the incorporation of new component types without obsoleting the system.

A Practical Component Packaging

A PRACTICAL PACKAGING SYSTEM for spaceborne electronic equipment must be able to accommodate, in an efficient and compatible fashion, a variety of component types. A packaging system will be described which provides such compatibility. It also provides suitable solutions to other constraints existing in the design of spaceborne digital equipment. This system has been implemented in prototype hardware form and is being applied to a variety of missile and space programs.

Design Procedure

At the outset of the packaging system development, the following criteria were established:

(1) Maximum use of integrated circuits (IC's).
(2) Adaptability to the use of thin film microcircuits.
(3) Compatibility with conventional components.
(4) A standardized modular system with minimum module types.
(5) A flexible interconnection system to provide easy adaptation of the module types to a variety of equipments.
(6) Use of conventional fabrication methods.

To achieve these objectives, a study was made of digital equipment which had been flown on missiles and satellites prior to the start of the study. Also studied were the types of missions and equipment requirements which might be anticipated in the near future. This study indicated that equipment on missile and space vehicles would include PCM telemetry, programmers, data compressors, real time decoders, and eventually general purpose computers. Types of circuits and circuit groups contained in these pieces of equipment were then defined. The degree of commonality at various functional levels was also analyzed. This analysis showed that there were many repetitive circuits and circuit groups involved, and that the use of standard circuit types was feasible.

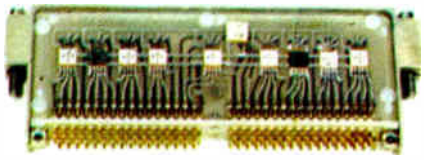
The systems study further considered the types of digital functions required and the optimum number of logic functions for a single module. An analysis of information storage needs indicated a strong tendency for grouping into two memory sizes. A study of instrumentation lists yielded the concusion that analog gates in multiples of 8 would provide the most flexibility.

As a result of the analysis of vehicle equipment functions, a list of 20 module types falling into five general categories was developed. These would fulfill 90% of the circuit needs for the types of spaceborne digital equipment considered. Types of components needed for each function, together with packaging requirements for the modules, and the basic requirements which had been established for interconnection flexibility and modularity then led to the development of the packaging morphology.

Module Types

The module types fall into five families, and within each family several related modules are provided to satisfy various needs. Table 1 lists the module families and types.

By W. A. KOENIG,
Manager, Communications & Command,
Dept. 55-42, Bldg. 151,
Lockheed Missiles & Space Co.,
P.O.B. 504,
Sunnyvale, Calif.



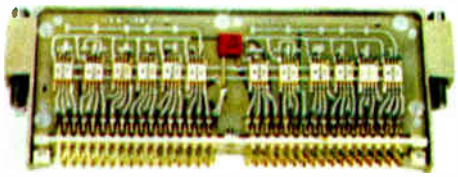
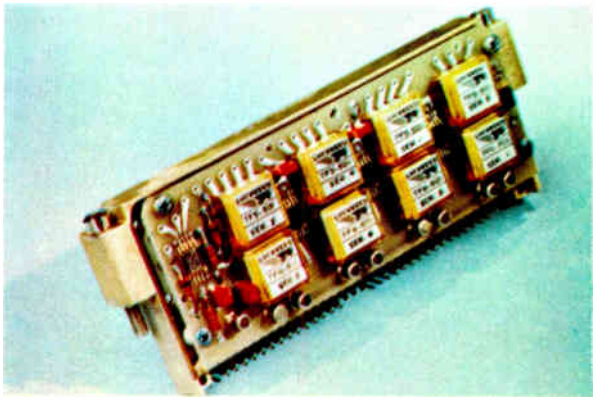


Fig. 2: Two types of logic module (left) make up the logic family. Both types use monolithic silicon integrated circuits of the DTL type.

Fig. 3: Programmer module shown below illustrates how thin film networks are used in conjunction with IC's to generate programming pulses.



System

Clock Modules—An analysis of clock functions indicated that for many uses the stability requirement is low and a rather simple design will suffice. The general purpose oscillator uses a crystal oscillator without temperature control and has a stability of 50 parts/million. For applications such as an orbital programmer, a high stability clock is provided which uses a crystal oscillator with temperature control and has a stability of 1 part/million/24 hrs.

Memory Modules—The basic memory module (M-1) is a 16 x 16 toroidal coil matrix using 50 mil. wide temperature range cores. The associated bit driver and sense amplifier are mounted on the same circuit board with the core matrix, Fig. 1. Memory planes, each containing 256 words 1 bit long, may be stacked in a modular fashion to provide the number of bits needed for a memory system up to a maximum of 32 bits/stack. Fig. 1 also shows the diode matrix module for decoding of the X-Y drive pulses. The M-9 memory module provides strobing and control circuits and also uses voltage failure sensing circuitry to protect against loss of information in the memory in the event of power failure.

Logic Modules—The logic family contains two types of logic modules, Fig. 2. Both types use monolithic silicon IC's of the DTL type. The L-1 logic module contains 12 four-input NAND/NOR gates with all inputs and outputs returned to the external connector for flexibility. The L-2 logic module provides nine binary elements for the implementation of shift registers, ripple counters and similar functions.

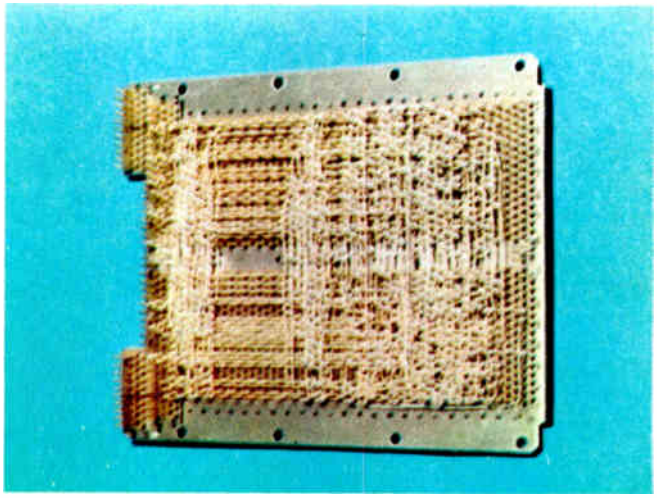
Power Supply Modules—Power supply requirements for the universal system are satisfied with three basic dc to dc converter modules which operate from 28 v. dc unregulated. All circuits in the system operate from either ±28 vdc or ±6 vdc, so the three types are a 15 w., 6 v. supply; a 15 w., 28 v. supply and a low power 6 v. and 28 v. supply.

Input/Output Modules—The Data Gate Module (I-1) uses a monolithic IC of the FET type. Each module mounts 16 TO-5 cans. These may be used as 32 high level gates (0-5 v.) or as 16 differential low level gates (0-50 mv).

A comparator module (I-2), a programmer module (I-3), and a translator module (I-7) accomplish the A to D conversion. Fig. 3 shows the programmer module. It illustrates how thin film networks are used in conjunction with IC's to generate programming pulses. The thin film circuits shown use titanium resistors and capacitors on an alumina substrate.

The remaining modules in this family include low and high level amplifiers for general purpose use, and a relay driver module. (*Continued on page* 50)

Fig. 4: Pin side of the wirewrap matrix interconnect board.



This new label puts mix rooms out of business

Mallinckrodt now pre-mixes TransistAR etchants to your proportions on any order of 480 gallons or more. Specify any combination of nitric, acetic and hydrofluoric acids*. You'll get well-known TransistAR high purity (read the label above, for example) and uniformity maintained to within ±1% of your specifications. It's a definite economy. Eliminates mixing errors. Frees your staff for more productive work. Contact us now for full details on new TransistAR mixed etchants.

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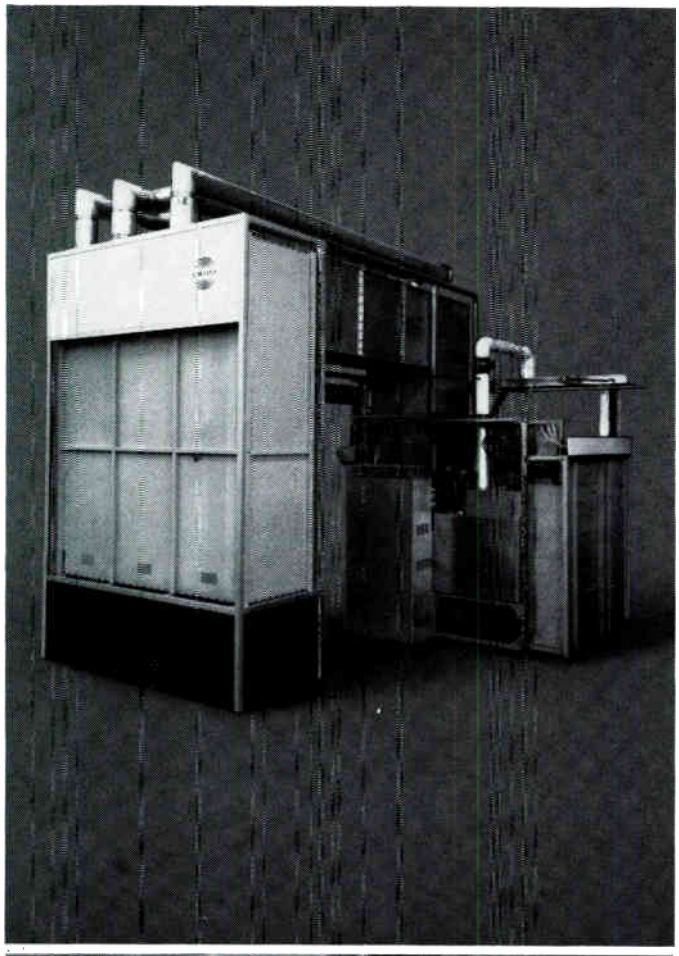

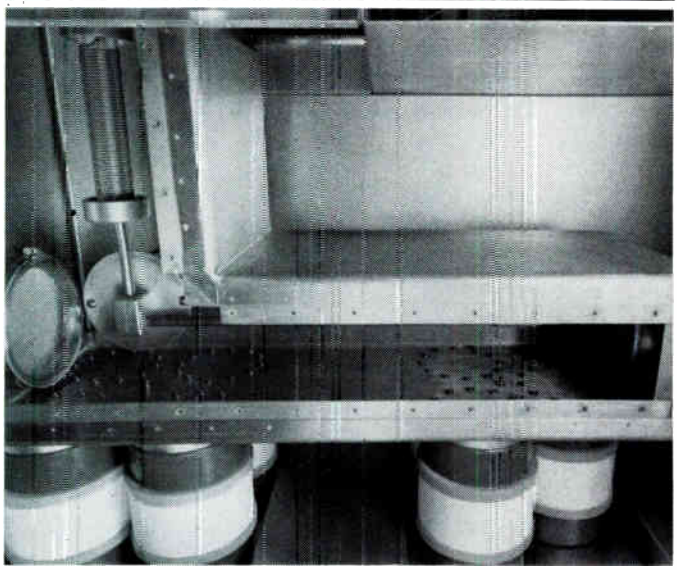

250 KW Transmitter Achieves Extremely High Tank Circuit Efficiency With Jennings Vacuum Capacitors

Two of the most significant features of Collins Radio Company's 821A 250 KW transmitter are the unusually high efficiency of the tank circuits in the final amplifier and the completely automatic tuning techniques. The output network employs large coaxial line sections which are automatically resonated by new internally forced-air cooled Jennings vacuum variable capacitors. It also utilizes the wide capacity range, high frequency response, and high voltage rating of Jennings capacitors to aid in automatic tuning anywhere in the frequency range of 3.95 to 26.5 megacycles.

This permits completely automatic tuning in a maximum of 20 secs and avoids the loss of valuable air time, usually 5 to 15 minutes, consumed by conventional transmitters.

In addition to the low loss dielectric and lowest inductance of any other capacitor Jennings new vacuum capacitors offer (1) highest maximum to minimum capacity change ratios (2) long life (3) high current capability (4) light weight (5) built-in corona rings on many models (6) shock resistant glazed ceramic envelope (7) wide variety to solve most desired combinations of capacitance, voltage, and current.

Whether it's 250 KW or 5 KW, Jennings vacuum capacitors will contribute more to superior transmitter performance than any other capacitor known. A brief examination of our new line of ceramic vacuum capacitors will suggest many new ways in which circuit design can be improved. We will be pleased to send complete details at your request.

JENNINGS TYPE
CVHP 650

Capacity:	1000 pf
Voltage Rating:	45 kv peak
Current Rating:	215 amps rms

JENNINGS TYPE
CFHP 1000

Capacitance Range:	30-650 pf
Voltage Rating:	45 kv peak
Current Rating:	250 amps rms

RELIABILITY MEANS VACUUM-
***VACUUM** MEANS*
ITT Jennings

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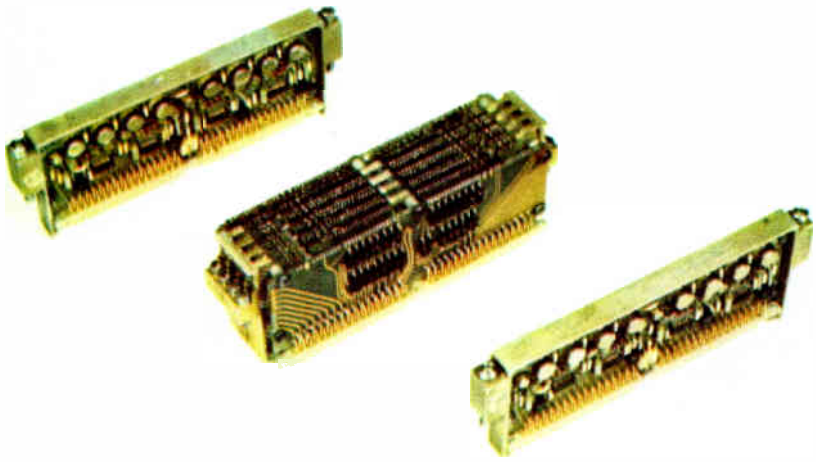


Fig. 5: Special interconnection method used in memory core stacks.

PACKAGING SYSTEM (Continued)

Interconnection Considerations

Interconnections in the packaging system are considered at the component and module levels. The prime consideration in the interconnection of components within the module is compatibility with the various components to be used. IC's may be packaged in either flat pack style or in the multi-lead TO-5 can. The former with thin, flat leads of goldplated Kovar is most suited for a welding or resistance soldering operation using a parallel gap machine. The TO-5 style of package may be either soldered to an etched circuit board or welded in a cordwood type of construction. Conventional components may either be soldered or welded. Consideration of these factors led to the conclusion that the familiar two-sided etched circuit board, with plated-through holes, provides a near-optimum solution to the problem.

Flat pack IC's are attached to the solder coated copper traces by a resistance soldering operation using a parallel gap welder. Attachment of the thin film circuits, IC's in TO-5 cans, and normal components is done with a wave soldering machine.

Selection of the interconnection media between modules involved consideration of such factors as the required density of point-to-point connections, documentation needs, tooling needs, compactness and flexibility. The methods considered included point-to-point wiring, two-sided etched boards, multilayer etched boards, and wirewrap techniques. Wirewrap was selected because it offers high pin density, is simple to document, comfortably accommodates complex interconnection patterns, and is easily changed.

Fig. 4 shows the pin side of the wirewrap matrix

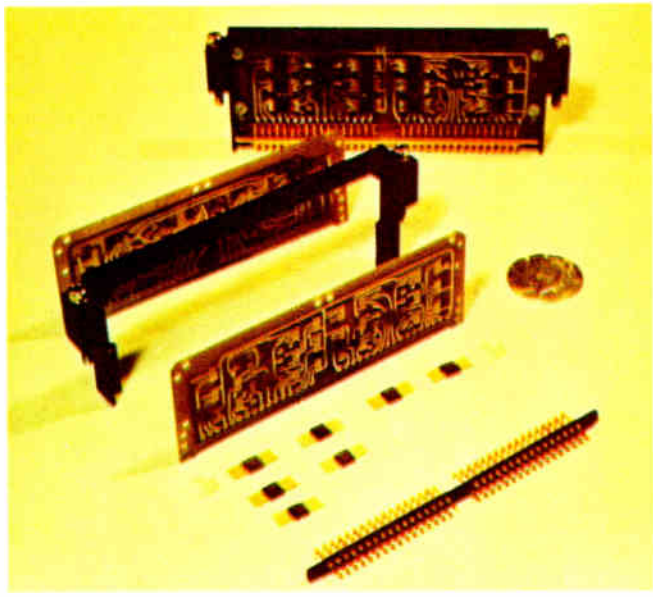
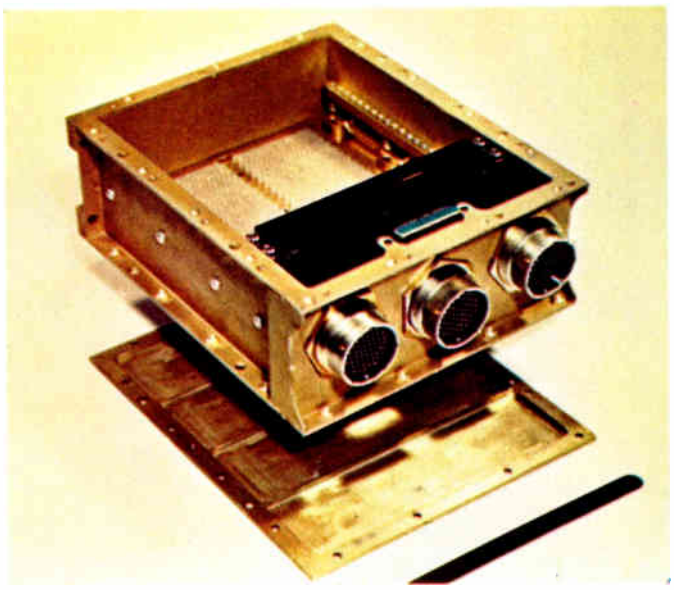


Fig. 6: Basic system module configuration. Two of the boards are attached to a cast aluminum frame to provide for mechanical support and heat transfer.

Fig. 7: Photograph shows how module frames, mounting rails, and wirewrap matrices are mounted in the standard enclosure. Enclosures are designed to be stacked.



motherboard which is used in the packaging system. The main pin field contains 1,524 pins for the interconnection of modules. Wiring shown in the figure is for a small (8 bit, 256 word) memory system with its associated logic and clock functions. It graphically illustrates the degree of wiring complexity encountered in interconnecting logic portions of such a subsystem. Power for all modules is supplied through a series of busses which run down the center of the matrix on the connector side.

A special interconnection method is used in memory core stacks, Fig. 5. The high pulse currents needed in a coincident current memory preclude the use of the wirewrap pins for memory plane interconnections. The photograph shows how buss wires are laid in slots on the edge of the memory boards in a pattern which alternately connects adjacent boards at the top and bottom of the assembly. This method provides for simple assembly and is independent of the number of planes in the stack.

Table 1: MODULE TYPES

Category	Module Number	Module Description
Clock	C-1	General Purpose Crystal Oscillator
	C-2	High Stability Crystal Oscillator
	C-3	Multivibrator
Memory	M-1	16 X 16 Core Plane
	M-2	Current Drivers (4)
	M-3	32 X 32 Core Plane
	M-8	Diode Matrix
	M-9	Strobe & Control
Logic	L-1	Nand/Nor Integrated Circuits (12)
	L-2	Binary (FF) Integrated Circuits (9)
Power Supply	P-1	+ 6 v Supply — High Power
	P-2	± 28 v Supply — High Power
	P-3	± 6 v ± 28 v Supply — Low Power
Input/Output	I-1	Data Gates (32 or 16)
	I-2	Comparator
	I-3	Programmer
	I-4	Relay Drivers (4)
	I-5	Low Level Amplifier
	I-6	High Level Amplifier
	I-7	Translator — Register

System Packaging

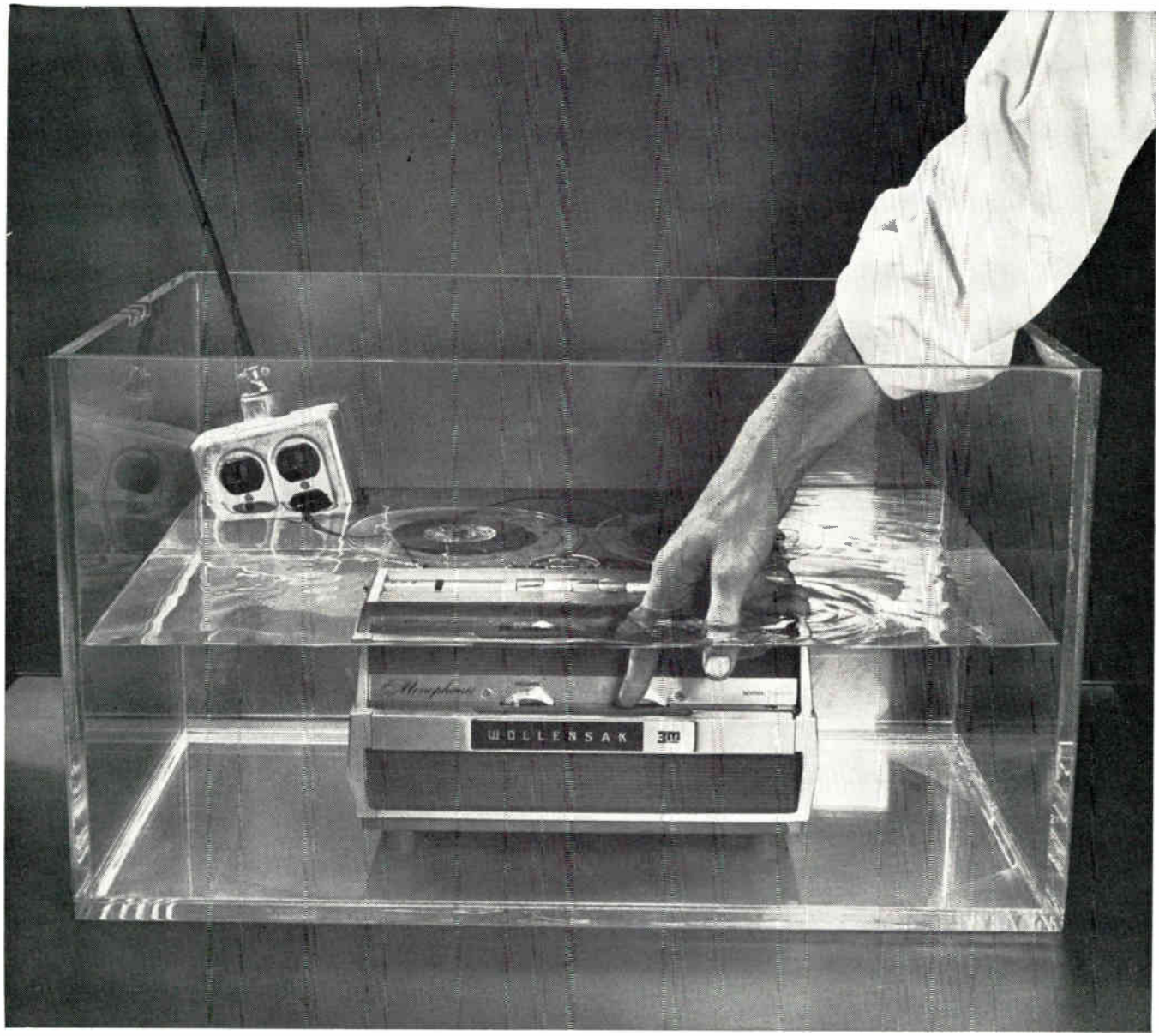
Design objective for the packaging system was that it be modular and that it accommodate a variety of types of components. A module with two dimensions fixed and with the third dimension variable offers a high degree of flexibility consistent with a simple mechanical system. Size of the module boards, as shown in several photographs, is about 2 x 5 in. The basic module consists of the circuit board and connector with its attached components. To provide for mechanical support and for heat transfer, two of the boards are attached to a cast aluminum frame, Fig. 6. Frames are provided in widths of ½ in., ¾ in., and on up in ¼ in. increments, to accommodate the various types of components used.

Fig. 7 shows how module frames, mounting rails, and wirewrap matrices are mounted in the standard enclosure. External connectors are mounted on the end face of the enclosure and covers are attached top and bottom. The enclosures are designed to be stacked and direct connections can be made between subsystems by means of an auxiliary connector. A half-sized enclosure is also provided. It is the same height and width as the standard enclosure, but is shorter and accommodates half as many frames.

Equipment which is to be operated in the hard vacuum of space must rely solely on conduction for removal of heat dissipated in the circuit components. Frames on which the module circuit boards are mounted provide a direct path for the conduction of heat to the enclosure and, thence eventually, to vehicle surfaces which are capable of radiating energy into space. For circuits where large amounts of heat must be dissipated, several means for transferring heat are used. Two of these methods are apparent in the M-1 memory module shown in Fig. 1. The bit driver circuit must generate large amounts of pulse power when the memory is cycled at its maximum rate and a pattern of "ones" is read into the memory. The transistor in the bit driver is clamped in a hole directly in the module mounting frame, thus maintaining its case temperature close to that of the equipment enclosure. Also, the etched circuit is arranged to provide a broad ribbon of copper from the area under the two heat dissipating resistors directly to the mounting frame.

Conclusions

The universal modular packaging system described provides a high degree of flexibility in the synthesis of digital and related equipment for use in space applications. The module families and the packaging system are currently being applied to a variety of equipment. This equipment includes a PCM telemetry, a memory subsystem, real time decoders, programmers, and timers. Validity of the design concepts have been verified. It has been shown that a variety of component types can be readily accommodated. Since much of the cost and time needed for equipment development is spent in circuit development, this phase has been effectively eliminated. It has been possible to generate a preliminary design, including size, weight, module counts, and approximate cost, in a matter of days after the establishment of performance needs. The use of module and enclosure configuration which have been environmentally qualified provides confidence in the physical integrity of the new equipment at the outset of the design. Physical arrangement of the basic modules and the manner in which they are combined, allow for the incorporation of new component types as they become available, without obsoleting the existing system.



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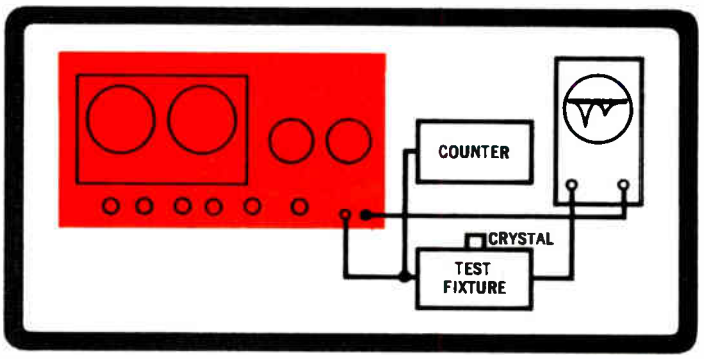
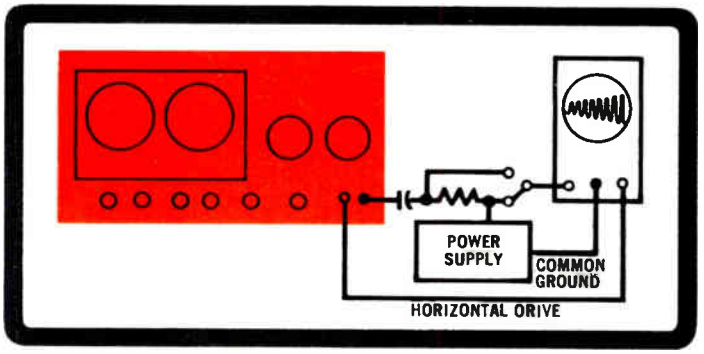


can measure the dynamic impedance of a power supply at any frequency from 20 Hz to 3000 MHz, or at several frequencies in that range, providing an instantaneous oscilloscope presentation of the supply's impedance characteristics?



can provide complete frequency transmission characteristics of telephone or other transmission lines for equalizing operations, materially reducing testing time, supplying total frequency coverage, and eliminating correlation errors between first and last test readings?

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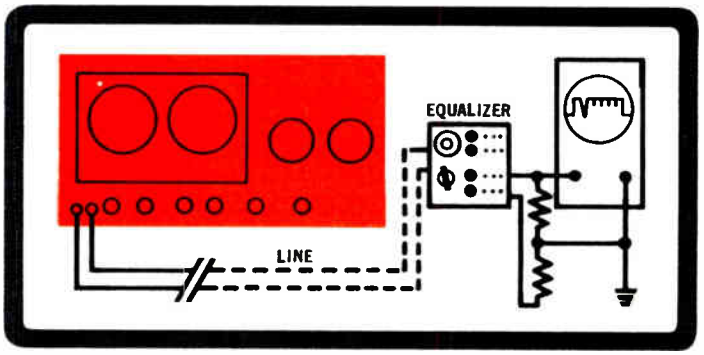

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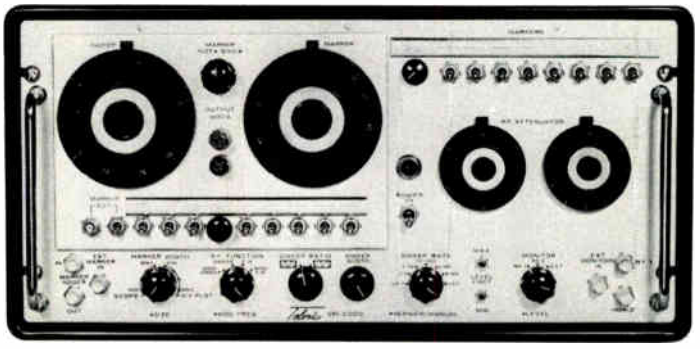

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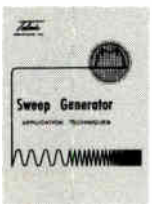

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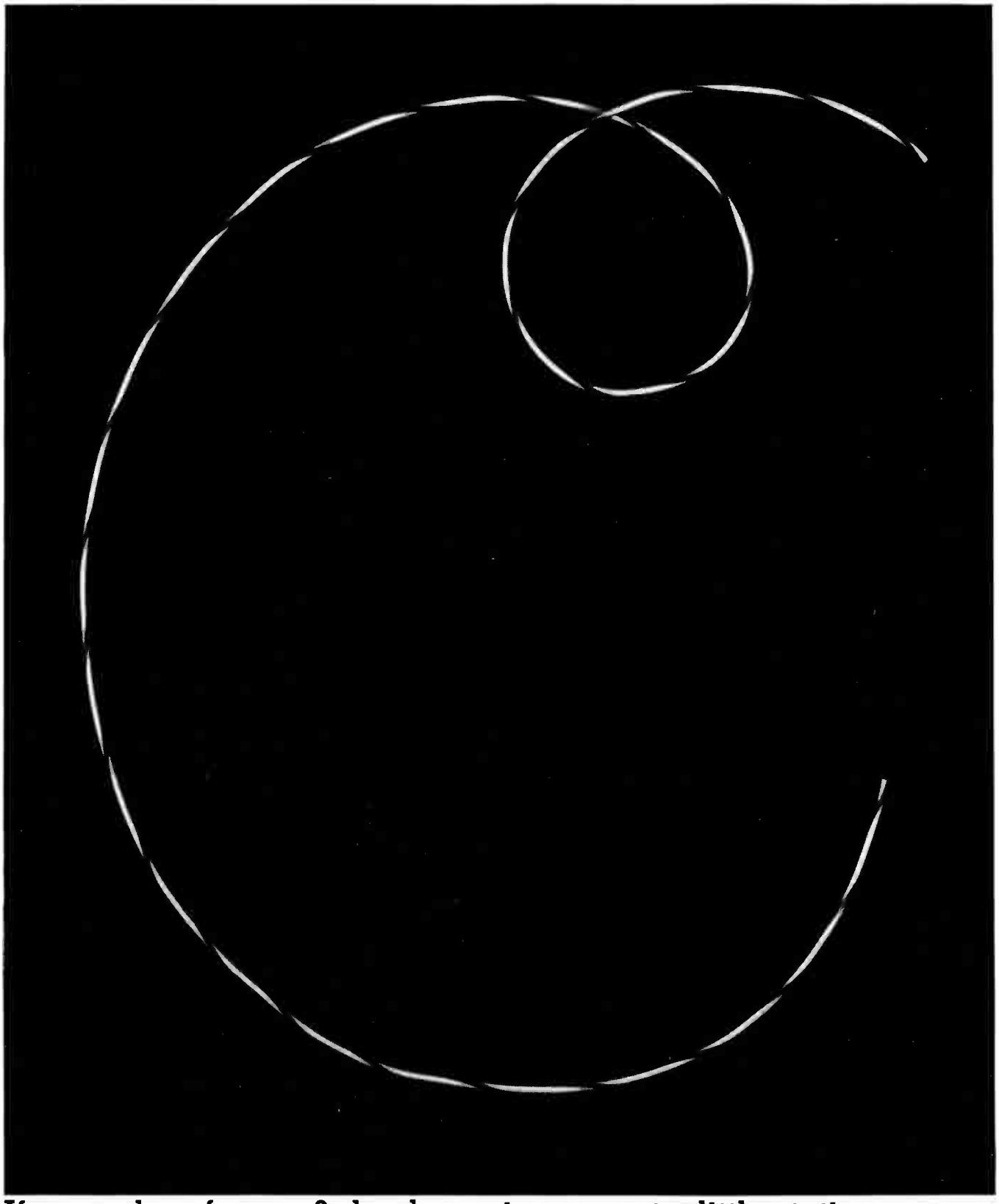

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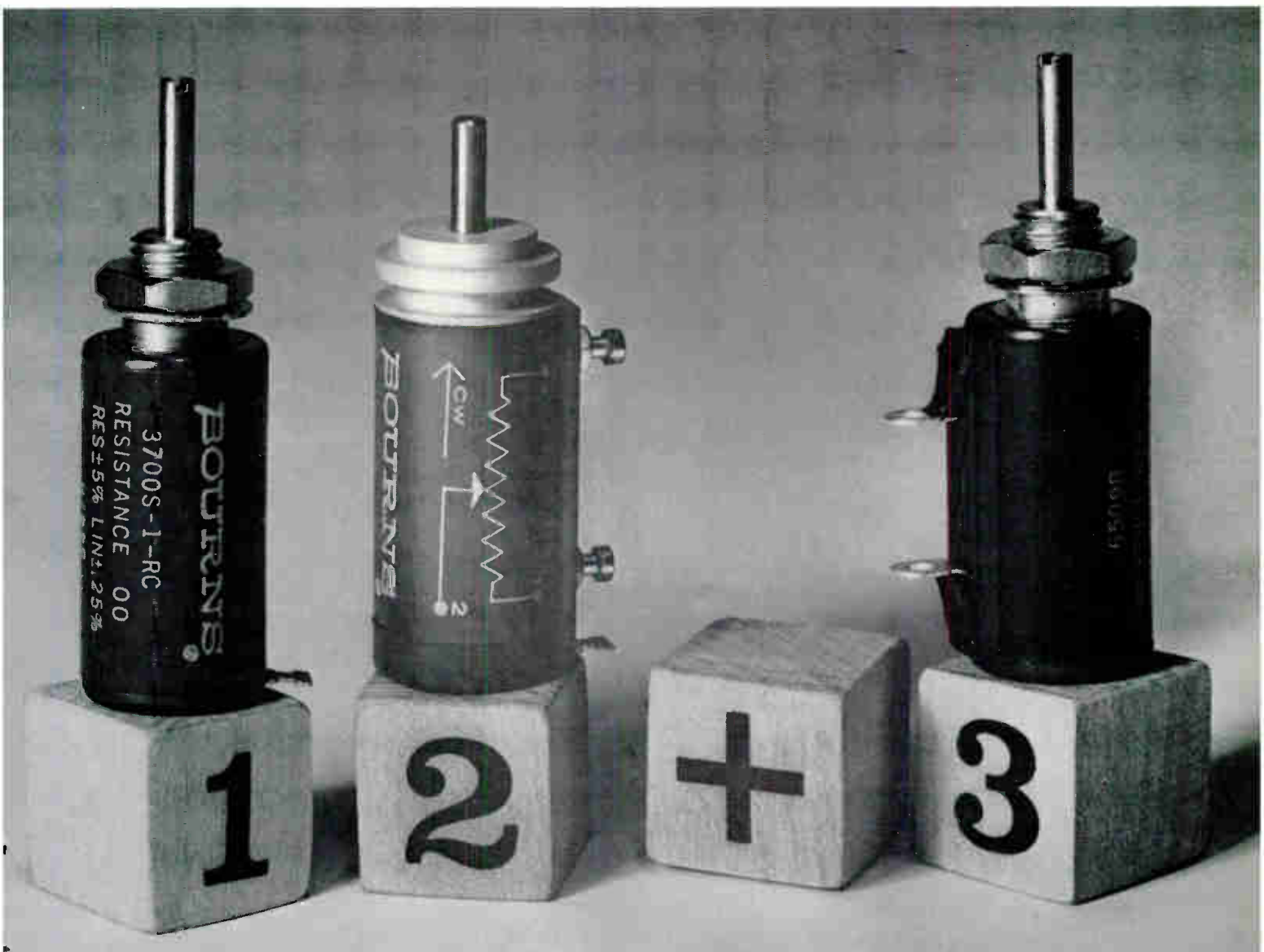

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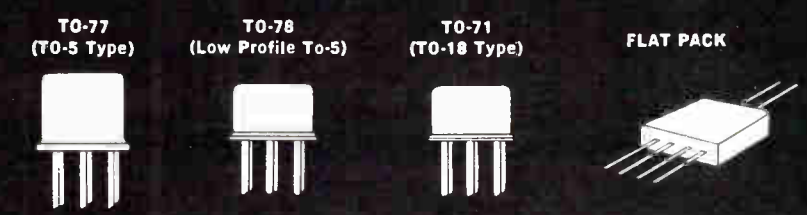

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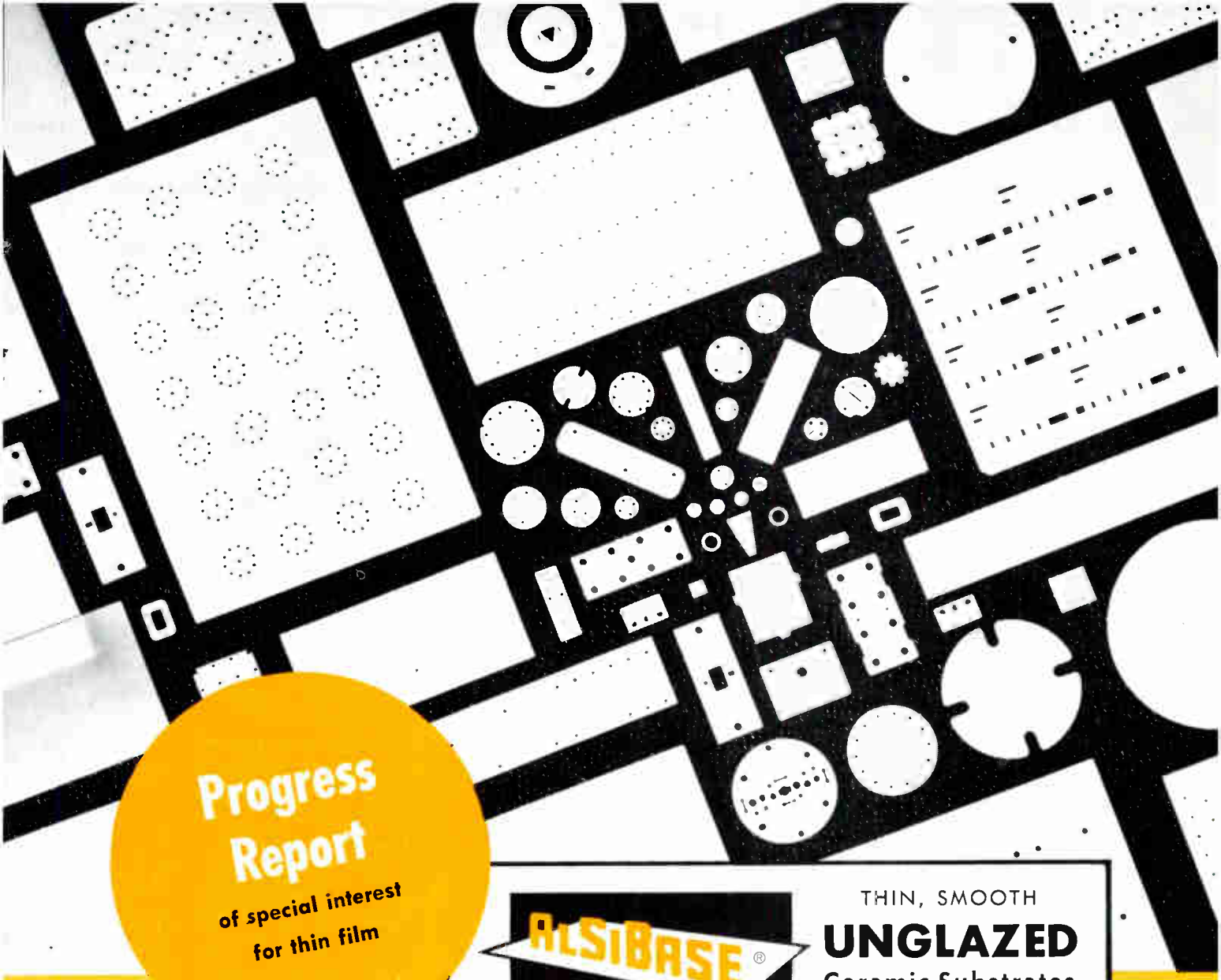

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Circle 42 on Inquiry Card

By J. E. COLE
The Marconi Co., Ltd.,
Chelmsford, Essex, England

Newer design aspects of FM equipment intended for conventional point-to-point work are discussed. Introduced noise, a major problem in microwave design work, is discussed in detail. Methods of calculating and thence overcoming this noise are given. Finally a complete 1800 channel two-way repeater system is described.

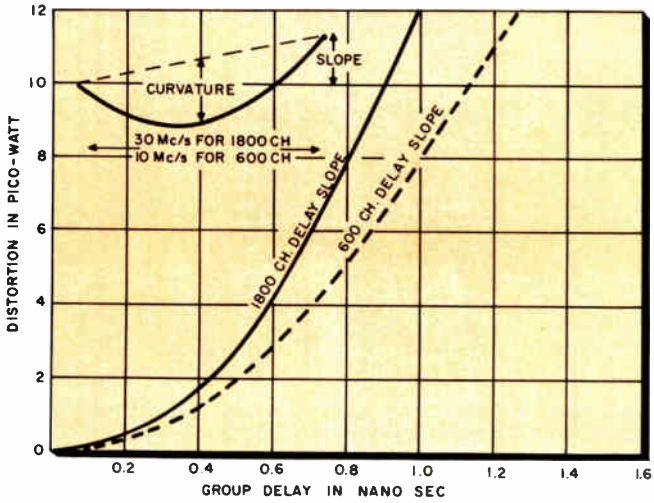

Fig. 1: Noise due to group delay slope.

Design Techniques for Wideband

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FEATURE

OVER THE PAST FEW YEARS there has emerged a radical new development in microwave transmission methods—namely, the use of satellite repeater stations. This is a tremendous advance as now a repeater station is not needed every 30 miles along the route.

The role of these satellite systems seems to be in the field of long-range communication whereas, for relatively short-haul needs, the ground-station repeater system will probably continue to be better and cheaper. In any event it will be years before satellite communication emerges from its pilot-scheme basis to provide a world-wide system. Thus, this article will be confined to some newer design aspects of current FM equipment intended for normal point-to-point work.

Overall Performance

Before going on to specific design details, let's first consider overall performance needs of a normal system.

Modern microwave links are designed to transmit wide bands of modulation frequencies up to 10 MC. Information transmitted may be multichannel telephony service of up to 2700 channels, a TV program, or several channels of radar information.

Of these, the most stringent design requirement is for multichannel telephony. It is only by great care in design that 2700 channels can be simultaneously modulated on a single carrier so that they can be retrieved at the end of a 1500 mile link with negligible distortion and an acceptable degree of added noise. Such a link will carry color TV with sound channel, black and white TV with sound channel, or radar information, without any difficulty.

As introduced noise is perhaps the major factor to be taken into account in microwave design work, this aspect will be discussed in some detail.

The C.C.I.R. requirement for a 1500 mile system is that the signal to noise (S/N) ratio in each channel must not be worse than 53 db. In practice it is usual to assess the ratio by specifying the noise power relative to an arbitrary signal level of 1 mw. Thus, in the 1500 mile system the permitted noise power is 53 db below 1 mw, or 5000 pw. This method of computation has the advantage that successive noise contributions can be easily added. It will be the one used here.

Noise in telephone channels comes partly from the thermal noise generated in the receivers proper and partly from intermodulation between channels. The speech channels are spaced uniformly over the entire video band and the overall effect is as though a random noise signal were spread over the band. Any intermodulation between channels causes an apparent increase in the thermal noise in any one channel. For the total noise allocation C.C.I.R. allows 1250 pw for thermal noise in receivers and 3750 pw for intermodulation noise.

Thermal Noise

Remember that we will discuss only the problems affecting normal ground-station microwave systems. In these, reliable propagation is limited to line-of-sight and repeater amplifiers will be needed about every 30 miles along the route. This means that a 1500 mile system will need 50 repeaters. After making allowance for terminal modulating equipment (say 250 pw), permissible noise for each repeater is limited to 20 pw. This figure defines all major equipment features such

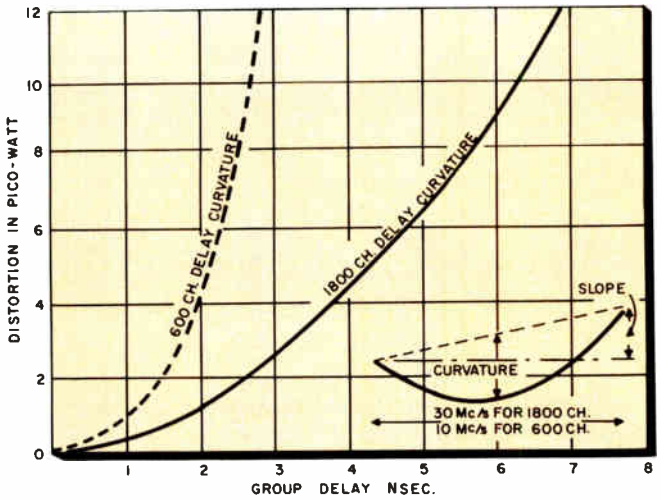
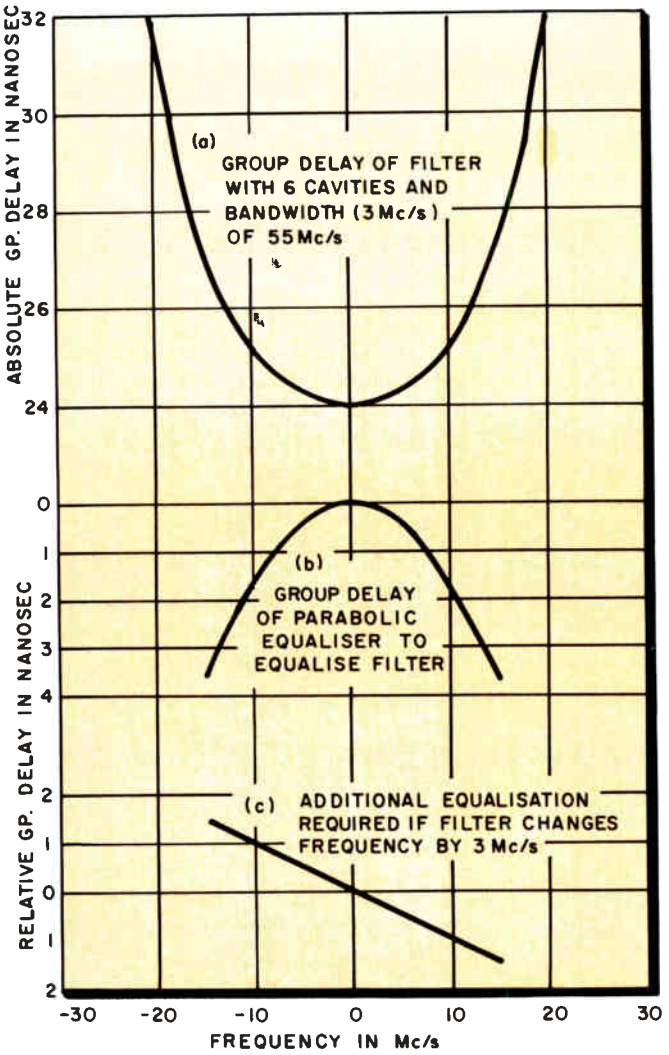


Fig. 2: Noise due to group delay curvature.

Microwave Links

Fig. 3: Group delay of waveguide filter.



as transmitter output power, antenna size, received signal level and noise figure.

Noise introduced by the receiver is $FKTB$ where F = overall receiver noise figure, K = Boltzmann's constant, T = absolute temperature and B = bandwidth in CPS.

Bandwidth of the equipment will be such that the noise around the carrier will be at a substantially uniform level over the bandwidth occupied by the traffic sidebands. Over any bandwidth of 3.1 KC (width of one telephone channel) the noise is $-169 + F$ dbw.

The S/N ratio at the receiver input is

$S - (-169 + F)$ dbw where

S = the signal level at the receiver input.

Now, although the noise above and below the carrier is uniform, this is an FM system and upon demodulation the noise power assumes a triangular distribution with frequency, rising for the highest frequency channels according to the factor

$20 \log \frac{\triangle f}{f}$ where

$\triangle f$ = the RMS deviation per channel and

f = the channel frequency.

In FM systems in which a high degree of frequency deviation is used—e.g., in broadcasting work—this effect is used to improve the S/N ratio. But, for microwave radio link uses, a low figure of frequency deviation has to be used, largely on the grounds of bandwidth economy. Under these circumstances there will be an actual deterioration in S/N ratio. A greater power output is designed into the system to overcome this.

Typically, for a 600 channel system, the deviation is 200 KC RMS and the top channel, where the noise is highest, is at 2.5 Mc. In this instance the FM noise degradation is 22 db. For an 1800 channel system the deviation is 140 KC RMS, the top channel is at 8 MC and the FM noise degradation is 35 db.

Noise in the frequency channels decreases pro rata with frequency decrease, whereas ideally there would be an even distribution of noise over all the channels. In practice this is approached by the use of pre-emphasis on the applied input signal. By this means the deviation in the highest channels is increased by 4 db and that in the lowest channels is reduced by 4 db with appropriate gradations in between. The noise in each channel is now a little more uniform. A 2.5 db improvement in S/N ratio is effected by using a weighting network. This net simulates the selectivity against noise which is provided by the human ear and the telephone earpiece.

Because of all these effects the S/N ratio in the highest channel now becomes:

$S - (-169 + F) - 22 + 4 + 2.5$

$= S - F + 153.5$ db for 600 channels

and

$S - (-169 + F) - 35 + 4 + 2.5$

$= S - F + 140.5$ db for 1800 channels

The S/N ratio must now be equated to the target of 20 pw or 77 db. Thus:

For 600 channels, $S = F - 76.5$ dbw

For 1800 channels, $S = F - 63.5$ dbw

By this means we have now defined the signal level and receiver noise figures needed to meet the 20 pw noise target. We will not discuss here the large variety of combinations of transmitter output power, antenna gain and receiver input stage which will give the needed performance. The choice of these is based mainly on cost factors.

The overall noise figure F used in the design calculations is the noise figure of the complete repeater.

Fig. 4: Formation of an echo.

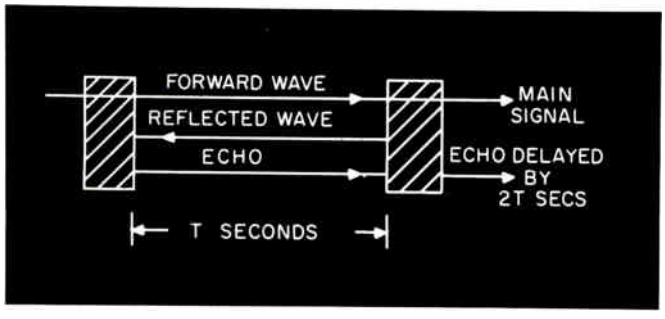
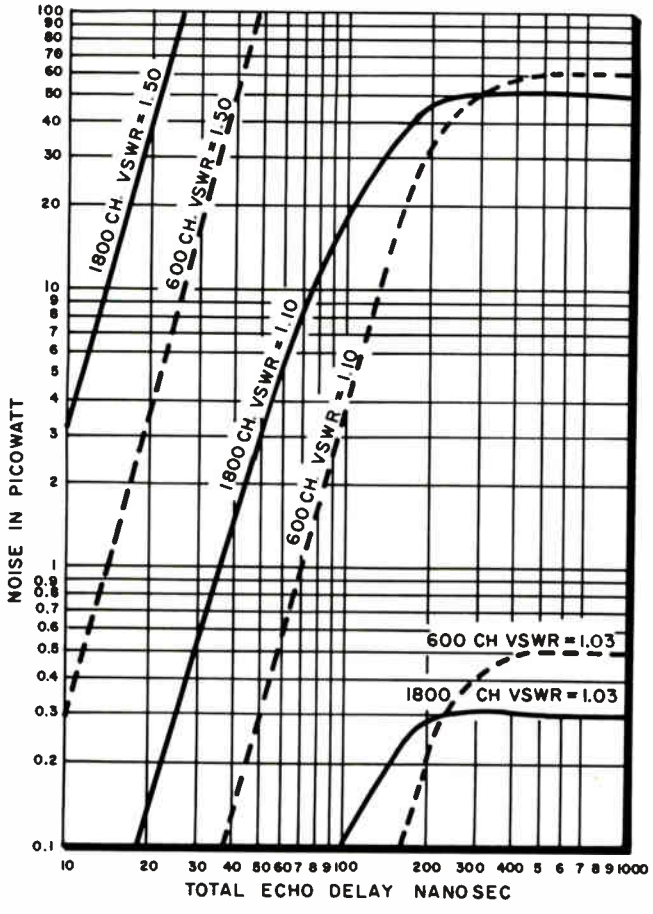


Fig. 5: Noise caused by echoes.



The major contribution to this will always be the first circuit noise, the mixer and the first i-f amplifier stages. But, in high capacity multi-channel work an additional hazard presents itself in the form of noise generated by the travelling wave tube itself. This is because, with a high-capacity system the input signal is high, the amount of protective gain before the TWT is reduced and so the TWT noise figure becomes a significant factor. Thus, in order that the noise contribution of the TWT is not excessive, it may become necessary to drive it with an input signal which is larger than normal. It is worth noting here that a high-gain TWT is a great embarrassment unless it has a correspondingly low noise figure.

TWT's suitable for the output stages of a microwave link now have noise figures of 27 db. The S/N ratio in an 1800 channel system is $S - F + 140.5 = S - 27 + 140.5$ db.

If from the 20 pw (77 db) noise for the complete repeater we can afford to allow 2 pw (87 db) for the TWT, then the S/N ratio which may not be exceeded is 87 db. Thus:

$87 = S - 27 + 140.5$

$S = -26.5$ dbw

This shows that a TWT with a 27 db noise figure should be driven with an input signal of 2 mw.

Intermodulation Noise

The remainder of the noise allocation (3750 pw) is reserved for intermodulation between channels. This distortion in FM links is caused mainly by:

(1) Non-uniform group delay in the bandwidth occupied by the first and second order FM sidebands.

(2) Echo distortion caused by successive reflections against mismatched impedances.

(3) Interference from parallel radio channels.

(4) Leakage or feedback within a repeater.

(5) Conversion of amplitude variations to phase variations (AM to PM conversions occurring in TWT's and limiting transistor amplifiers).

These effects exert a major influence on bandwidth and selectivity of the i-f and microwave filters and also on the magnitude of impedance mismatches throughout the equipment. Thus, each demands careful consideration to achieve the desired parameters of the system.

Group Delay Variations—Group delay variations distort the modulation because the relative timing of sidebands and carrier is upset. They may be grouped into two general categories. These are 'group delay slope' which alters the phase of the two sets of sidebands relative to one another, and 'group delay curvature' which alters the phase of the sidebands with respect to the carrier. Of the two, the group delay slope effect produces much the worse distortion.

The noise power is proportional to the square of the group delay variation. So, if successive repeaters have similar group delay variations, the noise will add according to the square of the number of repeaters. Ob-

(*Text continued on page 62*)

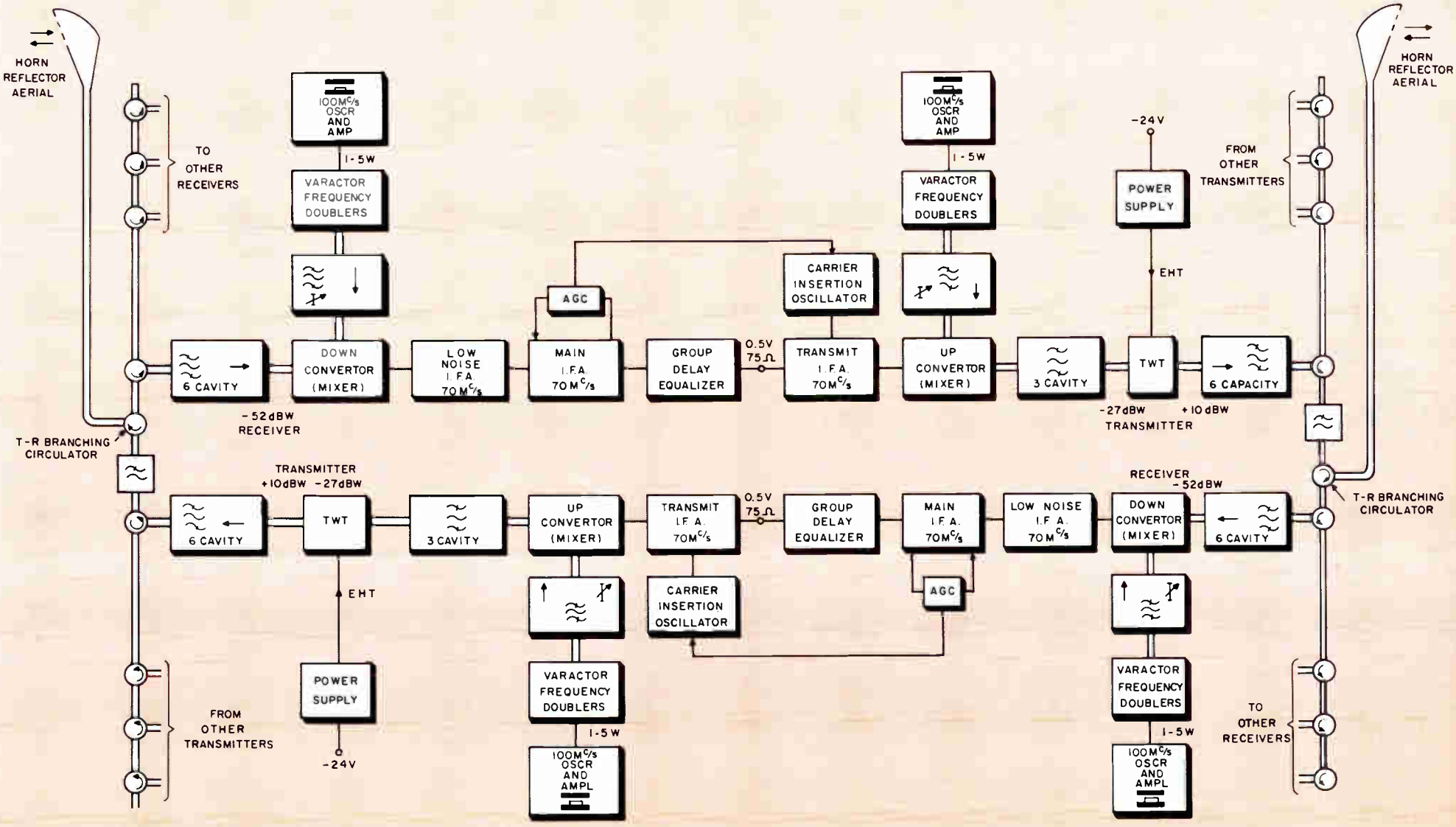


Fig. 6: An 1800 channel two-way repeater.

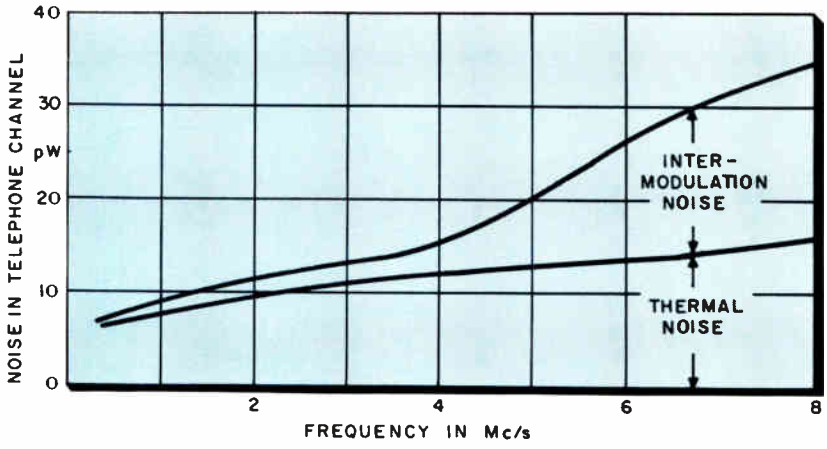


Fig. 7: Noise in a repeater (less feeders).

viously then, the allocation of 3750 pw would not go far amongst 50 repeaters.

This is overcome by designing the equipment so that the group delay of each repeater is equalized by special networks having inverse group delay characteristics. For complete effectiveness it is wise to aim at equalizing the group delay over the bandwidth occupied by the first and second sidebands of the highest modulation frequency, namely, over ± 5 MC for 600 channels and over ± 16 MC for 1800 channels.

After adjustment of the equalizers, the residual group delay variations should be random enough for them to cease to be directly additive and the distortion noise powers should once again add directly.

The curves of Figs 1 and 2 show the noise due to group delay slope and curvature. These curves enable the noise which is generated by group delay distortion to be calculated.

There is another form of group delay slope distortion which can be introduced by the effect of temperature upon waveguide filters. Normally, these filters are made from brass or copper waveguide, and so when the temperature rises the metal expands, increasing the lengths of the resonant cavities; conversely a drop in temperature produces contraction and a shortening of the cavity lengths.

Because of this, the whole frequency response, including the group delay response, is shifted bodily in frequency, the observed change at 6000 MC being about 1 MC per 10°C temperature change. Whenever the temperatures at all the repeater stations change simultaneously (e.g., at nightfall or at the onset of winter) the increase in noise power is large, as the noise introduced is proportional to the square of the group delay slope.

(A typical filter group delay response is shown in Fig. 3a. Response of an appropriate equalizer is shown in Fig. 3b and group delay slope for a change of 30°C is shown in Fig. 3c. The consequent distortion may be deduced from Fig. 1.)

The most common solution is to use filters made from low expansion steel (invar), but an alternative method is to stabilize the temperature of the equipment rooms.

Echo Distortion—When the reverse wave formed by reflection against a small mismatch is again reflected against another mismatch, an echo is created, Fig. 4. This echo is a source of distortion, which is aggravated if the echo amplitude is large and if the delay time of the echo is large.

The average distortion noise in the top channel for two equal mismatches (1.03 to 1.50) and various echo delay times, may be deduced from the graphs in Fig. 5.

Echo distortion is best eliminated at the source. The only satisfactory solution lies at the design stage, when every effort should be made to obtain accurate terminations and source impedances at both the microwave and intermediate frequencies.

In the waveguide feeder system connecting the equipment to the antenna, the echo delay time is inevitably large; in normal-sized waveguide it can amount to some 1.5 nsec./ft. Thus, in a feeder 150 ft. long the total delay time for the echo is about 450 nsec. Even with a VSWR of 1.1 at each end of the feeder and neglecting the mismatch of any intermediate bends, the average distortion is 50 pw, though in practice the echo amplitude is somewhat reduced by attenuation of the waveguide.

It follows that great care must be exercised in the installation of waveguide feeders, particularly for the highest capacity systems. Waveguide apertures of successive waveguide sections should, for instance, be accurately aligned with dowel pins. One modern approach to the avoidance of this hazard of echo distortion is to mount the antennas on the ground, pointing upwards to an inclined passive reflecting plate on the mast. Alternatively, the microwave equipment may be mounted at the mast head. In either event elimination of feeder attenuation enhances the S/N ratio.

Similar problems of echo distortion exist at intermediate frequencies. Delay time in polythene filled coaxial cable is 1.7 nsecs./ft. Thus, whenever cable length exceeds 10 ft., special attention must be paid to the accuracy of the terminating and source impedances.

Echo distortion also occurs in waveguide filters, and in high-Q filters the delay time is quite large. For maximally flat filters it can be computed from the equation:

$$\text{Delay (in seconds)} = \frac{K}{\pi B}$$

Where K = 2.0 for a 3 cavity filter
= 2.6 for a 4 cavity filter
= 3.9 for a 6 cavity filter

and B is the bandwidth in MC.

For a typical filter used in an 1800 channel equipment, the delay at the center frequency is 24 nsec., giving a total delay of 48 nsec. To maintain low echo distortion, the impedances next to the filter should have a VSWR of less than 1.05.

In practice, where a filter is next to a mixer or TWT of uncertain VSWR, a ferrite isolator should be placed next to the filter so that low echo distortion is assured.

Interference from Parallel Radio Channels—To increase the traffic capacity along a given route it is customary to use several radio frequencies along one path. Several sets of equipment may be provided at each terminal and repeater station and the outputs from several transmitters connected in parallel to a common antenna. Inputs to the receivers are likewise derived from a common antenna.

All units of a system which must operate under these circumstances call for very careful design. The following are some of the main issues in this connection:

(1) The branching arrangements must be carefully designed to prevent mutual interference between radio channels.

(2) The i-f amplifier selectivity must be such that interfering signals close to the carrier will not appear at the input to the final demodulator.

(3) The receiver microwave filter must provide selectivity to a degree which ensures that the interfering signals appearing in the image region and other sensitive areas of the receiver are sufficiently attenuated.

(4) The transmitter filter must attenuate all unwanted outputs of the transmitter, (especially those generated in the up-converting mixer), so that the chance of interference in adjacent receivers is minimized.

Leakage or Feedback within a Repeater—Another form of intermodulation noise is brought about by r-f leakage from a transmitter into a receiver. If, for instance, the leakage signal is 70 db down when it enters the receiver, and if it falls within the modulation band of the receiver, then the distortion noise in the affected channels will be 1 pw. The transmitting frequency of a repeater is usually made different from the received frequency; but there is still a chance that the leakage signal will be positioned on a sensitive region of the receiver or that it may cause trouble in adjacent receivers. Leakage directly into a receiver can be especially troublesome if it enters at a point beyond the protective waveguide filter.

Thus, special care must be taken over the tightening of waveguide couplings, the screening of i-f amplifiers, leakage from waveguide tuning screws, leakage from TWT mounts and the decoupling of power supply leads. In practice, leakage from or into a carefully tightened waveguide coupling is about 80 db and well-designed TWT mounts meet 65-70 db.

The worst situation exists if there is leakage directly between transmitter output and receiver input. The difference in level between these two points is 70 db and the attenuation of the complete leakage path must be at least 140 db if the noise is to be kept below 1 pw.

Conversion of Amplitude Variations to Phase Variations—In some devices, a change in amplitude of the input signal causes a variation in phase shift through the device. This means that amplitude variations or modulation will be converted to phase modulation. This spurious phase modulation creates distortion of the original FM traffic, and shows up as intermodulation noise.

The effect is particularly evident in TWT's, and in this case there are two ways of minimizing the intermodulation noise.

(1) The amplitude variations are reduced by arranging that the up-convertor, which is positioned just before the TWT (Fig. 6) should act as a limiter. By driving the up-convertor at a high 70 MC level, effective limiting can be obtained.

(2) By operating the TWT at less than peak power output, the AM to PM conversion may be reduced.

Complete Equipment Design

By using design methods outlined here, it is possible to design complete microwave link systems to meet a specified performance.

In Fig. 6 is shown the diagram of an 1800 channel two-way repeater (the Marconi H700 for 4000 or 6000 MC) designed on the principles discussed here.

The equipment uses all the most modern circuit techniques; transistorized 70 MC broad band i-f amplifiers; quartz crystal controlled local oscillator chains consisting of 100 MC transistor oscillator and amplifiers followed by varactor frequency multipliers specially designed for low FM noise; permanent-magnet TWT mounts; ferrite isolators and ferrite three-port circulators, and transistorized extra high voltage supplies for the TWT.

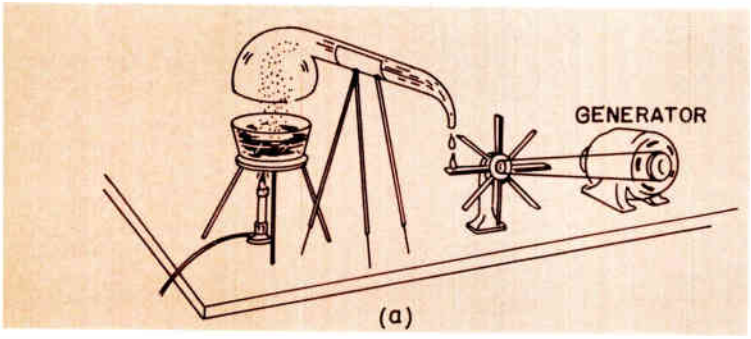
The extensive transistorization has enabled all the thermionic tubes (except the TWT) of previous equipments to be removed. The consequent saving in power supplies has made it possible to build a complete two-way repeater into a single 19 in. wide equipment bay.

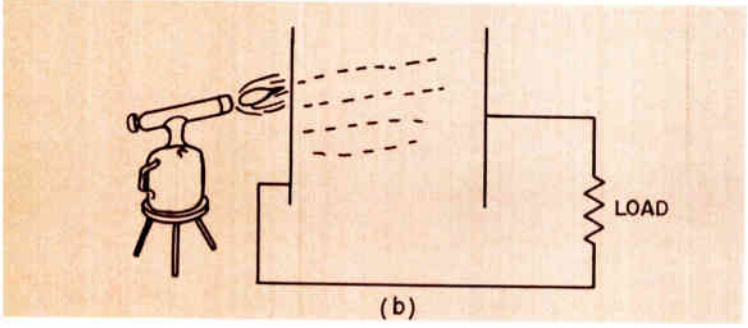
Thermal and intermodulation noise figures have been measured and the results are given in Fig. 7. These are very much as were predicted at the design stage of the equipment.

Acknowledgement

The author wishes to acknowledge the help of his colleagues in the preparation of this article and expresses his thanks also to the Director of Engineering & Research, The Marconi Co., Ltd., for permission to publish it.

Understanding Plasma Diodes and Amplifiers





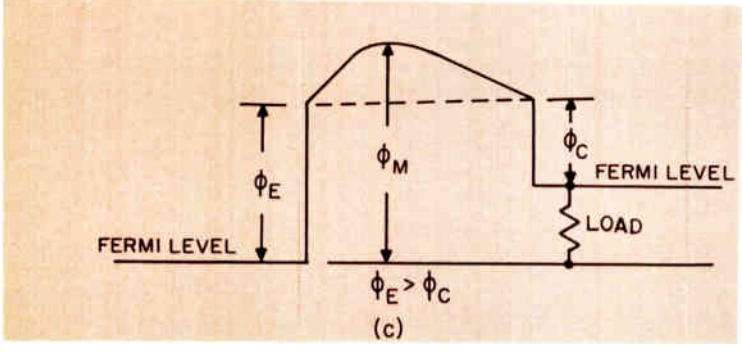


Fig. 1a: The thermionic diode operation is roughly analogous to the device sketched in the top drawing. In (1b) electrons are emitted thermionically, as in a diode, and give up their potential energy to the collector. The bottom drawing (1c) is a potential energy diagram for both of the systems above. Thermal energy is given electrons or water molecules until they have enough energy to overcome the barrier of height. Overcoming the barrier, they reach the collector and give up their energy to the load. Dashed line indicates the barrier.

By DR. LEON ZELBY
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Moore School of E. E. and
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Plasma devices are gaining in popularity as a result of improvements in technology and better understanding of gaseous discharges. Two new devices, representing two diverse uses of gaseous plasmas, are described and the principles of their operation are discussed.

IT WOULD BE DIFFICULT to estimate the fraction of the total power consumption which is used by plasma devices. All one needs to consider is the mercury vapor lamps lighting the streets and highways; neon signs in use; mercury pool rectifiers, power tubes and others in power stations; circuit breakers in distribution stations and many others. There is also another class of plasma devices which appear more "glamorous" whether because of the application, relative paucity, or novelty. To these belong the plasma amplifier, thermionic plasma diode, MHD generator, plasma propulsion engine, and laser.

It is the purpose of this article to discuss two of these —the plasma diode, and plasma amplifier. The reasons for selecting these two are that, first, they are now available; and second, they show the use of two principles.

The plasma diode can be considered a thermodynamic engine with electrons as the working fluid whose potential energy is converted to a useful output. The plasma amplifier, on the other hand, converts the kinetic energy of the plasma electrons to a useful output. In the diode, the plasma provides reduction, or elimination, of the local space charge; in the amplifier, the plasma provides enhancement of the local space charge. The apparently opposite functions of the plasma in these two devices can be reconciled if we realize that the plasma interaction region in the amplifier is several hundred times longer than that in the plasma diode.

The diode is a low voltage, high current device; the amplifier, a high voltage low current device. The amplifier is a low pressure (approx. 20-50 microns), and the diode a relatively high pressure (approx. 1mm = 10^3 microns) device.

Of the other new devices, the MHD generator and plasma propulsion engine are still in the experimental or pilot stage. And the laser has received much publicity already.

Plasma Diode (Thermionic Converter)

The operation of a thermionic diode can be explained on the basis of the mechanical analogue shown in Fig. 1a, somewhat reminiscent of a Rube Goldberg device. Water vapor, heated by the burner, rises and converts the kinetic energy of the water vapor molecules to potential energy of the condensate. On falling down, water droplets drive the paddle wheel which is connected to a load, a drive wheel of a machine, say. In the diode, Fig. 1b, electrons are emitted thermionically from the emitter. On reaching the collector, they give up their potential energy in the load as electric current.

Fig. 1c represents a potential energy diagram for both systems. Thermal energy is given electrons, or water molecules, until they have enough energy to overcome the barrier of height ϕ_M. Once they overcome the barrier, they reach the collector and give up their potential energy in the load. Generally, the height of the barrier is equal to the difference of the work functions of the emitter and collector, i.e., $\phi_E - \phi_C$. The local space charge formation, however, increases the barrier to a height ϕ_M.

Reduction of the distance between the emitter and collector reduces the effects of the barrier height increase. Unfortunately, the spacing must be very small (tens of microns). This creates mechanical problems, particularly when surfaces are heated.

To avoid some of these problems, plasma has been used to overcome the increase in barrier heights by space charge neutralization. This, ideally, results in a barrier of the type indicated by the dashed line in Fig. 1c. A more realistic potential energy diagram of a plasma diode is shown in Fig. 2a, with the corresponding charge density distribution (Fig. 2b), and a pictorial representation (Fig. 2c). The line connecting the two sheaths in Fig. 2a is slanted due to the finite conductivity of the plasma, with V_P representing the voltage drop across the bulk plasma. Comparison of Fig. 1c and Fig. 2a shows very clearly the reduction in the barrier height due to space charge neutralization. The positive sheath at the emitter serves another useful function. The electrons leaving the emitter find themselves in the accelerating field of the sheath so that they enter the bulk plasma with increased velocity and contribute to the degree of ionization by collisions with neutral molecules.

Some typical operating and technical data of the thermionic plasma energy converters are as follows: emitter to collector spacing of about 200 microns; cesium at pressures of about 1 torr; emitter temperatures at about 1800°K; emitter material tungsten, molybdenum; emitter area generally several square centimeters; power output about 20 w/cm² at a voltage of about 0.5-1.0 v; efficiency about 10-15%.

Much work has gone into development of new work function materials for use as collectors. Work function materials of about 1 ev are used in the more efficient converters, since that too contributes to the reduction of barrier.

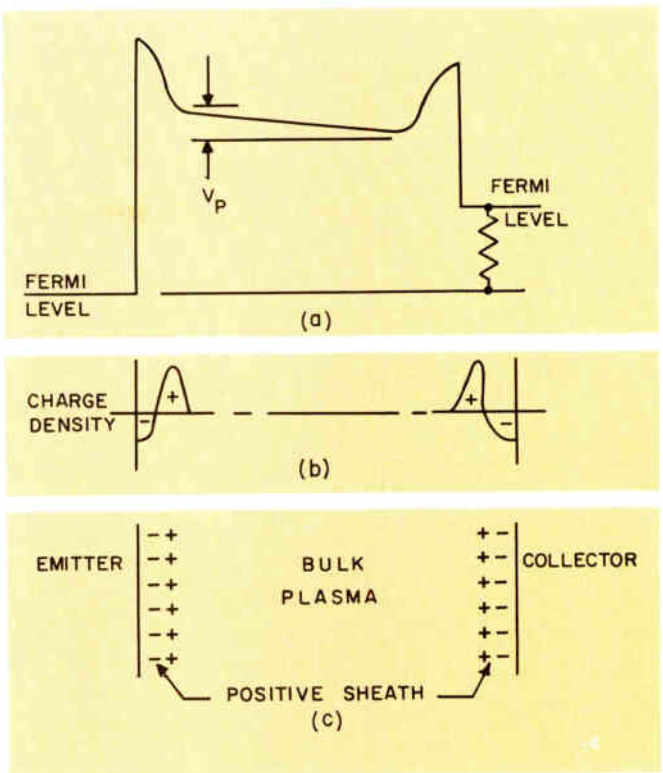


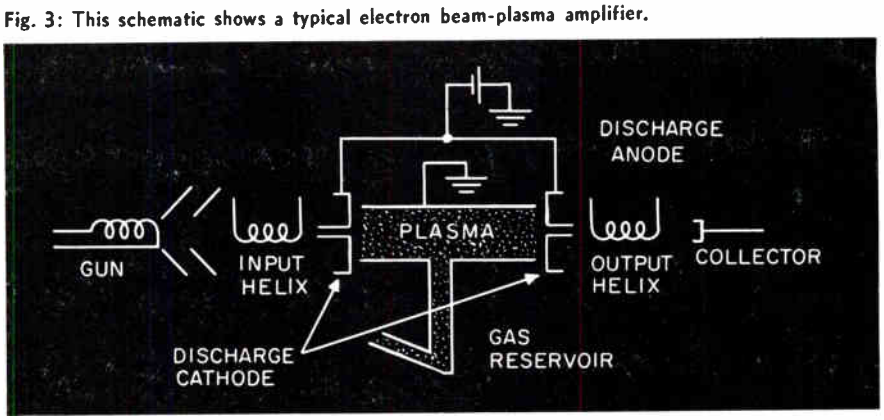
Fig. 2: Here is a more realistic potential energy diagram of a plasma diode (a), with the corresponding charge density distribution (b), and a pictorial representation (c).

Plasma Amplifier

Whereas plasma acts only as a "neutralizer" in the plasma diode, it acts as the "active" medium in the plasma amplifier. Its degree of activity is measured in terms of electronic gain, the decibel equivalent of the ratio of the output powers in presence and absence of plasma, other conditions being maintained equal. A schematic of a typical electron beam-plasma amplifier is shown in Fig. 3. The growth constant, in the case of a cold, collisionless plasma is

(*Continued on following page*)

Fig. 3: This schematic shows a typical electron beam-plasma amplifier.



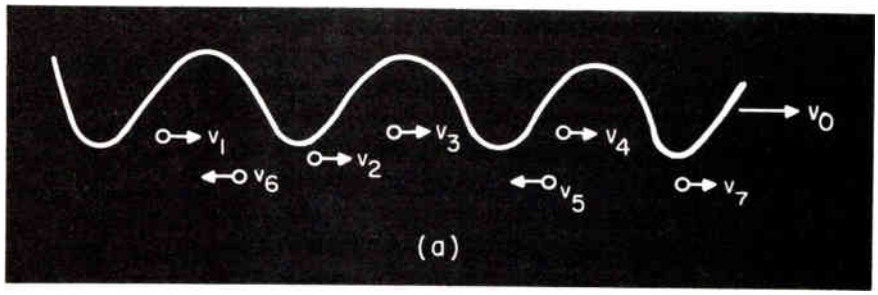
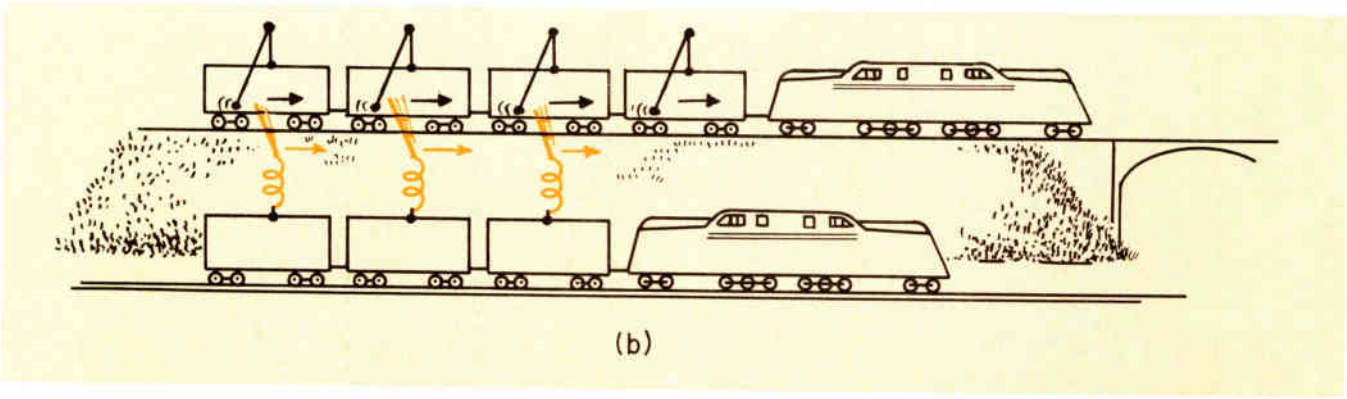


Fig. 4a: Amplification can be discussed in terms of transfer of kinetic energy of plasma electrons to the wave on the beam, sketched here. 4b illustrates the mechanical analogue of an amplifier.



$$\alpha = \frac{\Omega_p}{v_o \left(\frac{\omega^2_p}{\omega^2} - 1 \right)^{1/2}}$$

where Ω_p and ω_p are related to the electron density of the electron beam and plasma, respectively; v_o is the average velocity of the electron beam; and ω is the signal frequency. Note that for real α, ω must be smaller than ω_p. To keep the electron beam from scattering, the gas pressure must be rather low (of the order of microns). Yet, to maintain $\omega_p > \omega$, the degree of the ionization of the gas must be high. The relatively low gas pressure is consistent with the assumption of collisionless plasma, so that the extremely simple expression for α represents a fair approximation.

The mechanism of amplification due to interaction of the electromagnetic wave on the electron beam with plasma can be discussed either in terms of interaction of two intermixed streams of different velocities, i.e., plasma ($v = 0$) and electron beam ($v = v_0$). Or it can be discussed in terms of transfer of kinetic energy of plasma electrons to the wave on the beam. Since this latter lends itself more easily to pictorial representation, it will be considered here.

A sketch of the wave on the beam is shown in Fig. 4a. To an observer moving with velocity v_0 the wave appears stationary. From this frame of reference, we see the plasma electrons moving in various directions with velocities $v_1, v_2, \ldots v_n$. The electric field of the wave will accelerate some of these electrons, decelerate some, and will have no net effect on others. The electrons that move with velocities slightly greater than v_0 will appear nearly stationary with respect to the wave. If they are in proper phase, they will be decelerated by the electric field of the wave, their kinetic energy will be reduced, and the energy of the wave will be increased. Those electrons whose velocities are substantially different from v_0 will periodically gain and lose energy from and to the wave with a zero average energy transfer. The amplification requires then a suitable velocity distribution of the plasma electrons about the average electron beam velocity v_0. The requirement of near synchronism between the wave and plasma electrons is the same as that in standard traveling wave tubes between the wave on the electron beam and the wave on the structure.

The mechanical analogue of this amplifier in Fig. 4b shows two trains running on parallel tracks. One train has suspended oscillating pendula; the other oscillating vanes. Energy can be transferred from one to the other provided the train speeds are nearly the same. The device which is on the train that moves slightly faster than the other will lose energy. The energy will be transferred to the device on the other train and will result in increased amplitude of its oscillation.

One of the most important advantages of using plasma for amplification is its power handling capability at high frequencies (millimeter wavelengths). In this, plasma replaces the small structures which, due to extremely small tolerance requirements and small heat dissipation capability, lose their usefulness at such frequencies. Another advantage of use of plasma is the high electronic gain.

Some typical operating characteristics of such amplifiers in X-band are: electron beam voltage near 1 kv; beam current few milliamperes; gas pressure of the

(*Continued on page 70*)

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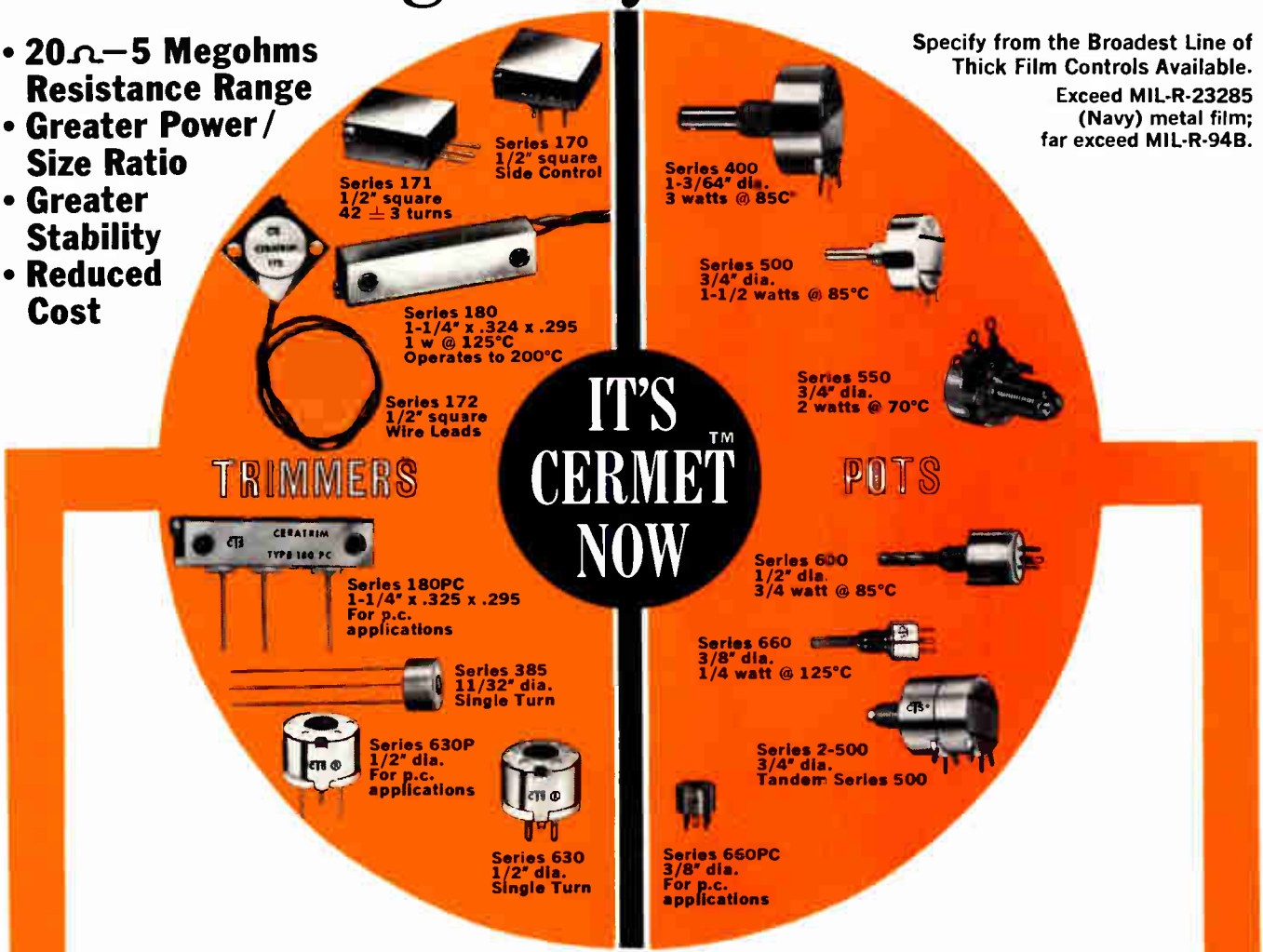

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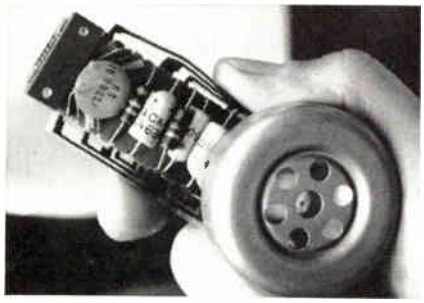
Report from

BELL LABORATORIES

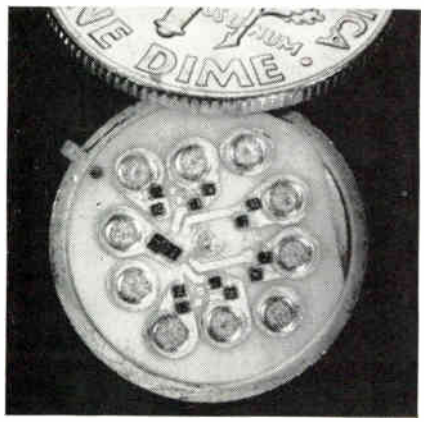
New circuits for communications

The success of a modern large-scale communications system depends importantly on the circuits of which it is built. For this reason Bell Telephone Laboratories places great emphasis on exploring new approaches to high-performance, economical circuit design. The circuits illustrated below are but a few examples of recent Bell Laboratories developments that are helping to advance the techniques of communications.

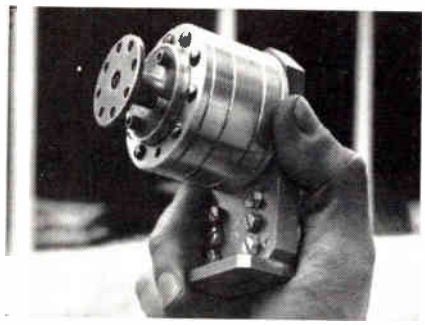
Bell Telephone Laboratories
Research and Development Unit of the Bell System



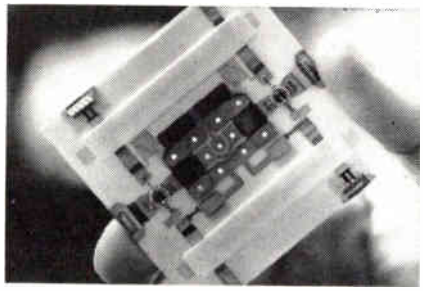
Circuit for mounting inside telephone handset for use by people with impaired hearing. Circuit includes one PNP transistor, provides up to 25 db gain, and has negative feedback for stability and to compensate for variations in component characteristics. Power is derived by taking a small part of direct current supplied to the telephone transmitter. Circuit board is flexible to permit part of conducting path to be bent and entire unit to fit snugly in narrow handset.



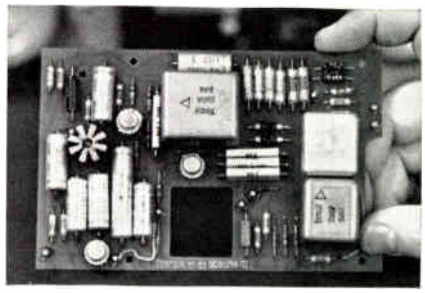
High-speed integrated logic package consists of 3 separate flip-flop circuits assembled together on a single header. On the 11-lead ceramic header, all circuit interconnections are made using gold thermocompression bond wires. This device contains 6 transistors (2 are required for each flip-flop) and 12 resistors. The individual flip-flops perform their switching functions with typical operating times of approximately 6 nanoseconds.



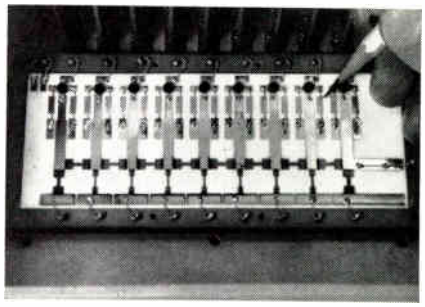
Parametric amplifier used in new microwave radio system will provide low-noise amplification to a radio frequency signal which is frequency-modulated by 1200 telephone conversations. It is a reflection type parametric amplifier operating in the 4-gigacycle range, providing approximately 13 db of gain using a varactor diode pumped at approximately 12 gigacycles. Its very low noise figure, typically 3.5 db, permits increased systems capabilities which are used to increase the number of telephone channels per radio channel.



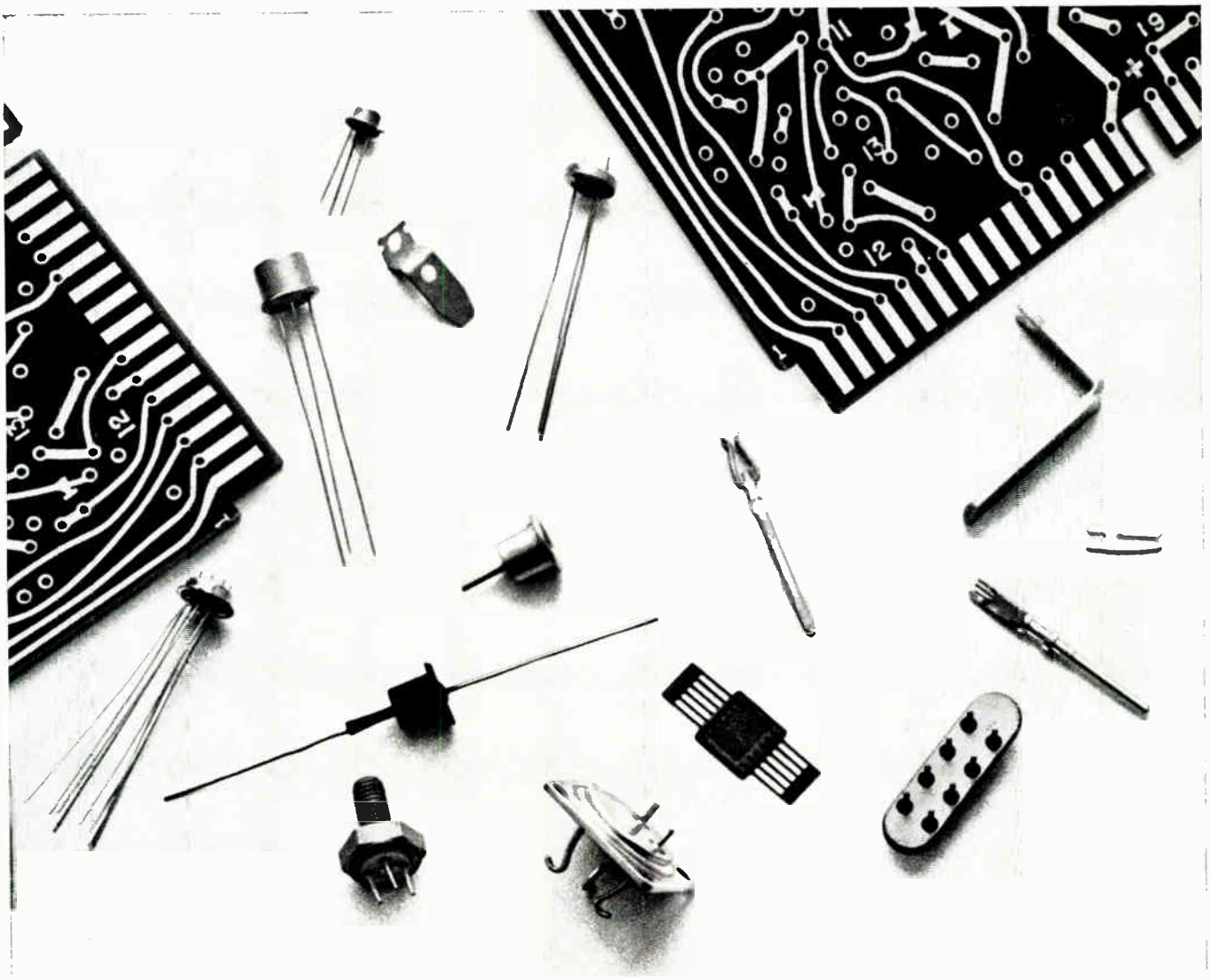
Integrated balanced microwave amplifier makes use of high-frequency germanium transistors for precise wideband applications. Each stage of amplifier (one stage shown) consists of a pair of electrically similar transistors whose inputs and outputs are combined by 3-db couplers. This arrangement eliminates tuning adjustments and provides excellent gain flatness and impedance matching. Multistage amplifiers of this type have been designed to operate with bandwidths of 1000 mc in the 0.5- to 3-gigacycle range, with noise figures of about 6 db.



Compressor circuit used in several telephone carrier systems raises volume of soft voice sounds and lowers volume of loud voice sounds. This new circuit effects a 2-to-1 reduction in dynamic range of a telephone signal, which is then transmitted with an improved signal-to-noise ratio. Nearly perfect compression is achieved over greater than the normal voice range, as a result of circuitry that varies the impedance of two precise silicon diodes. A 3-stage feedback transistor amplifier maintains desired stability and provides the required transmission characteristics.



Thin-film decoder for high-speed pulse code modulation systems converts binary pulse sequences into analog signals. Circuit consists of precision resistor network and multiply-encapsulated control diodes. Precision resistors (pointer) generate reference currents that are switched into resistive ladder network (I-shaped elements at bottom of unit). Output voltage is proportional to binary code applied to diodes. Precision sufficient for decoding 9-digit binary codes is obtained, at code rates up to 12 mc (108 mb/s pulse rates).



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PLASMA DEVICES (Concluded)

order of microns; beam-plasma interaction length a few centimeters; electronic gains about 20 db/cm; net gain of a tube is about 30 db.

The plasma diode, at least now, is primarily a device for use in space vehicles. In land based systems, it can be used with some other generating devices, using their rejected heat. This tends to increase the overall output and efficiency of the system. As a basic generator, however, it is not very useful in land based systems because of the low efficiency. Plasma diodes are available and are produced by RCA, Lancaster, Pa., and The Thermo Electron Engineering Co., Waltham, Mass.

The present day plasma amplifiers are not quite "off-the-shelf" items, with many models still in the experimental stage. They are useful in the range above 1GC for reasons mentioned above. The fact that they are more noisy than other TWT amplifiers makes them somewhat less desirable. Microwave Associates of Burlington, Mass. are quite active in the area of plasma amplifiers.

Selected Bibliography

PLASMA DIODES

1. *Proceedings of Government—Industry Thermionic Roundtable Discussions,* Power Information Center, University of Pennsylvania, June and December 1961.
2. *Symposium on Thermionic Power Conversion, Advanced Energy Conversion,* Vol. 2; July-September, 1962.
3. Report on the Thermionic Conversion Specialist Conference, Gatlinberg, Tenn.; October, 1963.
4. P. J. Brosens, "Solar thermionic generators for space power, *"Trans. of the ASME,* Series A, vol. 87, No. 3, pp. 281-289, July, 1965.

PLASMA AMPLIFIERS

1. *Proceedings of the Symposium on Electronic Waveguides,* Brooklyn Polytechnic Inst., Brooklyn, N. Y.; 1958.
2. *Proc. of the Symposium on Millimeter Waves,* Brooklyn Polytechnic Inst., Brooklyn, N. Y.; 1959.
3. *Proc. of the Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma,* Brooklyn Polytechnic Inst., Brooklyn, N. Y.; 1961.
4. *Wave Interaction and Dynamic Non-Linear Phenomena in Plasmas,* Penna. State University, University Park; 1963.

DATA RECORDING SYSTEMS will be installed in 42 MATS C-133's by Lockheed Aircraft Services Co. to help pinpoint the cause of aircraft accidents. The $4.5 million contract was awarded by the Air Force Logistics Command. Recording system retains a 15-hr. continuous record of critical aircraft engine and systems operations. A four-channel voice recorder also retains a 30-min. continuous loop tape record of all cockpit area and pilot to crew conversation. Recorder also contains a beacon to signal aircraft location in case of an accident.

HIGH TEMPERATURE BATTERIES capable of withstanding temperatures of 293°F for 100 hrs. prior to operation in a spacecraft are being designed by Douglas Aircraft for NASA. The batteries could be used for on-board power where extended charge and discharge cycles and the need for sterilization of the spacecraft are needed. Ten silver-zinc multi-plate cells with a capacity of 5 amp hours will be produced. The cells must be able to be recharged as much as 1500 times, be very light weight, operate in any position and withstand shock, acceleration and acoustic stresses.

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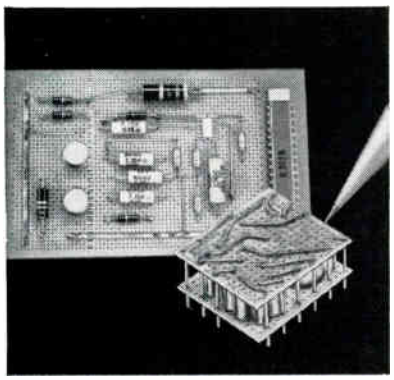
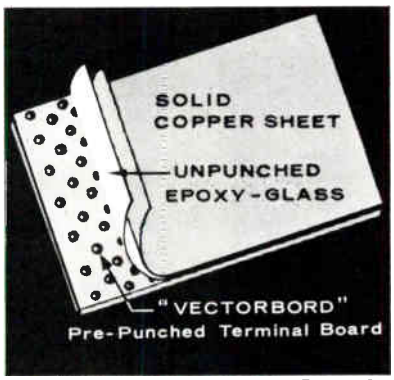


New Micro-Miniature Pre-Punched Insulating Board and Terminals – New Micro-Vectorbord is perfect as a holding matrix for making cordwood modules, and for mounting integrated circuits and discrete components. Dense small hole grid patterns and micro-miniature Push-In terminals, connectors, etc., permit high component densities. Made of epoxy glass in 4 grid patterns: 1/64" to 1/32" thick. Copper clading if required. Frames for stiffening and mounting in card guides. Plugbords with edge mounted Miniature Elco Varicons available 9-52 contacts spaced .05 centers.



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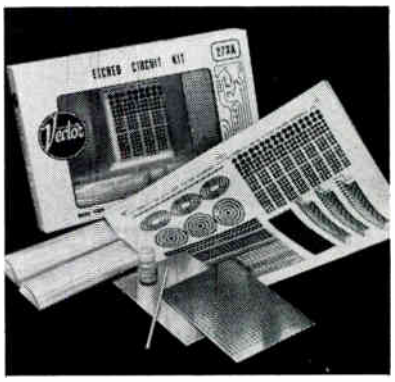
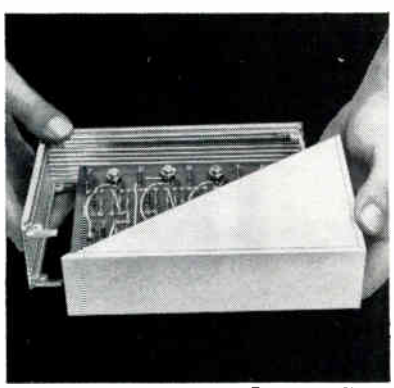
Copper Covered Sheets of Holes – COPPCO Vectorbord utilizes unpunched sheets of 2 oz. copper bonded to pre-punched insulating board with an adhesive liner of thin unpunched epoxy glass. The result is a sheet of holes with an unperforated copper surface. The inherent utility of pre-punched holes is immediately available for terminals or component leads below the unpunched copper and glass liner layers. Yet holes never interfere with etching conductor paths or areas wherever required. Available off-the-shelf on one or two sides of epoxy glass Vectorbord.

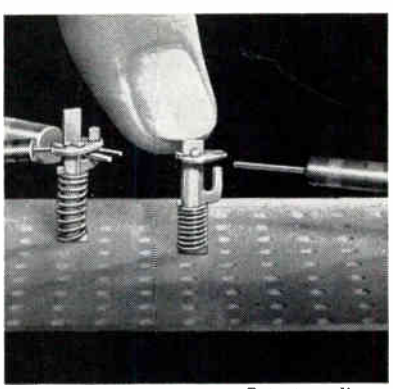


New Do-It-Yourself Resist Patterns for Etching Prototype Circuits in Minutes – New pattern sheets of Vector's Rub-On-Resist have lines from 1/64" to 1/8" and transistor pads for .05" and .1" center-to-center layouts. Easy-to-Use Vectoresist eliminates sticky tapes and photographic techniques for making prototype etched circuit layouts. Junctions do not undercut in etching because application pressure fuses joining pieces. Kit 27XA ($5.95) has 1 all-purpose Vectoresist sheet and everything else except hot water for making 2 etched circuit boards in minutes.



Patent pending

New Expandable Cases – New extruded aluminum Frame-Loc Rails are now available in wide size range to make sleek handsome circuit cases (or chassis) virtually any size or shape. Longitudinal grooves accommodate circuit boards on various center spacings. Circuits on etched cards requiring RFI shielding, or those employing bulkier components can be readily packaged. Complete "RF tight" cases with or without mounted shielded connectors, or case parts only are available with all hardware for plug-in rack, or chassis mounting.



Patent pending

Solderless Side Entry U-Clip Terminal – New Solderless U-CLIPS with less than .002 ohms resistance for instant "Push-In" use in 1/16" or 3/32" holes for testing or breadboarding circuits and components. A unique "side entry" slot for component wires is uncovered by finger pressure on a plunger permitting leads to be conveniently "laid in" rather than threaded through the terminal. Contact reliability is achieved by the possibility to criss-cross leads over a 270° range. Terminals may be used again and again.

Vectorize your breadboarding and profit 3 ways!

SPEED – With Vector hardware experimental circuits are assembled in minutes . . . without soldering.

DELIVERABILITY–Prototypes made with Vector hardware are handsome enough to deliver for customer approval.

SAVINGS–Experimental circuits made with Vector hardware can be quickly disassembled and the low cost components used over and over without clean-up.

Vector

ELECTRONIC CO., INC.

1100 Flower Street, Glendale, California

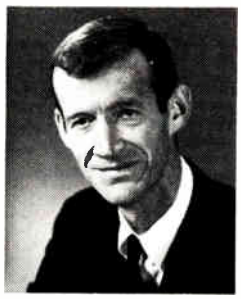
Presented on these pages are statements concerning various aspects of microwave technological developments as viewed by some of the key personages in the industry. The purpose is primarily to acquaint engineers with advances in technological areas outside their particular specialties. Trends revealed point the direction to new devices, equipment and systems made possible by advancing state-of-the-art.

Microwaves—Past, Present & Future

A State-Of-The-Art Report By Industry Leaders

"Electronic vs. Mechanical Scanning"

By D. G. Dudley
Group Scientist
Antenna & Microwave Group
Advanced System Technology
Autonetics Division, North American Aviation



A SHIFT IN EMPHASIS presently in progress in multimode avionics radars is causing a revolution in microwave component and material technology. This shift is from mechanical to electronic scanning.

It has been widely stated that the reason for this shift is the data rate limitations of mechanical scanning; but this view is at best an oversimplification. There are many mechanical scanners which can provide high data rates, but their mechanical inertia limits the antenna to certain fixed scan patterns, and places a serious limit on versatility. For example, the required number of hits on an object varies for different radar operational modes. Optimum information processing consists of time sharing the antenna beam and concentrating the energy in areas of interest. The accelerations, decelerations, and changes in directions involved are not compatible with mechanical fixed scan patterns.

The versatility required for optimum information processing unfortunately tends to be incompatible with lightness of weight, a fact which has caused great pressures on the manufacturers of microwave components. Although electronic scanning is a proven art (such scanning has been used in operational systems since 1957), its use has been limited to ground based and shipboard systems where weight has not been a severe problem. Such is not the case in an avionics package.

Let us consider a typical design. Production at X-band of an antenna array with a 2.5 degree pencil beam and a gain of 34 db requires approximately 2000 radiating elements. To keep the weight of the antenna system to under a few hundred pounds requires a pro rated weight per radiating element of approximately one ounce. If each element is to be fed by a phase shifter to produce scanning, the weight limitations on the phase shifter components and the accompanying transmission lines have become extreme. These limitations have sent component manufacturers scrambling for new ideas and new methods. The results are just now beginning to show.

Diode phase shifters are a good example of new results. At X-band, for example, diodes have been lightweight for some time but have been expensive, and their holders have been heavy. Decreases in cost per diode from $100 to approximately $10 have now been effected and in some cases the holder has been entirely eliminated. When one speaks of 3000 to 4000 diodes per antenna the decrease in total price from hundreds of thousands of dollars to tens of thousands is significant.

Ferrite phase shifters are another example. At X-band, the ferrite phase shifter can presently be purchased for approximately $100, exclusive of its drivers. Here, however, one of the major limitations has been the weight of the drivers. The development of the digital, latching ferrite phase shifter has simplified this problem because the latching characteristics require less total drive power and thus less weight.

As a final example, let us consider the important subject of transmission line technology. Since each radiating element must be somehow fed, the feeding networks can contribute a major portion of the total antenna weight. Fortunately, methods have already evolved which combine the radiator, phase shifter, and transmission line into one package and it has befallen the materials processing engineers to make the transmission line itself a minor contributor to the overall package weight. This is now being accomplished beautifully by plating techniques in which the transmission line outer walls are plated onto a mandrel, say teflon, and the mandrel then removed. Processes like electroforming are contributing significantly to this type of weight reduction.

"Microwave Devices and Equipment"

By M. E. Hines, V.P.
Director, Special Products Research
Microwave Associates, Inc.

DURING THE PAST FEW YEARS, reliable solid-state microwave devices of many types have achieved wide acceptance. Included are low noise parametric amplifiers, low noise tunnel-diode amplifiers, microwave signal sources using transistors and varactor harmonic generation, high power transmission line switches, high power T-R duplexers, power modulators and frequency converters, and high power phase shifters.

Although tubes are still required for high power microwave generation and amplification, solid-state devices now fill most requirements in new radar and communications equipment. Some types of microwave equipment can now be obtained which use solid-state devices exclusively, such as microwave communications relay for television and telephone multiplex, man-pack radar, beacons and transponders, telemetry transmitters and receivers, and Doppler navigation Radar. Phased-Array antennas, using diode phase shifters, are now being developed for multi-megawatt power levels. Experimental radars have been tested using solid-state duplexers at megawatt power levels.

High power solid-state microwave generation is a goal in active research programs. One of the most promising new principles being studied is the Gunn Effect in which microwave oscillations occur in bulk semiconductor materials.

The newer solid-state microwave devices offer many technical advantages over previous techniques, such as lower noise figure, lower signal losses and precision frequency control of microwave signals. In many cases, efficiency is improved and lower power supply voltages are usually required. Higher reliability is normally obtainable. Size and weight are usually reduced and even greater reductions are now being made possible through integrated circuit development of microwave functional devices.

Microwave Antennas

Dr. Edward A. Wolff,
Keltec Industries Inc.
Chairman, 1965 Int'l Ant. & Prop. Symposium, IEEE

IN THE MICROWAVE ANTENNA FIELD, much attention is being given to antenna arrays. Some facets of array design which are being pursued are mutual coupling for various types of array elements, feed network design and impedance matching, methods of electronic scanning, adaptive arrays, array thinning techniques and non-uniform element spacing, and arrays of large, high gain elements.

The needs of satellite communication systems and radio astronomy research have stimulated the development of large reflector antennas with low noise temperatures. Designers in this area are working on methods of electronically steering the beam, controlling the illumination of the reflector system for lower noise temperatures, and improving the design of monopulse schemes for tracking.

A relatively new development is the application of optical techniques utilizing the coherent radiation from lasers for the simulation of antennas and the determination of radiation patterns.

Interest is also continuing in broadband log periodic antennas, electromagnetic theory analysis techniques and antenna measurement techniques.

Antenna users are looking for large reflector antennas with higher gain/temperature ratios, large array antennas with better electronic scanning and pattern control, and better techniques for the erection of large antennas in space.

Trends in Solid State Microwave Design

By William P. Stearns,
Antenna and Microwave Group,
Military Electronics Division,
Motorola, Inc.

LOOK FOR AN INCREASINGLY WIDER AVAILABILITY and application of microwave frequency transistors. These will undoubtedly be used in low noise microwave receivers, and in both high and low power oscillators and transmitters. To cite a few examples, a 2.1 gc amplifier has been developed with a 4.1 db noise figure with 7 db gain. Octave-bandwidth amplifiers have been produced with 28 and 60 db gains from 500 to 1000 MHz and from 1.0 to 2.0 GHz, respectively.

These amplifiers can now provide low noise microwave receiver front ends at frequencies through S-band. Frequencies through C- and X-band will be realized within a few years. The noise figures of these amplifiers are comparable with present tunnel diode amplifiers and only about 2 db more than parametric amplifiers.

Second, increased application of microwave semiconductor diodes for microwave signal switching, phase shifting, signal leveling, attenuation and similar microwave signal control functions.

A completely passive—i.e., no external control signals—X_L-band power leveler has been developed using pin diodes and a self-contained diode detection circuit to control power to within a quarter of a db when the input power varies as much as 4 db.

Another example is an S-band (2 GHz) diode switch used in conjunction with an isolator-circulator and filter assembly to switch redundant solid state transmitters. The complete assembly—switch, ferrite isolator, and filter weighs only 5 oz.

Microwave bulk effect devices, such as electro-acoustical amplifiers, oscillators, and delay lines, depend upon the internal resonant and quantum mechanical characteristics of bulk semiconductor materials. Examples of such devices include the Gunn effect oscillator, a device that generates microwave power through the application of a dc voltage, and the cadmium sulfide electro-acoustical amplifier that has provided 34 db gain at 60 MHz. The range of operation from devices such as these is expected to range from 10

(Continued on following page)

MHz to 5 GHz. They can be made very small; e.g., approximately 0.070 x 0.040 x 0.015 in. for a 1 MHz oscillator.

Though certain problems exist presently in developing practical hardware (many of these problems have to do with the high conversion losses encountered in transducers, and the need for materials having high mobility and good heat sink capabilities), their small size potential will spur development activity and, ultimately, these devices will significantly enhance the miniaturization of microwave components and subassemblies.

Trends In Microwave Test Equipment

JOHN L. MINCK,
Marketing Manager, Microwave Division,
Hewlett-Packard Co.

MICROWAVE TEST EQUIPMENT is moving basically in two directions at once. Products are going to higher stability, and thus to higher accuracy on the one hand, and going to broader bandwidths on the other. The race toward wider band coaxial equipment is a good example.

Swept-frequency measuring equipment is increasing in importance. Accuracy levels which previously were attainable only by tedious point-by-point methods now can be achieved in continuously swept displays, thanks to higher directivity in couplers, flatter response in detectors, and new compensation methods, all of which, with the new and more stable sweepers, contribute to really level sweeper output. Continuous display of wideband response, with dynamic range as high as 30 db from square-law devices, is achieved by use of a plug-in for an oscilloscope. This is an example of the trend in new instruments, for it gives more information continuously and at a glance than was previously possible after many minutes with old ratiometer techniques. With effective new leveling techniques it can be provided with output so flat that digitized forward gain or return loss (SWR) measurements can be made.

The state of the instrument art often determines the limits of scientific investigation. As an example, a recently developed spectrum analyzer has opened up new applications. With 2 gc sweep, 60 db dynamic range in a single display, fully calibrated presentations, and a number of other new capabilities, it does jobs that could never be done before, and does others more easily, more rapidly, and more accurately.

Microwave instrumentation has been, for much the most part, useful in developing communication and radar technology. But, there are growing uses elsewhere. For instance, a new microwave spectrometer offers hitherto unavailable capabilities to the research and industrial analytical chemist.

There are still significant gaps in methods of microwave measurement. We have not seen the end of the contributions which can be made by spectrum analysis. In five years, most of the traditional methods of making microwave measurements will, we believe, have been supplanted by faster, more accurate, more convenient methods. The slotted line may well be obsolete by then. New instrumentation will probably be more costly than traditional microwave instruments, but its value, in saving time and solving previously insoluble problems, will earn its acceptance. This, we think, signifies challenge and opportunity for both the instrument design engineers and for the users of their forthcoming products.

Trends in Broadband Microwave Antennas

By Milton Nussbaum,
Senior V.P.
American Electronic Labs., Inc.

ALTHOUGH THE BROADBAND FREQUENCY independent antenna has been on the scene for only a relatively short time, it has already been incorporated into almost every conceivable application. There are myriad forms of the frequency independent antenna from monstrous LP arrays at the HF end of the spectrum, through inflatable space-borne VHF types, to miniature cavity-backed and conical antennas in X Band.

With increased application of broadband antennas, a considerable effort has been expended to simplify construction and reduce costs. In spite of the impression that the field has matured to the extent that only 'nit-picking' type modifications are required, there are still many unresolved problem areas. These technological deficiencies represent a challenge of sufficient magnitude to maintain an active, dynamic field.

Several general requirements which typify this thesis are:

1. Small, light weight, efficient, high gain antennas for HF and lower frequencies.
2. Airborne antennas with more uniform characteristics that are adaptable to the higher speed aircraft.
3. Improved versions of standard designs to narrow the performance gap between frequency independent and aperture type antennas.

We are making progress towards the ultimate solution to these problem areas but, admittedly, some specific requirements are orders of magnitude beyond the current state-of-the-art.

A few examples of the culmination of some recent development work at AEL are:

1. Development of a truly frequency independent cavity backed spiral antenna for flush mounted airborne use. Bandwidths as high as 12:1 with moderate gain have been achieved.
2. Development of a 20-70 mc planar log periodic antenna of half the conventional size with only a moderate decrease in efficiency.
3. Development of a unique crossed-planar log periodic antenna with very high cross-polarization isolation.
4. Improvement in the conventional pyramidal, log periodic antenna with more uniform characteristics to provide performance up to 13 gc.

These examples are referenced to point out that frequency independent antennas are really in their infancy with respect to many other fields. (*Continued on page* 163)

1965 SURVEY OF MICROWAVE SEMICONDUCTORS

ELECTRONIC INDUSTRIES

APPEARING ON THESE PAGES is the first known comprehensive compilation of semiconductors to function at frequencies above 1 GHz. The tabulation is based on replies to a questionnaire mailed to all companies known to make some type of semiconductor.

Because microwave semiconductors are relatively new, the editors sensed some confusion on the part of the company spokesmen as to just what components should be included in the listings. This confusion may have been reflected in the responses to some extent. And, we may appear to have been arbitrary in deciding to omit from the tables semiconductors for use as detectors and mixers. However, the criterion we followed was that all semiconductors included should be functional in some circuit which operates at 1 GHz or above. Thus, the component's cut-off frequency (at which db gain reduces to 0) should be above 1 GHz.

Some of the semiconductors listed are known to be experimental, but all of those shown are understood to be available on order.

It should also be recognized that just to have a microwave tunnel diode, varactor or transistor does not in itself assure operation at microwave frequencies. The circuit in which the device is employed and its physical layout are just as important. Thus, we hope to show by this tabulation the semiconductors that should be useful for microwave applications if suitably designed into circuits. Where supplied by the manufacturers, we have listed the semiconductors by categories based on suggested applications. Also given in the "Applications or Comments" column are manufacturers' suggestions for correct use and special operating conditions.

A surprising number of semiconductor manufacturers stated in reply to our questionnaire that they make no semiconductors for use at 1.0 GHz or above. We suspect that some of these companies do make semiconductors that, although not specifically designed for microwave frequencies, might work in some types of circuits at 1.0 GHz. We are certain, therefore, that as careful as we were to make this listing complete, there are probably omissions. Such omissions will, if brought to our attention, be corrected in future tabulations.

In the tables, no listing is given for microwave devices such as mixers, r-f power limiters and duplexers, t-r limiters, diode switches and phase shifters. Such devices have different configurations depending upon application and are somewhat difficult to categorize in a meaningful way. Electronic Industries may endeavor to tabulate such devices at a later date if there is sufficient interest on the part of our readers.

Unfortunately, data sheets from Hoffman Semiconductor Div. of Hoffman Electronics Corp. arrived too late to be included in the tablets. Hoffman makes germanium tunnel diodes with cut-off frequencies to 3.9 GHz for low-level switching and small signal applications and in TO-18 and DO-17 case styles.

The editors solicit comments from readers and from semiconductor manufacturers as to the usefulness and adequacy of the chart. If well received, the tabulations will be revised and re-issued again in the future.

Below are the complete addresses of companies whose semiconductors are included in the tables:

Microwave Semiconductor Manufacturers*

Alpha Microwave,
Division of Alpha Industries,
381 Elliot St.,
Newton Upper Falls, Mass.

American Electronic Laboratories, Inc.
Richardson Road,
Colmar, Pa.

Amperex Electronic Corp.
Semiconductor-Receiving Tube Div.,
Providence Pike
Slatersville, R.I.

General Electric Co.
Semiconductor Products Dept.,
Electronics Park,
Syracuse, N.Y.

Fairchild Semiconductor,
Division of Fairchild
Camera and Instrument Corp.,
313 Fairchild Drive,
Mountain View, Calif.

KMC Semiconductor Corp.,
Parker Road, R.D. 2,
Long Valley, N.J.

Microwave Associates, Inc.,
Burlington, Mass.

Micro State Electronics Corp.,
Subsidiary of Raytheon Co.,
Murray Hill, N.J.

Motorola Semiconductor Products, Inc.,
50005 East McDowell Road,
Phoenix, Arizona

Philco Corp.,
Solid State Products Operation
Lansdale Division
Lansdale, Pa.

RCA Electronic Components & Devices,
Microwave Tube & Semiconductor Operations,
Harrison, N.J.

Semiconductor Devices, Inc.,
875 West 15th St.,
Newport Beach, Calif.

Siemens America, Inc.,
(Siemens & Halske Aktiengesellschaft)
230 Ferris Ave.,
White Plains, N.Y.

Solid State Electronics Corp.,
15321 Rayen St.,
Sepulveda, Calif.

Sylvania
Electronic Components Group,
Semiconductor Div.,
Subsidiary of General Telephone & Electronics
100 Sylvan Road,
Woburn, Mass.

Texas Instruments, Incoporated,
Semiconductor-Components Div.,
13500 North Central Expressway,
Dallas, Texas.

Transitron Electronic Corp.,
168 Albion St.,
Wakefield, Mass.

*Based on returns from an ELECTRONIC INDUSTRIES questionnaire to all semiconductor manufacturers.

TABLE 1: SNAP-OFF VARACTORS

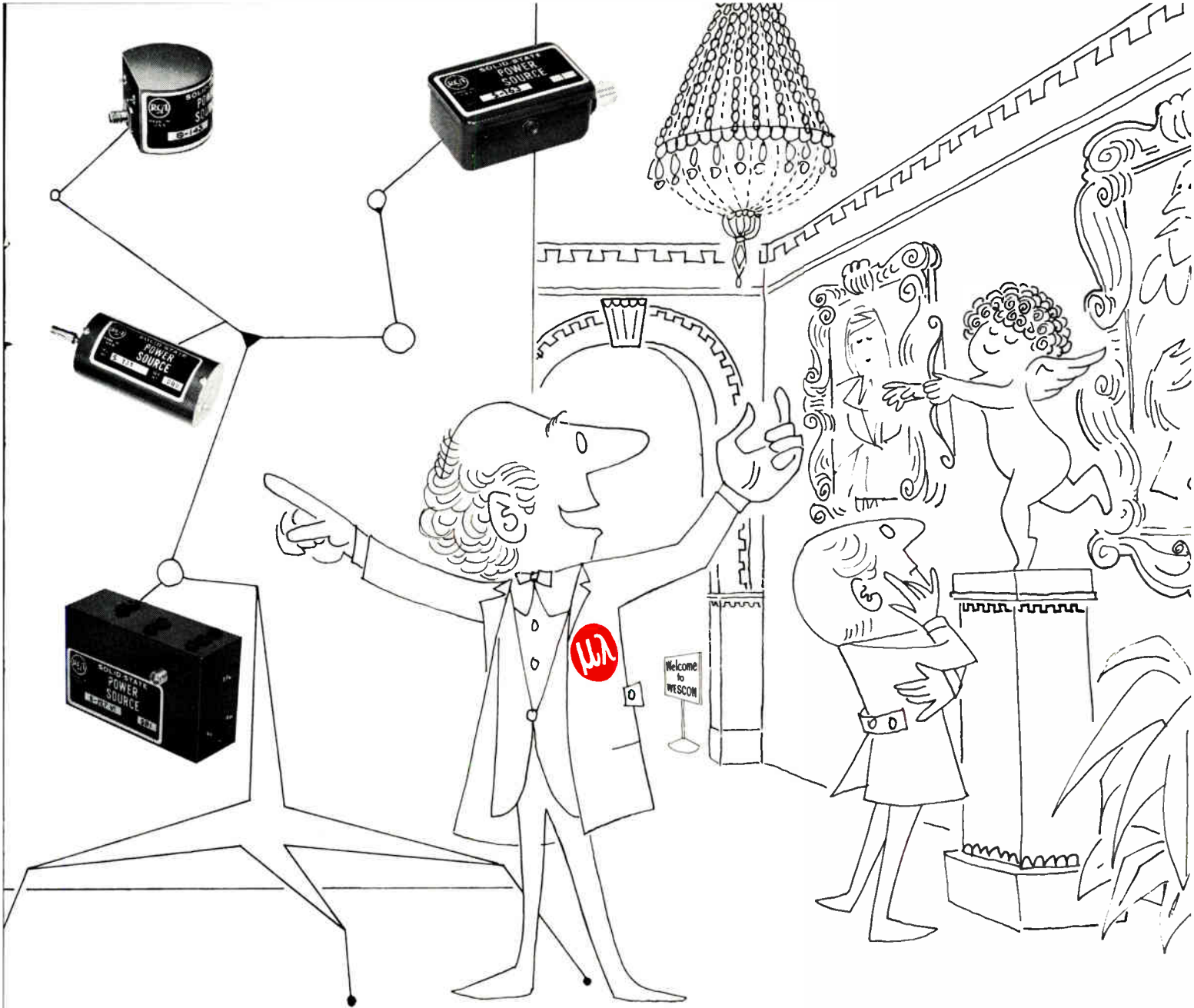
Snap-off varactors are silicon junction devices designed for single-stage, high-order harmonic generation with efficiency exceeding 1/n Output frequencies in typical applications are in S-, C-, and X-band. Snap-off varactors can also be used for pulse shaping and pulse amplification.

Company	Type	V_{BR} Breakdown Voltage at 10μa (v)	C_{jo} Junction Capacitance Min.-Max. at 0 Bias (pf)	τ Lifetime Min. (ns)	t_t Snap-Off Time Max. (ns)	θ Thermal Resistance Max. °C/W	I_F Forward Current Min. for 1v Forward Potential (ma)	Applications or Comments
Microwave Associates	4748	25	0.3, 0.6	10	.15	150	40	
	4749	25	0.5, 1.1	10	.10	125	40	
	4750	25	0.5, 1.1	10	.15	125	40	Test conditions:
	4751	25	0.5, 1.1	10	.20	125	40	I_f = 10 ma,
	4752	25	1.0, 1.6	10	.15	100	40	V_f = 10v,
	4753	25	1.5, 2.0	10	.15	75	40	and R_1 = 50Ω
	4754	20	0.5, 1.5	20	.20	500	40	
	4755	35	1.0, 3.0	30	.30	500	150	
	4756	35	3.0, 10.0	50	.50	500	200	

TABLE 2: VARACTOR TUNING DIODES

Tuning varactors are manufactured by both epitaxial growth and diffusion. Abrupt junction epitaxial types offer greater capacitance swing for the amount of bias applied; diffused types offer higher Q and low leakage current.

Company	Type	C Capacitance at 4v (pf)	Q (Min.) at 4v	V_{BR} Breakdown (v)	I_R Reverse Current (μa)	CR Typical Capacitance Ratio	CR Min./Max.	Applications or Comments
				at 10μa	at 25V		C(2V)/C(30V)	
Microwave Associates	4701B	6.8	200	35	0.5		2.5/2.9	Diffused, epitaxial, low voltage, high Q.
	4701B1	6.8	400	35	0.5		2.5/2.9	
	4701C	8.2	175	35	0.5		2.5/2.9	
	4701C1	8.2	350	35	0.5		2.4/2.7	All values at test temperature 25°C.
	4701D	10	175	35	0.5		2.7/3.1	
	4701D1	10	350	35	0.5		2.7/3.1	
	4701E	12	150	35	0.5		2.7/3.1	All values of capacitance are junction plus case.
	4701E1	12	300	35	0.5		2.7/3.1	
	4701F	15	150	35	0.5		2.7/3.1	
	4701F1	15	300	35	0.5		2.7/3.1	Q is determined at 50 Mc.
	4701G	18	125	35	0.5		2.7/3.1	
	4701G1	18	225	35	0.5		2.7/3.1	
	4701H	22	125	35	0.5		2.7/3.1	
	4701H1	22	225	35	0.5		2.7/3.1	
	4701I	27	75	35	0.5		2.7/3.1	
	4701I1	27	150	35	0.5		2.7/3.1	
	4702A	33	75	35	0.5		2.7/3.1	
	4702A1	33	150	35	0.5		2.7/3.1	
	4702B	39	75	35	0.5		2.7/3.1	
	4702B1	39	125	35	0.5		2.7/3.1	
	4702C	47	75	35	0.5		2.7/3.1	
	4702C1	47	125	35	0.5		2.7/3.1	
	4702D	56	50	35	0.5		2.7/3.1	
	4702D1	56	100	35	0.5		2.7/3.1	
	4702E	68	50	35	0.5		2.7/3.1	
	4702E1	68	100	35	0.5		2.7/3.1	
	4702F	82	40	35	0.5		2.7/3.1	
	4702F1	82	75	35	0.5		2.7/3.1	
	4702G	100	40	35	0.5		2.7/3.1	
	4702G1	100	75	35	0.5		2.7/3.1	
						C(2V)/C(100V)		
	4273B	6.5	100	110	0.5	4.5		Abrupt junction, epitaxial, high voltage, high Q.
	4273C	10	100	110	0.5	5.2		
	4273D	15	100	110	0.5	5.2		
	4273E	22	100	110	0.5	5.2		
	4273F	33	100	110	0.5	5.2		
	4273G	47	100	110	0.5	5.2		
	4019B	6.5	100	110	0.5	4.5		
	4019C	10	100	110	0.5	5.2		
	4019D	15	100	110	0.5	5.2		
	4019E	22	100	110	0.5	5.2		
	4019F	33	100	110	0.5	5.2		
	4019G	47	100	110	0.5	5.2		
					at 60V	C(2V)/C(60V)		
	4703B	6.5	150	75	0.5	3.5		Abrupt junction, epitaxial, low voltage, high Q.
	4703C	10	150	75	0.5	4.0		
	4703D	15	150	75	0.5	4.0		
	4703E	22	150	75	0.5	4.0		



THINKING DESIGN? THINK MODERN!
THINK RCA SOLID-STATE MICROWAVE DEVICES

Solid state is "in." It is your answer to low-cost power and reliability for over-all system economy. And you get both in the "years-ahead" capability RCA is assembling into its solid-state Microwave power sources. You can choose from a line of these packaged-circuitry devices whose space-age technology can make present-day systems obsolete.

TOM (Transistor Oscillator Multiplier) and TOVAR (Transistor Oscillator Varactor) devices are readily available over the frequency range of 500 Mc/s to 2250 Mc/s and with power outputs up to 2.0 watts.

Compact and rugged, these RCA devices are designed for low-cost volume production. They're ideal for new telemetry applications as well as low-cost scientific probes in near and outer space experiments in temperature, humidity, and weather-related information.

These power sources can be operated from batteries or solar cells (no DC to DC converter required)! So switch to solid state with RCA. Talk with your RCA Representative. He can tell you more about these designs with power output, efficiency, and frequency that meet your specific requirements. For technical data on specific types, write: RCA Commercial Engineering, Section K50Q, Harrison, N.J.

TYPICAL CHARACTERISTICS OF SIX OF RCA'S SOLID STATE MICROWAVE DEVICES

Type	Nominal Power Output	Freq. Range (Typical) (4)	DC Power (Volts/ma)	Typical Size	Modulation Charact.
S127V2	0.5 to 1.0 w	1.435 to 2.3 Gc/s(1)	30 v/200 ma	1" x 2" x 3"	±300 kc FM
S131	200 mw	1.435 to 1.8 Gc/s(1)	28 v/125 ma	1½" diam. x 3"	±300 kc FM
S163	100 mw	0.5 to 1.0 Gc/s(2)	28 v/150 ma	2⅜" x 1½" x 1⅛"	---(3)
S170	125-200 mw	1.435 to 2.3 Gc/s(1)	28 v/150 ma	1" diam. x 2"	100% AM (1vPP)
S172	200 mw	0.5 to 1.0 Gc/s(1)	28 v/70 ma	1" diam. x 4½"	---(3)
S173	2 watts	0.5 to 0.85 Gc/s(1)	30 v/470 ma	2⅜" x 1½" x 1⅛"	---(3)

(1) Manually tunable ±10 Mc from specified center frequency. (2) Manually tunable ±150 Mc from specified center frequency. (3) Optional features include FM or pulse modulation (ON/OFF); DC Regulation; various connectors. (4) All units are temp. compensated over —50°C to +70°C for nominal stability of ±0.1%.

RCA Electronic Components and Devices

The Most Trusted Name in Electronics

TABLE 2: VARACTOR TUNING DIODES (Continued)

Company	Type	C Capacitance at 4v (pf)	Q (Min.) at 4v	V_{BR} Breakdown (mv)	I_R Reverse Current (μa)	CR Typical Capacitance Ratio	CR Min./Max.	Applications or Comments
Microwave Associates Cont.	4703F	33	125	75	0.5	4.0		
	4703G	47	100	75	0.5 at 40V	4.0 C(2V)/C(40V)		
	4704B	6.5	150	50	0.5	3.0		
	4704C	10	150	50	0.5	3.0		
	4704D	15	150	50	0.5	3.0		
	4704E	22	150	50	0.5	3.0		
	4704F	33	125	50	0.5	3.0		
	4704G	47	100	50	0.5	3.0		

TABLE 3: VARACTOR HARMONIC GENERATORS

Company	Type	f In-Out Dynamic Test Frequency (gc)	P_{in} Input Power (w)	E_{ff} Overall Efficiency Min. (%)	C_{jo} Junction Capacitance at 6v Min.-Max. (pf)	V_{BR} Breakdown Voltage Min. (v)	θ Thermal Resistance Max. °C/W	Applications or Comments
Amperex Electronic Corp.	IN4885		25-40	64-55	28/39	150		Series Resistance (R_s) – 0.7 max. f_{co} – 80 GC (Typ.)
	IN4886		25	60	28/39	120		Series Resistance (R_s) – 0.8 max. f_{co} – 55 GC (Typ.)
Microwave Associates	4764	1, 4	2	45	1/2	40	75	
	4765	4, 12	1	30	0.6/1.2	24	125	
	4086	12, 24	0.15	15	0.2/0.4	8	500	
Micro State Electronics Corp.	Series							
	100-106				0.1/0.4	6-120		Silicon planar epitaxial
	110-116				0.4/1.0	6-120		
	120-126				1.0/2.0	6-120		
	130-136				2.0/4.0	6-120		
	140-146				4.0/8.0	6-120		
	150-156				8.0/15.0	6-120		
	160-166				15.0/25.0	6-120		
Semiconductor Devices	Series of devices available with V_{BR} from 6 to 120v and C_{jo} from 0.2 to 50.0+ pf. F_c = 10 gc							
Sylvania Electric Products	D4811C	1-2, 2-4	0.1	50				Frequency doublers
	D4821C	1-2, 2-4	0.2	50				
	D4831C	1-2, 2-4	0.5	50				
	D4841C	1-2, 2-4	1	50				
	D4851C	1-2, 2-4	2	50				
	D4861C	1-2, 2-4	5	50				
	D4871C	1-2, 2-4	10	50				
	D4811F/D4611G	2-4, 4-8	0.1	50				
	D4821F/D4621G	2-4, 4-8	0.2	50				
	D4831F/D4631F	2,4- 4-8	0.5	50				
	D4841F/D4641F	2-4, 4-8	1	50				
	D4851F/D4651F	2-4, 4-8	2	50				
	D4610J/D5147A	4-8, 8-16	0.1	40				
	D4620J/D5246B	4-8, 8-16	0.2	40				
	D4630H/D5246B	4-8, 8-16	0.5	40				
	D4640H	4-8, 8-16	1	40				
	D4651G	4-8, 8-16	2	40				
	D4610K/D5147B	8-10, 16-20	0.1	20				
	D4620J/D5246B	8-10, 16-20	0.2	20				
	D4630J/D5246B	8-10, 16-20	0.5	20				
	D4640J	8-10, 16-20	1	20				
	D4610K/D5147B	10-20, 20-40	0.1	20				
	D4620K/D5246B	10-20, 20-40	0.2	20				
	D5246B	10-20, 20-40	0.5	20				
	D4811F	1-2, 3-6	0.1	40				Frequency triplers
	D4821F	1-2, 3-6	0.2	40				
	D4831F	1-2, 3-6	0.5	40				
	D4841F	1-2, 3-6	1	40				
	D4851E	1-2, 3-6	2	40				
	D4861E	1-2, 3-6	5	40				
	D4811G/D4611G	2-4, 6-12	0.1	30				
	D4821G/D4621G	2-4, 6-12	0.2	30				
	D4831G/D4631G	2-4, 6-12	0.5	30				
	D4841G/D4641G	2-4, 6-12	1	30				
	D4851G/D4651G	2-4, 6-12	2	30				
	D4810J/D4610J/ D5147A	4-8, 12-24	0.1	15				

TABLE 3: VARACTOR HARMONIC GENERATORS (Continued)

Company	Type	f In-Out Dynamic Test Frequency (gc)	P_{in} Input Power (w)	E_{ff} Overall Efficiency Min. (%)	C_{jo} Junction Capacitance at 6v Min.-Max. (pf)	V_{BR} Breakdown Voltage Min. (v)	θ Thermal Resistance Max. °C/W	Applications or Comments
Sylvania Electric Products Cont.	D4820J/D4620J/ D5246B	4-8, 12-24	0.2	15				Frequency triplers (cont.)
	D4830J/D4630J/ D5246B	4-8, 12-24	0.5	15				
	D4840J/D4640J	4-8, 12-24	1	15				
	D5147B	8-10, 24-30	0.1	15				
	D5246B	8-10, 24-30	0.2	15				
	D5246B	8-10, 24-30	0.5	15				
	D5147B	10-20, 30-60	0.1	5				
	D5246B	10-20, 30-60	0.2	5				
	D5246B	10-20, 30-60	0.5	5				
	D4863A	0.6, 1.2	7	60				Typical Harmonic Multipliers
	D4862C	0.75, 1.5	5	60				
	D4253C/D4853C	1.2, 2.4	4	60				
	D4211D/D4811D	2.0, 4.0	0.3	33				
	D4242F/D4842F	2.4, 4.7	2.5	40				
	D4831H	2.4, 4.8	1.8	49				
	D4261C/D4861C/ D4851C	3.0, 6.0	1.4	47				
	D4222J/D4822G D4221J/D4821J	4.8, 9.6	1	35				
	D4651E	4.8, 9.6	2	35				
	D5047B	4.8,9.6	1.5	60				
	D4201K/D4801K	8,16	0.42	29				
	D4244/D4844 D4233B/D4833B	0.6, 1.8	0.9	33				
	D4241H/D4841H	8.0, 24	0.2	18				
	D5047C	9.6, 28.6	0.4 10	55				
	D5047	9.0, 4.5	0.35	1.7				
	D4957	10.0, 50	0.15					
	D4865	0.2, 1.2	2	40				
	D4252B/D4852B	0.26, 1.82	0.200	7.5				

TABLE 4: SILICON VARACTOR DIODES -- GENERAL PURPOSE

Company	Type	C_{jo} Junction Capacitance (pf)	R_s Series Resistance (ohms)	θ Thermal Resistance (°C/W)	V_{BR} Breakdown Voltage (v)	F_{co} Cutoff Frequency (gc)	Applications or Comments
American Electronic Laboratories	Series of devices available with V_{BR} from 6 to 160v. and C_{jo} at –6v. of 0.1 to 16.0 pf. Button, pill and cartridge packages available. Cutoff frequency min. from 5 to 180 gc.						For voltage tuning amplifiers, parametric amplifiers, frequency multipliers, high-speed power limiters and solid state crystal switches.
Microwave Associates	4321AA through 4321G	0.2-0.4 through 25.0-40.0		800 to 250	6		
	4041AA through 4041G1	0.2-0.4 through 25.0-50.0		500 to 25	6	80	
	4051AA through 4051G1	0.2-0.4 through 25.0-50.0		500 to 40	6	60	
	4322AA through 4322G	0.2-0.5 through 32.0-64.0		800 to 250	12		
	4042AA through 4042G1	0.2-0.5 through 32.0-64.0		500 to 25	12	80	
	4052AA through 4052G1	0.3-0.5 through 32.0-64.0		500 to 40	12	80	
	4324A through 4324G	0.3-0.6 through 20.0-40.0		400 to 250	24		
	4044AA through 4044G1	0.15-0.3 through 20.0-40.0	– to 0.5	to 20	24	75	
	4054AA through 4054G1	0.15-0.3 through 20.0-40,0	– to 0.5	300 to 35	24	75	

TABLE 4: SILICON VARACTOR DIODES -- GENERAL PURPOSE (Continued)

Company	Type	C_{jo} Junction Capacitance (pf)	R_s Series Resistance (ohms)	θ Thermal Resistance (°C/W)	V_{BR} Breakdown Voltage (v)	f_{co} Cutoff Frequency (gc)	Applications or Comments
Microwave Associates Cont.	4325AA through 4325G	0.2-0.4 through 25.0-50.0	21.0 to 0.6	800 to 250	48		
	4045AA through 4045G	0.2-0.4 through 25.0-50.0	– to 1.0	48 to 15	48	60	
	4055AA through 4055G	0.2-0.4 through 25.0-50.0	– to 1.0	300 to 30	48	60	
	4326AA through 4326G	0.2-0.5 through 32.0-64.0	21.0 to 0.6	800 to 250	60		
	4046A through 4046G	0.5-1.0 through 32.0-64.0	– to 1.0	100 to 15	60	40	
	4056A through 4056G	0.5-1.0 through 32.0-64.0	– to 1.0	125 to 30	60	40	
	4327A through 4327G1	0.25-0.5 through 16.0-32.0	21.0 to 1.0	400 to 250	90		
	4047A through 4047G1	0.25-0.5 through 16.0-32.0	– to 1.0	80 to 15	90	40	
	4057A through 4057G1	0.25-0.5 through 16.0-32.0	– to 1.0	100 to 30	90	40	
	4328A through 4328G	0.3-0.6 through 20.0-40.0	21.0 to 1.3	400 to 250	120		
	4048A through 4048G	0.3-0.6 through 20.0-40.0	– to 1.3	75 to 13	120	30	
	4058A through 4058G	0.3-0.6 through 20.0-40.0	– to 1.3	80 to 30	120	30	
Philco Corp.	Series						
	L4200	0.1-6.0 (–6v)			24-90	5-100 (–6v)	DO-23 glass cartridge package
	L4300	6-40 (–6v) 15-120 (0v typ.)			90-140	5-100 (–6v)	Do-4 package
	L4800	0.1-20.0 (–6v)			24-140	5-100 (–6v)	Welded-ceramic cartridge package
	L4900	0.1-20.0 (–6v)			24-120	5-100 (–6v)	Pill-PRONG. Welded-ceramic package.
Semiconductor Devices	11-9	1.5 (max.)				90	
	11-8	1.5 (max.)				80	
	11-7	2.0 (max.)				70	
	11-6	2.0 (max.)				60	High - Q, low breakdown voltage varactors.
	11-5	2.0 (max.)				50	
	11-4	3.0 (max.)				40	
	11-3	3.5 (max.)				30	
	11-2	4.0 (max.)				20	
	11-1	16.0 (max.)				10	
Sylvania Electric Products	Series						
	D4600	0.1-30 at 6v			6-120	5-200	General purpose silicon epitaxial varactors.
	D4800	0.4-30 at 6v			6-120	5-140	
Texas Instruments	XA706-XA713	0.4-30 C_T			24-120	5-120	Dissipation 0.75-3.5w. For tuning, parametric ampls., harmonic generators.

TABLE 5: LIMITER VARACTORS

Company	Type	C_{jo} Junction Capacitance at 0v Min.-Max. (pf)	R_s Series Resistance Max. at 500 mc (ohms) *	θ Thermal Resistance Max. °C/W	V_{BR} Breakdown Voltage Min. (v)	f_{co} Cutoff Frequency at 0v Bias (gc)	Applications or Comments
Microwave Associates	4684	1.8, 2.8	0.8	75	8	35	
	4685	0.4, 0.8	1.2	150	8	70	
	4686	0.3, 0.6	1.4	250	8	90	*Measure with 100-mA current.
	4687	0.2, 0.4	1.8	500	8	100	
	4688	0.1, 0.2	2.5	1000	8	100	

TABLE 6: HIGH POWER VARACTORS

Company	Type	C_{jo} Junction Capacitance at 0 v (pf)	R_s Series Resistance Max. at 500 mc (ohms)	θ Thermal Resistance Max. (°C/W)	V_{BR} Breakdown Voltage at 10 μa (v)	F_o Operating Frequency (gc)	Applications or Comments
Microwave Associates	4760AA	80/160	1.2	6	90	3	
	4760A	40/80	1.5	6	90	3	
	4760B	20/40	2.0	9	90	3	
	4760C	10/20	2.5	12	90	3	
	4760D	5/10	3.5	15	90	3	
	4761AA	80/160	1.2	6	120	3	Max. Junction Temperature 150°C
	4761A	40/80	1.5	6	120	3	
	4761B	20/40	2.0	9	120	3	
	4761C	10/20	2.5	12	120	3	
	4761D	5/10	3.5	15	120	3	
	4763	50/100	1.0	5	250	3	
Motorola Semiconductor Products	IN4388	C_T 10 (pf) (typ.)	2.0 at 50 mc		150 (typ. at 10 μadc)	to 1 (gc)	Harmonic generator silicon-diffused junction type.
	MV1808	C_T 5.8 (typ.)	0.5 (typ.)	19 (typ.)	80 (typ.)	to 3 (gc)	

TABLE 7: GALLIUM ARSENIDE VARACTORS

Company	Type	C_{jo} Junction Capacitance at 6v Min.-Max. (pf)	f_c Min. Cutoff Freq. 2v/6v (gc)	V_{BR} Min. Breakdown Voltage (v)	θ Max. Thermal Resistance °C/W	Applications or Comments
Microwave Associates	4644A	0.15, 0.30	240, 300	6	800	
	4644B	0.15, 0.30	190, 250	6	800	
	4644C	0.15, 0.30	160, 200	6	800	
	4644D	0.15, 0.30	120, 150	6	800	
	4644E	0.15, 0.30	80, 100	6	800	
	4645B	0.3, 0.6	190, 250	6	400	
	4645C	0.3, 0.6	160, 200	6	400	
	4645D	0.3, 0.6	120, 150	6	400	
	4645E	0.3, 0.6	80, 100	6	400	
	4646C	0.60, 1.2	160, 200	6	200	
	4646D	0.6, 1.2	120, 150	6	200	
	4646E	0.6, 1.2	80, 100	6	200	
Micro State Electronics Corp.	Series					
	4150-4156, 3250-3256	0.2/1.1	10-120	18		
	4200-4206, 3130-3136	0.2/1.1	10-120	30		
	4250-4256, 3160-3166	0.2/1.1	10-120	45		
	4300-4305, 3200-3205	0.2/1.1	10-100	60		
	4160-4166, 3260-3266	1.1/3	10-120	18		High voltage, high cut-off diffused junction mesa structure. For microwave switch, harmonic generator, modulator, limiter and duplexer applications. Power dissipation 300 mw to 1.5 w.
	4210-4215, 3150-3155	1.1/3	10-100	30		
	4260-4265, 3170-3175	1.1/3	10-100	45		
	4310-4314, 3210-3214	1.1/3	10-80	60		
	4170-4174, 3270-3274	3/6	10-80	18		
	4220-4223, 3140-3143	3/6	10-60	30		
	4270-4273, 3180-3183	3/6	10-60	45		
	4320-4322, 3220-3223	3/6	10-40	60		
	4180-4182, 3280-3282	6/10	10-40	18		
	4230-4232, 3145-3147	6/10	10-40	30		
	4280-4282, 3190-3192	6/10	10-40	45		
	4330-4331, 3230-3231	6/10	10-20	60		
Sylvania Electric Products	Series					
	D5047	0.4-1.0	200-350 at –6v Bias	–6		For both parametric amplifiers and high frequency harmonic multipliers
	D5200	0.3-2.4	150-350 at –6v Bias	6–40		
Texas Instruments	XV05	0.3/0.7 C_T	500	6 Min.		
	XV06	0.3/0.6 C_T	400	6 Min.		
	XV07	0.3/0.6 C_T	300	6 Min.		For use in parametric amplifier
	XV01	0.35/1.0 C_T	300	6 Min.		
	XV02	0.35/0.70 C_T	200	6 Min.		NF (db) – 3 at 16.5 gc
	XV03	0.35/0.60 C_T	150	6 Min.		
	XV04	0.35/0.60 C_T	100	6 Min.		
	XA900	0.4/1.4 C_T	50 (min.) V_R = 6v	30 (I_R = 1 μa)		High voltage types for use in tuning, harmonic generators, etc.
	XA901	0.4/1.4 C_T	100 (min.) V_R = 6v	30 (I_R = 1 μa)		
	XA902	0.4/1.4 C_T	200 (min.) V_R = 6v	30 (I_R = 1 μa)		

TABLE 7: GALLIUM ARSENIDE VARACTORS (Continued)

Company	Type	C_{jo} Junction Capacitance at 6v Min.-Max. (pf)	f_c Min. Cutoff Freq. 2v/6v (gc)	V_{BR} Min. Breakdown Voltage (v)	θ Max. Thermal Resistance °C/W	Applications or Comments
Texas Instruments	XA903	0.4/1.4 C_T	300 (min.) V_R = 6v	30 (I_R = 1 μa)		High voltage types for use in tuning, harmonic generators, etc.
	XA905	0.4/1.4 C_T	50 (min.) V_R = 6v	50 (I_R = 1 μa)		
	XA906	0.4/1.4 C_T	100 (min.) V_R = 6v	50 (I_R = 1 μa)		
	XA907	0.4/1.4 C_T	200 (min.) V_R = 6v	50 (I_R = 1 μa)		
	XA908	0.4/1.4 C_T	300 (min.) V_R = 6v	50 (I_R = 1 μa)		
	A600-A602	0.45/1.0 C_T	90-150	8		Parametric Ampls., switches, phase switches.
	A610-A612	0.45/1.0 C_T	90-150	8		

TABLE 8: PARAMETRIC AMPLIFIER VARACTORS

Company	Type	C_{jo} Junction Capacitance at 0v Min.-Max. (pf)	f_c Min. Cutoff Freq. (gc)	β Min. Beta	I_R Max. Leakage Current at 3v μA	V_{BR} Breakdown Voltage (v)	Applications or Comments
Alpha Microwave Div. Alpha Ind.	Series						
	101	0.2-0.39	50-300	5.0-3.5			Max. Pwr. Diss. – 150 mw (Si)
	102	0.40-0.79	50-300	5.0-3.5			
	103	0.80-1.59	50-225	5.0-3.5			
	201	0.2-0.39	50-300				Max. Pwr. Diss. – 150 mw (GaAs)
	202	0.4-0.79	50-300				
	203	0.80-1.59	50-225				
Micro State Electronics Corp.	6100, 6200, 6300	0.1/0.2	100 (6v)	3.5			Silicon
	6101, 6201, 6301	0.1/0.2	150 (6v)	3.5			
	6102, 6202, 6302	0.1/0.2	200 (6v)	4.0			
	6103, 6203, 6303	0.1/0.2	250 (6v)	4.5			
	6104, 6204, 6304	0.2/0.3	100 (6v)	3.5			
	6105, 6205, 6305	0.2/0.3	150 (6v)	3.5			
	6106, 6206, 6306	0.2/0.3	200 (6v)	4.0			
	6107, 6207, 6307	0.3/0.5	100 (6v)	4.0			Gallium arsenide
	262, 4101	0.2/1.0	80 (–6v)				
	263, 4102	0.2/1.0	105 (–6v)				
	264, 4103, 4403	0.2/1.0	130 (–6v)				
	265, 4104, 4404	0.2/0.8	160 (–6v)				
	266, 4105, 4405	0.2/0.7	200 (–6v)				
	20006, 4106, 4406	0.1/0.6	250 (–6v)				
	4107, 4407	0.1/0.5	320 (–6v)				
	4108, 4408	0.1/0.4	360 (–6v)				
Microwave Associates	4534	0.8, 1.2	50	5	1		
	4034	0.8, 1.2	50	5	1		
	4535	0.6, 0.9	60	5	1		
	4035	0.6, 0.9	60	5	1		
	4536	0.4, 0.65	70	5	1		
	4036	0.4, 0.65	70	5	1		
	4537	0.4, 0.6	80	5	1		
	4037	0.4, 0.6	80	5	1		
	4538	0.4, 0.6	100	3.5	1		
	4038	0.4, 0.6	100	3.5	1		
	4539	0.3, 0.5	120	3.5	1		
	4039	0.3, 0.5	120	3.5	1		
Sylvania Electric Products			at –3v Bias				
	D5046	0.3-0.8	150	3.0		5.5 at 10 μa	
	D5046A	0.3-0.7	200	3.0		5.5 at 10 μa	
	D5046B	0.3-0.6	250	3.0		5.5 at 10 μa	Silicon varactors for parametric amplifier applications
	D5146	0.3-0.6	75	8.0		5.5 at 10 μa	
	D5146A	0.3-0.6	100	8.0		5.5 at 10 μa	
	D5146B	0.3-0.6	125	8.0		5.5 at 10 μa	

TABLE 9: AMPLIFIER & OSCILLATING TRANSISTORS

Company	Type	V_{CBO} (v)	I_{CBO} (na)	h_{FE} Min.-Max.	f_T (gc)	$r_b' C_c$ (psec)	NF (db)	Applications or Comments
Amperex Electronic Corp.	A490	30	10	25/125	1.0	4-15	5	
Transitron Electronic Corp.	2N2784 2N3633	15 15		40/120 50/150	1.0 1.3			Switching or Amplifying
KMC Semiconductor Corp.	2N3880 K2501 K2502 K2503			6.5 db*	1.5		6	*At 1 gc Osc. Pwr. Out = 70 mw at 1 gc Osc. Pwr. Out = 85 mw at 1 gc Osc. Pwr. Out = 30 mw at 2 gc
Fairchild Semiconductor	MT1038 MT1039	30 30	500 500	20/80 20/80	1.0 1.0			Osc. Pwr. Out = 1.0 w at 1 gc Osc. Pwr. Out = 0.8 w at 1 gc
Motorola Semiconductor Products	2N3279, 2N3280 2N3281, 2N3282	30 (max.) 30 (max.)	1000 50 K (max.)	10/70 10/100	0.5 (typ.) 0.4	5 (typ.) 5 (typ.)	2.9 (typ.) 4.0 (typ.)	Germanium pnp epitaxial mesa diffused base. For use as high-gain, low-noise amplifiers, oscillators, mixers and frequency multipliers. Oscillation $f_{max.}$ = 2000 mc (typ.)
	2N3544	25 (max.)	10	25/		10 (max.)		VHF/UHF silicon npn epitaxial passivated transistor. P out at 1000 mc = 16 mw (typ.)
	2N3783, 2N3784 2N3785	30 (max.) 15 (max.)	5 K 5 K	20/200 15/200	0.8/1.6. 0.7/1.6	1/6 1/10	6.5 (max.)/7.0 (typ.) 2.9 (max.)	Germanium pnp epitaxial mesa.for high-gain, low-noise amplifiers, oscillators, and frequency multipliers.
Siemens & Holske	AFY34	−40		>10	3.5			Universal applications to 1.5 gc. Germanium pnp mesa.
Solid State Electronics Corp.	SST610	60	0.3 ma (typ.)	>5 K				npn silicon diffused mesa. Highly stable.
Texas Instruments	X3024A 2N3570 X3016A XS09 XS10 XS12 XS13	−15 min. −15 min. 30 min. 30 min. 30 min.	−6.0 max. −6.0 max. 1 max.	25/250 25/250 20/200 20/200 20/200	 1.4	2.0 2.0 5	5 at 1 gc 7 at 1 gc silicon 6 at 1 gc-silicon	Germanium. UHF and L-Band amplifier L-C Band oscillator. Silicon $P_{o\,min}$, 30 mw at 2 gc P_o 30 mw at 1 gc P_o 250 mw at 1.5 gc P_o 250 mw at 1.5 gc

TABLE 10: SWITCHING DIODES

Company	Type	Frequency (gc)	Insertion Loss, db (Forward Bias)		Isolation, db (Reverse Bias)		Power Level (w)	Applications or Comments
			Typ.	Max.	Min.	Typ.		
Philco Corp.	L4702	4.5	1.0	1.5	25	30	5.0	C through K-Band silicon epitaxial switching diodes
	L4703	5.0	1.0	1.5	25	30	5.0	
	L4704	5.5	1.0	1.5	20	25	2.5	
	L4705	6.0	1.0	1.5	25	30	5.0	
	L4706	6.5	1.0	1.5	25	30	5.0	
	L4707	7.0	1.0	1.5	25	30	4.0	
	L4708	7.5	1.0	1.5	25	30	3.0	
	L4709	8.0	1.0	1.5	20	25	2.5	
	L4710	7.5	1.0	1.5	25	30	5.0	
	L4711	8.0	1.0	1.5	25	30	5.0	
	L4712	8.5	1.0	1.5	25	30	4.0	
	L4713	9.0	1.0	1.5	25	30	3.0	
	L4714	9.5	1.0	1.5	25	30	2.5	
	L4715	8.5	0.5	0.75	20	25	5.0	
	L4716	9.0	0.5	0.75	20	25	5.0	
	L4717	9.5	0.5	0.75	20	25	5.0	
	L4718	10.0	0.5	0.75	20	25	5.0	
	L4719	10.5	0.5	0.75	20	25	4.0	
	L4720	11.0	0.5	0.75	20	25	3.0	
	L4721	11.5	0.5	0.75	20	25	2.5	
	L4722	12.0	0.5	0.75	20	25	2.5	
	L4750	13.0	0.4	0.75	20	25	5.0	
	L4751	13.3	0.4	0.75	20	25	5.0	
	L4752	14.0	0.4	0.75	20	25	5.0	
	L4753	14.5	0.4	0.75	20	25	4.0	

TABLE 10: SWITCHING DIODES (Continued)

Company	Type	Frequency (gc)	Insertion Loss, db (Forward Bias) Typ.	Insertion Loss, db (Forward Bias) Max.	Isolation, db (Reverse Bias) Min.	Isolation, db (Reverse Bias) Typ.	Power Level (w)	Applications or Comments
Philco Corp. Cont.	L4754	15.0	0.4	0.75	20	25	4.0	
	L4755	15.5	0.4	0.75	20	25	3.0	
	L4756	16.0	0.4	0.75	20	25	2.5	
	L4757	16.5	0.4	0.75	20	25	2.5	
	L4758	17.0	0.5	0.75	20	25	2.5	
	L4759	17.5	0.5	1.0	20	25	2.5	
	L4765	20.5	0.4	0.75	10	15	2.0	
	L4766	21.0	0.4	0.75	10	15	2.0	
	L4767	21.5	0.4	0.75	10	15	2.0	
	L4768	22.0	0.25	0.5	10	15	2.0	
	L4769	22.5	0.25	0.5	10	15	2.0	
	L4770	23.0	0.25	0.5	10	15	2.0	
	L4771	23.5	0.25	0.5	10	15	2.0	
	L4772	24.0	0.25	0.5	10	15	2.0	
	L4773	24.5	0.25	0.5	8	12	2.0	
	L4774	25.0	0.25	0.5	8	12	2.0	
	L4775	25.5	0.25	0.5	8	12	2.0	
	L4776	26.0	0.25	0.5	8	12	2.0	C through X-Band germanium switching diodes
	L4130	4.5	0.75	1.2	25	28	1.0	
	L4131	5.0	0.75	1.2	25	28	1.0	
	L4132	5.5	0.75	1.2	25	28	1.0	
	L4133	6.0	0.75	1.2	25	28	1.0	
	L4134	6.5	0.75	1.2	25	28	1.0	
	L4135	7.0	0.75	1.2	25	28	1.0	
	L4138	7.5	0.75	1.2	25	28	1.0	
	L4139	8.0	0.75	1.2	25	28	1.0	
	L4140	7.5	0.75	1.2	25	28	1.0	
	L4141	8.0	0.75	1.2	25	28	1.0	
	L4142	8.5	0.75	1.2	25	28	1.0	
	L4143	9.0	0.75	1.2	25	28	1.0	
	L4144	9.5	0.75	1.2	25	28	1.0	
	L4145	8.5	0.75	1.2	25	28	1.0	
	1N3482	9.0	0.75	1.2	25	28	1.0	
	L4146	9.5	0.75	1.2	25	28	1.0	
	L4120	10.0	0.75	1.2	25	28	1.0	
	L4147	10.5	0.75	1.2	25	28	1.0	
	L4136	11.0	0.75	1.2	25	28	1.0	
	L4122	11.5	0.75	1.2	25	28	1.0	

Texas Instruments	Type	V_{BR} (v)	I_R (μa)	V_F (v)	C_T (pf)	τ_{rr} (psec)	F_{co} (gc)	
	XD27	20 min.	0.05 max.	1 max. at 50 ma		100 max.		Metal silicon barrier diode
	XD28	15 min.	0.1 max.	0.85 max. at 50 ma		100 max.		
	A670	10 min.	.001 max.	1.4 max. at 5 ma		300 max.		Sampling and switching diode
	A671	10 min.	.001 max.	1.4 max. at 5 ma		300 max.		
	XD500	6 min.					144	Parametric ampl. and switches
	XD501	6 min.					108	

TABLE 11: PIN DIODES

Company	Type	V_{BR} Breakdown (v) min. at 10 μa	C_j Junction Capacitance max. (pf)	C_j Junction Capacitance typ. (pf)	C_T (cp + cj) max. at V_R = 50v f = 1 mc (pf)	R_s Series Resistance max. (ohms)	Applications or Comments
Micro State Electronics Corp.	6000, 6010	200			0.5, 0.4	1.5	
	6001, 6011	400			0.5, 0.4	1.5	
	6002, 6012	600			0.5, 0.4	1.5	
	6006, 6016	1,000			0.5, 0.4	1.5	Low C for broadband use. Suitable for waveguide coax strip line to X-band. Silicon.
	6007, 6017	1,400			0.5, 0.4	2.0	
	6003, 6013	200			0.9, 0.8	1.0	
	6004, 6014	400			0.9, 0.8	1.0	
	6005, 6015	600			0.9, 0.8	1.0	
	6008, 6018	1,000			0.9, 0.8	1.2	
	6009, 6019	1,400			0.9, 0.8	1.7	
Philco Corp.	L8313A, L8413A	200	.2	2.0		3.0	
	L8313B, L8413B	200	.2	2.0		1.5	
	L8314A, L8414A	200	.4	4.0		2.5	
	L8314B, L8414B	200	.4	4.0		1.2	For high power microwave switching, limiting and duplexing.
	L8315A, L8415A	200	.6	6.0		2.0	
	L8315B, L8415B	200	.6	6.0		1.0	
	L8316A, L8416A	200	.9	9.0		1.5	
	L8316B, L8416B	200	.9	9.0		0.8	
	L8317A, L8417A	200	1.5	15.0		1.5	

TABLE 11: PIN DIODES (Continued)

Company	Type	V_{BR} Breakdown (v) min.	C_j Junction Capacitance max. (pf)	C_j Junction Capacitance typ. (pf)	C_T (cp + cj) max. at V_R = 50v f = 1 mc (pf)	R_s Series Resistance max. (ohms)	Applications or Comments
Philco Corp. Cont.	L8317B, L8417B	200	1.5	15.0		0.7	
	L8323A, L8423A	300	.2	2.0		3.0	
	L8323B, L8423B	300	.2	2.0		1.5	
	L8324A, L8424A	300	.4	4.0		2.5	
	L8324B, L8424B	300	.4	4.0		1.2	
	L8325A, L8425A	300	.6	6.0		2.0	
	L8325B, L8425B	300	.6	6.0		1.0	
	L8326A, L8426A	300	.9	9.0		1.5	
	L8326B, L8426B	300	.9	9.0		0.8	
	L8327A, L8427A	300	1.5	15.0		1.5	
	L8327B, L8427B	300	1.5	15.0		0.7	
	L8333A, L8433A	400	.2	2.0		3.0	
	L8333B, L8433B	400	.2	2.0		1.5	
	L8334A, L8434A	400	.4	4.0		2.5	For high power microwave switching, limiting and duplexing.
	L8334B, L8434B	400	.4	4.0		1.2	
	L8335A, L8435A	400	.6	6.0		2.0	
	L8335B, L8435B	400	.6	6.0		1.0	
	L8336A, L8436A	400	.9	9.0		1.5	
	L8336B, L8436B	400	.9	9.0		0.8	
	L8337A, L8437A	400	1.5	15.0		1.5	
	L8337B, L8437B	400	1.5	15.0		0.7	
	L8343A, L8443A	500	.2	2.0		3.0	
	L8343B, L8443B	500	.2	2.0		1.5	
	L8344A, L8444A	500	.4	4.0		2.5	
	L8344B, L8444B	500	.4	4.0		1.2	
	L8345A, L8445A	500	.6	6.0		2.0	
	L8345B, L8445B	500	.6	6.0		1.0	
	L8346A, L8446A	500	.9	9.0		1.5	
	L8346B, L8446B	500	.9	9.0		0.8	
	L8347A, L8447A	500	1.5	15.0		1.5	
	L8347B, L8447B	500	1.5	15.0		0.7	

TABLE 12: GALLIUM ARSENIDE TUNNEL DIODES

Company	Type	R_N Negative Resistance Min.-Max. (ohms)	I_p Typical Peak Current (ma)	R_s Series Resistance Max. (ohms)	C_j Junction Capacitance Min.-Max. (pf)	F_r Minimum Resistive Cut-off Freq. (gc)	F_{xo} Minimum Self-Resonant Freq. (gc)	V_p Typical Peak Voltage (mv)	I_p/I_v Peak to Valley Ratio Min.	P Calculated Oscillator Power Available (mw)	F_{ro} (Min.) (gc)	Applications or Comments
KMC Semiconductor Corp.											15	High Freq. Osc.
Microwave Associates	4651A	35, 55	5	4	0.8, 1.5	10.0	10.0	150	15	0.25		At 900 Mc.
	4651B	35, 55	5	3	1.5, 2.5	8.0	7.5	150	15	0.25		
	4651C	35, 55	5	2	2.5, 5.0	5.0	6.0	150	15	0.25		
	4652A	15, 25	10	3	1.5, 2.5	9.0	9.0	150	15	0.50		
	4652B	15, 25	10	2	2.5, 5.0	6.0	7.0	150	15	0.50		
	4652C	15, 25	10	2	5.0,10.0	4.0	5.0	150	15	0.50		
	4653A	8, 12	20	2.0	2.0, 4.0	8.0	7.0	180	15	1.0		
	4653B	8, 12	20	1.5	4.0, 8.0	6.0	5.0	180	15	1.0		
	4653C	8, 12	20	1.5	8.0,20.0	4.0	4.0	180	15	1.0		
	4654A1	3, 5	50	2.0	–, 4.0	15.0	8.0	180	10	2.5		
	4654A	3, 5	50	1.5	5.0,10.0	6.0	6.0	180	10	2.5		
	4654B	3, 5	50	1.2	10.0,15.0	4.0	5.0	180	10	2.5		
	4654C	3, 5	50	1.2	15.0,30.0	3.0	4.0	180	10	2.5		
	4655	–, 13	20	3.0	–, 1.2	25	20	150	10			
Micro State Electronics Corp.	1540		5	3 (typ.)	0.75 (typ.)	10	17 (typ.)	160 (max.)				Microwave oscillator diodes.
	1541		10	2 (typ.)	1.5 (typ.)	9	11 (typ.)	165 (max.)				
	1542		20	1.5 (typ.)	3.0 (typ.)	8	7 (typ.)	170 (max.)				
	1530A		5	1.0 (typ.)	3.0 (typ.)	6		125				
	1531A		10	0.8 (typ.)	6.0 (typ.)	4		125				
	1532A		20	0.6 (typ.)	12.0 (typ.)	3.5		125				
	1533A		50	0.4 (typ.)	30 (typ.)	3.0		135				
	1534A		100	0.3 (typ.)	60 (typ.)	2.0		140				
	1535A		250	0.25 (typ.)	150 (typ.)	1.0		150				
	1536A		500	0.17 (typ.)	300 (typ.)	0.7		160				
R.C.A.	40076	1.1 (typ.)	200	0.8	16 (typ.)	5		240	15/1	12 mw @ Land S bands		For microwave oscillator.
	40058	4.4 (typ.)	50	3.0		2.0		180	12			For pulse generators, transistor drivers, microwave frequency converters and oscillators.
	40059	4.4 (typ.)	50	3.0		1.0		180	10			
	40060	11 (typ.)	20	8.0		1.0		180	11			
	40061	11 (typ.)	20	8.0		0.50		180	9			
	40062	22 (typ.)	10	9.0		0.70		180	10			
	40063	22 (typ.)	10	9.0		0.25		180	9			
	40064	44 (typ.)	5	12.0		0.45		170	10			
	40065	44 (typ.)	5	12.0		0.18		170	8			

TABLE 13: GALLIUM ANTIMONIDE TUNNEL DIODES

Company	Type	R_N Negative Resistance Min.-Max. (ohms)	I_p Typical Peak Current (ma)	R_s Series Resistance Typical (ohms)	C_j Junction Capacitance Typical (pf)	F_r Minimum Resistive Cut-off Freq. (gc)	F_{xo} Minimum Self-Resonant Freq. (gc)	V_p Typical Peak Voltage (mv)	I_p/I_v Peak to Valley Ratio Min.	P Calculated Oscillator Power Available (mw)	NF Noise Constant Max.	K Max.	Applications or Comments
KMC Semiconductor Corp.						25						0.95	High Freq. Low Noise Amp.

TABLE 13: GALLIUM ANTIMONIDE TUNNEL DIODES (Continued)

Company	Type	R_N Negative Resistance Min.-Max. (ohms)	I_p Typical Peak Current (ma)	R_s Series Resistance Typical (ohms)	C_j Junction Capacitance Typical (pf)	F_r Minimum Resistive Cut-off Freq. (gc)	F_{xo} Minimum Self-Resonant Freq. (gc)	V_p Typical Peak Voltage (mv)	I_p/I_v Peak to Valley Ratio Min.	P Calculated Oscillator Power Available (mw)	NF Noise Constant Max.	K Max.	Applications or Comments
Micro State Electronics Corp.	233A	85/120	1.0	3	3.0	3					0.85		Amplifier, converter, mixer types for phased arrays, microwave relay links, telemetry, radar.
	1504A/1560A	85/120	1.0	4	1.5	6					0.85		
	1505A/1561A	85/120	1.0	5	1.0	8					0.90		
	1507A/1562A	85/120	1.0	6	0.6	12					0.90		
	1508A/1563A	85/120	1.0	7	0.4	15					0.95		
	1512A/1564A	85/120	1.0	7	0.3	20					0.95		
	1520A	60/85	1.5	3	3.0	3					0.85		
	1521A/1581A	60/85	1.5	4	1.5	6					0.85		
	1522A/1582A	60/85	1.5	5	1.1	8					0.85		
	1523A/1583A	60/85	1.5	6	0.7	12					0.90		
	1524A/1584A	60/85	1.5	7	0.6	15					0.90		
	1525A/1585A	60/85	1.5	7	0.4	20					0.95		
	1526A/1586A	60/85	1.5	8	0.3	25					0.95		
	1509A/1570A	40/60	2.0	5	1.5	8					0.85		
	1506A/1571A	40/60	2.0	5	0.75	12					0.90		
	1510A/1572A	40/60	2.0	6	0.6	15					0.90		
	1511A/1573A	40/60	2.0	6	0.4	20					0.95		
	1513A/1574A	40/60	2.0	7	0.3	25					0.95		
	1575A	40/60	2.0	7	0.25	30					0.95		

TABLE 14: GERMANIUM TUNNEL DIODES

Company	Type	R_N Negative Resistance Min.-Max. (phms)	I_p Typical Peak Current (ma)	R_s Series Resistance Max. (ohms)	C_j Junction Capacitance Min.-Max. (pf)	F_r Minimum Resistive Cut-off Freq. (gc)	F_{xo} Minimum Self-Resonant Freq. (gc)	V_p Typical Peak Voltage (mv)	I_p/I_v Peak to Valley Ratio	I_o/R_N Noise Voltage Max. (mv)	$-G$ Neg. Cond. (mhos x 10^{-3})	Applications or Comments
General Electric Co.	IN2939		1.0	4.0	15 Max.	2.2 (Typ.)		65	7.15		6.6	Gen. Purpose Switching, Osc., Amp., and Converter Ckts.
	IN2939A		1.0	4.0	10 "	2.6 "		60	7.15		6.6	
	IN2940		1.0	4.0	10 "	2.2 "		65	4.55		6.6	
	IN2940A		1.0	4.0	7 "	2.6 "		65	4.55		6.6	
	IN2941		4.7	2.0	50 "	2.6 "		65	4.52		30	
	IN2941A		4.7	2.0	30 "	3.9 "		65	4.52		30	
	IN2969		2.2	3.0	25 "	2.5 "		65	4.58		16	
	IN2969A		2.2	3.0	15 "	3.3 "		65	4.58		16	
	IN3149		10.0	1.5	90 "	2.6 "		65	4.55		60	
	IN3149A		10.0	1.5	50 "	3.1 "		65	4.55		60	
	IN3150		22.0	1.0	150 "	2.2 "		65	4.58		100	
	IN3712(TD-1)		1.0	4.0	10 "	2.3 "		65	5.56		8.0	
	IN3713(TD-1A)		1.0	4.0	5 "	3.2 "		65	7.15		8.5	
	IN3714(TD-2)		2.2	3.0	25 "	2.2 "		65	4.58		18	
	IN3715(TD-2A)		2.2	3.0	10 "	3.0 "		65	7.09		19	
	IN3716(TD-3)		4.7	2.0	50 "	1.8 "		65	4.52		40	
	IN3717(TD-3A)		4.7	2.0	25 "	3.4 "		65	7.83		41	
	IN3718(TD-4)		10.0	1.5	90 "	1.6 "		65	4.55		80	
	IN3719(TD-4A)		10.0	1.5	50 "	2.8 "		65	7.15		85	
	IN3720(TD-5)		22.0	1.0	150 "	1.6 "		65	4.58		180	
	IN3721(TD-5A)		22.0	1.0	100 "	2.6 "		65	7.09		190	
	TD-9		0.5	6.0	5 "	1.3 "		60	5.0		4.0	
	TD-401	60/80	1.85	3.0	3.5 "	5.0 "						

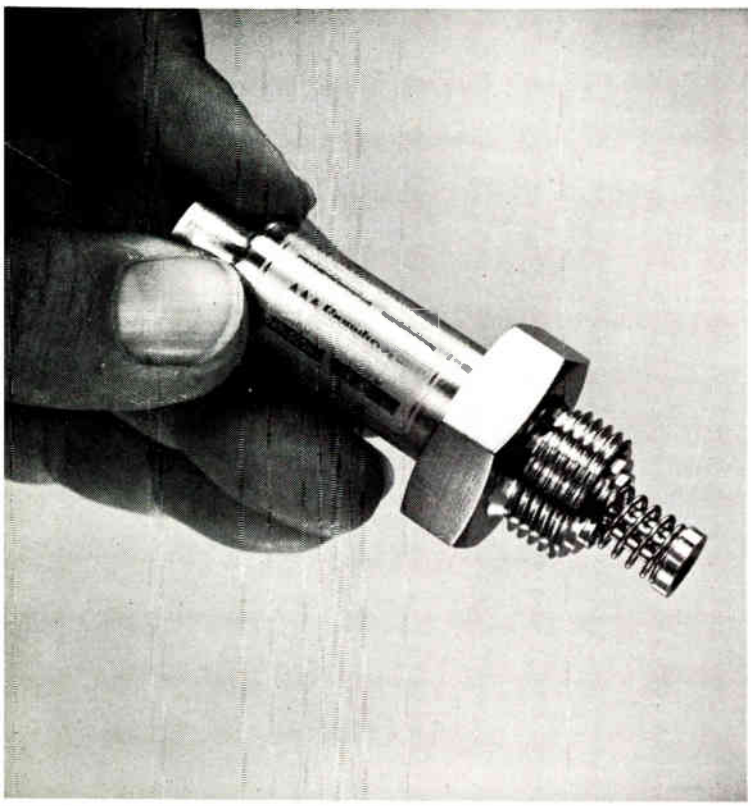
TABLE 14: GERMANIUM TUNNEL DIODES (Continued)

Company	Type	R_N Negative Resistance Min.-Max. (ohms)	I_p Typical Peak Current (ma)	R_s Series Resistance Max. (ohms)	C_j Junction Capacitance Min.-Max. (pf)	F_r Minimum Resistive Cut-off Freq. (gc)	F_{xo} Minimum Self-Resonant Freq. (gc)	V_p Typical Peak Voltage (mv)	I_p/I_v Peak to Valley Ratio	I_o/R_N Noise Voltage Max. (mv)	$-G$ Neg. Cond. (mhos x 10^{-3})	Applications or Comments
General Electric Co. (Cont.)	TD-402	60/80	1.85	4.0	1.8 Max.	10 (Typ.)						Gen. Purpose Switching, Osc., Amp., and Converter Ckts.
	TD-403	60/80	1.85	5.0	1.0 "	15 "						
	TD-404	60/80	1.85	5.0	0.75 "	20 "						
	TD-405	60/80	1.85	6.0	0.60 "	25 "						
	TD-406	60/80	1.85	6.0	0.48 "	30 "						
	TD-407	60/80	1.85	6.0	0.37 "	35 "						
	TD-408	60/80	1.85	6.0	0.30 "	40 "						

Company	Type	R_N Negative Resistance Min.-Max. (ohms)	I_p Typical Peak Current (ma)	R_s Series Resistance Max. (ohms)	C_j Junction Capacitance Min.-Max. (pf)	F_r Minimum Resistive Cut-off Freq. (gc)	F_{xo} Minimum Self-Resonant Freq. (gc)	V_p Typical Peak Voltage (mv)	I_p/I_v Peak to Valley Ratio	I_o/R_N Noise Voltage Max. (mv)	K_d Noise Constant Ratio (Max.)	Applications or Comments
KMC Semiconductor Corp.						25					1.45	High-Freq., Low Noise Amplifiers
Micro State Electronics Corp.	224A	85/120	1.5(typ)	2 (typ)	2.5 (typ)	3					1.35	Amplifier, converter, mixer types for phased arrays, microwave relay links, telemetry, radar.
	1005A/1201A	85/120	1.5 "	3 "	1.0 "	6					1.40	
	1007A/1202A	85/120	1.5 "	4 "	0.6 "	10					1.45	
	1020A/1204A	85/120	1.5 "	4 "	0.5 "	15					1.45	
	1021A/1205A	85/120	1.5 "	5 "	0.45 "	20					1.45	
	1022A/1206A	85/120	1.5 "	5 "	0.4 "	25					1.45	
	1023A/1207A	85/120	1.5 "	6 "	0.35 "	30					1.45	
	1208A	85/120	1.5 "	7 "	0.25 "	40					1.50	
	1140A	60/85	2.5 "	2 "	3.5 "	3					1.35	
	1141A/1241A	60/85	2.5 "	3 "	1.5 "	6					1.40	
	1142A/1242A	60/85	2.5 "	3 "	1.0 "	10					1.45	
	1143A/1243A	60/85	2.5 "	4 "	0.6 "	15					1.45	
	1144A/1244A	60/85	2.5 "	4 "	0.5 "	20					1.45	
	1145A/1245A	60/85	2.5 "	5 "	0.4 "	25					1.45	
	1146A/1246A	60/85	2.5 "	6 "	0.4 "	30					1.50	
	1247A	60/85	2.5 "	7 "	0.3 "	40					1.50	
	225A	40/60	3.5 "	2 "	2.0 "	6					1.30(typ)	
	1100A/1220A	40/60	3.5 "	2.5 "	1.4 "	10					1.30 "	
	1101A/1221A	40/60	3.5 "	3 "	0.8 "	15					1.35 "	
	1102A/1222A	40/60	3.5 "	4 "	0.6 "	20					1.35 "	
	1103A/1223A	40/60	3.5 "	5 "	0.4 "	30					1.40 "	
	1224A	40/60	3.5 "	6 "	0.3 "	40					1.40 "	
Microwave Associates	4604A	60, 80	1.5	8	---, 0.8	15	17	55	5	60		At 900 Mc.
	4604A1	60, 80	1.5	8	---, 0.5	25	22	55	5	60		
	4604B	60, 80	1.5	6	0.8, 1.5	10	12	55	5	65		
	4604C	60, 80	1.5	6	1.5, 3.2	3	6	55	5	85		
	4605A	40, 60	2.0	8	---, 0.9	15	15	55	6	60		
	4605B	40, 60	2.0	6	0.9, 2.0	10	11	55	6	65		
	4605C	40, 60	2.0	5	2.0, 4.0	3	6	55	6	85		
	4606A	25, 35	4.0	4	---, 1.2	15	13	55	6			
	4606A1	25, 35	4.0	4	---, 0.8	22	18	55	6			

TABLE 14: GERMANIUM TUNNEL DIODES (Continued)

Company	Type	R_N Negative Resistance Min.-Max. (ohms)	I_p Typical Peak Current (ma)	R_s Series Resistance Max. (ohms)	C_j Junction Capacitance Min.-Max. (pf)	F_r Minimum Resistive Cut-off Freq. (gc)	F_{xo} Minimum Self-Resonant Freq. (gc)	V_p Typical Peak Voltage (mv)	I_p/I_v Peak to Valley Ratio	I_o/R_N Noise Voltage Max. (mv)	Kd Noise Constant Ratio (Max.)	Applications or Comments
Microwave Associates (Cont.)	4606A2	25, 35	4.0	4	---, 0.6	30	21	55	6			At 900 Mc.
	4606B	25, 35	4.0	4	1.2, 2.5	10	10	55	6			
	4606C	25, 35	4.0	4	2.5, 4.0	3	5	55	6			
	4607A	8, 12	10.0	3	---, 2.0	15	9	60	6			
	4607A1	8, 12	10.0	3	---, 1.2	22	16	60	6			
	4607A2	8, 12	10.0	3	---, 1.0	30	18	60	6			
	4607B	8, 12	10.0	3	2.0, 4.0	8	6	60	6			
	4607C	8, 12	10.0	3	4.0, 8.0	3	4	60	6			
	4608A	3.5, 4.5	30.0	2	---, 6.0	10	6	80	6			
	4608B	3.5, 4.5	30.0	2	6.0, 12.0	5	4	80	6			
	4608C	3.5, 4.5	30.0	2	12.0, 25.0	3	2	80	6			
	4609A	1.6, 2.4	60.0	1	---, 15.0	8	5	80	6			
	4609B	1.6, 2.4	60.0	1	15.0, 30.0	4	3	80	6			
	4609C	1.6, 2.4	60.0	1	30.0, 60.0	2	2	80	6			
Philco Corp.	L4650/L4660	75(typ-min)	1.5	5(typ)	1.1 (typ)	6.0			5.0		1.50	Amplifier, Converter and Mixer
	L4650A/L4660A	75 "	1.5	5 "	1.1 "	6.0			5.0		1.35	
	L4651/L4661	75 "	1.5	5 "	0.7 "	10			5.0		1.55	
	L4651A/L4661A	75 "	1.5	5 "	0.7 "	10			5.0		1.45	
	L4652/L4662	75 "	1.5	5 "	0.6 "	12			5.0		1.55	
	L4652A/L4662A	75 "	1.5	5 "	0.6 "	12			5.0		1.45	
	L4653/L4663	75 "	1.5	5 "	0.5 "	15			5.0		1.55	
	L4653A/L4663A	75 "	1.5	5 "	0.5 "	15			5.0		1.45	
	L4654/L4664	75 "	1.5	5 "	0.4 "	20			5.0		1.55	
	L4654A/L4664A	75 "	1.5	5 "	0.4 "	20			5.0		1.45	
	L4655/L4665	75 "	1.5	5 "	0.3 "	25			5.0		1.55	
	L4655A/L4665A	75 "	1.5	5 "	0.3 "	25			5.0		1.45	
	L4656/L4666	75 "	1.5	5 "	0.25 "	30			5.0		1.55	
	L4656A/L4666A	75 "	1.5	5 "	0.25 "	30			5.0		1.45	
RCA	40077	110(typ-min)	1.0	6	1.3 (typ)	6	7 (typ)	65	10/1 (typ)	55 (typ)		Small signal
Sylvania Electric Products	D5360/D5560/D5570		1.2	8	1.5 (max)	5.0						Rj (ohms) 100 (typ)
	D5360A/D5560A/D5570A		1.2	4	0.45 "	25						100
	D5560B/D5570B		1.2	6	0.50 "	20						100
	D5361/D5561/D5571		1.8	7	2.0 "	5.0						67
	D5361A/D5561A/D5571A		1.8	3	0.60 "	25						67
	D5561B/D5571B		1.8	6	0.70 "	15						67
	D5362/D5562/D5572		2.7	6	3.0 "	5.0						44
	D5362A/D5562A/D5572A		2.7	2.5	0.75 "	25						44
	D5562B/D5572B		2.7	6	1.10 "	12						44
	D5363/D5563/D5573		3.9	6	5.0 "	5.0						31
	D5363A/D5563A/D5573A		3.9	2	1.00 "	25						31
	D5563B/D5573B		3.9	6	1.60 "	10						31
	D5364/D5564/D5574		5.6	6	7.0 "	5.0						22
	D5364A/D5564A/D5574A		5.6	1.5	1.40 "	25						22
	D5564B/D5574B		5.6	6	2.30 "	7.5						22
	D5365/D5565/D5575		8.2	6	10.0 "	5.0						15
	D5365A/D5565A/D5575A		8.2	1	2.00 "	25						15
	D5565B/D5575B		8.2	6	3.30 "	5.5						15



RP49 series linear position potentiometer (Humphrey, Inc.)

Below: PR-1 series rectilinear potentiometer (MEKTRON Div., California General, Inc.)

Bottom: Vermistat® AC potentiometer (Perkin-Elmer Corp.)

Part 2

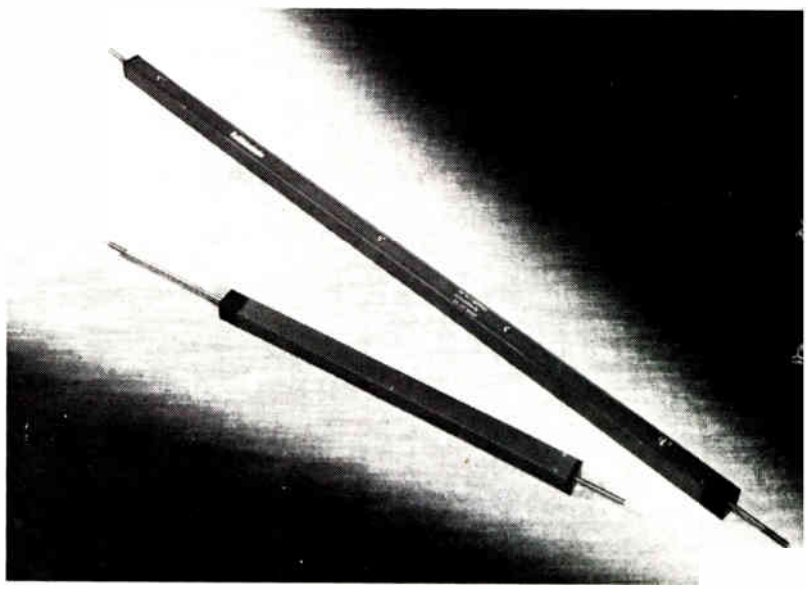
1965 Survey

Special Purpose Potentiometers

POTENTIOMETER SPECIFYING GUIDE (Part 2) covers variable resistors used as transducers, attenuators, rheostats and potentiometers for DC and AC voltage and current control applications. Transducer potentiometers listed in the charts are the light sensitive and pressure sensitive types as well as the rectilinear pots for transforming linear motion and position into corresponding electrical quantities.

Attenuators include rotary and slide audio types used in broadcasting, recording and sound motion picture installations, plus some video and RF types for TV and test equipment use. Rheostats are the variable resistors and slidewires, usually with one fixed and one movable terminal, and commonly used for generator field and motor speed control, lamp dimming and other

Linear motion potentiometers (Precision Line, Inc.)



Second in a series of special reports identifying suppliers and listing available Mil Spec precision potentiometers and their characteristics, as compiled by EI editors.

Of Potentiometer Specifications

applications involving variation of voltage and current.

Not covered in this Guide, however, are the special laboratory potentiometers for precision measuring of current and resistance.

Rectilinear Potentiometers

Rectilinear, or translatory potentiometers are circular, rectangular or tubular devices containing one or more resistance elements and wipers actuated by a shaft extending from the side or end of the enclosure. They are designed to present an electrical resistance that is proportional to the longitudinal travel of the shaft.

Rectilinear pots are used for precision position indication and control in automatic machinery, process equipment and computers. Linear and non-linear outputs are available as are shaft stroke lengths up to 30 or more inches. Wire, carbon, conductive plastic and films are used for resistance elements.

Attenuators

Control and mixing of audio in broadcasting, recording and motion picture projection is a primary application of attenuators. Attenuators permit the control of a number of loads or channels over wide limits and permit the setting of levels in one channel with minimum effect on the loading and response of other channels.

There are two general classifications for audio attenuators: (1) attenuators for unbalanced circuits (one side of line at zero potential); and (2) attenuators designed for balanced circuits (both sides of line above ground). Under each, attenuators are further grouped by circuit, such as "ladder" or "T" and "H." The Ladder control features simplicity and consists of consecutive π resistor sections combined to supply the required terminal impedances and reduction in volume. T and H networks have zero insertion loss for 1:1 impedance ratios and constant impedance, in and out, on all steps of control.

These networks may be inserted in a transmission line system without introducing reflection losses. In selecting an attenuator, the output level and impedance of the signal source should be considered. Circuit noise must be far below the signal voltage. For a high quality system (50-15,000 cy), at least 40-60 db program peaks above background noise is desirable. The wider the band, the higher the background noise. Therefore, it is not possible to set a hard and fast rule and say that "T" networks should be used for low level mixing (i.e., between source and preamplifier) and ladder networks for high level mixing (between preamplifier and main amplifier).

However, when the output of the source, volume range, frequency band, number of channels to be mixed and output desired are known, the best type control can be selected with ease. Rotary and slide types are available. Slide attenuators are frequently used in program mixing when the operator has to control multiple units with one hand (Daven).

Rheostats

Physically, a rheostat and a potentiometer may be identical, the difference being in how the device is wired into the circuit. The rheostat is usually connected as a series variable resistor, while the potentiometer is connected as a voltage divider.

When a potentiometer is used as a rheostat, it is recommended that a jumper be wired between the high resistance terminal and the rotor terminal. This shunt will provide added protection and longer life to the rheostat by minimizing arcing which may occur if the brush rides over dust or dirt that may accumulate on the track.

In selecting a rheostat (or potentiometer) use the following procedure:

1. Determine maximum current, and for tapers, also minimum current.
2. Compute required maximum resistance.

(Continued on page 92)

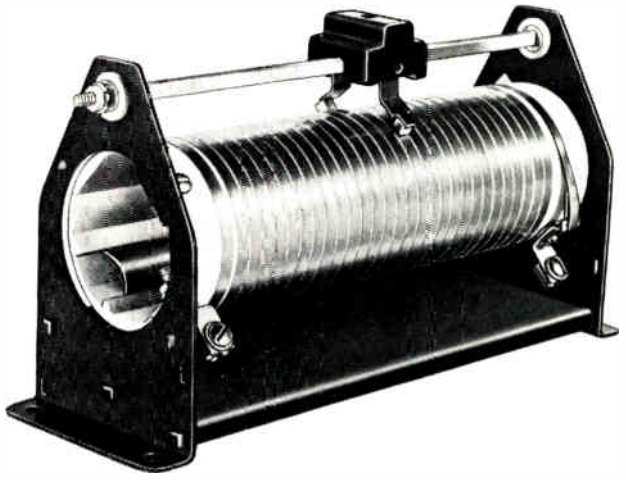
POTENTIOMETER SURVEY

Part 1 appeared in the October EI Issue.

Future Potentiometer Survey Parts will appear in these issues:

Part 3: Trimmer Potentiometers (EI January, 1966)

Part 4: General Purpose Potentiometers (EI March, 1966)



SWR Slidewire Resistor (Superior Electric Co.)

POTENTIOMETERS (Concluded)

3. Find power required.
4. Determine physical size required by mounting conditions, temperature rise, voltage, wattage and application.
5. Determine mechanical requirements such as bushing and shaft length, type, non-turn location, other features, temperature coefficient.
6. Select rheostat that provides desired characteristics (Memcor).

AC Potentiometers

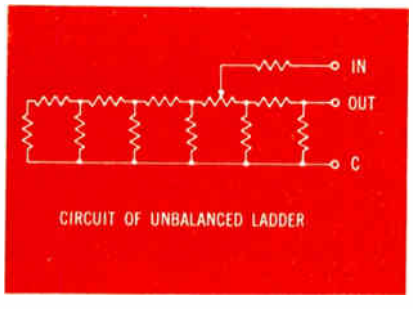
The AC potentiometer is a continuous rotation, multiturn unit which employs the principles of an auto transformer in relating voltage to shaft position. Used in military type servos and in computers, the AC potentiometer features high accuracy (typically ± .01% absolute linearity), low phase shift, low output impedance (20 ohms) and essentially infinite resolution.

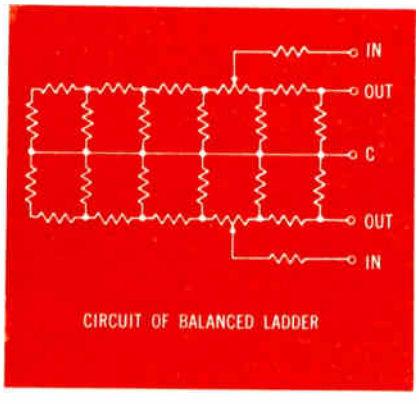
High linearity is achieved by the use of precisely located auto transformer taps that accurately define the output function. A toroidal resistance element interpolates between the taps. To remotely relate shaft position, a servo is positioned in accordance with an error signal transmitted by a null transformer in the AC potentiometer circuit (Perkin-Elmer).

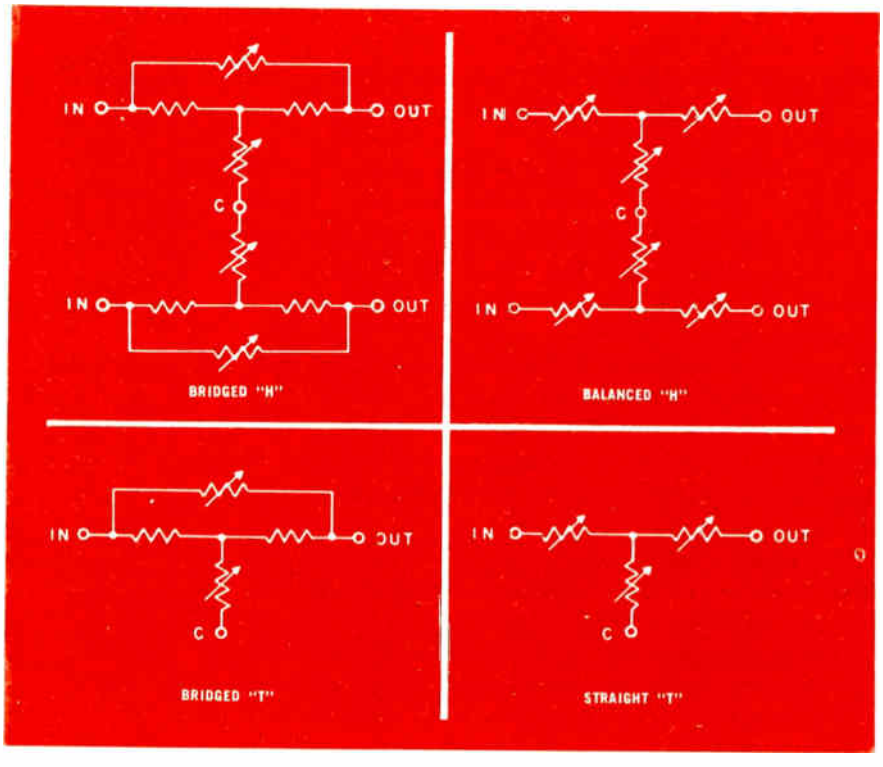
(Continued on page 94)

ATTENUATOR CIRCUITS

(Daven Division, Thomas A. Edison Industries)







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Model 3070 also offers slip-clutch action, the indestructible SILVERWELD® termination, and resistance wire with twice the normal cross-section area. Units are available immediately in a broad choice of terminal types and mounting styles, including two panel-mount versions.

Write today for free technical data.

Resolution:	0.032% to 0.15%
Standard resistances:	75Ω to 50K
Power rating at 70°C:	1.5W
Max. operating temp.:	175°C
Temp. Coeff. (entire unit)	70ppm/°C
Humidity:	Meets MIL-STD-202B, Method 106 (Cycling)
Size:	5/16"x 5/16"x 1 1/16"

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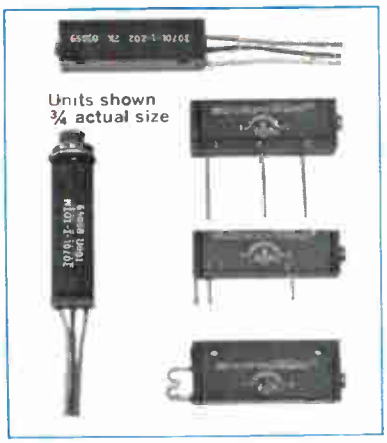

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Circle 50 on Inquiry Card

POTENTIOMETERS (Special Purpose)

Special Purpose Potentiometers and Rheostats	Type No. or Series	Potentiometer	Rheostat	Attenuator	Position Transducer	Photoconductive Transducer	Pressure Sensitive Transducer	Linear Motion	Differential	Carbon (C); Cermet (CT); Comp. (CO)	Met. Film(F); Cond. Plastic(CP); Wire(W)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Oper. Temp. (° C) Max.	Power Rating (W)	Linearity (±%)	Enclosed	Sealed	Servo Mtg. (S); Bush. Mtg. (B); Screw (SC)	Wire Leads (L); Pins (P); Terms. (T)	Miniature (M); Subminiature (S)	Height (In.)	Width (In.)	Length (In.)	Dia. (In.)	Weight (Oz.)
Aerovox Corp.	1210/30/50			X	(20 steps)					C		to .6	5					X		B	T	M			1.3	1.1	
Hi-Q Div.	2210/30/50	X			(10, 20 steps)							to 1K	5					X		B	T	M			1.3	1.1	
1100 Chestnut St.	—			*	(20 steps)					C	W	to .6	5					X		B	T				2.2	1.7	
Burbank, Calif.	—			*	(30 steps)					C	W	to .6	5					X		B	T				2.2	2.1	
	—			*	(32 steps)					C	W	to .6	5					X		B	T				2.2	2.1	
	—			*	(45 steps)					C	W	to .6	5					X		B	T				2.2	2.5	
	*Ladder, Bridged "T" and Bridged "H" Types																										
Bolton Electronics Corp.	—	X		(pendulum actuated)								.265					.5		X		T				1.5		14
246 Park Ave. Garden City, L.I., N.Y.	—	X		(pendulum actuated)								1					.5		X		T				1.1		14
Bourns, Inc. Trimpot Div.	3600	X		(10-turn clockface)								to 250	5			1.5					T				1	.75	
Riverside, Calif. 92507	3640	X		(10-turn clockface)								to 500	5			2.5					T				1.5	1.2	
California General, Inc.	PR1	X						X			W						.5				L					.6	
Mektron Div.	00776	X		(.6" stroke)				X				.001		N			1				L					1	
798 F St.	PR3	X		(6" stroke)				X				5					.5				L				8	.6	3.5
Chula Vista, Calif.	PR2	X		(4.6" stroke)				X				5		.001		2	.5				L				6.4	.5	
Carter Mfg. Co. 23 Washington St.	118GJ	X									W	25	5		150	3			X	B						.8	
Hudson, Mass.	118B	X							X		W	10		.13	150	1										.8	
Carter Precision Electric Co.	W300	X		T/L							W					5				B	T					2.7	
3401 W. Madison St.	V7	X		L	(dual)						W					4		X		B	T					1.4	
Skokie, Ill.	W201	X		L							W					15				B	T					1.4	
	V2	X		L							W					2		X		B	T					1.4	
Central Scientific Co. 237 Sheffield St. Mountainside, N.J.	PG3610		X	(slidewire)							W	to 5.7				425					T				12.5		
Clarostat Mfg. Co., Inc.	—		X									to 5				25				B	T						
Dover, N. H.	—		X									to 10				50				B	T						
	—		X		(Mil type)							to .2				25/50				B	T				1.5	1.8	
	51	X			(4 KV type)					CO		to 50K				1				B	T				1	2	
Computer Instruments Corp.	1000	X					X					to 10	10	N	85	.2	.5				T				1.4	1.1	2
92 Madison Ave.	4000	X					X					to 10	10	N	85	.25	.3				T		2	2	2.1		12
Hempstead, L. I. N. Y.	4500	X					X					to 10	10	N	85	.4	.3				T		2	2	3.2		14
	7000	X		(altitude transd.)								to 10	10	N		.2					T		2.6	2.6	2.6		8
	7100	X		(airspeed transd.)								to 10	10	N		.2					T		2.6	2.6	2.6		8
Daven Div.	—			1	(20 steps)							to 600	5			.6		X		SC					2	2.2	
Thomas A. Edison Industries	—			1	(30 steps)							to 600	5			.6		X		SC					2	2.2	
Livingston, N. J.	—			2	(20 steps)							to 600	5			.6		X		B					1.9	1.7	
	—			2	(30 steps)							to 600	5			.6		X		B					1.9	1.7	
	—			3	(20 steps)							to 600	5			.6		X		SC					3.8	2.7	
	—			3	(30 steps)							to 600	5			.6		X		SC					3.8	2.7	
	—			"T"	(45 steps)							to 600	5			.6		X		SC					2	2.7	
	—	X			(20 steps)							to 1K	5			.6		X		SC/B					1.9	1.7	
	—	X			(30 steps)							to 1K	to 2			.6		X		SC					2	2.2	
	2500			X								to 200	1			.5		X		SC					2	2.2	
	V250			"T"	(to 45 steps) (video to 10 mc)							75	2.5					X									
	1790			X	(video)							to 600						X									
	1080/90			X	(20/30 steps)									(printed circuit slide attenuator)													
	1. "T" and balanced ladder 2. Unbalanced ladder 3. Balanced "H"																										
Edcliff Instruments	3–120	X		(to 6" stroke)	X			X			W	to 300	5			4		X				M			7.6	.5	
1711 S. Mountain Ave.	3–131	X		(to 4" stroke)	X			X			W	to 300	5			3		X				M			5.7	.37	
Monrovia, Calif.	3–143	X		(to 6" stroke)	X			X			W	to 300	5			4		X								.75	
	3–150	X						X			W															.53	
Electro Scientific Industries	DP1211	D									W	to 100		.003				X		SC	T				5.9	3	
13900 N.W. Science Park Dr. Portland, Ore. 97229	DP1311	D									W	to 100		.0003				X		SC	T				6.9	3	

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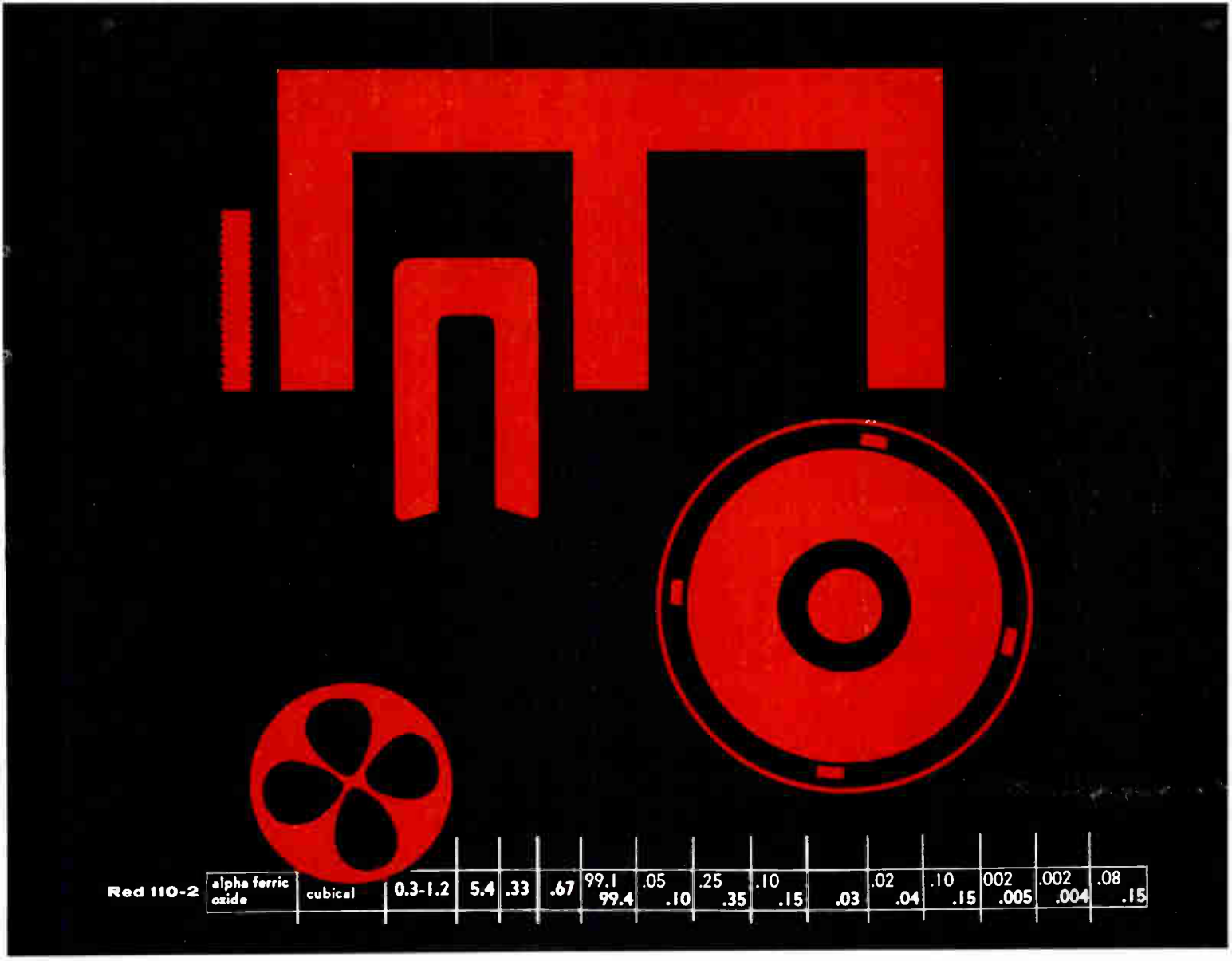
POTENTIOMETERS (Special Purpose)

Special Purpose Potentiometers and Rheostats	Type No. or Series	Potentiometer	Rheostat	Attenuator	Position Transducer	Photoconductive Transducer	Pressure Sensitive Transducer	Linear Motion	Differential	Carbon (C); Cermet (CT); Comp. (CO)	Met. Film(F); Cond. Plastic(CP); Wire(W)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Oper. Temp. (°C) Max.	Power Rating (W)	Linearity (±%)	Enclosed	Sealed	Servo Mtg. (S); Bush. Mtg. (B); Screw (SC)	Wire Leads (L); Pins (P); Terms. (T)	Miniature (M); Subminiature (S)	Height (In.)	Width (In.)	Length (In.)	Dia. (In.)	Weight (Oz.)
Electro-Techniques 11301 Ocean Ave. La Habra, Calif.	200	X	(1" stroke)					X			W	to 50	5			.5	1								2		
Fairchild Controls 225 Park Ave. Hicksville, L.I. N. Y.	— 999	X X	(to 6" stroke) X (.5" stroke) X					X X			W W	to 600 1	3			to 5		X					.3	.4	1.3		
John Fluke Mfg. Co. P.O. Box 7428 Seattle, Wash. 98133	40A 50A 60A 45A 55A 56A 65A 66A	D D D	 D D D D D								W W W W W W W W	to 10 to 100 to 100 to 12 to 120 to 120 to 120 to 120	.5 .05 .05	.02 .002 .0002		3 5 5 .5 .5 .5 .5 .5	.05 .005 .002	X X X X X X X X			T T T T T T T T				2.7 4.5 6 2.7 3.2 3.2 4.1 4.1	2 3 3 2 3 3 3 3	
Giannini Controls Corp. 1600 S. Mountain Ave. Duarte, Calif.	8644/46 8620 86125 84135 * Ohms/in.	X X X X	X (1/2" to 6" strokes) (1/10" to 1/2" strokes) (pendulum actuated)					X X				to 50 to 135* 2 7.5	5 5 5	N .002		3	.5 .5 1 .5										
Gotham Audio Corp. 2 W. 46th St. New York, 36, N. Y.	PREH	X		X				X		C		5K	10/20			.4		X			P						
Humphrey, Inc. 2805 Canon St. San Diego, Calif. 92106	CP34 RP33 RP35 RP48 RP49 RP67 RP82	X X X X X X			 X X X			 X X X X X	X		W W W W W W W	10 10 10 5 1 .14 20	10 5 3 10 5	.2	300 300 300 120 150 175 275	 4 .5 1 1 1.3 1		X X X X X X	 X X X X	S SC SC B SC B	L L 		 1 1	 .75 .62	 38 2.6 3.5 .6 6 2.5	1 .6 2 	 4 20 1.5
Markite Corp. 155 Waverly Place New York, N. Y. 10014	— — 2064 — — 9748 8761	X X X X X X X	(1" to 3" stroke) (1" to 10" stroke) (1.29 stroke) (1.89" stroke) (2.85" stroke) (1.34 stroke) (1.24 stroke)					X X X X X X X			CP CP CP CP CP CP CP	to 150 to 400 to 65 to 100 to 150 to 20 to 20	10 10 10 10 10 10	N N N N N N		to 2 to 7 .9 1 1	.5 .5 1 1 1 1 1				L L T L L		 .5 .87 .87 .68 .96	 1 1.7 1.7 .62 .62	 1.3 1.8 2.8 2.5 3	.5 .75 	
Maury Instrument Corp. 4555 W. 60th St. Chicago, Ill. 60629	1310	X						X				100			135	to 3		X	X	SC	T				to 6	1.2	12
Milwaukee Resistor Co. 700 W. Virginia St. Milwaukee 4, Wisc.	— — —		X (1½" stroke) X (2½" stroke) X (3" stroke)					X X X			W W W	5 15 25				100 200 300		X X X		B B B					2.5 3.5 4	2.5 3 3.5	
MRC Electronics Corp. 5300 21st Ave. Brooklyn, N. Y. 11204	A B C		X X X								W W W	5 10 10				25 50 100									1.4 1.5 1.7	1.6 2.2 3.1	
New England Instrument Co. Natick, Mass.	LMP	X	(5¼" stroke)					X			CP	500	10		125	.7	1				L				5.2		8
Ohmite Mfg. Co. 3660 Howard St. Skokie, Ill. 60076	C E G H K J L R P T N U 3000		X X X X X X X X X X X X X	 X							W W W W W W W W W W W W W	5 15 10 25 10 50 10 2.5 2.5 2.5 2.5 2.5 1K	10 10		340 340	7.5 12 75 25 100 50 150 500 225 750 300 1K to 50		X X	X	B B B B B B B B B B B B B	T T T T T T T T T T T T T	S				.5 .8 2.7 1.5 3 2 4 8 5 10 6 12	.3 .8 .3



THIS COLOR REPRESENTS A MASS TONE OF MAPICO RED 110-2.

Columbian Carbon focuses on the reduction of fluctuating characteristics in magnetic tape and ferrite components

It's a safe bet that product uniformity is a critical problem in your plant. Starting with extremely uniform raw materials goes a long way toward making your quality control problems considerably less difficult.

State of the art in ferrites advances at an extremely rapid rate. So do the requirements for iron oxides with pre-selected and controllable characteristics.

Columbian Carbon's Mapico® pure synthetic iron oxides are produced by a variety of carefully controlled methods, each designed to give a different shape, size and set of electronic characteristics. Uniformity from shipment to shipment is strictly held within pre-set narrow limits. Sixteen basic iron oxides are available in quantity.

Write for detailed specs. Or tell us about your particular application and special requirements. Columbian Carbon Company, Mapico Iron Oxides Unit, 380 Madison Avenue, New York, New York 10017. Branch offices and agents in principal cities.

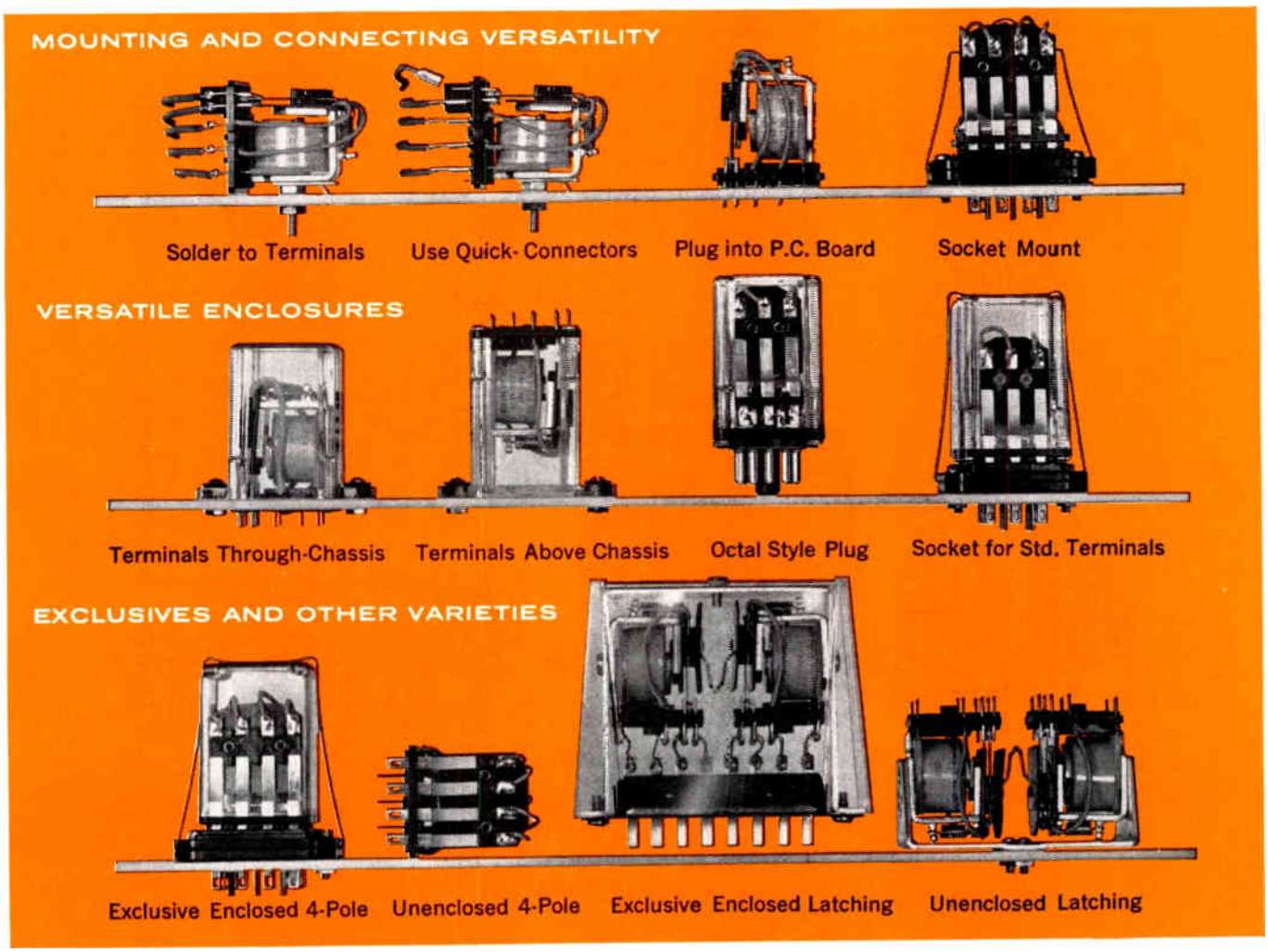
COLUMBIAN CARBON COMPANY

POTENTIOMETERS (Special Purpose)

Special Purpose Potentiometers and Rheostats	Type No. or Series	Potentiometer	Rheostat	Attenuator	Position Transducer	Photoconductive Transducer	Pressure Sensitive Transducer	Linear Motion	Differential	Carbon (C); Cermet (CT); Comp. (CO)	Met. Film(F); Cond. Plastic(CP); Wire(W)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Oper. Temp. (°C) Max.	Power Rating (W)	Linearity (±%)	Enclosed	Sealed	Servo Mtg. (S); Bush. Mtg. (B); Screw (SC)	Wire Leads (L); Pins (P); Terms. (T)	Miniature (M); Subminiature (S)	Height (In.)	Width (In.)	Length (In.)	Dia. (In.)	Weight (Oz.)
Perkin-Elmer Corp. Norwalk, Conn. 06852	2	X*	(10-turn)									200[1]					.02								2.7	1.7	8.3
	3	X*	(30-turn)									50[1]					.01								2.7	1.7	9
	4	X*	(10-turn)									30[1]					.05			S	T	M			1.6	1	2
	5	X*	(10-turn)									60[1]		.01			.05			S	T	M			1.8	.7	2
	7	X*	(20-turn)									100[1]		.004			.01										
	20	X*	(10-turn)											.13			.1										
	1. Input impedance Note: Terminal Linearities shown *AC Potentiometer																										
Precision Line, Inc. 63 Main St. Maynard, Mass.	—	X	(to 3" stroke)					X				2					.5				T			1			
	—	X	(3" to 5" stroke)					X				2					.25				T			1			
	—	X	(5" to 20" stroke)					X				2					.1				T			1			
Rex Rheostat Co. 149 Babylon Tpk. Roosevelt, L. I.	—		X	(slidewire)				(to 50 kc)				(2.8 amp.)															
Samarius, Inc. 300 Seymour Ave. Derby, Conn.	260		X								W	to 500				6				SC	T				1.4	3	5
	275		X								W	to 500				11				SC	T				2.6	3	7
	245		X								W	to 50				25				B	T				1.2	1.7	
	241		X								W	to 50				50				B	T				1.5	2.4	
Servanic Instruments, Inc. Costa Mesa, Calif.	G-1/2"	X	(6" stroke)					X				1-10		.005			.5		X		L					.5	
	G-3/4"	X	(24" stroke)					X				1-50		.005			.5		X		L					.75	
	2091	X					X					to 10	5	.3			.5		X						1.5	1	3.5
	2101	X					X					to 10		.3			1		X			S			1.5	.75	2
	2121	X					X					to 10	5						X						1.5	1.5	
	2131	X							X			to 10	5	.15					X						2.1	1.2	
	2151	X					X					to 10	5	.1					X						2.1	1.2	
	3031	X					X					to 10	5	.25			.85		X			S					1.8
	3051	X							X			to 10	5						X						3	1.5	
	3061	X					X					to 10	3	.25			.5		X						1.8	1	
	3071	X					X					to 10	5						X						1.1	1.5	
	3121	X					X					to 10	5						X			S			1.2	1.2	4
Subminiature Instruments Corp. Riverside, Calif.	—	X						X				2		.76			1.5					S					
	—	X					X	X				.056		.13			.26*					S					
	—	X					X	X				2		.4			.8*					S					
	*Terminal																										
Sparton Corp. 2400 E. Ganson St. Jackson, Mich.	831	X					X				W	to 10	5	.25				X							1.5	1.6	
	411	X					X				W	to 10	5	1	71		1.5	X					2.5	2.5	3.5		
	402	X					X		X		W	to 20	10	.25			1		X								
	224	X	(½" stroke)	X				X			W	to 2.5	10	.0015	71		.5										
	226	X	(10" stroke)	X				X			W	to 30	10				.5										
	401	X					X															S					
Herman H. Sticht Co. 27 Park Place New York, N. Y. 10007	—		X	(slidewire)								to 20K				to 1K		X							to 20	2.5	
Superior Electric Co. Bristol, Conn. 06012	SWR		X	(slidewire)								to 1				to 500				SC	T		6.1	4	12		
Tru-Ohm Prods. Memcor Div. Huntington, Ind.	R12½		X								W	to 5	10			12				B	T				.7	.8	
	R25		X								W	to 5	10			25				B	T				1.3	1.6	
	R50		X								W	to 10	10			50				B	T				1.4	2.3	
	R75		X								W	to 10	10			75				B	T				1.7	2.7	
	R100		X								W	to 10	10			100				B	T				1.7	3.1	
	R150		X								W	to 10	10			150				B	T				2	4	
	R300		X								W	to 2.5	10			300				B	T				2.2	6	
	RE25		X								W	to .5	10			25				B	T				1	1.6	
Ward Leonard Electric Co. Mount Vernon, N. Y. 10550	68	X			X	(½" stroke)					W	10						X	X								
	25R		X								W	5				25					T					1.6	
	50R		X								W	10				50					T					2.3	
	100R		X								W	10				100					T					3	
	150R		X								W	10				150					T					4	
	300R		X								W	2.5				300					T					6	
	N152		X	(Mil Spec.)							w	20	10			50					T						

down with "specials"!!

who needs 'em with Ohmite's big variety of *stock* GPR relays



■ All these and other physical variations are stocked for a variety of general purpose and specialized electrical functions such as plate circuit, thyratron, and indicator-light types. Both unenclosed and enclosed relays fit the same SOGPR socket. And don't forget, dual-purpose terminals (for soldering and quick-connectors) are standard on all unenclosed and most enclosed relays. Many models UL and CSA listed.

Contact Combinations—Up to 4PDT.

Contact Ratings—Two ratings: fine-silver contacts, gold-flashed, 5 amps resistive at 115 VAC or 32 VDC: silver-cadmium, 10 amps.

Coil Operating Voltage Range—Up to 230 VAC 60 cycles, or 110 VDC.

Coil Wattage—1.4 Watts DC: 1.6 watts (2.0 volt-amps) AC, except 2.4 watts (3.7 volt-amps) for 4-pole AC relays.

Insulation—Tested at 1500 VAC between terminals and ground.

Yours for the asking... Catalog 700 showing all Ohmite relay lines.

RHEOSTATS • POWER RESISTORS • PRECISION RESISTORS • VARIABLE TRANSFORMERS • RELAYS
TAP SWITCHES • TANTALUM CAPACITORS • SEMICONDUCTOR DIODES • R.F. CHOKES

OHMITE MANUFACTURING COMPANY
3662 Howard Street • Skokie, Illinois 60076
Phone: (312) ORchard 5-2600

Circle 53 on Inquiry Card

ELECTRONIC INDUSTRIES

NEW TECH DATA

". . . STATE-OF-THE-ART information on Components and Equipment."

Microwave Slide Rule

"RF Filter Slide Chart" is a 3-section "slide-rule" type chart providing spec. data for microwave filters. Designed for circuit designers and specifiers, the chart has 3 sections: "Chebishev Response," section No. 1, gives degree of attenuation at various freqs. for 2- to 19-pole filters. "Reflection - Transmission Relationships," section No. 2, gives voltage and power reflection/transmission characteristics and loss in db for various VSWRs. The "Bandpass," section No. 3, shows attenuation and bandwidth characteristics for 2- and 6-section filters, plus bandwidth and insertion loss for various types of filters. Telonic Engineering Co., 480 Mermaid St., Laguna Beach, Calif.

Circle 156 on Inquiry Card

Measurement Handbook

This pocket-size handbook explains the streamlined metric system adopted at the 11th General Conference of Weights and Measures. The publication also includes the latest revisions made in the system. Copies of the SI handbook are available from Brown Engineering Co., Inc., 300 Sparkman Dr. N.W., Huntsville, Ala.

Circle 157 on Inquiry Card

Microwave Tube Papers

Three technical papers, which deal with design advancements that have improved the performance of klystrons and TWTs and aided equipment manufacturers in solving system problems, are available. Entitled, "Negative Grid Control for Microwave Tubes"; "Noise Performance of Traveling Wave Tubes"; and "The Life of a Microwave Tube," they contain performance data and applications. Sperry Electronic Tube Div., Gainesville, Fla.

Circle 158 on Inquiry Card

Semiconductor Guide

Milgray's Guide to RCA Semiconductor Products, 20 pages, is illustrated and includes: an Index of RCA semiconductor devices; application guide to RCA transistors, from audio-freq. uses through r-f, power-switching and computer applications, etc. Milgray Electronics, Inc., 160 Varick St., New York, N. Y. 10013.

Circle 159 on Inquiry Card

Oscilloscope Cameras

A 12-page booklet on oscilloscope cameras and accessories is available. It describes standard camera systems and also contains detailed specs. on available components and accessories which can be used to simplify custom designing a camera to meet individual specific needs. In addition, the booklet features a series of waveform photographs illustrating many typical uses with various lens/object-to-image ratio combinations. Tektronix, Inc., P. O. Box 500, Beaverton, Ore. 97005.

Circle 160 on Inquiry Card

Connector Chart

This product news bulletin features a complete device/application chart. The special chart makes it simple for the user to determine the most suitable connector for a given application problem. The chart covers 150 types of caged jacks and combinations. Description includes actual size outline drawings, dimension drawings, cross sectional views and recommended applications. Cambridge Thermionic, 445 Concord Ave., Cambridge, Mass.

Circle 161 on Inquiry Card

Meter Catalog

"Quick Reference" Catalog (M865) illustrates a cross-section of a complete line of custom-built meters. It illustrates and describes various types of meters such as taut-band, ruggedized, aircraft, subminiatures, wattmeters, freq. meters, etc. All are built to an individual customer's order; therefore, nearly every range and type of indicating instrument can be provided. The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio

Circle 162 on Inquiry Card

Microwave Catalog

A completely revised 84-page catalog of precision microwave components and instruments is available from Microlab/FXR, 10 Microlab Rd., Livingston, N. J.

Circle 163 on Inquiry Card

Design a Switch

This catalog allows microwave engineers to order custom-made microwave switches. The catalog enables the user to call out standard microwave modules from the accompanying charts and receive a finished microwave switch which meets his specific need. When ordering a custom-made (for specific) microwave switch, the user merely chooses the model number which fulfills his needs from Chart A, adds the appropriate EIA waveguide size designation from Chart B, and fills in any additional alternate specs. from Chart C. Guide Industries Inc., 11855 Wicks St., Sun Valley, Calif.

Circle 164 on Inquiry Card

Design Aid Brochure

A design aid brochure entitled, "R-F and Microwave Dielectric Heating System Design Parameters," contains basic design data concerning means of generating r-f power at microwave and lower freq.; means of coupling r-f fields to material to be processed; and detailed data on various parameters of material, such as dielectric constants, loss constants, etc. The publication examines various factors governing the choice of processing frequencies. Useful equations and tables of parameters of various dielectric materials are included. Industrial Applications Laboratory, Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, Calif.

Circle 165 on Inquiry Card

Diode Catalog

Bulletin 3138-7, "Corotrons — High Voltage Regulating and Reference Diodes" is a 40-page catalog and technical data manual. Printed in 2 colors, it includes definitions, specs. and ratings on 43 basic models. Each basic model is treated separately, and performance and data are given for the various tubes within the voltage range for the basic model. Performance curves, dimensional drawings, photographs and schematics complement the descriptive data. The Victoreen Instrument Co., 10101 Woodland Ave., Cleveland, Ohio.

Circle 166 on Inquiry Card

Diode Wall Chart

This 17 x 11 guide lists the most popular of more than 4000 different zener and reference diodes. The guide includes zener diodes with nominal voltages from 2.4 to 200v. in ±5%, 10% and 20% tolerances. Dissipation ratings are from ¼w to 50w. Numerous Mil types are shown and case dimensions are detailed for the designer. Motorola Semiconductor Products, Inc., Dept. TIC, Box 955, Phoenix, Ariz. 85001.

Circle 167 on Inquiry Card

Microwave Processing

A brochure, "Microwave Processing Systems for Industry," describes the basic principles of microwave heating, the advantages of microwave processing, and typical industrial microwave processing systems. It also describes a microwave processing application laboratory where customers can obtain assistance in evaluating the use of microwave heating to meet their particular processing needs. Raytheon Co., Microwave & Power Tube Div., Waltham, Mass. 02154.

Circle 168 on Inquiry Card

Microwave Diodes

Data Sheet No. 4100A describes subminiature glass microwave diodes for use in mixing, video detection, etc. Both axial lead and ribbon lead construction are offered in this standard 1N830 series. These small diodes are ideally suited for stripline applications. Micro Oprics div. of Alpha Industries, Inc., 381 Elliot St., Newton Upper Falls, Mass.

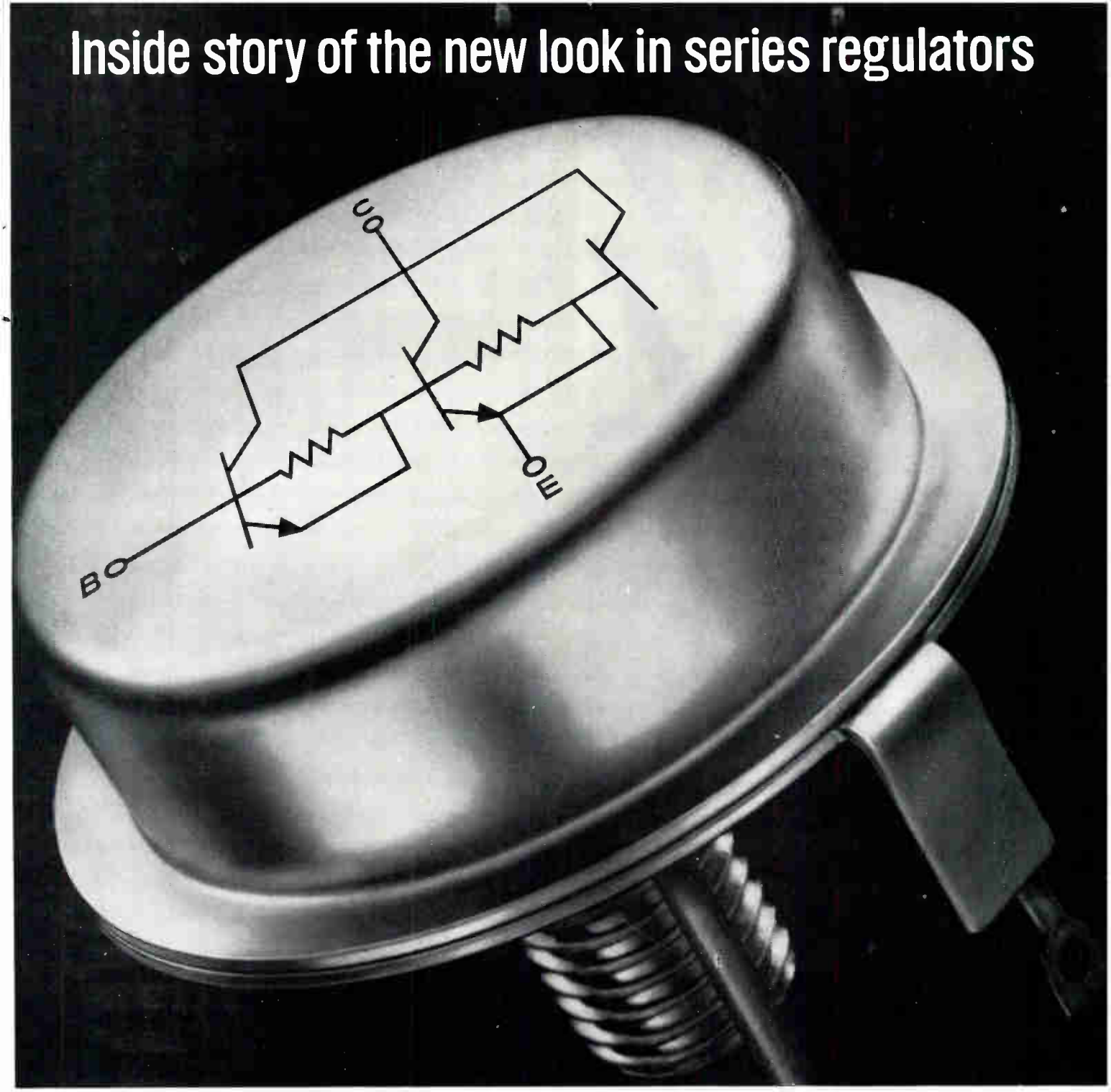
Circle 169 on Inquiry Card

Silicon Transistors

A 2-color technical bulletin entitled "Silicon Transistors in Power Supply Design" compares germanium and silicon power transistors. Illustrated with diagrams and curves, it covers power, leakage current, voltage considerations, and changes in V_{BE} vs. temp. Other significant electrical and thermal characteristics are compared, such as: gain and saturation voltage, transient response, a new design approach and economic considerations. Silicon Transistor Corp., East Gate Blvd., Garden City, N. Y. 11532.

Circle 170 on Inquiry Card

Inside story of the new look in series regulators



Westinghouse power integrated amplifiers eliminate a complete driver stage.

Save space, improve reliability, cut costs with Westinghouse power integrated amplifiers. Types 2N2233 and 2N3477 provide exceptionally high gain at high power levels—h_{FE} = 400 at 10 amps I_C, V_{CE} = 200 volts and P_D = 150 watts. Single and double ended packages provide complete design flexibility. Check these exclusive features:

- Hard soldered junctions eliminate thermal fatigue.
- Large emitter-base area puts an end to secondary breakdown.
- True monolithic construction stops runaway leakage.

SINGLE ENDED	DOUBLE ENDED	V_{CE}	h_{FE}
2N2226	2N3470	50	100 @ 10A
2N2227	2N3471	100	
2N2228	2N3472	150	
2N2229	2N3473	200	
2N2230	2N3474	50	400 @ 10A
2N2231	2N3475	100	
2N2232	2N3476	150	
2N2233	2N3477	200	

You can be sure if it's Westinghouse

And, of course, reliability is assured by the exclusive Westinghouse Lifetime Semiconductor Guarantee.* For full information call your Westinghouse salesman or distributor, or write to the Westinghouse Semiconductor Division, Youngwood, Pennsylvania.

*Westinghouse warrants to the original purchaser that it will correct any defect or defects in workmanship, by repair or replacement f.o.b. factory, for any JEDEC-type silicon power semiconductor during the life of the equipment in which it is originally installed, provided said device is used within manufacturer's published ratings and applied in accordance with good engineering practice. This warranty is applicable to devices of the stated types shipped after March 9, 1964, until further notice. This warranty shall constitute a fulfillment of all Westinghouse liabilities in respect to said products. This warranty is in lieu of all other warranties expressed or implied. Westinghouse shall not be liable for any consequential damages. SC-205G

Circle 54 on Inquiry Card

NEW TECH DATA

Design Monograph

"Elastomer Terminology" is a design monograph that should clarify the terminology relating to rubber and rubber products. Working definitions for such commonly misunderstood terms as modulus, damping, elongation, drift, tensile and elasticity are provided. Many of these terms are already a part of the technical language of the engineer, but they may have different meanings and thus cause misunderstanding when applied to rubber. Technical Information Dept., Lord Mfg. Co., div. of Lord Corp., Erie, Pa. 16512.

Circle 274 on Inquiry Card

Designer Data Book

A comprehensive Piezoelectric data book has been developed for electronic device, circuit and system designers. The 45-page technical book is entitled, "Piezoelectric Technology — Data for Designers." The book progresses from general descriptions of characteristics and principal uses of piezeoelectric materials and elements to coverage of piezoelectric constants and specific properties of ceramics. There also is a discussion of equivalent circuits and their application. Piezoelectric Technology is illustrated with 40 different figures and 7 tables. Conversion charts are included. Clevite Corp., Piezoelectric Div., 232 Forbes Rd., Bedford, Ohio.

Circle 275 on Inquiry Card

Circuit-Breaker Chart

A 5-step method for selecting circuit breakers for a wide variety of uses is available in an easy-to-use chart. This chart, entitled "Select a Circuit Breaker," is presented for 1, 2, and 3 pole circuit breakers with ratings from ¼ to 100a. and trip time ratings from 6msec. to 30 sec. at 200% of rated load. Wood Electric Corp., 244 Broad St., Lynn, Mass.

Circle 276 on Inquiry Card

Switch Catalog

Precision switches are illustrated in new catalog that has engineering drawings, specs., operating characteristics and ordering data on a complete line of standard snap action switches. Overtravel in electrical ratings are 2 to 25a. Cherry Electrical Products Corp., P. O. Box C439, Highland Park, Ill. 60036.

Circle 277 on Inquiry Card

Reference Chart

A reference chart of standard formulas and tables for use with laboratory test equipment is available. The reference chart features typical test set-ups for determining return loss and response, amplitude response, return loss measurement, and testing UHF converter performance. In addition, the reference booklet contains a dbmv microvolt chart, a return loss VSWR chart and transformation formulas. Blonder-Tongue Laboratories, Inc., 9 Alling St., Newark, N. J. 07102.

Circle 278 on Inquiry Card

Waveguide Isolators

Series 200 isolators offer up to 30db isolation and cover freqs. from 2.6 to 14.0Gc in bands up to ½ octave. VSWR's are 1.15 typical, 1.20 max. The loss in broadband models is 0.8db typical, 0.9 max. In medium and narrow band units the loss is typically 0.3db to 0.8db. Complete details available from Microwave Technology Div. of Alpha Industries, Inc., 381 Elliott St., Newton Upper Falls, Mass. 02184.

Circle 279 on Inquiry Card

Relay Catalog

This catalog lists 327 different relay models. Included are mercury-wetted contact and dry-reed relays, coaxial, time-delay, telephone-sealed and dust-covered relays. Magnecraft Electric Co., 5577 N. Lynch, Chicago, Ill. 60630.

Circle 280 on Inquiry Card

Microcircuit Hardware

This catalog describes microcircuit mounting hardware. It includes a new packaging concept for mounting circuit chips on mother boards, card mounting seats, card files, horizontal and vertical equipment drawers. The circuit chip mounting hardware makes possible easy, rapid handling of microcircuits through reliable pressure contact of circuit leads with mating leads on the mounting board. Scanbe Mfg. Corp., 1161 Monterey Pass Rd., Monterey Park, Calif.

Circle 281 on Inquiry Card

NEW TECH DATA

Coils Catalog

Over 300 precision-wound electronic components are described in a well-illustrated, 16-page, 2-color catalog. Included are complete lines of variable inductors, adjustable r-f chokes, subminiature r-f chokes, r-f transformers, iron-core chokes and ceramic coil forms. Listed in the catalog are inductances, Q min., test freqs., res. ohms and other data. Delta Coils, Inc., 1128 Madison Ave., Paterson, N. J. 07503.

Circle 282 on Inquiry Card

Resistance Element

A combined data sheet and designer's order form and self-mailer for a hot molded carbon resistance element is available. The data describes the availability of custom resistance elements for recording instruments, attenuators, servo followers, controllers, indicating instrumentation and calibration devices. It lists all the specs. and includes a temp. coefficient curve. The self-mailer permits the designer to sketch the mechanical design of the custom resistance element he would like to order and then fill in the electrical specs. Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 283 on Inquiry Card

Potentiometer Catalog

A 2-color, short-form potentiometer catalog is available which contains the latest data on trimming, precision, and non-linear potentiometers and miniature switches and turns-counting dials. It is designed for quick, easy reader reference and includes design details, photos, cutaway drawings and prices. Spectrol Electronics Corp., 1704 S. Del Mar Ave., San Gabriel, Calif. 91776.

Circle 284 on Inquiry Card

Product Catalog

This sectionalized product catalog pictures and describes industrial controllers, recorders, indicators, control systems, precision measuring instruments, thermocouples, and accessories. Catalog should be of great value to specifying engineers and buyers. West Instruments Corp., Schiller Park, Ill.

Circle 285 on Inquiry Card

OR/NOR Gate

SW301 is a 5-input OR/NOR gate. It has a fanout of 26 and a propagation delay of 6nsec. Operating temp. is —55 to +125°C and storage temp. is —65 to +200°C. Available in TO5 or flat packs. Complete data and schematic available from Stewart-Warner Microcircuits Inc., 730 E. Evelyn Ave., Sunnyvale, Calif. 94086.

Circle 286 on Inquiry Card

Components Catalog

"Erie Electronic Components" catalog, 28 pages, covers monobloc ceramic capacitors, tubular and discs, transcaps, button mica capacitors, feed thru and stand offs, trimmers, film capacitors and by-pass capacitor systems for transmitting tubes. Also broad band RFI filters, bushing and eyelet filters, multi section filters, silicon diffused rectifiers, diodes and integrated networks. Erie Technological Products, Erie, Pa.

Circle 287 on Inquiry Card

Synchro Handbook

This 42-page catalog not only lists a complete line of synchros, but also contains design data and circuits. Further, a definition of synchro terms is included. The Bendix Corp., Montrose Div., So. Montrose, Pa.

Circle 288 on Inquiry Card

Power Supply Catalog

Catalog B-657 gives complete specs. for a line of voltage and current regulated power supplies, and contains data of interest to all power supply buyers and users. New application notes, including some which are particularly useful for constant current operation, an up-dated glossary of power supply terms, and expanded explanations of regulated power supply capabilities are given. Kepco, Inc., 131-38 Sanford Ave., Flushing, N. Y. 11352.

Circle 289 on Inquiry Card

NEW TECH DATA

VSWR Nomograph

This nomograph simplifies the calculation of VSWR and reflection coefficient from minimum slotted-line width. It can also be used to convert freq. to wavelength and VSWR to reflection coefficient. Direct-reading freq. range of the chart is 0.3 to 10GC. General Radio Co., West Concord, Mass.

Circle 191 on Inquiry Card

Microwave Report

Report R11-457, "Microwave Components for Communications Systems," describes components for line-of-sight, troposcatter, and space communications systems. Included in the 28 pages are typical specs. for waveguide, isolators, circulators, filters, loads, switches, feed horns, and other systems. General system data and diagrams are also included. Airtron Div., Litton Industries, 200 E. Hanover Ave., Morris Plains, N. J.

Circle 192 on Inquiry Card

Microwave Catalog

This short-form microwave components catalog contains photos and brief specs. on flexible waveguide, rigid waveguide components, airborne and special-purpose antennas and feeds, stripline switches and power dividers, Beacotron TWT limiter tubes, noise sources, and TR tubes. Copies are available from Electronic Specialty Co., 4561 Colorado Blvd., Los Angeles, Calif. 90039.

Circle 193 on Inquiry Card

Telemetry Checkout

Data Sheet No. 348 gives full description and specification data on the Model 621 single-channel PCM decommutator, which provides economical check-out of PCM telemetry systems and sub-systems. The unit is designed for bench check-out work, accepts serial PCM data from telemetry commutator systems, r-f receivers, tape recorders, or PCM simulators. Telemetrics, Inc., 2830 S. Fairview Street, Santa Ana, Calif.

Circle 194 on Inquiry Card

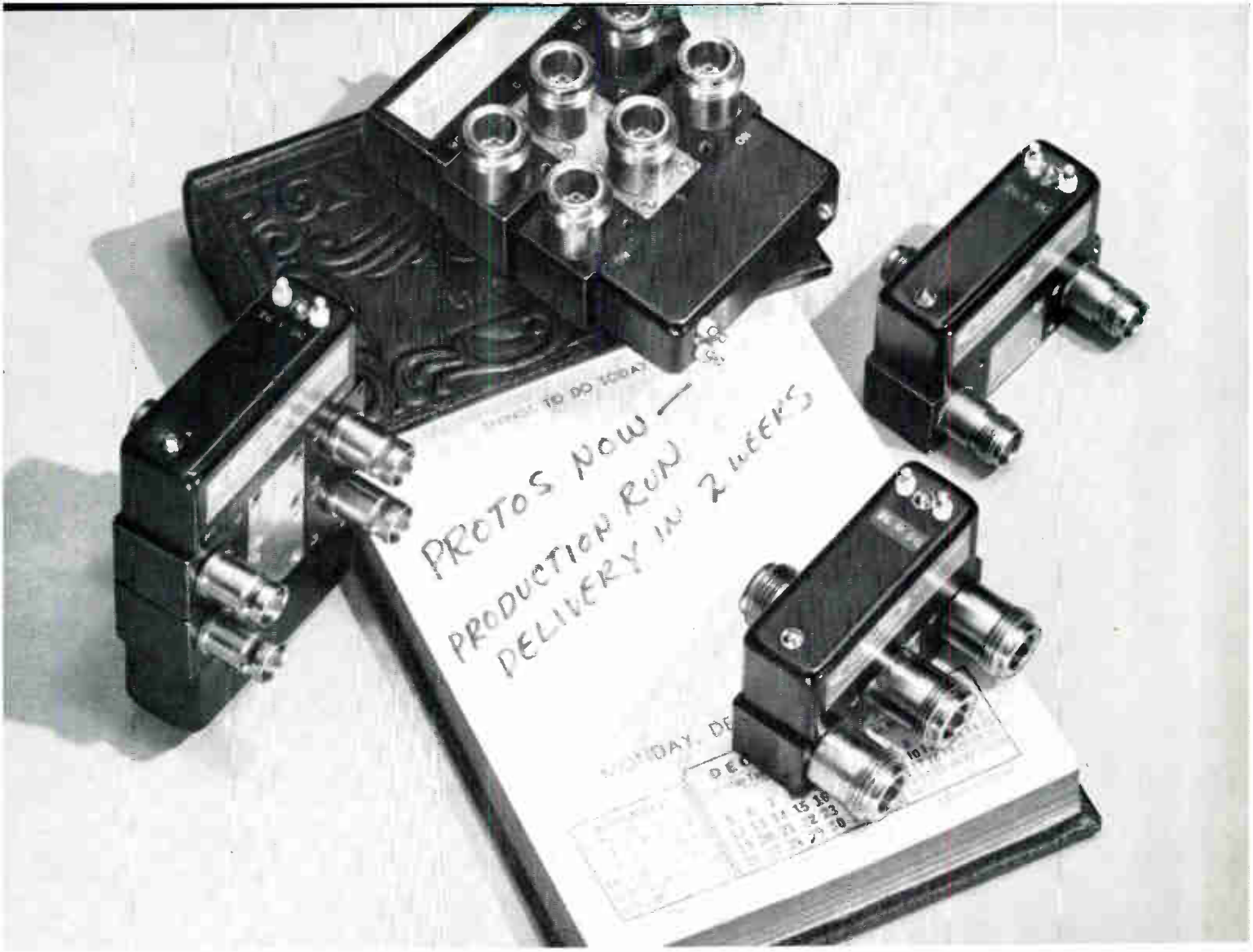
Klystron Amplifier

Data is available on a high gain, wide bandwidth klystron amplifier. The VA-877A delivers 10kw over a tunable frequency of 4.4 to 5.0GC. The tube is ideal for tropospheric forward-scatter uses. It may be operated synchronously tuned, or with the second and third cavities detuned for maximum bandwidth. Varian Associates, Tube Division, 611 Hansen Way, Palo Alto, Calif.

Circle 195 on Inquiry Card

IC Selection Guide

A complete guide to the selection of HLTTL Monolithic Integrated Circuits is available. The brochure combines circuit listings, schematics and logic diagrams with cross-references, specs. and circuit characteristics. The guide also outlines series circuits and specs. and gives Quality Assurance and reliability data. Write on *company letterhead* to Transitron Electronic Corp., Wakefield, Mass.



New Amphenol design cuts RF switch delivery to 14 days

Modular construction of Dynaform* switches puts prototypes or production quantities in your hands as quickly as they can be assembled and shipped.

OVER 300 VARIATIONS. Amphenol Dynaform switches are built from 23 standard modules. From these come over 300 switch variations: SPDT, DPDT, and Transfer. Shorting, non-shorting or resistor terminations can be provided. A variety of coil voltages are available.

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Specify Amphenol. . . . the leading name in cable, connectors, assemblies, RF switches, potentiometers, microelectronics

Circle 57 on Inquiry Card

NEW TECH DATA

Thyratron Theory

A 15-page brochure, "Hydrogen Thyratrons Theory and Application," describes the scope, principle of operation, construction, applications, characteristics and ratings of hydrogen thyratrons, and offers a guide for selection. Applications covered are the charge or discharge line-type pulsing circuits, as clipper tubes or hold-off triodes, and in Blumlein or clamper circuits. General Electric Co., Schenectady, N. Y.

Circle 196 on Inquiry Card

Switch Catalog

Forty-four pages of engineering ideas are contained in a new rotary, slide and lever switch catalog. Twelve rotary types from 1 to 2 13/16 in. dia., 2 types of lever switches and 5 sizes of slide switches are completely described. Engineering section shows why to choose a particular insulation material. The special considerations in life testing switches that make such tests more precise are described in detail. More than 100 complete engineering drawings are included. Centralab div. of Globe-Union Inc., P. O. Box 591, Milwaukee, Wis. 53201.

Circle 197 on Inquiry Card

IC Design Aid

In this application brochure, integrated circuit use is approached from the system designer's viewpoint, and development stages of a digital system are discussed. Problems encountered in designing ICs are enumerated and modular solutions are described. The brochure also includes logic transformation rules, hardware, and packaging designs, and system checkout and maintenance procedures. Whittaker Corp., Abacus Div., 12838 Saticoy St., N. Hollywood, Calif.

Circle 198 on Inquiry Card

Microwave Catalog

This revised and expanded catalog on microwave test equipment contains data on over 1200 standard waveguide and coaxial instruments and components. Freq. range covered are 2.0 to 40.0GC. This catalog contains complete information on waveguide and coaxial devices. All of these catalog items are available in the standard military waveguide sizes, as well as the EIA standard waveguide sizes. Complete technical data, descriptive test illustrations, and price lists are given. Waveline Inc., Caldwell, N. J.

Circle 199 on Inquiry Card

Miniature Trimmer

This bulletin describes miniature trimmer potentiometer Model MS37. The 0.375 in. dia. unit is wirewound and available in standard resistance ranges from 20 to 25KΩ. The bulletin contains details on all military specs. applied to production, packaging, and test procedures where applicable. The bulletin also includes electrical, mechanical, and environmental specs., and drawings. Minelco, 600 South St., Holbrook, Mass.

Circle 200 on Inquiry Card

New flexible lighting you can twist, coil, weave...

it's protected by ACLAR®

Panelescent® Tape-Lite—developed by Sylvania—makes lighting available in a continuous flexible ribbon only 1/32" thick. The electroluminescent light source consists of a thin strip of aluminum foil, a layer of phosphors and a transparent conductive coating—all sealed between protective layers of Allied Chemical Aclar fluorohalocarbon film.

Why did Sylvania choose Aclar? Because it protects better than any other transparent film! Aclar absorbs no water at all and transmits virtually no moisture vapor. It has excellent dielectric strength... withstands severe shock and pressure... resists tearing and pinholing, and is chemically inert to harshest chemicals. The film is fully transparent—all the brightness of Tape-Lite comes through!

Shielded by Aclar, Tape-Lite flexible lighting has many display and safety applications, as in decorative wall lighting, highway marking, and instrument panel illumination. What clear, strong, moisture-proof Aclar has done for lighting . . . it may be able to do for *your* product. To explore the possibilities, write to:

Allied Chemical

GENERAL CHEMICAL DIVISION
P.O. Box 353, Morristown, N.J.

Circle 59 on Inquiry Card

NEW TECH DATA

Pellet Resistors

Data is available on a new series of stripline pellet resistors used as terminations or wherever a resistor is needed in a flat package. Called Filmstrip, the flat pill configuration is simple to incorporate into almost any circuit. Optional leads are provided for possible use on PC boards or with coaxial components. Although the pellet resistors can be used from dc to 11Gc with a max. VSWR of 1.3 at the high freq. end, the optimum usage occurs from dc to 4.0Gc with a VSWR of less than 1.1. Filohm Corp., 48 W. 25 St., New York, N. Y. 10010.

Circle 206 on Inquiry Card

Application Notes

Application notes on the use of logarithmic amplifiers are available. The notes cover subjects such as photo-multiplier logarithmic amplification, logarithmic rate counting, and logarithmic video amplification using the output directly from a vidicon target. The use of logarithmic amplifiers in conjunction with sweep generators are also described. Optical Electronics Inc., Box 11140, Tucson, Ariz. 85706.

Circle 207 on Inquiry Card

Expansion System

Product bulletin PI 65011-1 describes the DES-30 Digital Expansion System. This unit adds hybrid capabilities to small analog computer facilities and, in addition, may be linked to a general purpose analog or digital computer or used as an aid in digital instruction or design. It is especially useful in advanced problem solving including simulation of discrete systems, statistical calculations, Fourier analysis, transport delay simulation, and incremental and interative computations. Electronic Associates, Inc., W. Long Branch, N. J.

Circle 208 on Inquiry Card

Tapes

Detailed specs. and application data for the full line of electrical insulating, protective, and color-coding tapes are contained in a new 16-page catalog. Included are electrical characteristics, physical characteristics, dimensions, and packaging data. Plymouth Rubber Co., Inc., Tape Div., 104 Revere St., Canton, Mass. 02021.

Circle 209 on Inquiry Card

Adhesive Guide

This 3-color, 8½ x 11 in. fold-out selection guide (Z-TPCR551) lists a complete line of tube packaged adhesives and sealants for bonding and sealing any common type of material. The guide lists 8 adhesives and 17 common types of materials, and designates the proper adhesive for a specific material bonding application. A chart lists 4 sealants that will meet almost any type of sealing requirement. Adhesives, Coatings and Sealers Div., 3M Co., 2501 Hudson Rd., St. Paul, Minn.

Circle 210 on Inquiry Card

Con Avionics' new silicon power supply has an M.T.B.F. of 100,000 hours and a 5 year guarantee. It costs $65.

These dc regulated power supplies are available in nearly 200 different voltage-current combinations. Silicon transistors are used throughout and the units operate in ambients as high as 75°C, with a small external heat sink.

The Mean Time Between Failure of the modules is 100,000 hours, calculated according to Mil Handbook 217. They are certified to meet the environmental tests of Mil-E-5272, and most of the requirements of three other mil specs. In addition, they meet the RFI requirements of Mil-I-6181.

Prices start at $65. Every time you specify one of these supplies, instead of a comparable germanium unit, you save considerable money. If you're using commercial supplies, typical savings-per-unit are about $40. For military supplies it's much more.

The fastest way to get complete technical information and prices is to write, call, TWX or wire Gerry Albers at Con Avionics.

SPECIFICATIONS

	STANDARD MODEL	"A" MODEL
Total Regulation (Line and Load)	±0.5%	±0.05% or 2 mv.
Ripple (rms. max.)	10 mv	1 mv or .003%
Temperature Coefficient	0.07%/°C	0.015% °C

ALL MODELS	
Input	105-125 v ac, 47 to 440 cps
Temperature	75°C ambient max. 95°C base plate max.
Response Time	10 microseconds
Military Specifications	Certified to meet the environmental requirements of MIL-E-5272 and the RFI requirements of MIL-I-6181

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NEW TECH DATA

Drum Memory System

The VRC Type 1116 Drum System stores up to 524,000 18-bit words. The system costs less than 10¢/word, complete, in large capacity size. It is word addressable with 8.5msec. average access time, and sequential words are available at a 17μsec. rate. The memory is adaptable to any computer with direct memory access. Vermont Research Corp., Precision Park, North Springfield, Vt. 05150.

Circle 211 on Inquiry Card

Readout Catalog

The DiGi line of incandescent numeric readouts are described in a new catalog. The 2-color brochure features complete product specs., actual-size photographs and detailed outline drawings. Microphysics Inc., 68 Urban Ave., Westbury, L. I., N. Y. 11590.

Circle 212 on Inquiry Card

Laser Welding

Laser Welding Research Report (F-51-851), 12 pages, highlights circuit board welding methods which give excellent fusion welds on conventional types of claddings without substrate damage. Also described are solder reflow techniques employing the laser as a heat source to join integrated circuits and other devices to boards where melting and fusion of board cladding is not required. Examples of unique laser welder uses are included. Union Carbide Corp., Linde Div., 270 Park Ave., New York, N. Y. 10017.

Circle 213 on Inquiry Card

Telemetry System

A block diagram of the Model 8420 Telemetry System, specs., and system description are contained in Bulletin 8420. The system can handle PCM, PAM, PDM, FM and range time code signals. Digital processing performed on data channels includes: editing, merging of multiple inputs, smoothing, data compression, limit check, scaling, linearizing, time editing, and converting to display codes. Beckman Instruments, Inc., Systems Technical Information Service, 2500 Harbor Blvd., Fullerton, Calif. 92634.

Circle 214 on Inquiry Card

Strip Conductor

A new brochure describing edge-conditioned aluminum strip conductor is available. The edge-conditioned conductor has rounded edges—free of burrs, ridges and other irregularities which may cause concentrated high voltage stresses in coils, transformers and other electrical uses. The brochure contains technical data to aid in the design of components using aluminum strip conductor. Frequently used formulas and a chart which plots electrical resistivity against conductor size are included. A section is devoted to data on typical interleaving materials and methods of joining strip conductor. Reynolds Metals Co., PRD-100, Richmond, Va. 23218.

Circle 215 on Inquiry Card

ANOTHER FIRST FROM U.S. COMPONENTS!

NEW REMOVABLE CRIMP-CONTACT REPC* CONNECTORS THAT MEET TRI-SERVICE SPECS MIL-C-23353/9 AND MIL-C-23353/10—AVAILABLE NOW!

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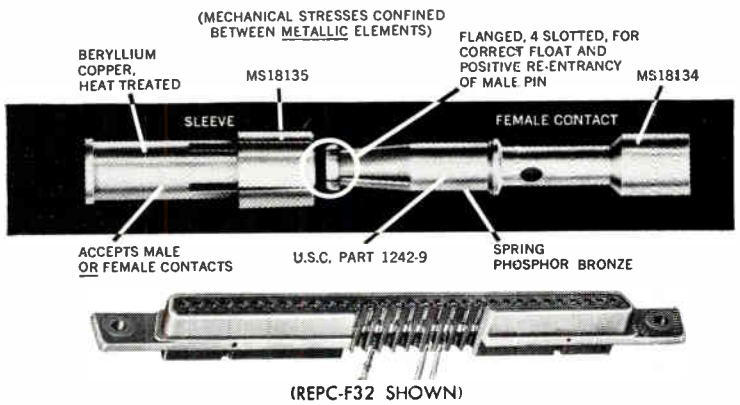
*REmovable RE-entrancy Printed Circuit



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The new U. S. C. REPC concept utilizes the unique REMI design that confines mechanical stresses between *metallic* elements only. Five years of use in millions of REMI connectors is *proof* of its established reliability! This outstanding U. S. C. patented ** contact sleeve design, is now specified as MS18135 (per MIL-C-23216) along with U. S. C. Part No. 1242-9 (female crimp-barrel socket contact MS18134 per MIL-C-23216), on both new military specification sheets.

Why settle for less than the best removable crimp-contact connector for *your* equipment? Write for the new REPC brochure or phone today for prompt assistance regarding your standard or special connector needs.

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CONTACT CENTER-TO-CENTER .156 INCH.

CONTACTS: Part 1242-9 meet MS18134 per latest MIL-C-23216 and are ordered separately. Type is crimp, removable, closed-entry.

NO. OF CONTACTS: 7, 11, 15, 19, 23 (in Military Spec.) and 32 Contact.

TEST VOLTAGE: 1800 V.R.M.S. at Sea Level.
CURRENT RATING: 7.5 Amps.
MATING CONNECTORS: Any numerical counterpart in UPCC-M ( ) A, B, or C Series.

CONNECTORS WITH 7 THRU 23 CONTACTS MEET APPLICABLE PROVISIONS OF NAS713 AND NAS714.
VARIOUS POLARIZATIONS OPTIONAL.

FULL LINE OF CRIMPING TOOLS AVAILABLE—
MIL-T-22520A CLASS I, MS3191 (ALL) and CLASS II TOOLS.
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TEST VOLTAGE: 1800 V.R.M.S. at Sea Level.
CURRENT RATING: 7.5 Amps.
MATING CONNECTORS: Any numerical counterpart in UPCC-SGM ( ) A, B, or C Series.

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INTERNATIONAL NEWS

London—International Instruments, Electronics and Automation Exhibition at Olympia, May 1966, will be used as a spring-board for major sales drives by the electronics industries of countries which are directly in competition with the United Kingdom.

London—After ten years of continuous operation on some of the most advanced statistical research programs, the Elliott Brothers 401, first Elliott computer sold commercially, is being retired to a science museum.

Hull—Ideal-Standard Ltd., a leading British manufacturer of plumbing equipment, will soon join U.K.'s growing ranks of automated firms by installing an NCR 315.

Shepperton, Middlesex — Dynamco Systems Ltd., incorporated Winston Electronics, has signalized its first month under the new name by booking about $15 million in new orders for data logging systems.

Cambridge—A new Grating Infrared Spectrophotometer that provides resolution needed in the 3000cm^{-1} region has been exhibited by Unicam Instruments Ltd. The range 650 to 4000 cm^{-1} is covered with two gratings back to back.

Glasgow—A Sperry Rand Univac 1108 computing system has been ordered by Great Britain's National Engineering Laboratory at East Kilbride, Scotland, to be used to prepare machine tool control tapes.

Munich—"SIERRA," a system of two 3003 SIEMENS data processors that books seats and sleeping berths, prints seat reservations and tickets, computes prices, performs accounting, and prints passenger lists, is to be supplied to the Spanish railways.

Berlin—Sperry Gyroscope has sold two SGN-10 Inertial Navigation Systems to be evaluated as part of an all-weather landing program by Deutsche Lufthansa A.G. in Boeing 707 aircraft.

Amsterdam — A 960-conversation microwave network installed by General Telephone & Electronics International Inc. will serve the four largest cities in The Netherlands, including Rotterdam, Utrecht and The Hague.

Copenhagen — Raytheon will distribute Engelhard Industries' "Capac" cathodic protection for ships in continental Europe, equipment and spare parts will be stocked in Copenhagen.

Erlangen — Siemens-Schuckertwerke has opened its new research center in Bavaria. At a cost of 100 million DM, it is Europe's largest private enterprise research establishment.

Montpellier — Seven months after ground breaking, IBM France's new plant has started assembly of IBM System/360 computers, which will be shipped to customers in Europe.

Paris—A new ground-based secondary radar system, SECAR, developed by Marconi and Compagnie Francaise Thomson Houston (CFTH) can interrogate on all civil and military modes.

Basel—More than 600 manufacturers were represented at the second International Exhibition of Industrial Electronics (INEL 65) held September 7 through 11 in the Swiss Industries Fair.

Zurich—Balzers Inc., of Liechtenstein, which supplies a large amount of high-vacuum equipment to the world, has acquired Trub-Tauber Scientific Division, Zurich, maker of research instruments.

Taranto—Italy's newest and most modern steel plant, Italsider Steel Corp., is using a Westinghouse automatic mill control to regulate ingot buggy travel between soaking pits and slab-mill conveyors.

Madrid—Burroughs Corp. announced a new subsidiary in Spain, Burroughs S.A., with headquarters in Madrid. The company also will have offices in Barcelona, Bilbao, Seville and Valencia.

New Delhi — The government of India, through its wholly owned company, Bharat Electronics Ltd., has awarded RCA a $5 million contract for military electronic equipment.

Tokyo—Hitachi Ltd. has given RCA a contract for more than $7 million to supply airborne digital data link equipment for Japan's F-104J Self Defense Forces aircraft.

Hong Kong — A new company, Transelectronics Ltd., with a production capacity of one million radio chassis per year will soon be established ing Hong Kong, according to Far East and Pacific, ITT Corp.

MICROELECTRONIC DEVELOPMENTS . . .

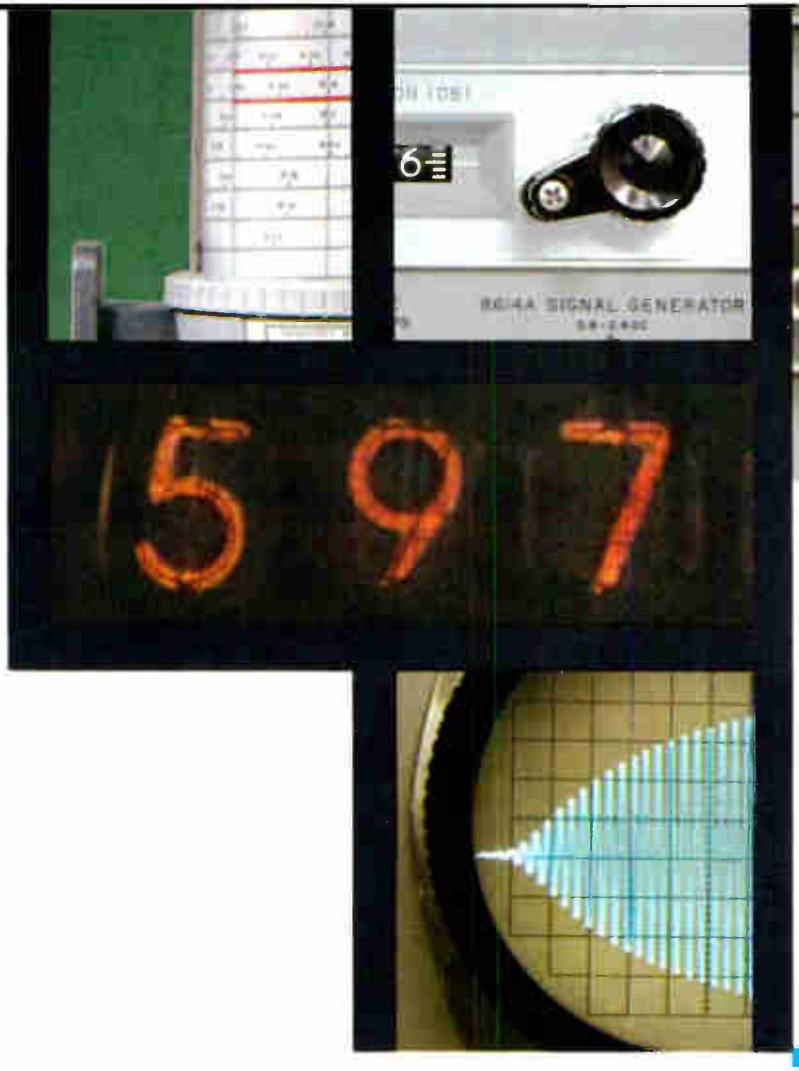
In a major expansion of microelectronic product lines, General Instrument Corp. has introduced a whole "family" of standard off-the-shelf MOS integrated circuits, designed for low cost computers, calculators, data processing, communications and other electronic systems.

A line of ceramic resistive pastes for silk screen printing for microelectronics has been announced by Electro-Science Laboratories, Inc. New resistive glaze compositions feature "superior heat stability, greater resistance to severe moisture exposure and improved electrical load stability." They may also be used for making discrete resistors or as part of a thick film hybrid circuit. Standard sheet resistivities in decade ranges from 10 to 20K ohms per square are offered.

Precision artwork stepping machine, "designed to be more accurate than any available until now," has been introduced by The Jade Corp., Bethayres, Pa., for micro mask manufacturing. The machine, Jade 4M, offers precise image placement with a repeatability of ±10 microinches (0.000010) for monolithic circuits. The Jade 4M can generate any stepped field with an area of 3 x 3 in. Maximum image size at 10X is 0.05 x 0.05 in. with a resolution of 200 lines/mm (0.001 in. lines).

"In response to demands for seminar service," an integrated circuit seminar will be held in Philadelphia, Pa., December 6-10, by the Integrated Circuit Engineering Corp., Phoenix, Ariz. Free brochure describing the seminar and rates is available from I.C.E.'s Eastern Office, P.O. Box 4388, Philadelphia, Pa. 19118.

Fast-pump vacuum system which produces pressures of below 10^{-6} Torr in less than 5 min. with ultimate vacuum of 10^{-7} Torr has been developed by Denton Vacuum, Inc. Designated Model DV-503-FP, the system pumps at about twice the speed of conventional systems. Some typical applications include evaporation and deposition of thin films for optics, semiconductors, microelectronics and printed circuit production and carbon evaporation.



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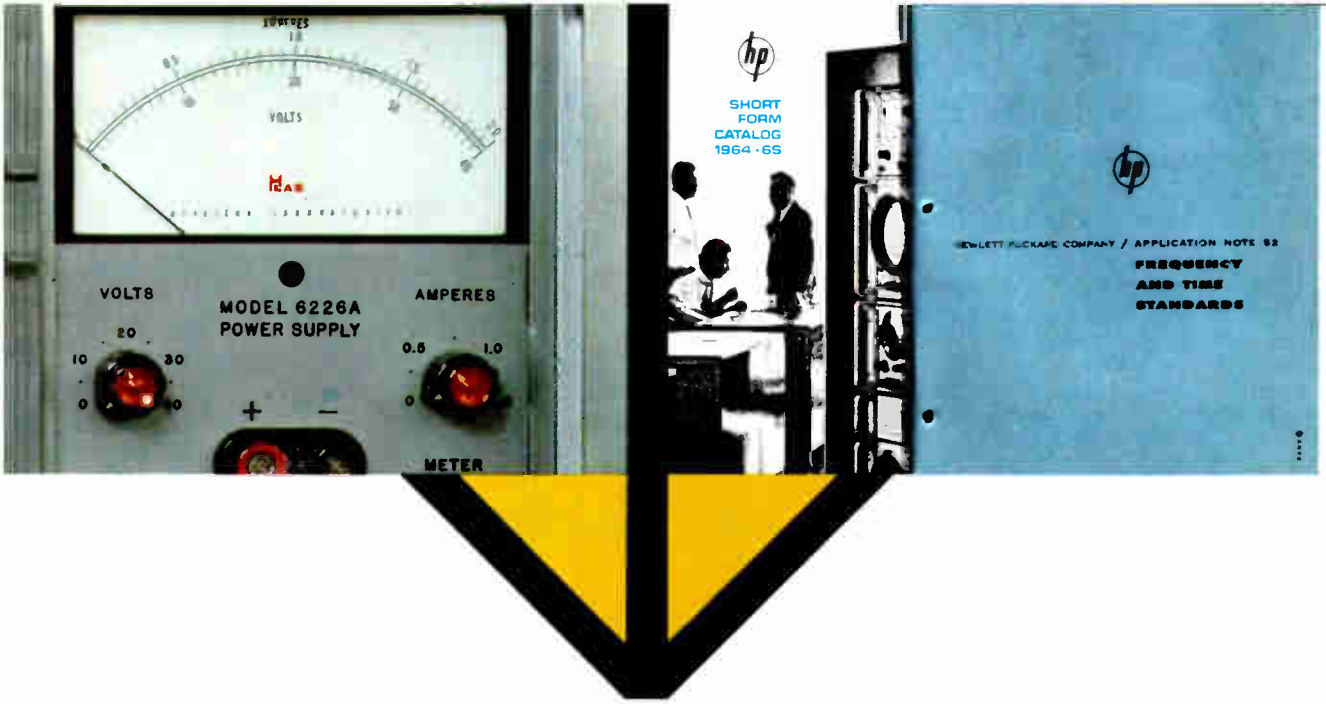

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- ☐ Please send the hp Shortform Catalog
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SHORTFORM CATALOG

For a complete index listing with brief specs of all Hewlett-Packard measuring instruments, use the postcard to request your copy of the hp shortform catalog.

DATA SHEETS

Or request complete details on instruments that will help you solve your measuring problem. Just ask for a data sheet on specific instrument model numbers, or describe the basic function, frequency range, etc. of the instrument you need.

APPLICATION NOTES

Use the postcard to obtain a complete index of more than 50 application notes available from Hewlett-Packard and its divisions. Typical subjects include time domain reflectometry, spectrum analysis, loop gain measurements, ac voltmeter selection, crystal control of signal sources 1 to 40 gc, strain gage recording.

GENERAL CATALOG

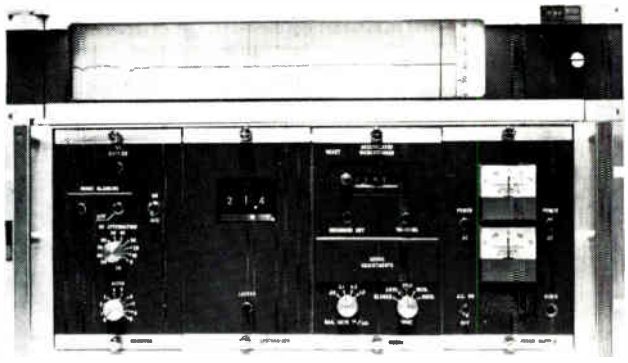
Information and specifications on the more than 900 instruments in the Hewlett-Packard product line are presented in the 400-page Hewlett-Packard General Catalog #25, available without charge from your local Hewlett-Packard field office.

HEWLETT hp PACKARD

An extra measure of quality

ALL CHANNEL RECEIVER

Model 1320 All-Channel VLF Phase Tracking Receiver tunes from 5 through 80kHz (751 channels). Designed by RMS Engineering, Inc., Atlanta, Ga., it calibrates frequency standards by comparing them with stabilized Government VLF transmissions.



Parts 26 and 27 of the 1965 Book of ASTM Standards, recently published by the American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa., contain all the ASTM standards for plastics. In the two parts there are 448 standards of which approximately 21% are new, revised, or changed in status. These parts replace and supersede all previous editions. Part 26, 548 pages (224 standard), costs $10.00 (ASTM members: $7.00). Part 27, 822 pages (224 standards), is priced at $15.00; (ASTM members: $10.50).

Program charts can be prepared by relatively inexperienced personnel using a curve-following instrument made by Corning Instrument and Controls, Penndel, Pa. It automatically adjusts process set points to a pre-determined time schedule or program. Accuracy is ±0.15%.

Failure rates for off-the-shelf silicon-monolithic integrated circuits have been established by Battelle researchers on the basis of about 68 million part-test hrs. of data. No failures have been reported for operating-life tests at 25°C, so it can be determined only that the failure rate is less than an upped 60% confidence limit of 0.067%/1000 hrs. This report, Order 614 103N, "Reliability of Integrated Circuits Used in Missile Systems," can be had from Clearinghouse, U.S. Dept of Commerce, Springfield, Va. 22151. Price, $3.00

A Waveform Analysis Center to meet the need for spectrum signature data has been established at Weston-Boonshaft and Fuchs Div. of Weston Instruments, Hatboro, Pa. Capabilities include low-cost investigation of transient and random signals in dynamic environments for determining signal contact, power spectra, and transfer functions.

A low-cost automatic 11 point program panel for use with pressure calibration systems is available from Gilmqre Industries, Inc., Cleveland, Ohio. According to the manufacturer, the Model 349 Programmer can complete an 11 point calibration run unattended, saving both test time and personnel. All preset pressures can be scanned up-scale, and when the highest set point is reached, the system reverses and returns through the same set points of scanning down-scale.

Basic research laboratories working with chemical kinetics, election exchange rates, molecular structurers, odd electron wave functions and other phenomena will be interested in a spectrometer made by Varian Associates, Palo Alto, Calif. Model E-3 is a 9.5Gc instrument with a built-in X-Y recorder that allows spectral data to be presented in terms of field measurement.

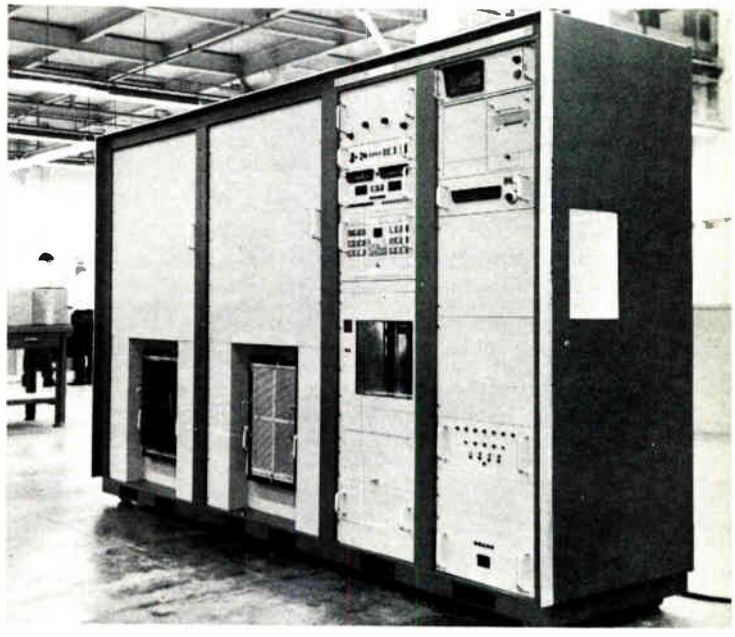
An instrument that provides dc output voltage directly proportional to the logarithm of the input frequency has been developed by Omnigraphic Corp., Houston, Tex. Called the HLFC-120 Log Frequency Converter, it should find uses in acoustical and vibration system, for filter and amplifier testing, and for nuclear counting. The instrument allows frequency response curves to be automatically plotted without mechanical linkages between the sweep oscillator and recorder.

Rapid, accurate Go/NoGo limit testing and analog measurements is provided by tape-programmed Model 9400. The basic system consists of a digital voltmeter or multimeter, an input scanner, tape reader, and a data-control unit. Perforated tape provides the program data. A front panel keyboard allows manual data insertion. The limit testing or measurement output data is available in the form of isolated contact closures for alarm and/or recording, or it is visually displayed. The tester is a product of Auto Data Inc., Kearny Mesa Rd., San Diego, Calif.

A convenient method for calibrating radiation pyrometers is offered by the Acutemp, a precision temp. calibrator. Made by Pyrotel Corp., Mamaroneck, N.Y. it gives direct temp. dial readout in various ranges from 0° F to 1000° F.

NASA GETS FACTs

NASA is using a special version of an automatic circuit tester to simulate voltage outputs and validate wiring between its Houston Center and units under test. The basic tester, called FACT (Flexible Automatic Circuit Tester), was developed by Hughes Aircraft, Culver City, Calif., to checkout hardware ranging from cabling to complex airframe or missile wiring.



Small changes in temperature, often encountered in electronic equipment can be measured using currently available fast detectors. New Cryogenic cooling methods make this method practical.

Photoconductive Detectors For Infrared

The "Cryomite" closed cycle cooler by Malaker. The mercury-doped germanium infrared detector is mounted behind the window at left.

THE APPLICATION OF LONG-WAVELENGTH, photoconductive detectors to infrared (IR) scanning, plotting or mapping of electronic devices offers advantages over other types. But, cryogenic cooling of such detectors is needed. Some of the available detectors, together with their operating mechanisms, are shown in Table 1. There are four general categories of detectors: thermal, photoconductive, photovoltaic, and photoelectromagnetic. A discussion of each type follows.

Thermal Detectors

Thermal detectors include such devices as thermistor bolometers, thermocouples, thermopiles, and the Golay Cell. These detectors are generally wideband; that is, with appropriate windows they cover the complete IR spectrum. But, they are not very fast, because thermal conduction through a solid or a gas takes time. The faster ones have time constants of about 1 msec.

Photoconductive Detectors

When radiation impinges on a photoconductive dedector, a change of conductivity takes place that is separate from any heating effect. Because the mechanism is a basic quantum electronic effect, the response time is very fast. Depending on the lifetime of the charge carriers in the particular photoconductor used, response times shorter than 1μsec have been observed. The spectral range covered by a particular photoconductor is much narrower than the spectral range of thermal detectors; but in general the photoconductor is more sensitive in this narrower range. Fortunately, many different photoconductive detector materials have been developed; and the spectral ranges overlap. Thus, photoconductive detectors can be selected for almost any portion of the IR spectrum.

Photovoltaic Detectors

Radiation applied to the junction of a photovoltaic detector causes a potential difference across the detector. Such detectors are very fast but cover a narrower spectral range than do thermal detectors.

Photoelectromagnetic Detectors

Radiation on a PEM detector causes a potential difference across the detector. The response is very fast over a narrow spectral range. Apart from the relatively low-level signals produced by the photovoltaic and photoelectromagnetic detectors, the main disadvantage to their use for the application to be discussed is the lack of enough detectors to cover a significant part of the IR spectrum.

Detector Applications

One use is to detect the IR radiation from electronic components and equipment that vary little in temperature from normal room ambient. The detector to be used must match the spectral range of radiation emitted from the components. As shown in Fig. 1, the spectral power (W_λ) from a 25°C black body is plotted as calculated from the Stefan-Boltzmann equation. Also plotted are the spectral detectivity curves of two photoconductive detectors—cadmium doped germanium (Ge:Cd) and mercury doped germanium (Ge:Hg). Peak detectivity of these detectors corresponds closely to the peak radiation emitted from objects at 25°C, and it was for this reason that they were selected. Fast time response and high detectivity of these detectors allows them to be used for rapid scan display on an intensity modulated long persistance oscilloscope. They would have been used more than they have if it had not been for the need of cryogenic cooling, heretofore quite difficult.

By GEORGE F. GIGGEY

Raytheon Co., Infrared and Optical Research Laboratory, Burlington, Mass.

Measurements

Detector cooling reduces thermal noise in the detector for weak signal observation. Ge, for instance, has many allowable energy levels due to impurities in the crystal lattice. By controlling the type and amount of a particular impurity, one can almost "tune" the material to be sensitive to certain IR spectral regions. Impurity levels in Ge are shown in Fig 2. The shallow acceptor levels of Cd, Hg and Cu are selected for reasons that will be discussed with the aid of Table 2. The discrete impurity energy levels of these three elements in Ge were chosen because of the relation of available energy level to spectral response. The photon energy (E_i) in electron volts of the radiation to be detected is given as $h\nu = hc\lambda$ where h is Planck's constant, and ν is the frequency which can also be expressed as c/λ (the speed of light divided by the wavelength of the radiation). If this photon energy is greater than the impurity level in the Ge, the impurity atoms will be ionized into charge carriers by the radiation, and photoconductivity takes place. If the photon has less energy than the impurity energy level, there is no effect on the material. From this relationship, it is seen necessary to have smaller impurity levels to obtain photoconductivity at longer wavelengths. A useful form of this relationship between maximum wavelength response or cutoff wavelength (λ_{max}), and the available energy level, is given at the bottom of Table 2. Using this relationship, the cutoff wavelengths for the materials considered in this table are: Ge:Hg, 13 microns; Ge:Cd, 21 microns; and Ge:Cu, 31 microns.

For photoconductivity to take place, the lattice energy (which is given as a function of kT, where k is Boltzmann's constant and T is the absolute temperature in °K) must be less than the impurity energy level in the crystal. If this condition is not maintained, the impurity atoms will be ionized by the lattice energy and the effect of the incoming radiation can not be observed.

For a typical impurity level in Ge, the number of charge carriers per cc (ionized impurity atoms) versus detector temperature is shown in Fig. 3. This plot is without incoming signal radiation and is shown for two different background levels. Detector temperature increases to the left, and the total number of charge carriers is the sum of the thermally excited carriers,

TABLE 1: PHOTOCONDUCTIVE DETECTORS

TYPE	PRIMARY OPERATING PRINCIPLE	EXAMPLE
THERMAL	Thermal change in resistance	Thermistor Bolometer
	Heat transport accompanied by charge transport	Thermocouple
	Thermal expansion of a gas	Golay Cell
PHOTO-CONDUCTIVE (PC)	Photoionization produces current carriers thereby changing electrical conductivity	PbS PbSe PbTe InSb P-type Ge(Au) Ge-Si(Zn,Sb) Ge(Cu) Ge(Zn)
PHOTO-VOLTAIC (PV)	Photoionization produces electron-hole pairs separated by internal electric field at junction, thus establishing potential difference	InSb InAs
PHOTO-ELECTRO-MAGNETIC (PEM)	As hole-electron pairs produced by Photoionization diffuse into material, they are separated by external magnetic field, thus establishing potential difference	InSb

TABLE 2: IMPURITY ENERGY LEVELS vs SPECTRAL RESPONSE IN GERMANIUM.

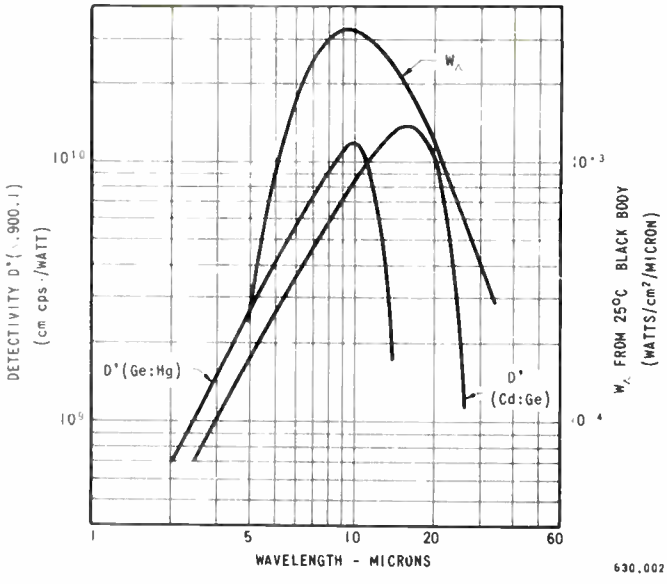
DISCRETE ENERGY LEVELS IN GERMANIUM

Hg	0.09 ev
Cd	0.06 ev
Cu	0.04 ev

$$E_i = h\nu = \underbrace{\frac{hc}{\lambda}}_{\text{Photon Energy}} \geq \underbrace{f(kT)}_{\text{Lattice Energy}}$$

$$\lambda_{max} = \frac{1.24}{E_i}$$

Fig. 1: Detectivity of cadmium and mercury-doped germanium infrared detectors. Spectral power curve of 25°C black body is shown for comparison.



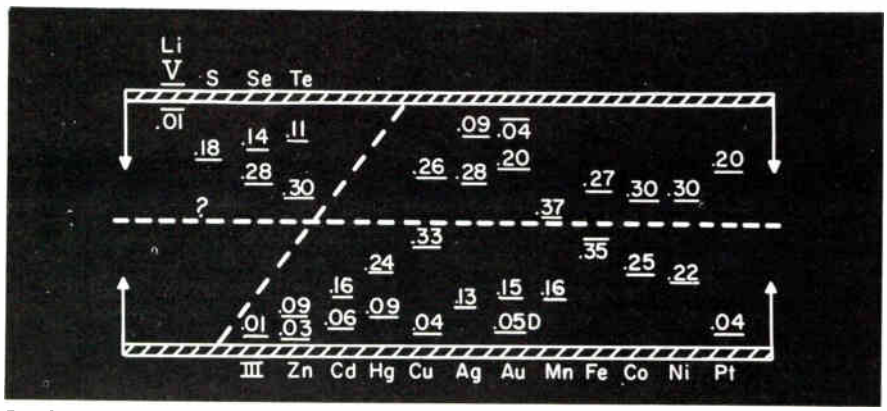


Fig. 2: Energy levels of impurity atoms in germanium.

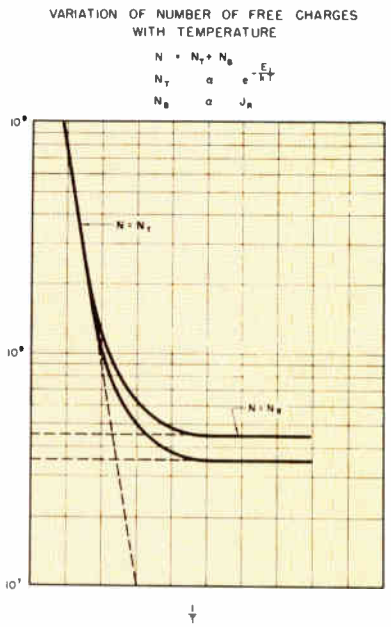


Fig. 4: Detectivity vs temperature for cadmium-doped germanium.

PHOTOCONDUCTIVE DETECTORS (Continued)

N_T, and the background carriers, N_B. The number of background carriers is determined by the flux density of background radiation incident on the detector.

The effect of detector temperature on detectivity is shown for cadmium doped germanium in Fig. 4. As shown, the detectivity drops off with detector temperature above 25°K. Similar figures can be drawn for other impurities in Ge with requirements of 30°K or lower for Ge:Hg and 17°K for Ge:Cu. Generalizing then, for photoconductive detectors with increasingly longer wavelength cutoff, lower detector temperatures are needed.

Detector Cooling Methods

Heretofore, the most practical method of cooling detectors has been to make use of the normal boiling point of various liquefied gases. Below 30°K there are only three liquified gases available—neon, hydrogen and helium. A metal liquid helium dewar suitable for IR detector cooling to 4.2°K is shown in Fig. 5. This dewar has a side-looking window near the bottom and is shielded with liquid nitrogen to reduce the helium evaporation rate. Dewars of this type can operate on one filling for 6-8 hrs. The filling operation and the accessory equipment needed to operate this dewar are shown in Fig. 6. A liquid helium storage tank is shown with a vacuum insulated transfer tube which is used to transfer the liquid helium to the detector dewar.

The increased availability of liquid helium at lower cost has made it more practical for detector cooling. It now is shipped by air freight and truck anywhere in the country. This availability and low cost make it practical to fill a detector dewar in the morning and operate it all day for about a dollar an hour.

A newer method for cooling detectors requiring temperatures of 30°K or less is by using one of the many cryogenic refrigerators designed for IR cooling. There are several closed cycle coolers using Joule-Thompson expansion valves or expansion engines to reach temperatures of 30°K or below. But, one development of the past two years that has done much to make detector refrigeration more practical is the availability of coolers based on the Stirling cycle. These are available from several manufacturers. One production model from Cryogenerators, Inc., called the Cryogem, is shown in Fig 7. Another is the "cryomite" made by Malaker (photo page 118). These are closed cycle coolers; thus, no liquefied gases or make-up gases are needed for operation. In addition, Stirling cycle

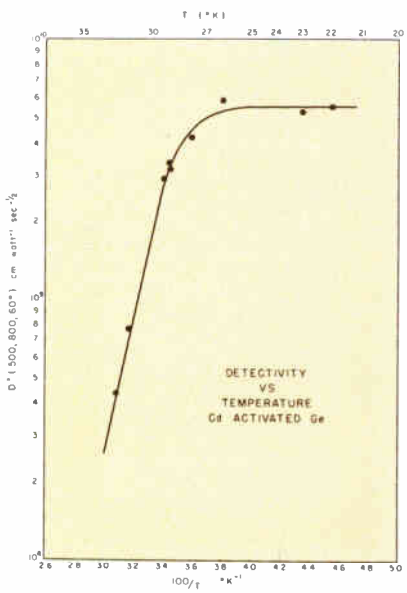


Fig. 3: Variation of free charges with temperature for a typical impurity level in germanium.

Fig. 5: Liquid helium dewar for infrared detector cooling to 4.2°K.

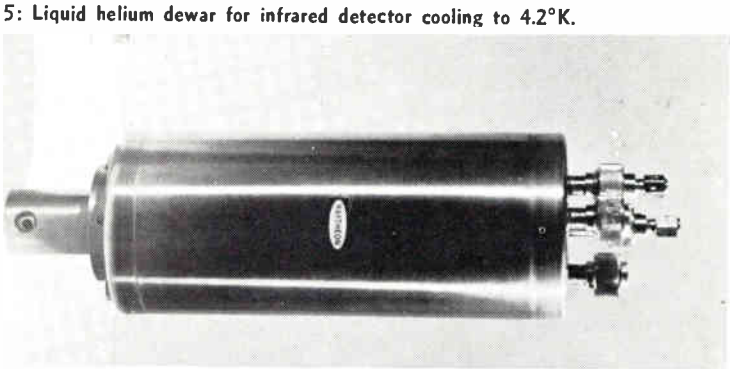
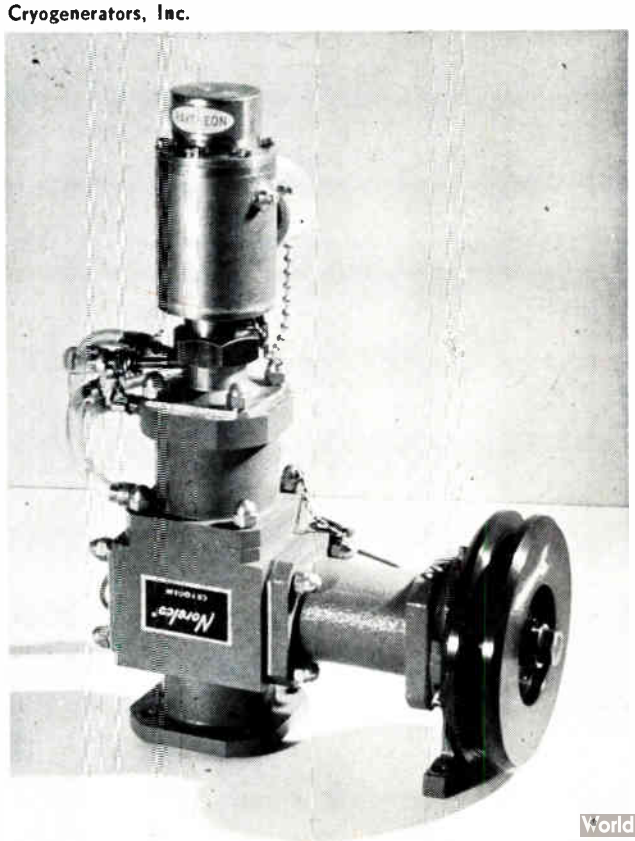


Fig. 6: (left) Filling and operating setup for liquid helium dewar.

coolers are very compact (12 in. in length and 15 lb in weight) and will operate in any attitude. They are particularly useful with mercury doped germanium detector material. The encapsulated detector is mounted on the cold head just behind the window in the vacuum jacket. The electrical connections to the detector are made by vacuum tight connectors on the side of the vacuum jacket. The cooler is driven by a fractional horsepower motor. Ambient temperature cooling is required either by water or air circulation to remove the heat of compression. These coolers can then be operated anywhere with only an electrical power source and the availability of ambient temperature heat rejection.

Fig. 7: A "Stirling cycle" cooler—the Cryogem, made by Cryogenerators, Inc.



EIA CONSOLIDATES IN NEW WASHINGTON BUILDING

Electronic Industries Association has moved into its new nine-story building at 2001 "I" St., N.W., Washington, D.C. The Engineering Department, once based in New York, and the Newark (N.J.) Type Registration Office have joined the other departments in D.C.

Staff operations for the seven product division and five service departments of the 42-year-old trade association for electronics manufacturers are housed in one location for the first time since the late 1930's. The West Coast representative will remain in Hollywood.

EIA's new mailing address is 2001 Eye St., N.W., Washington, D.C. 20006; new switchboard number, area code 202, 659-2200.

SATURN I-B WILL USE SOLID-STATE TELEMETRY

The initial flight of the Saturn I-B early next year will mark the "first vehicle on which all telemetry transmitters are solid state devices," reports Electronic Communications, Inc.

The Douglas S-IVB second stage will be equipped with ECI Model 503 VHF, FM solid state transmitters now in quantity production. The units were designed with a special FM modulator to assure that the stability requirement of 0.005% is met. The system has a modulation frequency response from dc to 200 KC.

The transmitter operates directly from the craft's 28-volt source, eliminating need for an external supply and a dc-dc converter. The units accommodate SS/FM, PAM/FM/PCM/FM and FM/FM inputs and deliver 3 watts of r-f power on any fixed frequency in the 216 to 260 MC range.

AUDIO-VISORY NURSE CALL FOR PATIENT EMERGENCY

A transistorized "Audio - Visory" Nurse Call system, designed for "effective and instant communications for hospitals at low cost," was disclosed by Motorola. Patient stations are solid state, no relays are used and equipment is expected to be almost maintenance free, reports Motorola.

Another highlight of the system is the attractively styled nurse master station, which not only provides instant visual indication of the calling room, but also classifies the call according to urgency.

SHIPBOARD RADAR SIMULATOR SOLID-STATE, COMPACT

A marine radar simulator for training on board ship has been developed by Solaratron's Military Systems and Simulation Division. The equipment is small, fully transistorized, and suitable for bulkhead mounting on merchant or navy vessels.

It will provide training in anti-collision problems and ship, helicopter or aircraft direction, according to the firm, of Farnborough, England. The simulator can be fitted without the need to modify the ship's radar equipment, and can be completely isolated from live radar.

The equipment can feed any ship's live radar displays with up to four simulated radar echoes, each of which is controllable with respect to course and speed.

HIGH RADIATION SOURCE FOR LASER PUMPING

A high-intensity radiation device has been developed by Union Carbide Corporation's Linde Division. Designated the vortex-stabilized arc radiation source, the device is reported usable and important in continuous laser pumping, solar simulation, high-speed melting of exotic materials, and hypervelocity re-entry simulation.

Tests of the arc device have shown it to be a more intense continuous radiation source than carbon-, mercury-, or xenon-arc lamps. The device has produced a radiance of 7200 watts/cm² steradian, using argon.

As a heat source, the vortex-stabilized arc also has shown good performance. A radiation flux at the surface of the arc column of 22,000 watts/cm² has been achieved.

THREE-COLOR CRT DISPLAY FOR NUCLEAR REACTOR

A three-color cathode-ray tube alphanumeric display for a data processing and control system for a computer-controlled nuclear reactor will be supplied by the Industrial Products Div. of IT&T.

The division is producing the high-speed three-color display system for Astrodata, Inc., Anaheim, Calif., prime contractor to the Atomic Energy Commission for the computer-controlled system.

The display equipment includes an alphanumeric character generator and a model KM-906, 19-inch high-speed three-color Computer-Scope.

EDITOR'S NOTEBOOK

TWO DEVICES—a computer and an optical reader—are assuring personnel of Roberts Dairy Company, Omaha, Neb., prompt and accurate handling of dairy orders. Daily, retail and wholesale salesmen inscribe orders on prepared forms with lead pencil. An IBM 1231 optical reading device scans the forms and transfers data from 1,200 sheets per hour directly into an IBM computer for processing.

AUTO ANTENNA that "performs efficiently at broadcast frequencies as well as 27 MC on CB" has been developed by Webster Manufacturing, South San Francisco, Calif. The antenna has an encapsulated top-loading coil to achieve one-quarter wavelength resonance for operation of a CB transceiver. Webster says there is no degradation when it is used for the entertainment radio.

AUTOMATION will certainly not retire "The Coldstream Guards" or even join Her Majesty's household regiments as a regular unit, the guardsmen would have it known. It's just that a closed-circuit TV system by EMI Electronics Ltd. (Hayes, Middlesex) was used to keep watch over priceless objects during 150th anniversary of the Battle of Waterloo, at London's Wellington Barracks. It was a bit of a help while the sergeant-major stepped down for a pint, you know?

ELECTRONIC SIRENS have a new champion in Motorola. A combination siren and public address vehicle warning system offers all the advantages of mechanical operation without age-old mechanical problems, according to Motorola. The transistorized audio amplifier is capable of producing a variety of warning sounds and public address functions. The system boasts 100 w of siren output power and 45 w of public address output power when used with two speakers.

LEAK DETECTOR—A portable mass spectrometer-type unit developed by Mikros Division of Varian Assoc., detects one part of helium in 10 million parts of air, can be attached to any basic vacuum system for spot leak detection. The assembly is comprised of a gun-electrometer optics module in stainless steel housing and a portable solid state electronics module containing the power supply and all controls.

EDP SYSTEM will eventually help eliminate the "out of stock" phrase at Harry S. Manchester Inc., Madison, Wis., department store. Company officers said that with its shiny new IBM System/360 Model 20 the "company will be a pioneer in the use of computers by department stores of this size. We expect our operation to be a model for other stores in our class."

ZOOM LENSES, which allow photographers to shift easily from telephoto views to wide angle photos, will be designed automatically for Bell & Howell Cameras by an SDS 930, Scientific Data Systems announced. The computer will be used to solve complex math formulas needed in design of both zoom and fixed focal length lenses.

DIGITAL PLOTTER is being used to proof-read material in minutes that still requires man 20 hours to complete, California Computer Products Inc. reports. The system is currently being used to check accuracy of control tapes for automated machine tools in experiments at IIT Research Institute in Chicago. An error in the tape shows up as a bulge on otherwise smooth lines. The tape holds 240 pages of numbers.

BOOKS

Microwave Tube Characteristics Tabulation, 14th Ed.

Published 1965 by D.A.T.A. Inc., Box 46, Orange, N. J. 07050. Price $18.50 in the U. S. and Canada or $20.50 elsewhere.

Tabulation covers technical characteristics of the commercial microwave tube lines of 48 U.S. and overseas manufacturers. Types covered include Backward Wave Tubes, Helitrons, Klystrons, Magnetrons, Platinotrons, and Traveling Wave Tubes.

Semiconductor Junctions and Devices

W. B. Burford III and H. G. Verner. Published 1965 by McGraw-Hill Book Co., 330 West 42nd St., New York, N.Y. 10036. Price $12.00. 328 pages.

Book provides a simplified, self-study approach to important aspects of transistor operation, the Fermi energy and black box concepts and use of Esaki and other single junction diodes.

The engineer will gain practical pointers on how to form a planar junction . . . what relationship equilibrium currents have to p-n junction . . . whether a device is reliable . . . and how junctions behave under external bias. References and indexes enable ready access to answers for these and other important questions.

Microwave Tube Characteristics Networks and Telephone Traffic

V. E. Benes. Published 1965 by Academic Press Inc., 111 Fifth Ave., New York, N.Y. 10003. Price $12.00. 319 pages.

Book is a systematic study of the combinatorial nature of communications networks, and of the traffic in them. Three kinds of traffic theory problems are considered: combinatorial problems of network design, probabilistic problems of traffic analysis (encompassing statistical problems of traffic measurement and analytical problems of calculation of the grade of service), and variational problems of routing traffic in networks. Emphasis is on basic concepts rather than engineering formulas, but practical problems always motivate the choices of topics.

ASTM Standards, Part 29: Electrical Insulating Materials

By ASTM. Published 1965 by the American Society for Testing and Materials, 1916 Race St., Phila., Pa. 19103. Price $19.00; to members $13.30. 1104 pages.

This book is one part of the 1965 Book of ASTM Standards which is comprised of 32 parts. It is issued annually. It contains all current formally approved ASTM standard and tentative specifications, methods of test, recommended practices, and definitions, as well as certain other related materials, such as proposed methods. Each part contains all actions accepted at the Annual Meeting preceding the issue date. All other actions accepted by the Society at least six months before the issue date are also included.

Modern Science and Technology

Edited by Robert Colborn. Published 1965 by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N.J. Price $22.50. 750 pages.

Scope of this book ranges from such articles as the abstract, theoretical "Dynamics of Space-Time" and "Gravity Experiments" to accounts of industrial practice such as "Non-traditional Machining" which reports on current advances in metalworking. Book contains material on such wide ranging topics as lasers, atomic absorption, traffic control, nuclear power, food processing by nuclear radiation; the chemistry of silicon and fluorine; rockets and boosters; international communication by satellite; learning machines and computers; reliability and quality control; and oceanographic studies.

Books Received

Photometry, 3rd Ed.

By John W. T. Walsh. Published 1965 by Dover Publications, Inc., 180 Varick St., New York, N.Y. 10014. Price $3.00. 544 pages, paperback.

This Dover edition is an unabridged and unaltered republication of the third edition published by Constable and Company in 1958.

2-Way Mobile Radio Handbook, Revised Edition

By Jack Helmi. Published 1964 by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis 6, Ind. Price $3.95. 223 pages, paperback.

PHONE CIRCUITRY

Components and circuit board of new "Trimline" telephone receiver, designed by Henry Dreyfuss, and being made by Western Electric for the Bell System. Dial, recall button, receiver and transmitter are in the handset, doing away with need to reach for standard base to dial. Printed circuitry and miniaturization permit handset to weigh only 12 oz. Set will be available at some extra charge by 1967.

NARROW BAND SYSTEM CUTS COST IN TV SENDING

A new technique for television developed by a New York engineer permits pictures to be transmitted over ordinary telephone lines instead of coaxial cable.

The engineer, George J. Doundoulakis, reports that his method can be a source of great savings in television. He estimates the reduction in closed-circuit line charges at 95%. According to the inventor, the system, which he calls Sonic Vee, economizes on microwave frequencies by velocity scanning. The engineer says his narrow bandwidth method can transmit a picture with high definition using 30KC rather than the usual 4.5MC. A telephone line uses 3,500 cycles, so nine telephone lines would be enough.

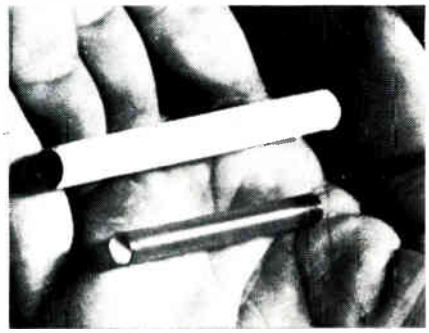
Mr. Doundoulakis asserts that Sonic Vee also has FM uses. FM stations may be able to send TV pictures over part of the extra radio channel that they now use, apart from their regular broadcasts, to provide music for restaurants and other clients.

The inventor, and his associate, Ira Kamen, also say that the narrow bandwidth will reduce costs of home recording and playback equipment. They predict inexpensive libraries of plays on tape.

WATER-COOLED LASER

A new water-cooled laser unit (6-868) that delivers up to 125 joules, more than 50 joules four times a minute, has been introduced by Maser Optics, Inc. Laser head uses a split, hinged, quick-opening, dual-elliptical, highly-polished, silver-plated cavity.

LASERS FOR THE MASSES



Lasers are moving into the science classroom, low-budget industrial and biological research, and even the home workshop. An inexpensive, less precision ruby rod has been deveolped by United Electronics Laboratories, Louisville, Ky. UEL claims the rods are of the same Cr concentration and crystallographic orientation as those now used in large research laboratories. They are offered in two sizes and with instructions for assembling equipment.

WORLD-WIDE CONTROLS SEEN FOR CHEMICAL PROCESSING

Petroleum and chemical companies with plants throughout the world are expected to develop world-wide systems using satellites to control refineries and continuous process units.

This projection is the result of a recent study on "Developments in Advanced Process Control Systems" by The Diebold Group, Inc. The study was made for a group of petroleum and chemical companies.

Projected findings show that petroleum and chemical industries are within ten years of seeing computer-based systems automatically adjust valve positions and start or stop pumps throughout the world. The decision or plan would be produced at one central location.

EDP TO ALERT DOCTORS ON PATIENTS' CONDITIONS

A computer-based electronic "early warning system" to alert physicians in surgery on swift and subtle physiological changes in a patient's condition is being developed for Presbyterian Medical Center in San Francisco.

The Institute of Medical Sciences, research affiliate of the center, and IBM Corp., in the joint study, report that the major engineering problem is to select reliable sensing systems which will produce maximal physiological data with little or no interference to the patient's comfort.

Dr. Herbert D. Steinbeck, IBM's life science team manager, said that the patient monitoring system will use a standard IBM 1800 computer which is to be installed at the medical center.

SCIENTISTS FIND TECHNIQUE FOR NEW MAGNETIC ALLOYS

Scientists of IBM Corp. have developed fabrication techniques which may be used to create entirely new magnetic alloys which would otherwise be impossible to mix, according to IBM spokesmen.

Using a special vapor-deposition technique, Drs. Arthur S. Nowick and Siegried R. Mader have produced magnetic films of cobalt-gold alloys with compositions from 25% to 60% gold. Normally, gold and cobalt mix only slightly.

Scientists say the deposition technique can be used to extend the known range of magnetic alloys. Magnetic films produced by the process can be either amorphous or metastable crystalline. All films produced to date are stable, even above room temperature.

The cobalt-gold alloy is ferromagnetic even when amorphous. Amorphous alloys have a low coercive force, and it may be possible to create amorphous films with less coercive force than that of crystalline alloys.

READY, AIM, TALK!

Space talk by light beam will be tested early in 1966 between Gemini 7 and ground stations. Gail Wedgwood sights through optical telescope of RCA laser transmitter, similar to one to be tried on Gemini 7. NASA has scheduled the laser talk experiment during a proposed 14-day orbit.

RR REVIVAL IS POSSIBLE WITH EDP

Combined computer-based communications network and advances in information technology will permit railroads to retrieve, in the 1970's the freight business which they have lost to trucks, waterways, air and pipelines. This is based on a conclusion by The Diebold Research Program.

The Diebold Research Program study postulates a new concept for the control of rail freight operations which currently depend upon bill of lading and waybill data. If this proposed data system were installed in the 1970's, car use could be improved from 20% to 50%; improvement would increase revenue from $10 to $20 million annually for every 10,000 freight cars owned, Diebold reports.

System-wide freight operations will be controlled at a central headquarters by 1975. The network will depend upon recent developments in data input devices. By providing centralized car inventory and distribution, shippers can expect at least a 25% improvement in speed of receiving an empty car.

15" COLOR TUBE LOOMS

The Radio Corporation of America announced plans to produce early next year 15 in. rectangular color CRTs for lightweight portable receivers. The 15-inch tube will provide an ideal combination of weight and size that can be carried around but still have a large enough screen for comfortable group viewing.

GERMANIUM TUNNEL DIODES MASS PRODUCED

The microwave germanium tunnel diode, long known for its delicate nature, is now being mass produced by Sylvania. The batched-produced units are so rugged they can be assembled directly into hybrid thin-film integrated circuits.

A new manufacturing technique, which allows up to 3000 passivated devices on one wafer, is the key to the device's ruggedness. In manufacture, an oxide protection is applied to cover all of the diodes on the surface of each slice. The contacts then are placed over the oxide. No external supports are needed. This is due to a thin-film technology which allows the fabrication of passive components on the units while in slice form. The diodes are completely ruggedized and provide long-term stability of characteristics. Due to the new manufacturing process, they have lower series resistances than standard tunnel diodes. Resistive cutoff frequencies greater than 50Gc have been obtained.

The new series, designated D-5360, D-5560, and D-5570, withstand repeated temperature cycles from cryogenic to +100°C. They exceed Mil-STD 750 mechanical stress testing of 1500 G shock, 20 G vibration, 20,000 G centrifuge.

NEW PHONE PUTS DIAL IN PALM OF HAND

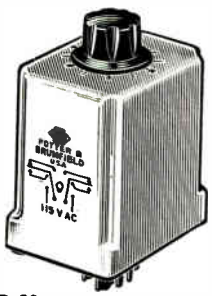
It used to be that a circuit was designed and components were chosen to fit the circuit. Then, the package was designed to contain the circuit. And, now? Turnabout.

Henry Dreyfuss, noted designer, came up with his small "Trimline" receiver for Bell Telephone. Object was an exterior package that would appeal to the user. All circuitry, except the bell, is in the handpiece, including the dial.

And now the engineers' problem: design a curved palm-sized circuit package to fit the "Trimline" receiver (which can be dialed either seated or reclining). The need was for flexible printed circuits and miniaturization. Tiny components were designed to fit the space.

There are no integrated circuits for this device as yet, but its only a matter of time. The next version of this receiver will be the push-button model to replace the dial in the future.

These P&B relays are immediately available at factory prices from your electronic parts distributor



CD-38

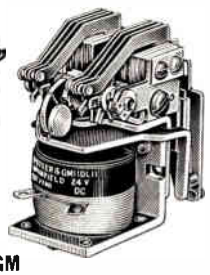
SOLID STATE TIME DELAY—You get excellent timing characteristics in these knob-adjustable solid state relays. Timing range: 0.6 to 60 seconds. AC or DC models. Internal DPDT relay rated at 10 amperes, 115V AC resistive. For continuous duty over temperature range of −40°C to +55°C.

KHP

COMPACT FOUR-POLE RELAY—Small, rugged 4PDT relay designed to meet exacting requirements of data processing, computer and process control applications. Rated at 3 amperes at 30V DC or 115V AC resistive. Solder terminals. Special sockets have printed circuit or solder lug terminals. Also available hermetically sealed.

PR

POPULAR 25 AMPERE POWER RELAY—Compact, heavy-duty power relay listed by U/L and CSA. Screw terminals and rugged construction suitable for industrial application requiring reliability and long life. AC or DC models.



GM

VERSATILE IMPULSE/SEQUENCING RELAY—Unusual single-coil relay can be used to latch, step, count and switch in sequence. Switching occurs during drop-out for greater reliability. AC or DC models. Contacts rated for 3 amperes. Can also be furnished with uni-directional printed circuit boards having 10 or 12 switch positions.

KR3-H

SMALL RELAY SWITCHES 20 AMPERES—Three KR3-H relays will fit in space required for most other 20-ampere relays. Mechanical life exceeds one million operations and twin contacts are rated at 20 amperes at 115V AC, 60 cycles resistive or 28V DC, 1 HP 115/230V 60 cycles. Contact terminals will accept ¼" quick-connects or solder connections.

Contact arrangement: SPST-NO-DB.

...and there are 60 other types to choose from!

Chances are, you'll save both time and money when you order standard P&B relays from an authorized distributor. You'll get speedy service at factory prices. Your P&B distributor has available more than 60 basic relay types totalling 627 coil voltages and contact arrangements. All are shown in our new Stock Catalog 100 . . . free from your electronic parts distributor. Ask for a personal copy today.

POTTER & BRUMFIELD

Division of American Machine & Foundry Company, Princeton, Indiana
Export: AMF International, 261 Madison Avenue, New York, N.Y.

PROFESSIONAL GUIDELINES

Reporting late developments affecting the employment picture in the Electronic Industries

ACADEMY OF SCIENCE SPAWNS ACADEMY OF ENGINEERING

To cope with increasing engineering problems faced by the U. S. Government, a National Academy of Engineering (NAE) was established in 1965, thereby strengthening the role of the engineer in our society.

The National Academy of Sciences, founded during the Civil War, has been major advisor to Government on scientific matters. During World War I, the National Research Council was set up to carry out major government research projects. After World War II, it came to light that more than half of the projects administered by the NRC were actually engineering in nature. The Congressional charter for the NAS covers the NAE as well.

Membership in the Academy of Engineering will be based largely on pioneering accomplishments in a new field of technology or contributions to engineering theory and practice, with processes or finished products as important as publications.

Currently, membership includes the 25 members of the founding committee plus about 20 recently admitted. The roster is expected to swell to 300 or more within several years.

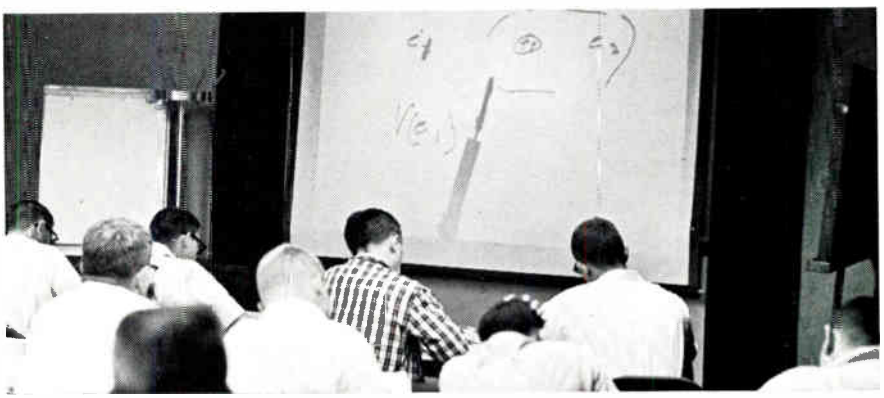
N. J. R&D COUNCIL SEEKS TO UP-GRADE TECHNICIANS

Following a successful conference on curricula for and training of technicians, the New Jersey Council for Research and Development will soon release a report laying the groundwork for education-industry programs to enhance the supply of technicians in the state.

New Jersey, which reportedly accounts for 10% of the nation's R & D dollars, faces a growing shortage of scientists, engineers, and technicians, according to a Council survey.

The report will emphasize the need for technicians ready to go to work at the end of two years college-level training, curricula recommended by conferees, and the need for industry to "upgrade the image" of technicians so parents and students alike will view such a career as desirable.

INDUSTRIAL CHEMISTS SEE BLACKBOARD 250 MILES AWAY



Texas A&M University is now conducting graduate-level chemistry courses by telephone for industrial chemists at Corpus Christi and Freeport over a GT&E communications system which transmits written data through conventional telephone circuits for visual display.

DEMAND FOR TECHNICAL HELP SEEN RISING THROUGH 1970

A climate of continuing demand for engineers, scientists and other professional technical people may possibly extend through 1970, predicts Deutsch & Shea, Inc.

The prediction is based in part upon an analysis of demand for technical help during the past five years, as measured by the Engineer/Scientists Demand Index maintained by the New York firm that specializes in the technical manpower field.

During the past five years demand for technical persons has fluctuated widely. The Index, based on 1961 as 100.0, has ranged from a low of 65.2 to a high of 153.7. These extremes, however, cancelled themselves out in the long run and the 60-month average for the Index has been 101.2.

This indicates that, although the extent of the demand for technical people varied during the past five years, there has been a considerable market for their services during that period.

The past 12 months have seen a new pattern of demand emerging; a slow, steady upswing in recruiting activities. This contrasts with past years when upturns have been abrupt and quickly followed by downtrends in demand. This suggests a growing market for the services of engineers and scientists in the immediate future.

For long-range, vast national investments in R&D during the past few years should result in the growth of new technologies, and the start of many planned activities. All of these activities will result in increased demands for technical manpower from now through 1970.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 134.

DATA CLEARINGHOUSE BEGINS INTERNSHIP PROGRAM

Recent science and engineering graduates, documentalists, and science librarians are acquiring first-hand knowledge and work experience in operating the Commerce Department's Clearinghouse for Federal Scientific and Technical Information.

Many graduates are now in a one-year internship to learn modern methods used by the Clearinghouse in handling large volumes of scientific and technical data. According to Bernard M. Fry, Clearinghouse director, the program is designed to offer a unique and challenging experience for young documentalists of high potential.

The program will train the intern, reports Mr. Fry, by giving him a broad-based work experience upon which he may build a career in science documentation and information handling if he wishes.

Microwave installation serving Alaskan RR System (Motorola).

Market for Microwave Components

SHIFTING MICROWAVE MARKETS have been undergoing several stages. Defense slashbacks began in 1963. Consolidation of markets and companies that started in 1963-64 is still continuing. At the same time, defense-aerospace-industrial markets keep improving.

Microwave markets were created—and depressed—by defense operations. The market that had grown like topsy for years—suddenly fell flat. When the bottom fell out of the estimated $1.5 to $2 billion government microwave market, the $200 to $250 million industrial markets obviously could not take up the slack.

In retrospect, the setback suffered by certain defense microwave companies in 1963-64 only *seemed* greater when contrasted with the sharp growth of defense microwave markets and companies up to the end of 1962. But not all component, equipment or systems contractors were hurt. Though microwave test equipment makers suffered, Hewlett-Packard Co., for example, "significantly increased government sales."

Microwave companies recently experienced a game of musical chairs. Some were marking time, merging, being acquired, or going bankrupt. Technologies were explored, while defense weapon system programs were stalled, phased-out, or cancelled. Older programs and systems were maintained, retrofitted or refined. In sum, the military turned from being the biggest builder to being the biggest user of microwave systems.

But that corner has been turned. And Wall Street brokers already turned over higher stock prices in anticipation of improved business for firms including: Collins Radio, Raytheon, Microwave Associates, Sanders Associates, Sperry Rand and Varian Associates, among others.

Here are glimpses of microwave markets:

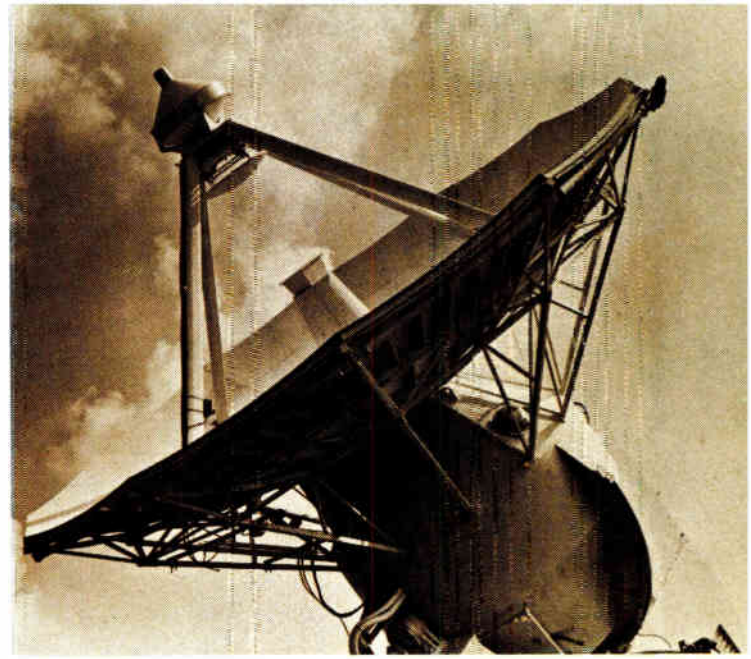
THE DEFENSE MARKET holds the lion's share, with radar constituting 55% to 60% of military microwaves. Phased-array radar is the big white hope. Its main capability is simultaneously tracking ballistic missiles and directing defensive fire. Mechanically-directed antennas are too slow. The phased-array antenna's narrow beam is computer-programmed and electrically-steered for faster operation.

Phased-arrays will be used in the proposed Nike X missile site radar system to help protect wide areas of continental U. S. The Army recently awarded a $12,405,408 contract to Western Electric (WE), for Nike X *preproduction* engineering and planning. This award enables long range work for a program that might swell into more than $6 billions!

MP-7 portable microwave equipment can be placed into operation within minutes after being placed at a battle scene (Motorola).

By SIDNEY FELDMAN
Associate Editor
ELECTRONIC INDUSTRIES

Microwave market mix continues to shift in emphasis. Events of recent years reduce firms through shake-out, merger or acquisition. Survivors expect bigger market portions because there will be fewer competitors. Biggest market area is still defense radar.



Antenna system, 30-ft. diameter, for Apollo Unified S-Band tracking/communication system built by Collins Radio for Nasa-Goddard.

Turns Upward

But such financing depends upon costs of the Vietnam war, the nuclear threat of Communist China, plans for the Department of Defense (DOD) Fiscal Year 1967 budget. Certain scientists claim Nike X may prove unfeasible. Yet tiers of contractors expect work from these WE major subcontractors: Ampex, Douglas Aircraft, General Electric, Martin, Raytheon, and Sperry Rand.

Microwave Associates also points to "increasing use of analogous technology applicable in systems ranging from all-solid-state Air Force radars to satellite antennae." Phased-array components may find growth markets in allied fields, particularly in microwave switches.

Defense markets developing along with radars and associated systems for manned fighter aircraft include the F-111, the RF4C reconnaissance aircraft, the new A-7A VAL naval and marine attack plane, the YF-12A reconnaissance bomber. Other aircraft radar markets may be beefed-up with defense operations, ranging from anti-submarine warfare to war in Vietnam.

There will be fewer production items, such as Polaris submarines and Minuteman missiles. Slackened production is expected for ground-to-air and ground-to-ground missiles, depending upon Vietnam. Other missile activities continue for DOD and the North Atlantic Treaty Organization (NATO).

Ralph Bondley, GE Microwave Tubes, observes new high emission cathode that can reach emission densities beyond 10a per sq.cm.

THE AEROSPACE MARKET utilizes microwaves for telemetry, tracking, navigation, communications relay, and radioastronomy ears to detect radio energy sources from outer space. This still relatively small market of several million dollars at times generates more publicity than profits. It also enables microwave companies to help advance themselves, along with the state-of-the-art.

Noteworthy areas include:

- National Aeronautic and Space Administration (NASA) has a new, unified S-band microwave system that should enhance aerospace communications and tracking. It was built and installed by Collins Radio for NASA-Goddard. NASA is building a microwave laboratory at its Electronics Research Center, Cambridge, Mass.
- Communications Statellite Corp. (COMSAT) space system utilizes microwaves to compete sharply with foreign government communications monopolies and the American Telephone & Telegraph Co. (AT&T).
- American Broadcasting Co. would decrease dependence upon AT&T and also challenges COMSAT's right as sole operator of U. S. communications satel-

ELECTRONIC INDUSTRIES Professional Profile

Please type or print

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

Name _____ Tel. No. _____

Street Address _____ Zone _____

City _____ State _____

☐ Single ☐ Married ☐ Citizen ☐ Non-Citizen Date of Birth _____

Will Relocate ☐ Yes ☐ No. If Yes ☐ Another City ☐ Another State

Salary Desired to Change Jobs in present area _____

Salary Desired to Change Jobs and relocate in another area _____

Professional Memberships _____

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

SIGNIFICANT EXPERIENCE AND OBJECTIVES

STATE ANY FACTS ABOUT YOURSELF THAT WILL HELP A PROSPECTIVE EMPLOYER EVALUATE YOUR EXPERIENCE AND JOB INTERESTS. INCLUDE SIGNIFICANT ACHIEVEMENTS, PUBLISHED PAPERS, AND CAREER GOALS.

Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia, Pa. 19139. This resume is confidential. A copy will be sent only to those Companies advertising for engineering personnel in this issue, whose number you circle below.

800 801 802 803 804 805 806 807 808 809 810

MICROWAVE INDUSTRY SUMMARY FOR SELECTED PRODUCTS*

PRODUCTS	Dollar Value—Year 1964 1st Half	2nd Half	1964 Year
1. Components (Includes (1) ferrite, (2) semiconductor, (3) non-ferrite, non-semiconductor assemblies, and (4) solid state duplexer assemblies)	$41,427,967	$45,844,684	$87,272,651
2. Tubes (Magnetrons, Klystrons, Traveling Wave, Gas Duplexer, and High Vacuum Microwave Tubes)	$72,164,660	$63,441,507	$135,606,167
3. Semiconductor Diodes**	$5,166,293	$6,009,087	$11,175,380
4. GRAND TOTAL	$118,758,920	$115,295,278	$234,054,198
SYSTEMS			
Point-to-Point Systems***	1st Half	2nd Half	1964 Year
Line of Sight Relay above 470 mc; Beyond the Horizon Systems—Scatter, Video Relay above 1,000 MC	$32,379,318	$25,597,518	$57,976,836

* Derived from data obtained from regular manufacturers' reports to the EIA Marketing Services Department on Microwave Components, Microwave Systems, Microwave Tubes, and Microwave Diodes, Data on Microwave Components represents total industry sales; tubes, Diodes and Systems data represents actual company inputs to EIA, with no estimation for non-participating manufacturers.
** Includes mixer diodes, video detectors, varactors, microwave tunnel diodes, and switching diodes (excluding crystal mount) operating above the 1 KMC frequency level.
*** This figure is orders received and therefore will be somewhat different from actual sales for any given time period. It includes Line of Sight Relay Systems above 470 MC, Beyond the Horizon (Scatter) Systems and Video Relay Systems above 1,000 MC sales for the industrial, common carrier, Government, and export markets. "Non-electronic" items (towers, poles, electrical power facilities, switchboards, etc.) are not included.

MICROWAVE MARKET (Continued)

lites. ABC seeks Federal Communications Commission (FCC) authority to build a $21.5 million synchronous-orbit satellite system.

THE COMMUNICATIONS MARKET also involves educational television and ultra-high-frequency (UHF) television. Solid-state microwave TV transmitters and receivers have been developed as TV relays for broadcasting special events. Microwaves help link TV communications networks in many parts of the world. Overseas, International Telephone and Telegraph Corp. (ITT) created transistorized microwave equipment for prime new links between London and Northern France.

Hard times in defense microwave business were eased by the continuing build-up of domestic telecommunications links. Both AT&T and Western Union (WU) expanded their microwave facilities, aided by defense suppliers. WU inaugurated its coast-to-coast microwave beam relay network (over which this editor spoke briefly).

AT&T broadened its microwave radio relay system which now represents about 50% of the Bell System's total telecommunications switching network. Installations comprise about 1,700 microwave towers that bounce signals along 43,000,000 circuit miles of AT&T's Long Lines Dept. message network. Associated Bell companies use other microwave facilities.

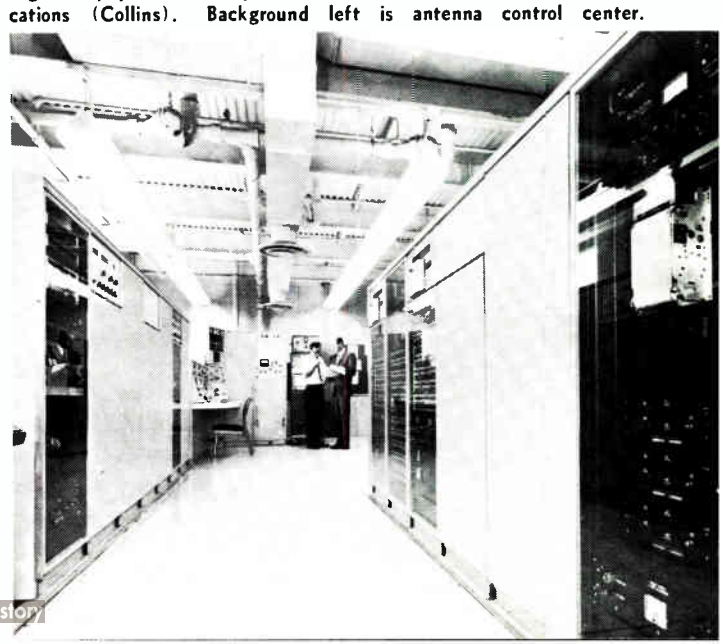
THE INDUSTRIAL MARKET, unlike government markets, requires greater capital investment by microwave equipment makers to stimulate demand. Motorola, long in government and industrial microwave markets, may launch a campaign to broaden sales among public utilities, common carriers, and other industrial customers. Litigation also continues over AT&T's special services and rates that compete with private industrial microwave systems.

Varied promising markets also include air and surface ground control systems; small craft marine radar; civilian aircraft weather radar and altimeters. Quasi-exotic applications include use of microwave power tubes for: cooking and industrial heating; thermionic energy conversion; chemical and food processing; plasma and magnetohydrodynamics power generation, and microwave power transmission.

THE INTERNATIONAL MARKET can be double-edged, since foreign countries offer markets and foreign companies offer competition. Microwave capabilities are available chiefly in England, France, West Germany, Italy, Norway, and Japan.

English and French microwave companies are developing joint radar systems, among other applications. English firms do well in Commonwealth countries. The Japanese and West Germans keep making strides in microwave operations. Yet ITT will install Ground Control Approach Radar Systems for the Royal Nether-

Digital equipment for Apollo Unified S-Band tracking /communications (Collins). Background left is antenna control center.



lands Air Force. And General Telephone & Electronics International built the first microwave system to link two South American countries: Argentina and Uruguay.

Biggest dollar growth comes from Europe, because of its rapidly improving technology in communications and defense electronics.

Successful microwave companies are making advances in technology, as well as in marketing and management. In the technical area there are many frontiers of activity, including:

- Expansion of microwave industry operations is hampered by inadequate measurement capability. Activities here are being conducted by the Microwave Circuit Standards Section of the National Bureau of Standards.
- Electromagnetic compatibility (EMC) is of great import in the design and sales of microwave and other electronic systems. DOD alone may represent about a $15 million annual market for EMC instruments.

A buyer's market had developed as a result of DOD's tighter grip on its dollars, tighter control on systems and replacement parts, and tightening-up of procurement practices which, in turn, caused companies to tighten-up their operations.

As a result, there has been a series of mergers, consolidations and some bankruptcies. Eitel-McCullough was merged into Varian Associates. The Microline products of Sperry Rand's Microwave Electronics Division were acquired by Narda Microwave. And in some cases both electron tube and solid state electronic components marketing operations were combined. And the end of these consolidations is not in sight. For this, DOD may be both blamed and credited.

Currently, microwave markets are easing-up with expanding operations such as the Nike X. Yet the pressure is on for microwave companies to operate as well in the business office as in the laboratory and on the production floor. One enterprising sales approach is Microwave Associates' integrated marketing program.

A computer monitors about 200 to 250 microwave programs in the development stage, and about 50 programs in the "bid stage," without contract awards. Microwave Associates believes this gathering and analysis of military and industrial information may give it six-to-nine months' lead-time over competitors.

Microwave marketers are being confronted by double jeopardy in the marketplace: government buyers are tough because they're sophisticated, and industrial buyers can be tougher because they are sophisticated about their own needs, but unsophisticated about electronic applications. In the long run, surviving microwave firms expect bigger cuts of the market pie partly because there will be fewer hungry competitors to feed.

ENGINEERS NEED, DESIRE MORE STUDY, SURVEY FINDS

Engineers are finding it tough to keep pace with the swiftly-moving current of knowledge flowing from universities, government and industry.

Some 2000 Pennsylvania engineers, in answer to a survey on continuing education, claim that engineers, need further and continuing study in the basic sciences and mathematics, in new techniques and the use of new tools, in the updating of communication skills, and in management.

The study has been summarized in an 80-page report by Drs. Samuel S. Dubin, a psychologist, and H. LeRoy Marlow, a management educator, of Pennsylvania State University.

Only working engineers who obtained a B.S. degree in engineering prior to 1959 were surveyed.

Engineers do not necessarily want college credit courses, the Penn State professors found. What they really want are informational courses and seminars, meetings and communications. They believe these will help them improve their professional skills.

The study outlined special recommendations for universities, companies, professional societies, government and the individual engineers to help in the updating process.

ENGINEER-TEACHER WAGES RISING, REPORT SHOWS

The average teacher of engineering now earns $10,725 through regular teaching plus another $2,775 for other activities such as consulting or writing.

Total professional income of $13,500 represents an increase of 11.7% since the last study in 1962, according to a survey of 7,000 engineering teachers by the Engineering Manpower Commission of Engineers Joint Council. Increase for the previous 2-year period was 9.7%.

The study shows progressively increasing income for (1) instructors ($7,675), (2) assistant professors ($10,700), (3) associate professors ($13,275), and (4) professors ($17,850). Department heads earn higher basic salaries and their total income ($18,050) has also overtaken that of professors. The previous survey showed lower outside professional earnings for department heads. Engineering deans were highest in the group with $20,300.

WHAT'S NEW

CLOSE SUPPORT FOR TROOPS

THE AIR FORCE IS EVALUATING an aerial photographic reconnaissance system they hope will aid close support for ground troops. Called Project See Fast, the photo scanning and reconstruction system was developed by Philco Corporation's Aeronutronic Div., Blue Bell, Pa. The purpose of the system is to scan sensing imagery and reconstruct it at a remote receiver station. This will provide field commanders with a real-time view of action in a forward position.

The system uses an airborne single-line, flying-spot scanner to transform data from 70mm photographic film to video form for transmission via data link to a relay aircraft. From here it is retransmitted to a ground-station van. There, a cathode-ray tube film recorder converts the video data to a photographic image on 5 in. film. Rapid film processing and viewing provisions permit near real-time analysis of the data.

The unit can scan 50 ft. of aerial photographs on 70mm film at a rate of 1 inch/sec. and reproduce them at two times the size on 5 in. film at a rate of 2 inch/sec. The overall resolution is 20 optical lines/mm with 10 shades of gray ranging from neutral density 0.2 neutral density 2.0.

A line trace formed by a 1.2 mil (half brightness) spot on the scanner's 5 in. CRT light source is imaged 1 to 0.5 on the continuously moving 70mm photographic images. The intensity of the spot is modulated by the density of the emulsion in the photograph, and its light is collected by a photomultiplier which yields the video signal for transmission. The system operates in the near ultra-violet spectral region. The light-collecting system of the video photomultiplier produces a 100:1 range of densities, and eliminates ambient light which could cause signal-to-noise degradation. It also

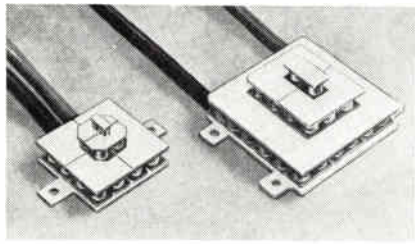
A photoscanning and reconstruction system is being tested to provide military field commanders with aerial photographic reconnaissance data in near real time. Photo at left is the original sensor imagery; at right is the reconstructed photo.

distributes the light of the scanning spot over an area of the photocathode, preventing noise from being introduced into the video by variations in gain across the photosensitive surface. Another photomultiplier, called a grain canceller, collects the light directly from the CRT. Since this light is not modulated by data on the film, it contains only the noise variations of the CRT phosphor. The outputs of each photomultiplier are logged and subtracted, yielding a noise-free video which is combined with a synchronizing signal for transmission.

A ground or airborne terminal recorder accepts the signal from the data link receiver, performs the signal processing necessary to extract the synchronizing signal, and exposes the 5 in. film.

NEW PRODUCTS

THERMOELECTRIC MODULES



Cooling units provide up to 115°C reduction from room temp.

These units are useful where either a small quantity of heat must be removed or precise temp. control is necessary. Hot side electrical isolation is provided so components can be readily mounted to cold side, and hot side fastened to convenient heat sink. Three-stage units, the TC-821 and TC-1851, providing up to 115°C temp. reduction, handle heat loads up to 1w. Two-stage units, the TC-44 and TC-185, provide up to 90°C temp. reduction, and can handle as much as 8w. of heat removal with appreciable temp. reduction. Ohio Semitronics Inc., 1205 Chesapeake Ave., Columbus, Ohio 43212.

Circle 266 on Inquiry Card

DOUBLE-SHIELDED BWO

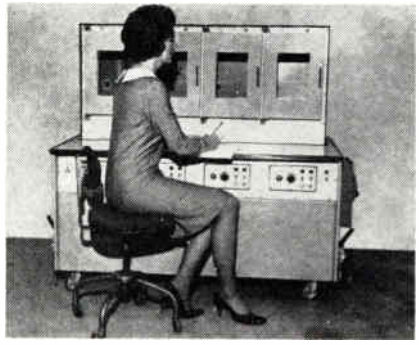
Features magnetic and RFI shielding. Meets Mil-I-26600 and Mil-I-6181.

This line of BWOs offers double shielding (unsaturated magnetic shielding and RFI shielding) and filtering. The WJ-2005 covers C-band (4.0-8.0GC), with 20mw minimum power output and helix voltage of 300-1800v. The WJ-2006 covers X-band (8.0-12.4GC), with 50mw minimum power output and helix voltage of 450-1500v. The WJ-2007 covers Kμ-band (12.4-18.0GC), with 40mw minimum power output and helix voltage of 550-2000v. Cathode current for all 3 is 10ma max. and the units measure 3 x 3 x 8 in. Watkins-Johnson Co., 3333 Hillview Ave., Palo Alto, Calif.

Circle 268 on Inquiry Card

ENVIRONMENTAL SYSTEM

Multiple test bay temp. chambers for continuous checkout of components.

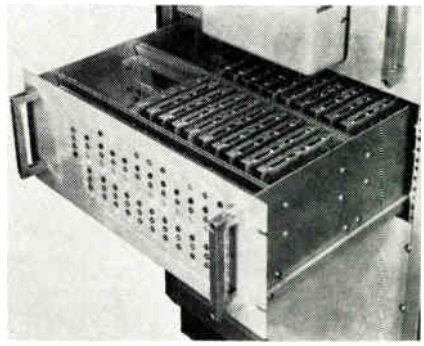


The individually controlled chambers of this unit have a range of 0 to +50°C and can be controlled within ±⅛°C. Temp. setting of 1 chamber has no effect upon the other chambers. Each may be individually programmed. In an initial application, the system operates at temps. at-or-near amb. for sorting of products whose characteristics vary widely with a few degrees change in temp. Difficulties of keeping accurate temp. control in a chamber near amb. are overcome through use of constant mechanical refrigeration bucked by heat in the individual chambers. Delta Design, Inc., 8000 Fletcher Pkwy, La Mesa, Calif.

Circle 267 on Inquiry Card

MEMORY UNIT

Stores tape-programmed numerical control system instructions.



The model 201 numerical control system memory modular performs the same function, when used with a single-line reader, that previously required a block reader. The unit's advantages are derived from its flexibility. Inputs can be slow-speed mechanical or high-speed photocell signals, and the unit can be closed by either logic signal level or contacts. The solid-state, expandable memory stores binary-coded decimal, decimal, or any standard code. Control logic speed is said to be fast enough to use with the highest speed reader presently available. Westinghouse Products Support Equipment Dept., Box 153, Baltimore, Md.

Circle 269 on Inquiry Card

IC CORE MEMORY

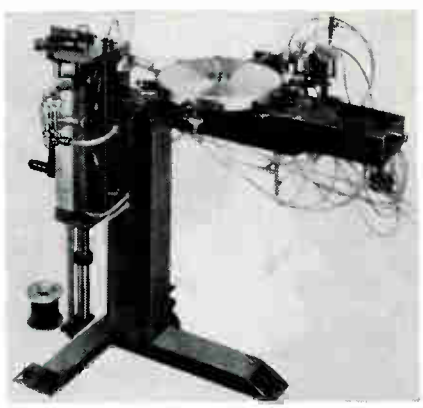
Operating speed of 1μsec. full cycle and access time is less than 500nsec.

The ICM-40 is an integrated-circuit, coincident-current, random-access core memory. The 5¼ in. high unit, designed for mounting in a standard relay rack with pull-out front-of-rack access, permits word capacities to 16,384. Standard operating modes include clear/write, read/restore, and read/modify/write cycles. Output signals include memory busy, information available, and end-of-cycle. Hold address control input also is available which interfaces with both discrete component and integrated circuit systems. Computer Control Co., Inc., Old Connecticut Path, Framingham, Mass.

Circle 270 on Inquiry Card

COIL WINDER

For high production runs of suppressor chokes and resistors.



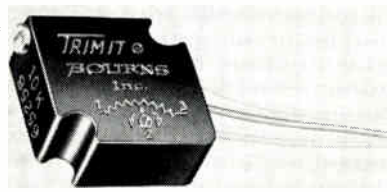
The Rotawinder™ is an entirely air-operated coil winding and finishing machine which produces close or space-wound coils at the rate of 600/hr. or better. It has a pneumatically operated transfer turret with multiple stations. Although loading is done manually, an automatic clamp-and-pull action severs the surplus wire tail at the axial lead, so that no further trimming is needed. Unclamping and ejection after the final operation is automatic. Automated wire welding to the axial leads is available as an option. Associated American Winding Machinery, Inc., 750 St. Ann's Ave., Bronx, N. Y.

Circle 271 on Inquiry Card

NEW PRODUCTS

LOW-COST POTENTIOMETER

Resistance range, 10Ω to 20K (±10%). Power rating 0.25w. @ 25°C.

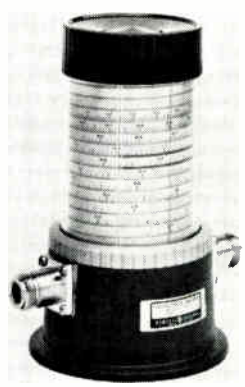


The ½ in. sq. wirewound Model 3257 Trimit® potentiometer is priced at $2.36 in 100 piece quantities. It features an idling mechanism which prevents damage from forced adjustment at the end of wiper travel; a temp. range from —65 to +105°C; fused Silverweld® termination, which eliminates the chief cause of potentiometer failure; and shock and vibration capabilities of 20G and 10G. Bourns, Inc., 1200 Columbia Ave., Riverside, Calif.

Circle 272 on Inquiry Card

COAX WAVEMETER

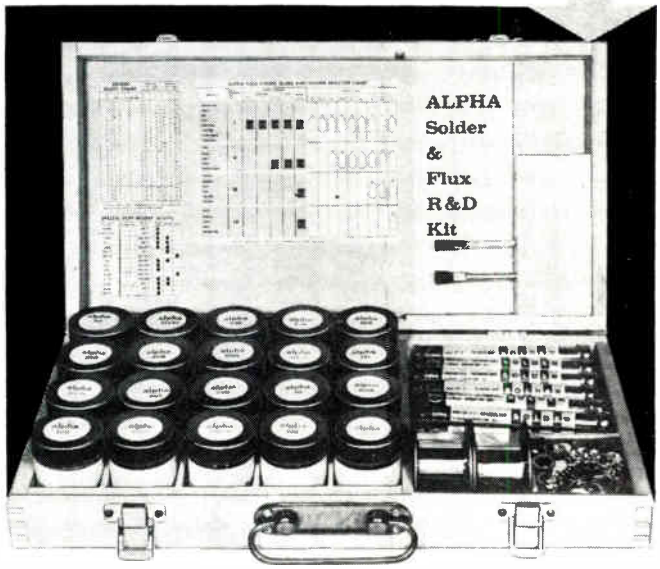
Coaxial microwave freq. meter covers 3.7 to 12.4 GHz with no spurious responses.



Model 537A has a spurious-free response across nearly 2 octaves. This is accomplished by a tuned cavity for the quarter-wave mode, with concurrent damping of three-quarter wave modes. It has a 75 in. direct-reading scale, with scale calibrations accurate to ±0.1%, in increments of 10 MHz. Worst-case overall accuracy is ±0.17%, allowing for scale errors, humidity variations from 0 to 100%, temps. ranging from 12 to 33°C, and for backlash. The instrument provides at least 1db response dip at resonance, and has Q in excess of 1000. Hewlett Packard, 1501 Page Mill Rd., Palo Alto, Calif. 94304.

Circle 273 on Inquiry Card

the all new ALPHA SOLDER and FLUX R & D KIT



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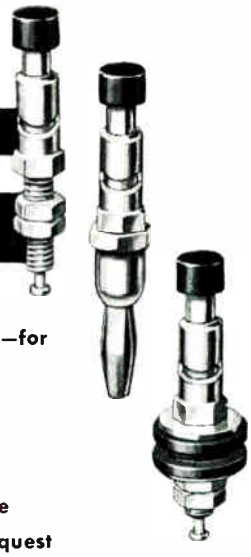

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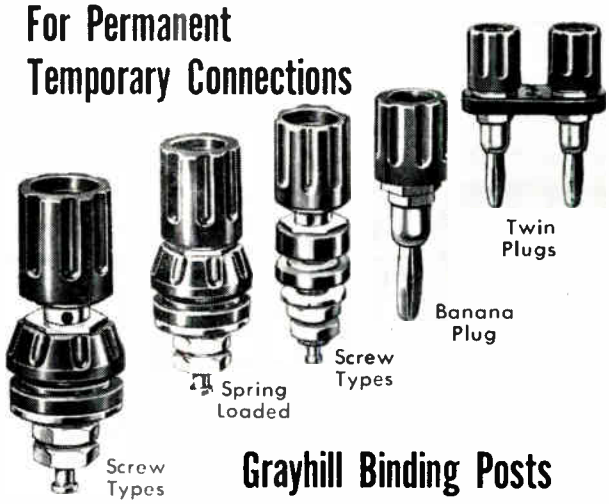

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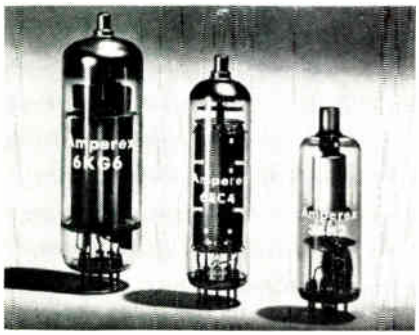


Tubes currently available in this line are the 6KG6 horizontal output pentode; 6EC4 damper diode; and 3BH2 high-voltage rectifier diode. The 6KG6 runs 50°C cooler than comparable tubes at max. operating conditions. It offers 34w. max. plate dissipation and 1.4a. peak anode current. The 6EC4 is rated for 5600v. PIV and 450ma average cathode current. The 3BH2 features an anti-corona shield. Amperex Electronic Corp., Semiconductor and Receiving Tube Div., Slatersville, R. I. 02876.

Circle 216 on Inquiry Card

PRE-AMPLIFIER

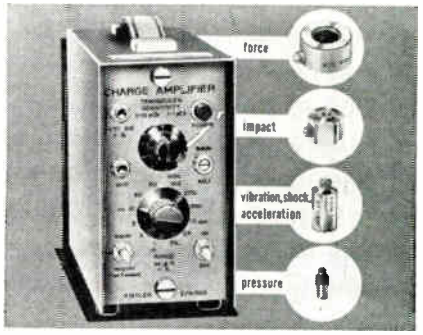
Provides a 1 million to 1 voltage gain over a freq. of 0.1 cps to 100kc.

The low-freq. seismic amplifier provides high gain and low noise with min. size and weight in a rugged package. Uses range from the laboratory to seismic field exploration. Other military and commercial uses exist in such areas as l-f sonar systems and VLF communications. The amplifier extracts low-level signals. Each stage provides a 30db gain with an input impedance of 100K. Noise equivalent is less than 0.2μv. General Electric Co, Military Communications Dept. (1-55), P. O. Box 129, Oklahoma City, Okla.

Circle 218 on Inquiry Card

ELECTROSTATIC AMPLIFIER

Simplifies operation and calibration of piezoelectric systems.

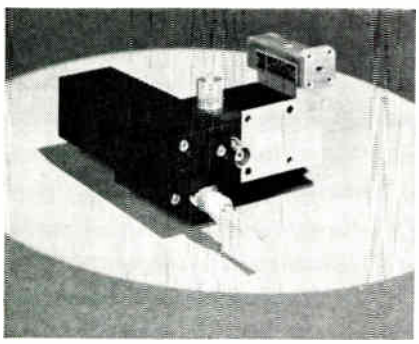


Model 503 incorporates 12 full-scale ranges from 1 to 50K psi, pounds or G's full-scale to match the extensive range of a quartz transducer. It accommodates any transducer sensitivity. Freq. response is from near dc to more than 100kc. The non-saturating electronics, with a MOS insulated gate input transistor, recovers instantaneously from extreme overloads of either polarity. Max. linear output signal exceeds ±10v. and ±10ma. Kistler Instrument Corp., 8989 Sheridan Dr., Clarence, N. Y. 14031.

Circle 220 on Inquiry Card

PREAMPLIFIER CONVERTER

Receiver noise figures are reduced to 2.5db, greatly improving radar sensitivity.

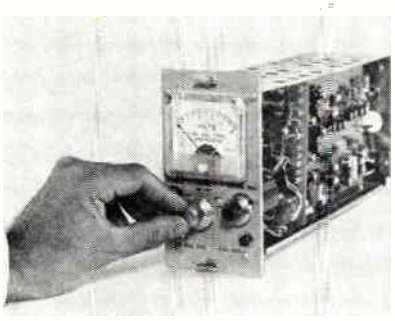


This low-noise K_u-band preamplifier-converter is suitable for airborne uses. The package includes a low-noise 2.3db nondegenerate parametric amplifier, a miniature mixer with 6db SSB noise figure, and an all solid-state local oscillator. The preamplifier-converter can be electronically tuned over a 600mc band anywhere in K_u band, with an r-f gain of 20db at a typical 3db bandwidth of 60mc. Package weight is 18 oz. and overall dimensions are 2.7 x 4.5 x 4 in. Texas Instruments Incorporated, P. O. Box 6015, Dallas, Tex.

Circle 217 on Inquiry Card

FREQ.-TO-DC CONVERTER

Provides 10 selectable overlapping freq. ranges continuously adjustable.



The frequency-to-dc converter Model PI-408 provides 10 selectable overlapping freq. ranges. These are continuously adjustable from 50 cps to 50kc full scale, with automatically selected crystal-controlled calibrate freq. for each range. Additional features include transformer coupled input with 60db common-mode rejection, low output impedance — less than 0.5Ω, improved linearity and stability, and scaled sq. wave output with marker pulses for every 10 and 100 input pulses. Anadex Instruments Inc., 7833 Haskell Ave., Van Nuys, Calif.

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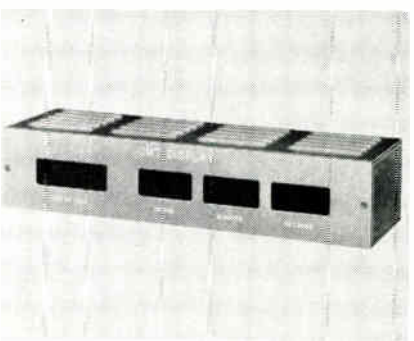
TRANSISTORIZED DISPLAY

Provides operator with instant and continuously visible digital information.



TNA-100 Series are used in systems where low-level signals are present. This package displays day of year, hrs., min. and sec. Signal input is low-level binary coded decimal, 1 wire/bit. An integral power supply provides the high voltage required by the display tubes. Input signals and 115vac enter the unit through connectors in the rugged metal case. The digital display assembly is also ideal for computer and guidance system readouts, digital clocks, etc. Transistor Electronics Corp., P. O. Box 6191, Minneapolis, Minn. 55424.

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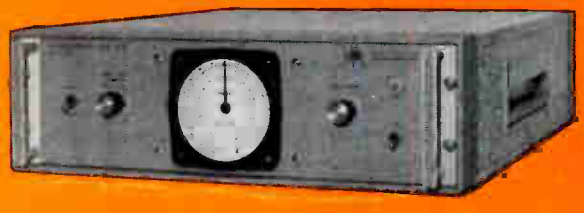

RECORDER-SWEEPER DRIVE, SERIES 1570
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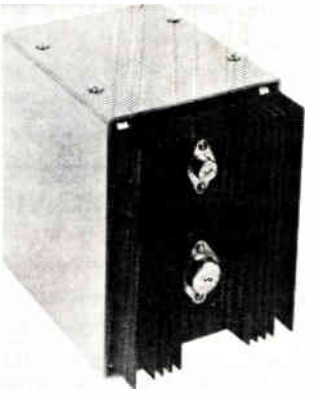
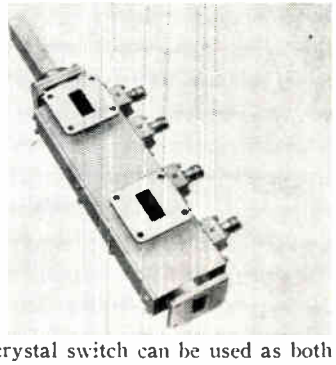


The MS series silicon regulated dc power module has a response time of 50msec and dynamic impedance of 0.0005 ohms. This device is self-cooled and requires no additional heat dissipating devices, enabling it to operate up to 81°C. Protection devices include automatic electronic current limiting, short-circuit protection and automatic overload protection. It is currently available in voltage ranges from 3-100v, and currents from 100ma to 12a. Perkin Electronics Corp., 345 Kansas Street, El Segundo, Calif.

Circle 222 on Inquiry Card

MICROWAVE SWITCH

TR crystal switch provides 140db isolation between transmitter and receiver.



This crystal switch can be used as both a TR and a pulse-forming device. It has a switching speed of less than 10nsec. and provides an isolation of 140db. The switch is a DPDT configuration. In a typical application it allows the transmitter to be transferred to internal dummy load when in the receive mode. R-F leakage is maintained 90db below the input signal in order to minimize the coupling between stages. The average power handling capability over all operating modes can be as high as 1w CW. Max. VSWR is 1.5:1, and instantaneous bandwidth is 200 MC at X-band. American Electronic Laboratories, Inc., P. O. Box 552, Lansdale, Pa.

Circle 223 on Inquiry Card

Tung-Sol Read-Out Lamp Saves Customer Two Operations, Cuts Shrinkage

Our customer's problem stemmed from handling. The bulbs he bought went first to a wiring company to have lead wires attached. (Shrinkage here due to lead wire damage). After the leads were attached the bulbs went to a molder to have bases added. (More shrinkage due to bulb damage and lead wire breakage). Shrinkage in both operations ran as high as 15 per cent.

Now Tung-Sol does the whole job and the customer has benefitted 4 ways: (1) two processing steps eliminated. (2) valuable production time saved. (3) inventory reduced. (4) gets 1000 usable lamps for every 1000 purchased.

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If your application requires only bulbs, ask for a quotation from Tung-Sol. The Tung-Sol line of miniature and subminiature lamps is extensive. Quality is the best that more than half a century of know-how can produce.

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ONE ENVIRONMENTAL CHAMBER WE DON'T MAKE

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If this capability fits into your plans, write for details on all our environmental cabinets. You'll probably find just the unit you're looking for. Ask, too, for data on Blue M furnaces. ovens and baths. There's no obligation.

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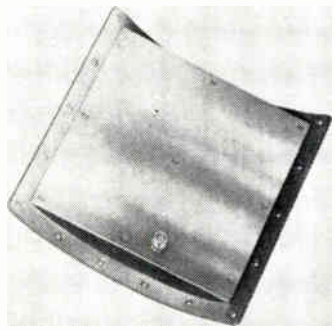
NEW PRODUCTS

TELEMETRY ANTENNA

It has a VSWR *of 1.5:1 over any 1.0*MC *band. Polarization is linear.*



The DM AK18 is a shallow cavity telemetry antenna for use on missiles and rockets which are approx. 15 in. in dia. Designed for conformance to missile surface and configuration, with a minimum of penetration into the vehicle, the DM AK18 provides max. radiated power in a vertical plane. The stainless steel unit is flush mounted and weighs 2 lbs. Efficiency is 90%. Dorne and Margolin, Inc., Westbury, N. Y.

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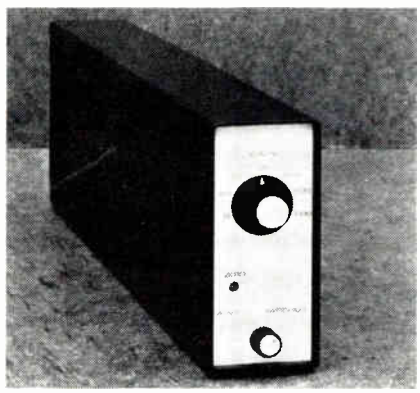
WIDE-BAND AMPLIFIER

Gain settings from 10 to 1000. Delivers an output of 100ma at ±20v.



The ADV-1 amplifies small signals from low-impedance sources, such as thermocouples and strain gauges. It is well suited to many instrumentation system applications, for data acquisition, and general laboratory use. It has a self-contained power supply. Active components are silicon devices which achieve low-drift, low-noise and fast recovery from overloads. Other principal features are high gain accuracy and high common-mode rejection. Eight ADV-1 amplifiers, assembled in a rack adapter, can be mounted in a standard 19 in. rack using 5¼ in. vertical panel space. Fairchild Instrumentation-West, 844 Charleston Rd., Palo Alto, Calif.

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341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380
381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400

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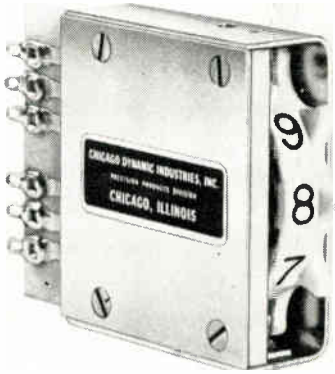
NEW PRODUCTS

SEALED SWITCH

Both panel and switching elements separately sealed against environments.

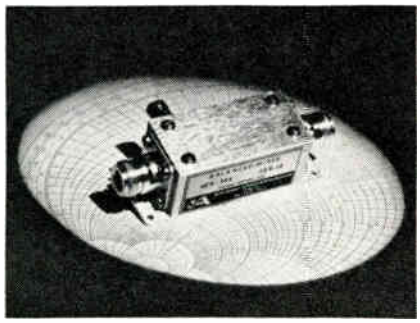


Series PS are sealed tab-type thumbwheel switches with panel and switching elements separately sealed against all hostile environments. Complete sealing not only protects the switch against dust, salt spray, corrosion and other contamination, but prevents any contamination from getting through to relays and other components. Especially recommended for RFI applications. Switch life exceeds 100,000 operations. Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversay Blvd., Chicago, Ill. 60614.

Circle 226 on Inquiry Card

RING MODULATOR

The 5 to 100MC unit uses no filters. Gives high isolation.

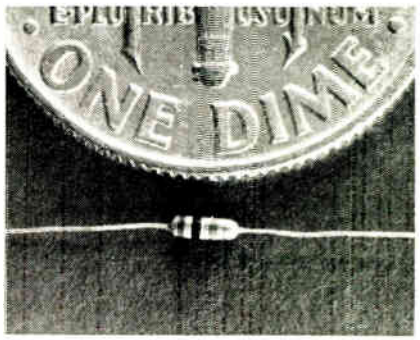


Model HFX-306 is a double-balanced mixer. It uses no filtering or tuned circuits to achieve isolation of greater than 20db between any 2 ports. Freq. range is 5MC to 100MC for all ports. The unit may be used as a mixer or modulator with input and output freqs. anywhere within the 5-100MC band. Replaceable hot carrier diodes obtain low noise figure (8db max.) and min. intermodulation distortion. External bias provides for optimum operation at drive levels from 0.5 to 50mw. It can be used as an up and down converter mixer to give double sideband output with carrier suppressed 20db or more. Anzac Electronics, Inc., Moody's Lane, Norwalk, Conn.

Circle 227 on Inquiry Card

MICRO-MINIATURE RESISTORS

They are 0.102 in. long and 0.035 in. dia. and are rated at 30mw.

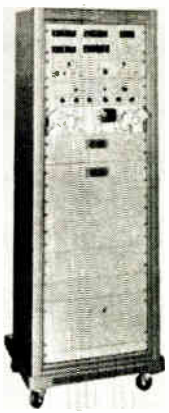


RKL 2 resistors are designed for hybrid or cordwood circuits. Resistance values are 47Ω to 100KΩ (±20% or ±10%). The carbon deposit is extended to cover cavities at the ends of the rod. The leads are soldered to nickel plating overlaying the carbon in these cavities. This assures stable electrical contact, a strong mechanical bond and provides a long resistance path. Quantity prices are as low as 18¢ each. British Radio Electronics Ltd., 1742 Wisconsin Ave., N.W., Washington, D. C.

Circle 228 on Inquiry Card

WIRING SYSTEM

Instructs production wiremen in point-to-point wiring.



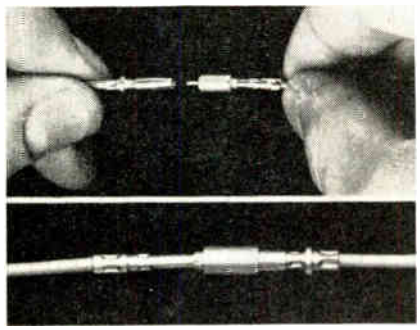
This zero defect wiring system instructs production wiremen in point-to-point wiring with numeric, alphanumeric or other illuminated displays. It verifies that punched tape instructions were correctly carried out before providing new instructions. Automatic testing for continuity or shorts is also provided. The system prevents errors from being built into products; eliminates wiring debugging, repair and reinspection; and provides automatic mode for continuous in process quality assurance. Micro Metrics, Inc., 176 Pennsylvania Ave., Paterson, N. J.

Circle 229 on Inquiry Card

NEW PRODUCTS

MINIATURE CONNECTOR

Said to give zero defect performance after numerous quick disconnects.

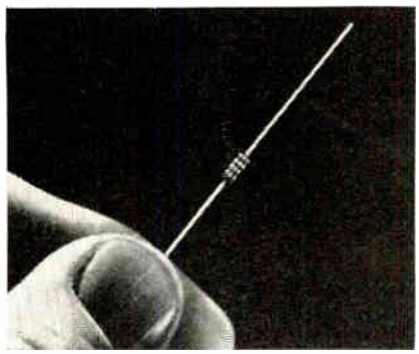


The ConeX series are miniature wire-to-wire interconnecting devices. Overlapping segments of the 2 wires, hand-inserted into the devices, are forged into 1 section with electrical conductivity better than that of an equivalent length of wire. ConeX may be connected and disconnected any number of times and at any point within a circuit with a hand swaging tool. Its simple construction, plus wire-to-wire contact, protects it against hostile amb. environments, shock and vibration. Solatron Enterprises, 5658 Bankfield Ave., Culver City, Calif. 90230.

Circle 232 on Inquiry Card

FIXED RESISTORS

The ⅛w. hot molded fixed resistors are ideal for miniaturized equipment.



Type BB hot molded resistor is rated ⅛w. at 70°C amb. It offers a theoretical packaging density approaching 730K units/cu. ft. The resistor, with full length leads, weighs 0.074 grams. They may be used with encapsulating casting resins. The leads are adaptable to substantial weld scheduled latitude, and they are solder-coated to make them readily solderable even after long periods of storage. The resistors meet the requirements of Mil-R-11, Style RC05 and are available in resistances from 2.7Ω to 100 megohms. Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wisc. 53204.

Circle 233 on Inquiry Card

NEW PRODUCTS

MILLIVOLT SYSTEM

Reads the output of any load cell, pressure transducer or low level signal.

Model H reads true force in the "curve" mode with a standard load cell. The accuracy is +0.025% of reading. It reads mv/v. on the plus or minus mode of any device with an accuracy of +0.015% of reading. The system has automatic balance, requires no stabilization, is completely portable and can be set up with a 10 min. warm up time. Operation is extremely simple. Correction or multiplication factors are not necessary; the only requirement is load and read. Gilmore Industries, Inc., 3355 Richmond Rd., Cleveland, Ohio. 44122.

Circle 240 on Inquiry Card

BATTERY CHECK-OUT

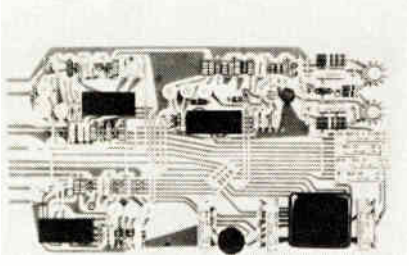
Provides complete and automatic electrical check-out of exotic batteries.

This battery analyzer, discharger, and charger tests silver zinc, silver cadmium, nickel cadmium, conventional lead acid batteries, and individual cells of any battery type. Manual operation allows selection of closely-held constant current charge or constant current discharge at all battery or cell voltages, or constant potential charge with current-limit crossover. An ampere hr. read-out in both charge and discharge modes provides indication of battery capacity and acceptability. Test circuits analyze the battery. Macarr Inc., 4360 Bullard Ave., New York, N. Y.

Circle 242 on Inquiry Card

ANALOG MULTIPLIER

Output is proportional to instantaneous product of 2 input voltages.



Hallefex® Model 1700-153 analog multiplier is a self-contained solid-state device. This unit consists of 2 input amplifiers, a multiplier using 2 thin-film Hall-effect voltage generators and an output amplifier. True algebraic products are obtained through 4-quadrant multiplication, and the resultant output voltage has a true mathematical sign. Power requirements are ±20vdc. Output voltage is 0.1 times the 2 inputs within the range of −10 to +10vdc at 1ma. Static accuracy is ±0.5% of full scale. Helipot Div. of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634.

Circle 241 on Inquiry Card

DC POWER SUPPLIES

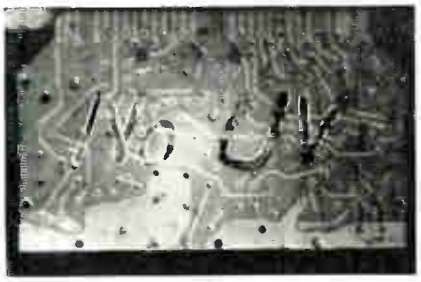
Compact, well regulated dc supply with 20 watts output.

STB Series Models 6102A and 6106A use as their reference element a temp.-compensated zener diode having a temp. coefficient of less than 20 ppm/°C. A high gain feedback amplifier with a matched silicon differential amplifier package monitors and controls the output voltage. The input voltage is 105-125/210-250vac, single phase 48-63 CPS. The output of the 6102A is 0-40v. at 0-500ma, and the output of the 6106A is 0-100v. at 0-200ma. Ripple and noise is less than 40μv RMS and less than 100μv peak to peak. Hewlett-Packard / Harrison Div., 100 Locust Ave., Berkeley Heights, N. J.

Circle 243 on Inquiry Card

FLUORESCENT COATING

For printed circuit boards. Simplifies production control.

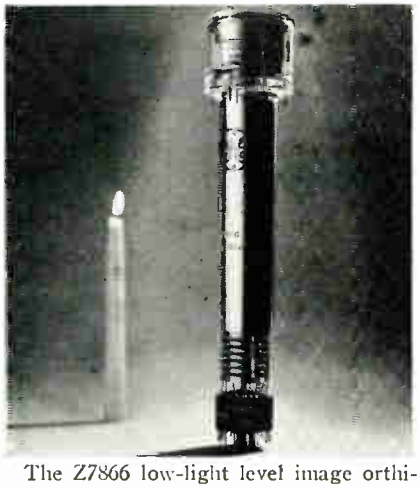


Eccocoat T 264 F is a 2-part, thixotropic epoxy coating designed for PC boards. In daylight it is transparent and water white, while under ultraviolet light it fluoresces a bright yellow green. Inspection under UV highlights surfaces that have not been coated, thus providing a simple and rapid means for quality control. It is a solventless system, so that any porosity in the laid-down film is eliminated. Its adhesion to plastics, ceramics, glass, metals and wood is excellent. Emerson & Cuming, Inc., Canton, Mass.

Circle 244 on Inquiry Card

IMAGE ORTHICON

Allows stations to shoot good quality color in black and white lighting.

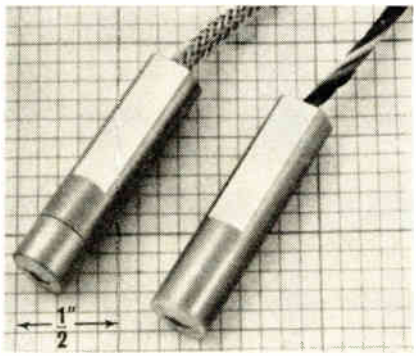


The Z7866 low-light level image orthicon can be used for low-light level conditions in the studio, as well as for such remote pickup as night time sports and news events. Peak-to-peak signal vs. RMS noise is 40:1 to 45:1. The new I.O. has a long-life target which lasts about 4000 hrs. Low noise is achieved with a unique construction feature. The high sensitivity and high resolution enable the tube to produce good-quality color pictures with 50-100 ft.-candle illumination, and black and white pictures in 25-50 ft.-candles. General Electric Co., Electronics Park, Syracuse, N. Y.

Circle 245 on Inquiry Card

NEW PRODUCTS

MAGNETIC DRUM HEAD



For use with non-contacting magnetic memory or storage drums.

The 4047D can be used alone or in multiples in a variety of operating mounts. Heads are individually adjustable for head-to-drum spacing. Max. mechanical stability is achieved by using a metallic structure throughout. It integrates into both solid-state and vacuum-tube circuits and withstands continuous 120ma dc without damage. Standard inductance is 67μh for each leg at 100KC with a gap of 0.001 in. Industrial Div., Pickering & Co., Inc., Sunnyside Blvd., Plainview, L. I., N. Y.

Circle 234 on Inquiry Card

TELEMETRY RECEIVER

Provides high-quality reception under severe electromagnetic interference.

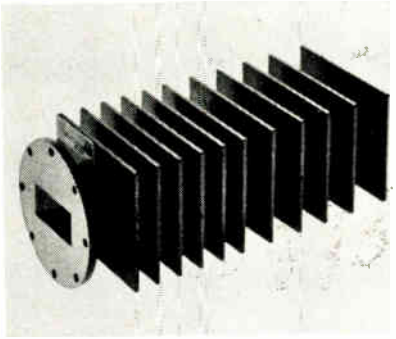
The Model 4004 DTR (Diversity Telemetry Receiver) rejects co-channel and adjacent-channel interference and gives optimum RFI isolation. It operates through the S-band. Two receivers and a predetection combiner on one chassis give improved performance and simplified maintenance. The 4004 DTR is completely modular. Radio-freq. tuning units to cover 130 to 2300MC plug in from the front panel. The internal plug-in modules can be changed without system realignment. A switch on the tuner provides continuous tuning across the band, or selects 1 of 2 crystal-controlled freqs. for fixed signal reception. ITT Federal Laboratories div. of ITT Corp., San Fernando, Calif.

Circle 235 on Inquiry Card

NEW PRODUCTS

HIGH POWER TERMINATIONS

Highly efficient dummy loads cover freq. range from 3.95 to 40GC.



A series of 7 standard terminations are available for terminating high-power waveguide transmission systems. A new dissipative material eliminates common problems such as deterioration at high temp., moisture absorption, and damage due to shock and vibration. All units have external cooling fins and are equipped with standard waveguide flanges. They provide high power absorption combined with min. VSWR characteristics in a small physical configuration. No auxiliary external cooling is required. Waveline Inc., Caldwell, N. J.

Circle 236 on Inquiry Card

MINIATURE LAMPS

Bulb diameters as small as 0.094 in.; length is 0.145 in.

These microminiature lamps are available in voltages from 5 to 28 and in 3 styles: sub-midget flanged base, unbased with wire terminals, and with axial lead wire terminals. "Tipless" style bulbs permit undistorted end viewing. Lamp life is 100,000 hrs. The axial-lead style was developed for imbedding in thin wall panels. It provides a broad source of light, dissipates heat over a wide area, allowing a wider selection of panel materials, and eliminates the tendency to terminal lead short circuits. Hudson Lamp Co., Kearny, N. J. 07032.

Circle 238 on Inquiry Card

WIRE UN-WRAP TOOL

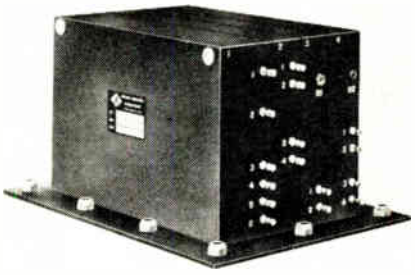
Removes and replaces wire connections on solderless type terminals.

This hand tool removes and replaces coiled wire connections on wire wrap type terminals. It does the job without the usual procedure of destroying the connection by uncoiling, cutting off the wire, stripping insulation, and then gun wrapping a new connection. The un-wrap end of the tool slightly loosens the wire coil so that it may be removed intact from the terminal. When located on another terminal the re-wrap tool retightens the wire coil. Time used is sec. and no damage to the coil results. McCallus Industries Inc., 6324 Vesper Ave., P. O. Box 88, Van Nuys, Calif. 91408.

Circle 237 on Inquiry Card

BWO POWER SUPPLY

Built for severe Mil-E-5400 Class 2 environmental requirements.



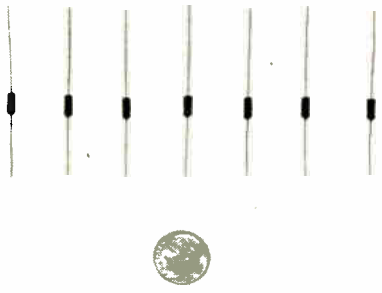
With the Model PM 1346, high-voltage, lightweight, programmable dc-to-dc BWO power supply, dc power is taken from 28vdc source and converted to 3 well regulated dc outputs. Output #1 is programmable from 300v. to 1350v. at 8ma. Ripple is less than 100mv. Output #2 gives 90 to 150vdc at 1ma and a ripple of under 100mv. Output #3 provides 6.3vdc at 1a. for the BWO filament. The output varies less than 1% under all possible combinations of line variation, load change, long term drift, and amb. temp. change. Pioneer Magnetics, Inc., 1745 Berkeley St., Santa Monica, Calif. 90404.

Circle 239 on Inquiry Card

NEW PRODUCTS

REFERENCE DIODES

Temp. coefficients of 0.001%/°C over a current range (0.5 to 7.5ma.).

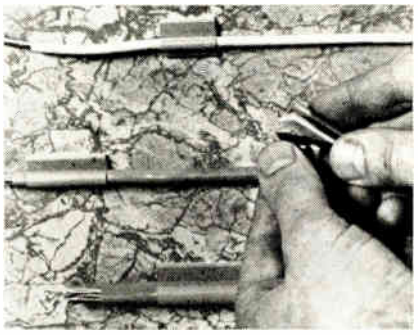


Series 1N4916 through 1N4932A are 19.2v., low-noise, temp. compensated reference diodes. The diodes have a max. steady power dissipation at or below +50°C of 400mw and operating temp. range of −65°C to 175°C. They offer low noise and are ideal for use in audio, or small signal circuits where noise interference is to be held to a min. Typical noise is approx. 0.2μv/sq. ft. cycle. Dickson Electronics Corp., 310 Wells Fargo Ave., Scottsdale, Ariz.

Circle 250 on Inquiry Card

CABLE CLAMP

Holds cable in place without screws or other mechanical fasteners.

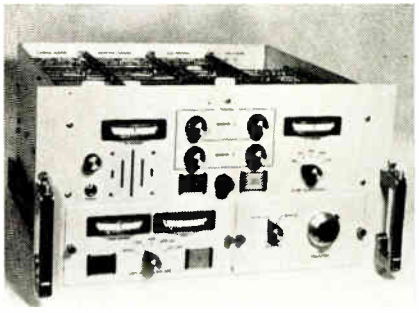


The Scotchflex brand adhesive cable clips are constructed of polyvinylchloride with a foam adhesive backing. They are available in 4 sizes to handle bundles or jacketed cable from ⅛ to ½ in. in dia. The new, foam adhesive backing allows the clamp to be quickly and firmly mounted to any clean, dry surface, including such areas as electronic equipment chassis, walls, desks, etc. They hold JKT or coaxial cables. Dept. D5-700, 3M Co., 2501 Hudson Rd., St. Paul, Minn. 55119.

Circle 251 on Inquiry Card

TRACKING RECEIVER

Freq. range is 225 to 260MC. RF input: 3 channels from monopulse feed.



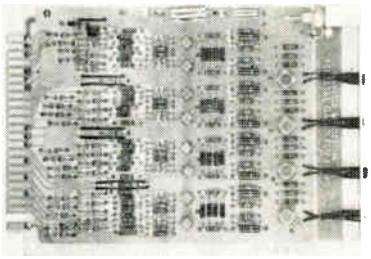
Model 103 Monopulse Tracking Receiver, supplied with a 3-channel pedestal-mounted preamplifier-converter unit, covers the 225 to 260MC band. One sum channel plus 2 identical error channels derive azimuth and elevation error signals for control of large ground antennas. Noise figure is better than 4.5db across band. Gain is 30db (±1db) across band to 50Ω loads. UED Aerospace Div., Teledyne Systems Co., 12930 Panama St., Los Angeles, Calif. 90066.

Circle 252 on Inquiry Card

NEW PRODUCTS

GATED FLIP-FLOPS

Contains 4 flip-flops which are useful for control functions.

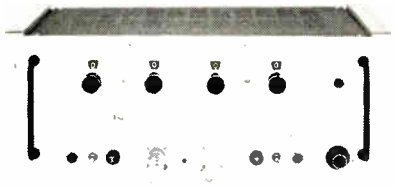


Model 03 module is a complete new line of 1MC system logic functions available in both germanium and silicon versions. The flip-flops, which can be used either individually or together, are alerted by a "O" level at one input and triggered by a positive-going transition at another point. Since the triggering transition is typically the trailing edge of a pulse, all required conditions can be set up without encountering race condition or critical timing problems. Navigation Computer Corp., Valley Forge Industrial Park, Norristown, Pa.

Circle 253 on Inquiry Card

HIGH VOLTAGE SUPPLY

Furnishes 300 to 5000vdc; accurate to 0.1%. Output is 15ma.

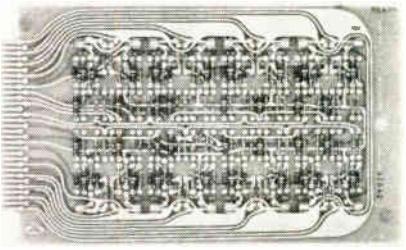


The Model 243 provides potentials for photomultiplier tubes and other detectors. Other applications include calibration tests, voltage gradients studies and leakage resistance measurements. Four in-line calibrated dials permit the output voltage to be set in 1v. steps from 300 to 5000vdc. Accuracy is within ±0.1 of dial setting. A trimming potentiometer permits interpolation between steps with 15mv resolution. Max. current load is 15ma dc. Output polarity can be positive or negative. Keithley Instruments, 12415 Euclid Ave., Cleveland 6, Ohio.

Circle 254 on Inquiry Card

MULTIPLEXERS

High-speed units handle as few as 8 channels and as many as 128 channels.



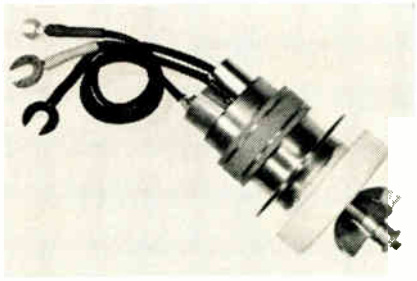
Series 970 multiplexers can handle from 8 to 128 channels. The units accept single-ended inputs or differential 3-wire inputs consisting of a differential input and guard shield. Gain is adjustable from 1 to 20, so that input signals as low as ±500mv full scale are amplified to ±10v. With an internal impedance less than 1Ω the amplifier delivers 10ma to the multiplexer load. For differential inputs, an input resistance of 100 megohms is maintained and amplification is available externally. Astrodata, Inc., P. O. Box 3003, 240 E. Palais Rd., Anaheim, Calif.

Circle 255 on Inquiry Card

NEW PRODUCTS

COMPACT THYRATRON

Designed specifically for radar uses. Mean anode current is 600 ma.

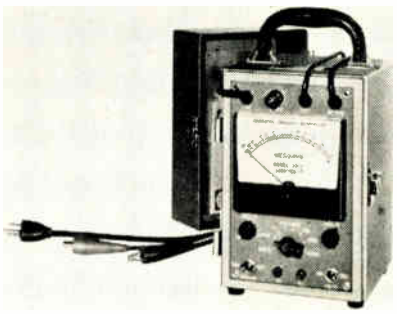


E2830 is a metal-bodied deuterium-filled pulse modulator thyratron. Tube measures 4½ x 2¼ in. dia. and has a peak anode voltage of 20kv., forward and reverse, peak anode current is 500a. It can also be used as a grid-controlled rectifier with ratings of 20kv., forward and reverse, and 1a. mean current. The metal body facilitates grid cooling and enables the gas density of the tube to be kept constant. This contributes to compactness and well controlled triggering characteristics at high power. The M-O Valve Co. Ltd., Brook Green Works, London W.W. 6, England.

Circle 256 on Inquiry Card

MEGOHMMETER

Available for measuring resistances to 10 million megohms.



Model 2851 Vibrotest portable megohmmeter measures resistances as great as 10 million megohms at 500 vdc, or 2 million at 100v. Its 100v. test potential complies with the new EIA standard for measurement of composition, film and wirewound resistors having resistances over 100KΩ. The range may be multiplied by 1, 10, 10^2, 10^3, 10^4, and 10^5 by means of a rotary selector switch. Six megohm ranges are available at either 500vdc (±5v.) or at 100vdc (±5v.). Accuracy of ±2% is achieved over the greater portion of the scale range when used at 500v.; at 100v., accuracy is within ±5% over most of scale. Associated Research, Inc., 3777 W. Belmont Ave., Chicago, Ill. 60618.

Circle 257 on Inquiry Card

"Microwave Energy Sources"

By T. Moreno
V.P., Tube Div.
Varian Associates

MODERN RADAR SYSTEMS that utilize sophisticated pulsing techniques have forced the development of high-power, wide band amplifiers with good phase linearity. Modern crossed-field amplifiers and hybrid klystron-TWT amplifiers deliver high peak and average powers over greater than 10% bandwidths. Further technological progress in this area can be anticipated.

Requirements of forward scatter and satellite communications systems have led to notable progress in sophisticated, high-power, continuous wave microwave transmitters. A new generation of sophisticated, high-power klystrons has been evolved for these requirements. The satellite systems have also led to the development of ultra-reliable traveling-wave tubes that are carried in the satellites themselves.

There is currently much government-sponsored development activity in the area of sophisticated broadband TWT's for electronic countermeasures. It is evident that a great need is felt for higher-performance systems in this area, and as a result, much government funding has been concentrated in advancing the state-of-the-art.

In the low-power area, significant inroads have been made by solid-state sources into an area once monopolized by vacuum tubes. Microwave transistors have begun to appear, coupled with multipliers using varactors and step-recovery diodes, they provide energy for a variety of new applications. In the future, bulk effect semiconductor devices, such as Gunn-effect oscillators and Reed diodes, can be expected to receive much attention, and great improvements in performance will almost certainly be achieved.

Microwave Semiconductor Devices

By Dr. Arthur Uhlir, Jr.
V.P., Manager, Semiconductor Div.
Microwave Associates, Inc.

HIGHER-POWER HIGH-FREQUENCY TRANSISTORS serve as attractive sources in their own right up to 2 GHz and have moved the fundamental oscillator (or power amplifier) for many transistor-varactor sources to the 500-1000 MHz range. One watt of cw power at 12GHz will become reproducible and relatively economical. Packaging of plural varactor elements for convenient use will be a significant advance. Series and parallel connections will merely increase power capability, while push-pull and bridge circuits will also improve electrical stability and bandwidth.

Increasing reliability in packaged PIN diodes for microwave switching will be paralleled by availability of reliable PIN chips for hybrid micro-electronic circuits.

No new receiving mixer designs up to 5 GHz should be undertaken without consideration of Schottky-barrier mixer diodes which will have reproducibility far improved over earlier experimental types. For X- to K-band, point-contact devices made with fused-glass pin beads and epitaxial silicon represent the first point contact diodes to be made in a package with good thermal expansion match.

Looking more than one year ahead, one can be sure that basic circuits such as balanced mixers will be integrated. Also, new methods of microwave generation may find practical application. Avalanche oscillators are already available for experimental evaluation, largely because of the reproducibility inherent in silicon devices at the present time. On a laboratory basis, however, gallium arsenide Gunn effect devices are capable of more efficiency: 5% versus 0.1%.

"Microwave Tubes"

By: Thomas D. Sege
General Manager
EIMAC, A Division of Varian Associates

THE STATE-OF-THE-ART IN MICROWAVE ELECTRON TUBES was for a long period the limiting factor in weapons system design. Today, systems may include a mixture of tubes and semiconductor devices, or may even include no electron tubes.

Faced with prospects of diminished business from the military, the industry responded with a surge of manufacturing economies and increased product reliability. These resulted from the rapid maturation of techniques throughout the industry's technologies: dry pumping with its singularly beneficial effect on tube life is one example.

Startling new products, such as the traveling wave tube are now unlikely. Rather, one can expect a strengthening of the trend toward refinement and control which has already brought some tube processes to the point where computerized design programs can be used with confidence.

The industry is entering other sectors of the economy. After serving almost entirely within that most elegant of electronic regimes—communications—microwave is moving out of the parlor into the kitchen to cook and bake, and into the industrial plant for the controlled and efficient heating and drying of a vast range of materials.

The microwave techniques of the youngest element of the tube industry are being absorbed by the eldest. Planar gridded triodes operating at ever increasing frequency and power levels have characterized this trend to date.

Generally within the industry, design problems are no longer approached with an air of mixed excitement and apprehension but rather with confidence in anticipation of accomplishment.

 (Continued from page 163)

"Solid State At Microwave Frequencies"

By H. K. Jenny

Manager, Advanced Development Engineering
Microwave and Power Devices,
Electronic Components and Devices,
Radio Corporation of America

RAPID ADVANCES IN THE MICROWAVE SOLID-STATE art are heralding unprecedented progress for the users of microwave frequencies. The key words are simplicity, reliability, and economy, since microwave applications have to date been very much limited by the high cost per operating hour.

Solid-state devices are rapidly moving into power-oscillator and amplifier applications. Today, cw powers exceeding 100 watts at UHF, 5 watts at S band, and 1 watt at X band have been demonstrated in integral subsystems. Within the next two years, these levels will increase by more than an order of magnitude.

Integrated solid-state microwave circuits which combine to perform two or more functions such as oscillation, conversion, amplification, detection, switching, limiting, and phase shifting are starting to evolve as the building blocks of tomorrow's sky-rocketing utilization of the huge microwave frequency spectrum.

A sobering thought should, however, be added. Paradoxically, technology is advancing at such a rapid pace that designs never fully realize their production potential. The circle is completed by some equipment designers who, all too often, ask for the exotic rather than for proven production hardware. This circle tends to keep the volume of a given device down and its cost up. On the other hand, many agree that a system can be more effective in terms of cost and performance if it is planned around available hardware rather than the exotic.

"Military Radar"

By Leonard Swern

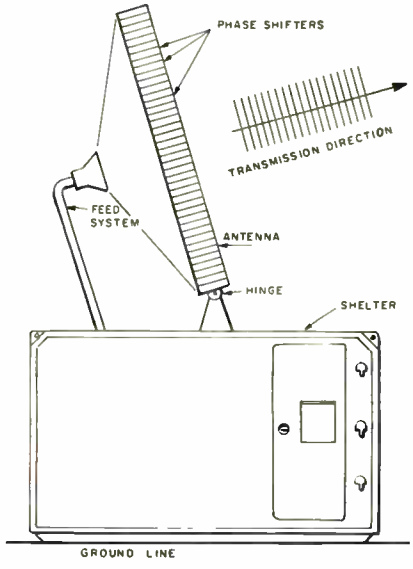
Sperry Gyroscope Company,
Division of Sperry Rand Corporation,
Great Neck, N. Y.

ONE OF THE MOST SIGNIFICANT DEVELOPMENTS for radar designers is the portable, electronically scanned radar. While radar systems which scan with no moving parts are not new, those that were built in the past were very large, heavy and narrow band. Now, with the advent of the compact, low-loss, digital microwave phase shifter, it is possible to design completely passive antennas containing no power sources; and these antennas are therefore lightweight, stowable, and relatively inexpensive. Such an antenna (Fig. 1) is space fed with microwave energy from a single source. The only electrical contacts to it are the drive wires for activating the phase shifters. It may easily be hinged for air transport, and can be quickly erected at any spot. The phase shifters are short sections of waveguide or strip transmission line containing either square-loop microwave ferrites, or semiconductor variable-capacitance diodes.

. . . The continuing advances in solid state components—in microelectronics in general—enable the system designer to greatly increase radar reliability. Airborne and spaceborne radars can now be designed which contain no vacuum tubes, except the CRT display. Even the source of microwave energy is a semiconductor device which has, essentially, an indefinite lifetime. The conventional low frequency portions of the radar consist of monolithic microcircuits; and the small number of interconnections between these integrated circuits is probably the major remaining source of potential failures in the system. More and more circuit functions are being integrated in a single wafer of semiconductor, and the attendant reductions in size and weight are a bonus to the increased reliability just discussed. It is important to note that the compactness which solid state techniques permit in these air and spaceborne radars allows much more sophisticated characteristics to be built into systems. We now have multi-function airborne systems containing the kind of elaborate signal processing capabilities that were formerly possible only in large ground installations. Although the advances in airborne systems are most dramatic, ground and ship-based radars have also benefited, of course, from the reliability and compactness of solid state and microcircuit technology.

Signal processing in present day radars has given them many of the characteristics of modern communication systems. Because of space limitations, we cannot give an adequate description of pulse coded systems containing adaptive features which fit them optimally both to the environment and to the threat. It is important to note though, that a very sophisticated radar technology has been built up in recent years which draws heavily on information theory and digital logic. The results of all this ferment are becoming visible now on radar sites all over the earth, and in space as well.

Phase shifter antenna design is lightweight, stowable and relatively inexpensive.



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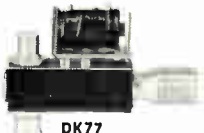

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AUTEC ELECTRONIC SYSTEMS NOW BEING INSTALLED

Implementation of electronic systems is in process for the weapons range facility of the U. S. Navy's Atlantic Undersea Test and Evaluation Center (AUTEC), according to ITT Corp. ITT Federal Laboratories, domestic research and manufacturing division, is prime contractor for the AUTEC weapons range facility in the British Bahamas.

AUTEC, the world's most advanced undersea antisubmarine warfare (ASW) weapons testing facility, will have underwater tracking instrumentation located 10 miles off the east coast of Andros Island, about 130 miles southeast of Miami.

The sea is more than a mile deep at that point, due to a valley-like underwater depression. This ravine is about 100 miles long and 20 miles wide. The site was selected because it is one of the few deep-water locations that provides a relatively quiet, controlled sea environment that is close to land.

The weapons range will be 35 miles long and 5 miles wide, with an impact area 6,000 yards in diameter at its southern end. Underwater instrumentation will enable the Navy to accurately evaluate the performance of advanced weapons whose trajectories pass through both air and water, as well as advanced torpedoes.

An underwater communications system will be installed to permit voice contact between submarines and shore facilities during test operations.

Underwater hydrophone arrays in the weapons testing area will permit tracking of submerged weapons with an accuracy greater than that obtainable by radar tracking of airborne targets.

P-C BOARD PRESS

A 30-ton laminating press, recently featured at NEP/CON '65, has all features needed for semi-automatic production of multilayer printed circuit boards, according to Pasadena Hydraulics, Inc. Platens have a total usable working area of 163 square inches. Press will develop maximum material pressure of 370 P.S.I. and will control accurately down to 12 P.S.I. Pressure control accuracy is ±1.2 P.S.I. over the working area during heating and cooling cycle.

ELECTRONIC INDUSTRIES

Advertisers — November 1965

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A computer controlled telemetry ground station is being designed for NASA Marshall Space Flight Center by Defense Electronics, Inc. All telemetry parameters will be selected and controlled by a general-purpose digital computer.

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One feature of the system is a VHF/UHF Receiver Subsystem, consisting of eight DEI Model CR-101 Computer-Controlled Receivers. The computer can turn the equipment on or off and select any of 16 crystal-controlled carriers in VHF or UHF.

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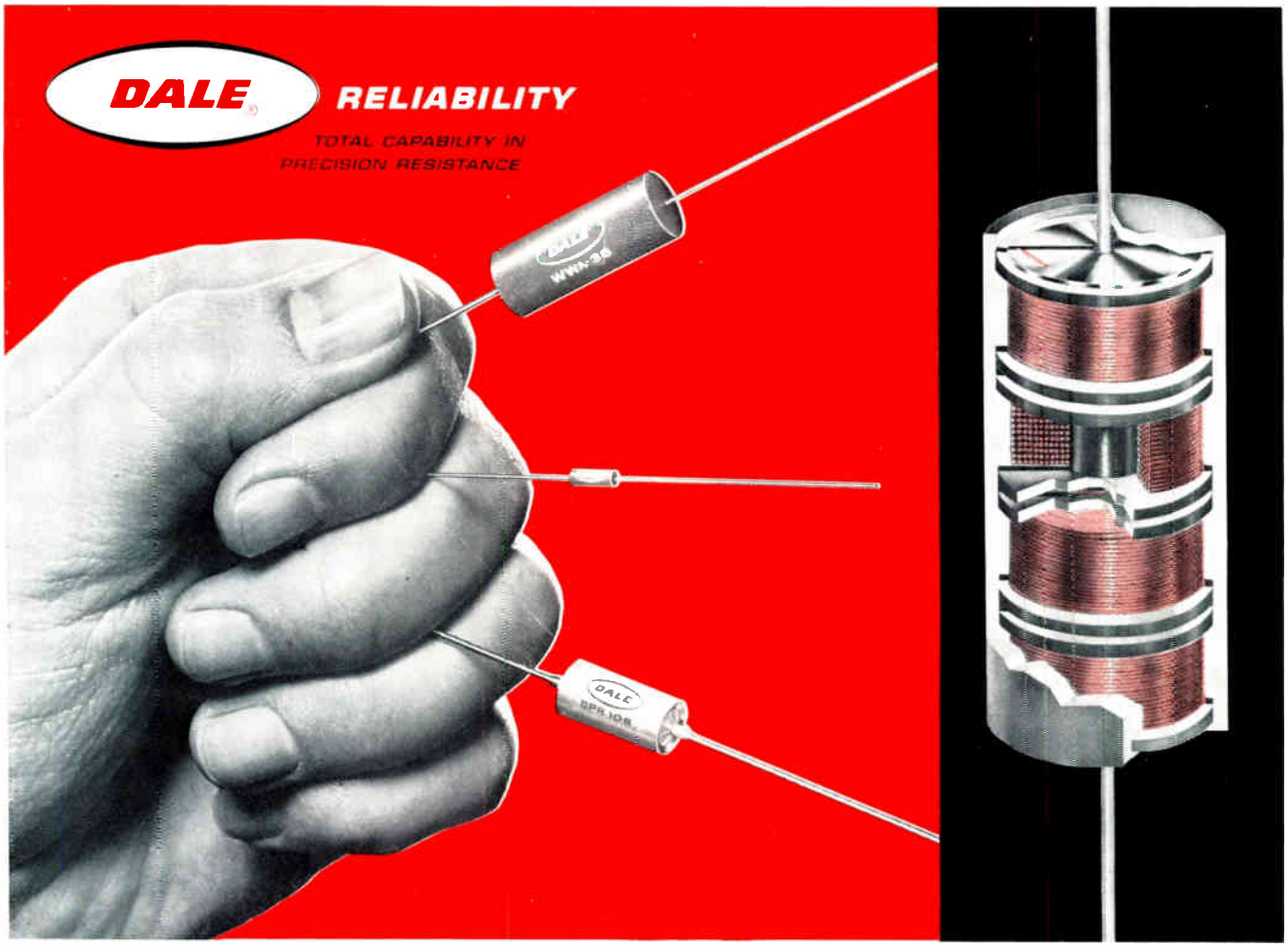
The Proprietor of British Patent No. 830,736 for "An improved Magnetic Recording and Reproducing method and an apparatus for Carrying out such method," is desirous of entering into negotiations for the sale of the Patent, or for the grant of a license thereunder. Communications should be addressed to Page, White & Farrer, 27, Chancery Lane, London, W.C.2.



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MWA-10	–	.125	1 ohm – 125K ohms	.312 x .078
WWA-13	–	.125	1 ohm – 300K ohms	.375 x .125
WWA-22	–	.15	.1 ohm – 350K ohms	.250 x .250
WWA-23	RB-56	.15	.1 ohm – 600K ohms	.375 x .250
WWA-24	RB-55	.20	.1 ohm – 800K ohms	.500 x .250
WWA-26	RB-54	.25	.1 ohm – 1 Megohm	.750 x .250
WWA-36	RB-53	.33	.1 ohm – 3 Megohms	.750 x .375
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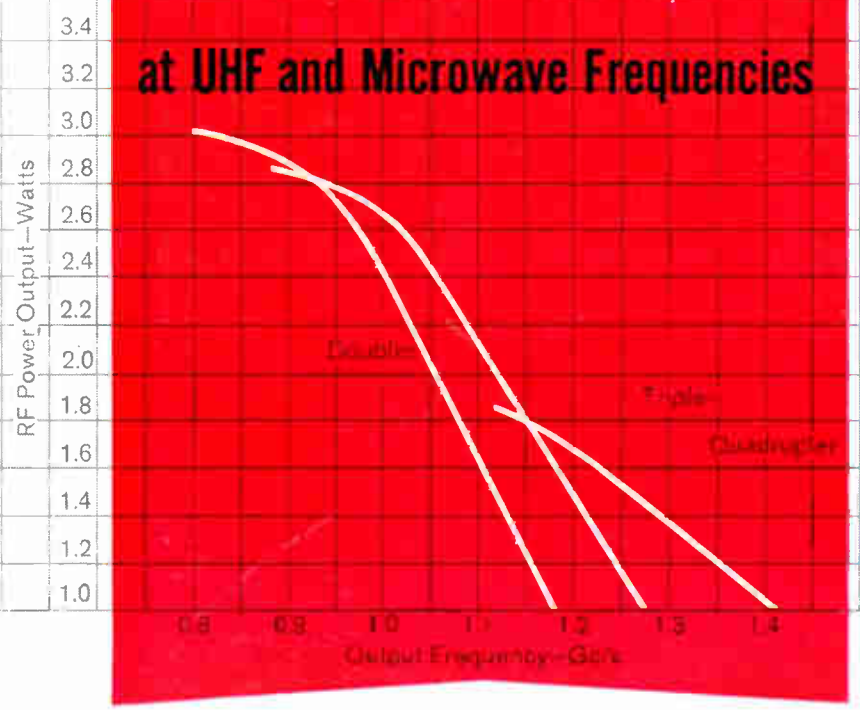

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Output Power	3 (typ)	2.5 (min)	Watts
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